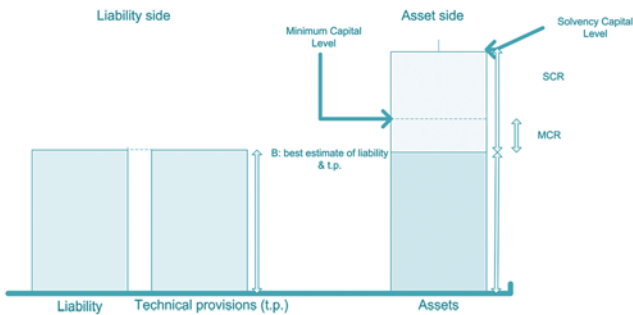


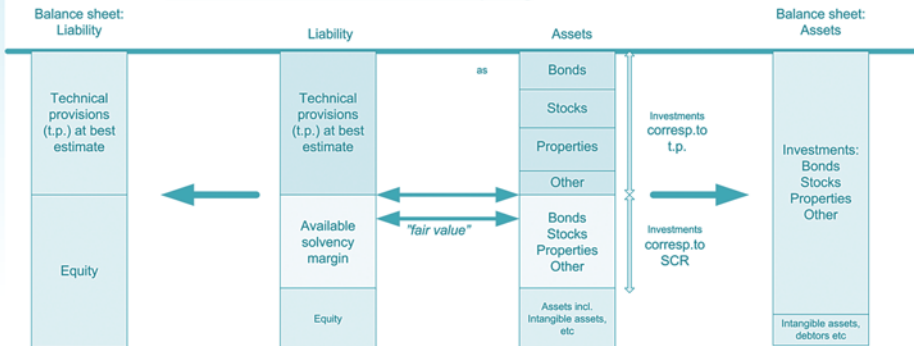
# Solvency

## Models, Assessment and Regulation

### SOLVENCY ASSESSMENT – Supervisory process



### ACCOUNTING ASSESSMENT – Financial reporting



Arne Sandström



Chapman & Hall/CRC  
Taylor & Francis Group

# Solvency



Models, Assessment and Regulation



# Solvency

Models, Assessment and Regulation

Arne Sandström

Swedish Insurance Federation  
Stockholm



Chapman & Hall/CRC

Taylor & Francis Group

Boca Raton London New York

Published in 2006 by  
Chapman & Hall/CRC  
Taylor & Francis Group  
6000 Broken Sound Parkway NW, Suite 300  
Boca Raton, FL 33487-2742

© 2006 by Taylor & Francis Group, LLC  
Chapman & Hall/CRC is an imprint of Taylor & Francis Group

No claim to original U.S. Government works  
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-10: 1-58488-554-8 (Hardcover)  
International Standard Book Number-13: 978-1-58488-554-2 (Hardcover)  
Library of Congress Card Number 2005048465

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the author and the publisher cannot assume responsibility for the validity of all materials or for the consequences of their use.

No part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access [www.copyright.com](http://www.copyright.com) (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC) 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

**Trademark Notice:** Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

---

### Library of Congress Cataloging-in-Publication Data

---

Sandström, Arne.

Solvency : models, assessment and regulation / by Arne Sandström.

p. cm.

Includes bibliographical references and index.

ISBN 1-58488-554-8

1. Finance--European Union countries. 2. Insurance companies--European Union countries--Finance. I. Title.

HG186.A2S26 2005

658.15'094--dc22

2005048465

---



Taylor & Francis Group  
is the Academic Division of T&F Informa plc.

Visit the Taylor & Francis Web site at  
<http://www.taylorandfrancis.com>

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

---

## *Preface*

---

As a member of the Comité Européen des Assurances's (CEA) solvency working group, I received a number of working papers written by the former chairman of the working group, Jukka Rantala. At the same time, early 2003, the International Actuarial Association's (IAA) working group on solvency assessment produced a draft report. During the summer that year, I tried to write a common theory as a platform for my own further work. Later that summer and during the autumn, I tried to formalize some of the risk categories proposed in different papers (IAA and CEA). An actuary, who had read one of my early drafts, told me that he had never before read anything as concrete as this on solvency. His remarks encouraged me to continue writing.

