

CHAPMAN & HALL/CRC FINANCE

Handbook of Solvency for Actuaries and Risk Managers Theory and Practice

Arne Sandström



CRC Press
Taylor & Francis Group

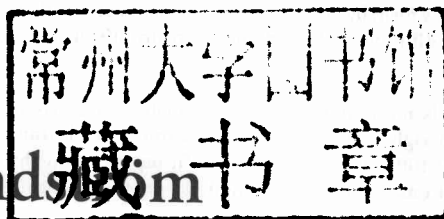
A CHAPMAN & HALL BOOK

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Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an informa business

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Chapman & Hall/CRC
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

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Printed in the United States of America on acid-free paper
10 9 8 7 6 5 4 3 2 1

International Standard Book Number: 978-1-4398-2130-5 (Hardback)

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Library of Congress Cataloging-in-Publication Data

Sandström, Arne.

Handbook of solvency for actuaries and risk managers : theory and practice / Arne Sandström.
p. cm. -- (Chapman & Hall/CRC finance series)

Includes bibliographical references and index.

ISBN 978-1-4398-2130-5 (hbk. : alk. paper)

1. Risk (Insurance) 2. Risk (Insurance)--European Union countries. 3. Asset-liability management.
4. Asset-liability management--European Union countries. 5. Risk management. 6. Risk
management--European Union countries. I. Title.

HG8054.5.S26 2011

368.001--dc22

2010042931

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and the CRC Press Web site at
<http://www.crcpress.com>

Preface

WHEN I FINALIZED my first book on solvency in 2005,* I felt that it was not enough. The book, which in many ways was written as an egoistic action—I needed a platform to stand on in the work on solvency and especially on the European Solvency II project—was published during a period when the solvency discussion was intense, both within the European Union and worldwide. In this, my new book, I want to write about the things it lacked. For example, I wanted a stringent and clear definition of solvency. I also thought that the historical review could be made broader and that the theory behind the calculation of the capital requirement could be made more comprehensive.

The goal of this handbook on solvency, and especially on the European Solvency II project, is to be just a *handbook*. The focus has been on the *valuation of assets and liabilities* and *calculation of capital requirement*, and also on the *calculation of the standard formula* within the European Solvency II project.

While I was planning a short course on solvency in Brussels in February 2009 I felt a need to include the development and calibration of the different submodules for the standard formula in my book. This after my friend Professor Jan Dhaene, KU Leuven, had asked me to include that in my solvency course.

The handbook does not include any main discussion on (partial) internal models as that would be the subject for another book. The main audience is professional actuaries and risk managers. I hope that it can be used in the education of actuaries and risk managers, at least as a start and as a handbook.

I am grateful to many friends and colleagues for their valuable comments on different parts of the book. I especially thank Peter ter Berg, Yvette Chrissantonis, Jan Dhaene, Boualem Djehiche, Valérie Kupferman, Mariano Selvaggi, and Mario Wüthrich. I also thank my present and former colleagues Ellen Bramness Arvidsson, Karin Chenon, Lena Friman-Blomgren, Jimmy Hollén, Christian Salmeron, Ellinor Samuelsson, and Patric Thomsson for their valuable comments.

* *Solvency. Models, Assessment and Regulation*. Chapman & Hall, Boca Raton, FL. ISBN: 1-58488-554-8.

Reader's Guide

THE HANDBOOK CAN BE divided into two main sections:

- General ideas about solvency (Parts A, B, and C)
- The European Solvency II project (Parts D, E, and F)

The first section discusses the solvency concept, the historical development, and its place as a part in an enterprise risk management approach. Further, there is a more general discussion on valuation, investment, and own-capital together with modeling and measuring. The last part, Part C, discusses dependence, risk measures, and capital requirements. Subrisks and aggregation are also important parts. The main risks—market, credit, operational, liquidity, and underwriting risks—are discussed in general terms.

The second section, devoted to the European Solvency II project, starts with its general ideas, valuation, investments, and own-funds (Part D). The second part of this section, Part E, is devoted to the standard formula framework. These two parts are based on CEIOPS' final advice. All calibrations done earlier in different quantitative impact studies (QIS), together with the political progress of the project, are given in the appendices (Part F).

The following table shows the structure of the book.