Having read paper after paper on solvency assessment, I realized that no summaries or reviews had been published of the solvency work done in Europe. For this reason, and because the EU Solvency II project was one of the hottest topics for the European insurance industry, I decided to write this book.

Writing on this topic could easily have resulted in a 10-volume encyclopedia. My aim, however, was to fill the gap I mentioned above and to provide inspiration for further work.

It is my hope that the reviews of work in different countries and the smorgasbord of ideas will help to provide this inspiration.

Proposals and opinions stated in this book are mine and do not necessarily reflect the ideas of my employer (Swedish Insurance Federation) or of any committee or working group of which I am a member.

I am grateful to many friends and colleagues for their valuable comments on earlier drafts. Especially, I thank Jukka Rantala, who encouraged me to finish this book. I also thank Erik Alm, Nigel Boik, Ellen Bramness Arvidsson, Allan Brender, Malcolm Campbell, Boualem Djehiche, Jeremy Dunn, Gundula Griesmann, William Hewitson, Philipp Keller, Lasse Koskinen, Jens Pagter Kristensen, Arild Kristiansen, Jarl Kure, John Kah Kern Lim, Helen Martin, Peter Millington, Teus Mourik, Jörgen Olsén, Peter Skjødt, Rolf Stöltzing, and Robert Thomson. They have all contributed to making this a more accurate and readable book through their useful comments and feedback.

I also thank my colleagues Karin Chenon, Ellinor Forslund, Birgitta Holmin, and Birgitta Nordström for valuable discussions and support.

**Arne Sandström**



---

# *Contents*

---

<b>Chapter 1</b>	<b>Introduction .....</b>	<b>1</b>
1.1	General Outline of the Book .....	1
1.1.1	Part A: Past and Present: A Historical Review and Different Approaches to Solvency (Chapters 3–6) .....	1
1.1.2	Part B: Present: Modeling a Standard Approach (Chapters 7–11) .....	1
1.1.3	Part C: Present and Future: EU Solvency II — Phase 2: Groups and Internal Modeling in Brief (Chapters 12–14) .....	2
1.1.4	Part D: Appendices .....	2
1.2	Organizations .....	2
1.2.1	BIS and BCBS .....	2
1.2.2	CEA .....	2
1.2.3	CEIOPS and EIOPC .....	3
1.2.4	Groupe Consultatif .....	3
1.2.5	IAA .....	4
1.2.6	IAIS .....	4
1.2.7	IASC and IASB .....	4
1.3	A Selection of Solvency Readings .....	5
1.3.1	The 1980s .....	5
1.3.2	The 1990s .....	6
1.3.3	Since 2000 .....	6
<b>Chapter 2</b>	<b>Solvency: What Is It? .....</b>	<b>7</b>
2.1	In the 18th Century .....	8
2.2	What Does Solvency Mean? .....	9
2.2.1	International Association of Insurance Supervisors .....	10
2.2.2	The EU Directives .....	11
	Summary .....	12
<b>Part A</b>	<b>Past and Present: A Historical Review and Different Approaches to Solvency (Chapters 3–6)</b>	
<b>Chapter 3</b>	<b>The European Union: Solvency 0 and Accounting .....</b>	<b>15</b>
3.1	The Works of Campagne .....	16
3.1.1	Campagne's Non-Life Approach .....	16
3.1.2	Campagne's Life Approach .....	21
3.2	Other Steps toward the First Directives .....	22



3.3	The Non-Life Directives (First, Second, and Third) .....	23
3.3.1	Equalization Reserves .....	27
3.4	The Life Directives (First, Second, and Third) .....	28
3.5	Calculating the Solvency Margin for Non-Life Insurance	
	Business .....	33
	Summary .....	33
3.6	The Insurance Accounting Directive (IAD) .....	36
3.6.1	The Importance of Disclosure .....	36
3.6.2	Balance Sheet (Section 3, Article 6) .....	37
3.6.3	Profit and Loss Account (Section 5, Article 34) .....	38
3.6.4	Valuation Methods (Section 7, Articles 45 to 62) .....	38
<b>Chapter 4</b>	<b>The European Union: Solvency I .....</b>	<b>41</b>
4.1	The Müller Report .....	43
4.1.1	Risks for Insurance Undertakings .....	44
4.2	Comments from Groupe Consultatif .....	45
4.2.1	Non-Life Risks .....	46
4.2.2	Life Risks .....	46
4.3	The Solvency I Directives .....	47
4.3.1	The Solvency I Non-Life Directive .....	48
4.3.2	The Solvency I Life Directive .....	49
4.4	Calculating the Solvency Margin for Non-Life Insurance	
	Business .....	50
	Summary .....	50
<b>Chapter 5</b>	<b>Steps toward Solvency II: 1.....</b>	<b>55</b>
5.1	Bank for International Settlements (BIS): The New Basel Capital Accord .....	55
5.1.1	1988 Capital Accord .....	56
5.1.2	Basel II .....	59
5.2	IASB: Toward a New Accounting System .....	70
5.3	IAIS: Insurance Principles and Guidelines .....	73
5.3.1	Guidance 6: Solvency Control Levels Guidance Paper .....	78
5.4	IAA: A Global Framework for Solvency Assessment .....	78
5.4.1	Short Summary .....	78
5.4.2	Risk Categories .....	80
5.5	EU: Solvency II — Phase I .....	85
5.5.1	Lamfalussy Procedure .....	87
5.5.2	Summary of Phase I .....	89
5.5.3	The KPMG Report (KPMG, 2002) .....	91
5.5.4	The Life Report (MARKT, 2002e) .....	92
5.5.5	The Non-Life Report (MARKT, 2002f) .....	94
5.5.6	The Sharma Report (Sharma, 2002) .....	94

<b>Chapter 6</b>	<b>Steps toward Solvency II: 2</b>	<b>101</b>
6.1	Australia	102
6.1.1	The Capital Base	106
6.1.2	Prescribed Method	106
6.1.3	Disclosure	110
6.2	Canada	111
6.2.1	Dynamic Capital Adequacy Testing	112
6.2.2	Minimum Continuing Capital and Surplus Requirements for Life Insurance Companies	113
6.2.3	Minimum Capital Test for Non-Life Insurance Companies	114
6.3	Denmark	116
6.4	Finland	122
6.4.1	The Risk Theoretical Model	123
6.5	The Netherlands	129
6.5.1	Realistic Value	130
6.5.2	Solvency Test	132
6.5.3	The Continuity Analysis	136
6.6	Singapore	137
6.6.1	Valuation of Assets (MAS, 2004a, Part IV)	138
6.6.2	Valuation of Liabilities (MAS, 2004a, Part V)	138
6.6.3	Total Risk Requirement	140
6.6.4	Financial Resources and Capital Requirements	143
6.6.5	Financial Resources Warning Event	143
6.7	Sweden	143
6.7.1	Technical Issues in Valuation of Liabilities	145
6.7.2	Technical Issues in Calculating the Safety Margin	145
6.8	Switzerland	148
6.8.1	Target Capital	149
6.8.2	Market Consistent Valuation	152
6.8.3	Risks	153
6.8.4	Standard Models	153
6.8.5	Asset Model	153
6.8.6	Life Insurance Model	154
6.8.7	Non-Life Insurance Model	155
6.8.8	Credit Risk Model	155
6.8.9	Scenarios	155
6.8.10	Aggregation of Scenarios with Standard Models	157
6.8.11	Parameters	158
6.8.12	Internal Models	159
6.9	U.K.	159
6.9.1	Pillar I: A Twin Peaks' Approach	160
6.9.2	Pillar II: Individual Capital Adequacy Standards	160
6.9.3	ECR: Non-Life Solvency Regime	161
6.9.4	The Asset Risk	162