		European Solvency II	
	General Solvency Issues	CEIOPS' Final Advice	Background and Calibration
General solvency and risk management issues	Part A Chapters 1 through 5		
Solvency II—general	Section 2.3	Part D Chapter 22	Part F Appendices C+D+E
Valuation and investment	Part B Chapters 6 through 11	Part D Chapters 23 through 25	Part F Appendices F+G
Modeling and measuring → Capital requirements	Part C Chapters 12 through 21	Part E Chapters 26 through 34	Part F Appendices H–P
	Part F Appendices A+B		

Web Site Information

FOR THE GENERAL PART of the book and for general discussions on solvency and accounting I would like to recommend the following Web sites:

IAIS—International Association of Insurance Supervisors:

<http://www.iaisweb.org/>

IAA—International Actuarial Association:

<http://www.actuaries.org>

BIS—Bank for International Settlements:

<http://www.bis.org>

IASB—International Accounting Standards Board:

<http://www.iasb.org>

For the Solvency II part of the handbook I have mainly used different sources that can be found on the Internet, such as documents from the European Commission, EIOPC, and CEIOPS. Their Web sites are

European Commission & EIOPC—European Insurance and Occupational Pensions Committee:

http://ec.europa.eu/internal_market/insurance/index_en.htm

CEIOPS—Committee of European Insurance and Occupational Pensions Supervisors:

<http://www.ceiops.org>

There are also other Web sites that the interested reader can visit:

CEA—The European Insurance and Reinsurance Federation:

<http://www.cea.eu>

CRO Forum—Chief Risk Officers:

<http://www.croforum.org>

CFO Forum—European Insurance Chief Financial Officers:

<http://www.cfoforum.nl>

AMICE—Association of Mutual Insurers and Insurance Cooperatives in Europe:

<http://www.amice-eu.org>

GC—Groupe Consultatif Actuariel Europeen:

<http://www.gcactuaries.org>

Future Information

MY INTENTION WAS TO include CEIOPS' proposal for final advice that was published on mid-November 2009 and at the end of January 2010.

The final advice that will be adopted by the European Commission and accepted by the European Parliament is not included. Level 3 measures, such as standards and guidance, are also not included.

However, I will update any important information regarding the Solvency II development and my book, on my Web site, www.SolvencyII.nu.

Any misprints and corrections of the book will also be published on my Web site.

Arne Sandström
www.SolvencyII.nu

Abbreviations

3L3	Three Level 3 Committees, that is, CEBS, CEIOPS, and CESR
A	Assets
AAA	American Academy of Actuaries, United States
AB	Annualized amount of benefits (Solvency II)
ABI	Association of British Insurers, United Kingdom.
ABS	Asset backed securities
ac	Index for epidemic/accumulation risk (Solvency II)
ACAM	L'Autorité de Contrôle des Assurances et des Mutuelles (the French Supervisory Authority for mutuals)
AccY	Accounting year
ACME	The Association of European Cooperative and Mutual Insurers (now AMICE)
Adj	Adjustment for risk-absorbing effect (Solvency II)
AE	Actual expenses
Af	Average annuity factor (Solvency II)
AFIR	Actuarial Approach for Financial Risks; AFIR was founded in 1986 as a Section of the International Actuarial Association (IAA)
AGOF	Available group own funds
AIE	Actual inheritance earnings
AISAM	The International Association of Mutual Insurance Companies (now AMICE)
A/L	Asset–Liability (matching)
ALM	Asset–Liability Management
AMA	Advanced Measurement Approaches
AMCR	Absolute minimum capital requirement (Solvency II)
AMICE	The Association of Mutual Insurers and Insurance Cooperatives in Europe
AN	Index for annuities, together with WC (Solvency II)
AO	Index for accident and others insurance risk (Solvency II)
AOF	Ancillary own funds
AP	Published assets (usually book values)

APRA	Australian Prudential Regulation Authority
APT	Arbitrage Pricing Theory
AR	Autoregressive Annual replenishment requirement for current annuity table Index for epidemic/accumulation risk (Solvency II)
ARCH	Autoregressive Conditional Heteroskedasticity
ARM	Asset risk margin
ARP	The Argentine peso
ART	Alternative risk transfer (considered as a type of reinsurance)
ASB	Actuarial Standards Board, United States
ASM	Available solvency margin (own funds under Solvency II; (regulatory) available capital to cover capital requirements)
ASRF	Asymptotic single-risk factor (model)
ASTIN	Actuarial STudies In Nonlife insurance; ASTIN was created in 1957 as the first section of the International Actuarial Association (IAA)
ATM	Index for Accumulation/trend/modification risks
AUD	The Australian dollar
AY	Accident year
bbl	Barrels
BE	Best estimate
BIA	Basic Indicator Approach (Basel II method for credit risk)
BIPIT	Bivariate probability integral transformation
BIS	Bank for International Settlements, Basel, Switzerland
BK	Black–Karasinski (model)
BOF	Basic own funds
BS	Balance sheet
BSCR	Basic solvency capital requirement (Basic SCR)
C	Capital requirement Corporate bond Document-classification within EU: Documents relating to official instruments for which the Commission has sole responsibility. Some are transmitted to the Council or Parliament for information
CAPM	Capital–Asset Pricing Model
CaR	Capital at risk
CAS	Casualty of Actuarial Society
CAT/Cat	Catastrophe (risk) Index for Cat-risk capital charge (Solvency II)
CBNI	Covered but not incurred
CCI	The comprehensive industrial concentration index
CCR	Current capital-at-risk
cd	Credit derivative
cdf	Cumulative distribution function
CDR	Claims development result
CDS	Credit Default Swaps

CE	Current estimate Claims expenditure (Solvency II)
CEA	“Comité Européen des Assurances.” The CEA is the European insurance and reinsurance federation Current estimate of assets
CEBS	Committee of European Banking Supervisors
CEL	Current estimate of liabilities
CEO	Chief Executive Officer
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
CESR	Committee of European Securities Regulators
CET	Central European Time (Greenwich + 1 hour)
CF	Cash flow
CfA	Call for Advice (i.e., calls by the European Commission for CEIOPS’ comments on certain aspects of Solvency II. The calls have been grouped in three waves.)
CFO	Chief financial officers
CFT	Cash-flow testing
CHF	The Swiss Franc
CI	Concentration index
CIA	Canadian Institute of Actuaries
CIR	Cox–Ingersoll–Ross (interest rate model)
CLN	Credit-linked notes
CLRM	Complementary loss ratio method
CO	Index for concentration risk (Solvency II)
CoC	Cost-of-capital (rate)
CoCM	Cost-of-capital margin
COM	(European) Commission (Services) Document classification within EU: Proposed legislation and other Commission communications to the Council and/or the other institutions, and their preparatory papers. Commission documents for the other institutions (legislative proposals, communications, reports, etc.).
COMP	DG COMP: EC’s DG for Competition (European Commission) COMP Council (European Council)
COMPASS	Task force of CEIOPS
Contr	Contribution
Coreper	Committee of permanent representatives meeting (Comité des représentants permanents)
Coreper I	Consisting of the deputy head
Coreper II	Consisting of the heads, that is, the “EU Ambassadors”
COSO	Commission of Sponsoring Organizations (of the Treadway Commission)
CP	Consultation paper Concentration penalty
CPI	Consumer Prize Index

CR	Capital requirement
	Capital resources
	Index for credit risk (Solvency II)
	Index for currency risk, together with MR (Solvency II)
	Combined ratio
CRA	Credit Rating Agencies
CRC	Current capital requirement
CRD	Capital Requirements Directive (within EU; Basel II implementation)
CRO	Chief Risk Officer
CS	Credit spread
CSE	Credit spread equivalent (Solvency II)
CSFB	Credit Suisse First Boston (bank)
CSR	Credit spread risk
CSWG	Commission Solvency Working Group (within EU)
CTE	Conditional tail expectation
CTP	Current technical/mathematical provisions
CVaR	Conditional Value-at-Risk
CWG	Council Working Group (European Council)
CY	Current year
D&O	Directors and officers
DB	Deutsche Bundesbank
DCAT	Dynamic capital adequacy testing
DD	Distance to default
DDM	Dividend Discount Model
DFA	Dynamic financial analysis (a simulation technique based on integrated modeling to analyze the overall financial and risk situation of an insurance company over a given time period, thus supporting integrated corporate control taking account of all risk factors)
DFAC	Dynamic financial analysis committee, CAS U.S.
DG	Directorate General (within the European Commission)
DI	<i>Dagens Industri</i> , Swedish daily financial paper
DKK	The Danish krona
DP	Discussion Paper
dpf	Discretionary participating features
DPT	Default point
DR	Index for default risk (Solvency II)
	Index for disability risk together with LR (Solvency II)
DRMC	Dynamic Risk Modeling Committee, CAS U.S.
DSD	Deeply subordinated debt
DSOP	Draft Statement of Principles
DST	Dynamic solvency testing
DT	Index for deferred taxes (Solvency II)