6.9.5	The Reserving Risk .....	163
6.9.6	The Underwriting Risk .....	163
	Charge Factors .....	164
6.9.7	ECR: Life Solvency Regime .....	165
6.10	U.S. ....	166
6.10.1	$C_0$ Asset Risk — Affiliates .....	168
6.10.2	$C_{10}$ Asset Risk — Other = $\sum_j \alpha_{10j} C_{10j}$ .....	168
6.10.3	$C_2$ Insurance Risk = $\sum_j \alpha_{2j} C_{2j}$ .....	169
6.10.4	$C_3$ Interest Rate Risk = $\sum_j \alpha_{3j} C_{3j}$ .....	169
6.10.5	$C_4$ Business Risk = $\sum_j \alpha_{4j} C_{4j}$ .....	170
6.10.6	Comparison of the Three RBC Models .....	170
6.11	Some Other Systems .....	171
6.11.1	Germany .....	172
6.11.2	Norway .....	173
6.12	Summary of Different Systems .....	177

## Part B Present: Modeling a Standard Approach (Chapters 7–11)

<b>Chapter 7</b>	<b>The Fundamental Ideas .....</b>	<b>183</b>
7.1	A Model for the Solvency Assessment .....	183
7.1.1	Fair Value .....	186
7.2	Level of Capital Requirements .....	186
7.3	Risks and Diversification .....	188
7.4	Risk Measures .....	192
7.4.1	Coherent Risk Measures .....	193
7.4.2	Three Risk Measures .....	193
<b>Chapter 8</b>	<b>Valuations .....</b>	<b>197</b>
8.1	Fair Value: Introduction .....	197
8.2	Purposes of Valuation .....	199
8.3	Best Estimate of Insurance Liability and Technical Provisions .....	200
8.3.1	Risk-Free Interest Rate .....	201
8.3.2	Technical Provisions .....	201
8.4	Fair Value .....	203
8.4.1	Fair Value in a Pure Accounting Standard Environment .....	203

8.4.2	Fair Value in a Mixed Accounting Standard and Solvency Regulation Environment .....	207
-------	---	-----

## **Chapter 9 Dependencies, Baseline, and**

	<b>Benchmark Models .....</b>	<b>213</b>
9.1	Risk Measures .....	213
9.2	Assume Normality .....	214
9.2.1	A First-Order Approximation .....	215
9.2.2	Standard Deviation Principle .....	215
9.2.3	Value at Risk in the Case of Normality .....	216
9.2.4	Expected Shortfall in the Case of Normality .....	216
9.3	Assume Nonnormality .....	219
9.3.1	Risk Measure Based on NP Approximation.....	219
9.3.2	Other Risk Measures .....	221
9.4	Correlations between Risks: Different Levels of Conservatism .....	222
9.4.1	The Baseline Approach .....	222
9.4.2	A Benchmark Approach .....	225
9.5	Parameters in a Factor-Based Model .....	228
9.5.1	Parameter Classification .....	229

## **Chapter 10 One Example of Risk Categories and**

	<b>Diversification .....</b>	<b>231</b>
10.1	Insurance Risk .....	233
10.2	Market Risk .....	234
10.2.1	Bonds .....	236
10.2.2	Equities .....	236
10.2.3	Property .....	236
10.2.4	Cash (and Others) .....	236
10.2.5	General Issues .....	236
10.3	Credit Risk .....	237
10.4	Operational Risk .....	238
10.5	Liquidity Risk .....	238
10.6	Dependency .....	239

## **Chapter 11 A Proposal for a Standard Approach: From Formula to Spreadsheet .....**

	<b>to Spreadsheet .....</b>	<b>243</b>
11.1	The Insurance Risk, $C_{IR}$ .....	244
11.1.1	Underwriting Risk, $C_{ur}$ .....	244
11.1.2	Biometric Risk, $C_{br}$ .....	245
11.1.3	Surrender and Lapse Risk, $C_{slr}$ .....	246
11.1.4	Expenses/Costs Risk, $C_{er}$ .....	246
11.2	Market Risk, $C_{MR}$ .....	247
11.2.1	Bonds.....	248
11.2.2	Equities .....	248