Dur	Duration
DUS	Dödlighetsundersökning, Swedish insurance mortality study
DY	Development year
E&O	Events and occasions
E	Expenses (Solvency II)
EAD	Exposure at default
Earn	Earned premiums (Solvency II)
EBA	European Banking Authority
EC	European Commission
ECB	European Central Bank
ECFIN	DG ECFIN: EC's DG for Economic and Financial Affairs (European Commission)
ECOFIN	Economic and Financial Affairs Council (European Council of Finance Ministers)
ECON	Economic and Monetary Affairs Committee (European Parliament)
ED	Exposure Draft
EDF	Expected default frequency
EDHEC	École De Hautes Études Commerciales du Nord is a French business school founded in 1906
EEA	European Economic Area
EEC	European Economic Community
EEK	The Estonian kroon
EEV	European Embedded Value
EH	Expected health risk capital charge (Solvency II)
EIOPA	European Insurance and Occupational Pensions Authority
EIOPC	European Insurance and Occupational Pensions Committee
EL	Expected loss
EMPL	Employment and Social Affairs Committee (European Parliament) DG EMPL: EC's DG for Employment, Social Affairs and Equal Opportunities (European Commission) EMPL Council (European Council)
ENTR	DG ENTR: EC's DG for Enterprise and Industry (European Commission)
EP	European Parliament Earned premiums (Solvency II)
EPD	Expected policyholder deficit
EQ	Equity
EQU	Market value of overall equity and UCITS exposure (Solvency II)
ER	Index for equity risk, together with MR (Solvency II) Index for endowment risk Index for expense risk, together with LR or HR (Solvency II)
ERM	Enterprise risk management
ERM-II	Enterprise Risk Management Institute International, United States

ERM II	Exchange Rate Mechanism II
ES	Expected shortfall
ESA	European Standard Approach
ESFS	European System of Financial Supervisors
ESMA	European Securities and Markets Authority
ESRB	European Systemic Risk Board
ESRC	European Systemic Risk Council, now changed for ESRB
EU	European Union
EVC	Extreme-Value Copulas
EVT	Extreme-Value Theory
EWS	Early-Warning System
Ex	Index for expense risk (Solvency II)
exp	Index for health expense risk (Solvency II)
Exp	Expense risk capital charge (Solvency II)
F	Failure (index)
FA	Final Advice
FASB	Financial Accounting Standard Board, United States
FAST	Financial Analysis Solvency Tools, used by NAIC, United States (old FAST) Financial Analysis and Surveillance Tracking, used by NAIC, United States
FC	Fixed cost risk
FCD	Financial Conglomerate Directive
FD	Framework Directive
FDB	Future discretionary benefits
FfC	Framework for Consultation
FFSA	Fédération Française des Sociétés d'Assurance (the French Insurers Association)
FI	Financial instruments Market value of fixed income assets (Solvency II)
FIN-USE	Forum of User Experts in the Area of Financial Services (set up by the European Commission in 2004)
FinReq	Financial Requirements Expert Group, CEIOPS
FQR	Financial quota share reinsurance
FR	France
FSA	Financial Services Authority, United Kingdom
FTK	Financial Assessment Framework, the Netherlands
FX	Index for Foreign Exchange (risk)
g	gross, is used as gCR, gKC, and so on (Solvency II)
GA	Granularity adjustment
GAAP	Generally Accepted Accounting Principles
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GBP	The British sterling
GC	Groupe Consultatif Actuariel Européen (association of European actuaries) General Collateral
GCM	Grand correlation matrix (Grand dependence matrix)

GD	Generalized duration
GDV	Gesamtverband der Deutschen Versicherungswirtschaft e. V. (German Insurance Association)
GE	Index for General premium and reserve risk, together with WC (Solvency II)
gen	Generalized
GER	Germany
GISG	General Insurance Study Group, United Kingdom
GMAD	Generalized mean-absolute deviation
GNAIE	Group of North American Insurance Enterprises
GOF	Group (total) own funds
GP	Gross premium
GPD	Generalized Pareto distribution
gr	Gross
GR	Gross reserves
GSCR	Group SCR
GSV	Guaranteed Surrender Value
GWP	Gross written premiums
H	Also used for HHI Health risk capital charge (Solvency II)
H5N1	Virus (“the flu virus”)
HGP	Total health gross premium (Solvency II)
HHI	The Herfindahl–Hirschman index
HJM	Heath–Jarrow–Morton (interest rate model)
HKI	The Hannah–Key index
h.o.t.	Higher-order terms
HR	Index for health risk capital charge (Solvency II)
HRT	Heavy Right Tail
HTI	Hall–Tideman index
IA	Impact Assessment
IAA	International Actuarial Association
IAD	Insurance Accounting Directive (with EU)
IAIS	International Association of Insurance Supervisors
IAS	International Accounting Standards
IASB	International Accounting Standards Board
IASC	International Accounting Standards Committee
IBNER	Incurred but not enough reported
IBNR	Incurred but not reported
IBNS	Incurred but not settled
IC	Insurance Committee
ICAS	Individual Capital Adequacy Standards, United Kingdom
ICMS	Individual company market share (GDV model)
IF	Income factor (GDV model)
IFRS	International Financial Reporting Standards
IGD	Insurance Group Directive

IGT	Intragroup Transactions
i.i.d.	Independent and identically distributed
IL	Illiquid liabilities
	Incurred losses (Solvency II)
ILS	Insurance-linked securities
ILW	Industry Loss Warranties
IM	Internal Model
IORP	Institutions for Occupational Retirement Provisions
IPD	Investment Property Databank
IR	Index for interest rate risk (Solvency II)
IRB	Internal rating-based (Basel II method for credit risk)
IRIS	Insurance Regulation Information System (used by NAIC, United States)
IRTS	Interest rate term structure (risk-free)
ISG	Indicators Subgroup of the Social Protection Committee, Employment and Social Affairs DG (within European Commission)
	Interservice Steering Group
IT	Income bearer (GDV model)
	Individuated t -copula
	Information Technology
IV	Intrinsic Value
IWG	Insurance Working Group (European Council)
JLS	DG JLS: EC's DG for Justice, Freedom, and Security (European Commission)
JPY	The Japanese yen
JTF	Joint Task Force (for European supervisory committees)
JURI	Legal Affairs Committee (European Parliament)
KB	Kickback risk
KC	The KC-factor gives risk mitigating effect due to future profit sharing in the capital charge (Solvency II)
KMV	Kealhofer, McQuown, and Vasicek (founded the KMV model)
KR	Kickback risk
L	Liabilities
LA	Liquid assets
	Index for lapse risk (Solvency II)
La	Index for lapse risk (Solvency II)
LCR	Liquidity coverage ratio
LDI	Liability-driven investments
LG	Liquidity gap
LGD	Loss-given default
Liab	Liability
LIBOR	The London Interbank Offered Rate
LL	Liquid liabilities
LO	Index for longevity risk (Solvency II)
LOB/LoB	Line of business
Long	Longevity

LP	Published liabilities
LPM	Lower partial moments
LPT	Loss portfolio transfer
LR	Loss ratio
	Index for life risk capital charge (Solvency II)
LRM	Liability risk margin
LSAD	Lower semi-absolute deviation
LT	Index for long-term health risk (Solvency II)
LTL	The Lithuanian litas
LUR	Life underwriting risk
LWG	London Working Group (also Sharma WG)
MARKT	DG MARKT: EC's DG for Internal market and services (European Commission)
MA	Hidden reserves on the asset side of the balance sheet
MAD	Mean-absolute deviation
MAT	Marine–Aviation–Transport
MCCSR	Minimum Continuing Capital and Surplus Requirement (Canada)
MCR	Minimum capital requirement
MEL	Mean excess loss
MEP	Member of the European Parliament
MGF	Minimum guarantee fund (Solvency I and II)
ML	Implicit margin of the published liabilities
	Market loss
	Maximum likelihood
MMP	Multiyear/multiline products
MO	Index for morbidity risk capital charge (Solvency II)
mod	Modified (duration)
MoU	Memorandum of Understanding
Morb	Morbidity
Mort	Mortality
MP	Mathematical provisions
MR	Index for market risk (Solvency II)
	Index for mortality risk, together with LR (Solvency II)
	Index for excessive loss/mortality/cancellation risk together with HR (Solvency II)
	Index for claims/mortality risk, together with LT (Solvency II)
MS	Market share
MSCI	Formerly Morgan Stanley Capital International Inc.
MTP	Multitrigger products
MSE	Mean square error
MV	Market value
MVA	Market value of assets
MVL	Market value of liabilities
MVM	Market value margin