11.2.3	Property .....	248
11.2.4	Cash (and Others) .....	248
11.3	Credit Risk, $C_{CR}$ .....	249
11.3.1	Default Credit Risk, $C_{dcr}$ .....	249
11.3.2	Concentration Risk, $C_{cor}$ .....	250
11.3.3	Reinsurance Counterparty Risk, $C_{rr}$ .....	250
11.4	Operational Risk, $C_{OR}$ .....	250
11.5	The Total Factor-Based Model .....	251
11.6	A Spreadsheet Approach .....	253
11.7	Parameter Estimates .....	259
11.8	An Example .....	264

## Part C Present and Future: EU Solvency II — Phase 2: Groups and Internal Modeling in Brief (Chapters 12–14)

### Chapter 12 The European Union: Reinsurance, Insurance Groups, and Financial Conglomerates ..... 273

12.1	Reinsurance.....	273
12.2	Insurance Groups and Financial Conglomerates .....	276
12.2.1	Group Level Solvency .....	277
12.2.2	Financial Conglomerates .....	279

### Chapter 13 The European Union: Solvency II — Phase II .... 283

13.1	Recommendations for the First Pillar .....	284
13.2	Recommendations for the Second Pillar .....	284
13.3	Recommendations for the Third Pillar .....	285
13.4	General Considerations .....	285
13.5	The First Wave of Requests (Pillar II) .....	288
13.6	The Second Wave of Requests Will Include the Following Issues (Pillar I) .....	289
13.7	The Third Wave of Requests Will Include the Following Issues (Pillar III) .....	289
13.8	A Brief Summary .....	290
13.8.1	Pillar I Features .....	290
13.8.2	Pillar II Features .....	291
13.8.3	Pillar III Features .....	291

### Chapter 14 Further Steps ..... 293

14.1	Internal Models and Risk Management .....	295
14.2	Forecasting the Future and Risk Management .....	296

## **Part D    Appendices**

<b>Appendix A    A Proposal for a Standard Approach:                   One Step toward Application .....</b>	<b>301</b>
<b>Appendix B    Insurance Classes .....</b>	<b>343</b>
<b>Appendix C    From the Non-Life Directives .....</b>	<b>349</b>
<b>Appendix D    From the Life Directives .....</b>	<b>363</b>
<b>Appendix E    IAIS: Insurance Principles, Standards,                   and Guidelines .....</b>	<b>377</b>
<b>Appendix F    From the Proposed Reinsurance Directive .....</b>	<b>381</b>
<b>Appendix G    Annex I and Annex II in the Insurance                   Group Directive .....</b>	<b>391</b>
<b>Appendix H    From the Financial Conglomerates Directive ....</b>	<b>401</b>
<b>Appendix I    Prudent Person Rule .....</b>	<b>409</b>
<b>References .....</b>	<b>413</b>
<b>Index .....</b>	<b>425</b>



# 1

---

## *Introduction*

---

---

### **1.1 General Outline of the Book**

The first chapter of this book briefly introduces some of the organizations mentioned in the following chapters and also includes a reading list. Chapter 2 discusses the concept of solvency, and the remaining chapters are divided into four main parts.

#### **1.1.1 Part A: Past and Present: A Historical Review and Different Approaches to Solvency (Chapters 3–6)**

In this part we discuss the models, assessment, and regulations from a historical perspective. Chapters 3 and 4 are devoted to solvency regulation and accounting within the EU. The background of the three non-life and life directives (Solvency 0) is discussed in Chapter 3, and the newly adopted Solvency I in Chapter 4. The work toward Solvency II looks at some international approaches in banking, accounting, supervision, and the actuarial field and is reviewed along with the first phase of the European Solvency II project in Chapter 5. The solvency systems of 12 different countries are summarized in Chapter 6.

#### **1.1.2 Part B: Present: Modeling a Standard Approach (Chapters 7–11)**

A basis for solvency modeling is discussed in Chapter 7, and the valuation of assets and technical provisions (liabilities) in Chapter 8. Dependency and different conservative approaches are discussed along with a baseline and a benchmark approach in Chapter 9.

To illustrate the theoretical discussion, an example of risk structure and the effects of diversification are included in Chapter 10. The benchmark approach is used to construct an example of a standard solvency model that is converted into a simple spreadsheet approach, presented in Chapter 11. Some parameter estimates and a simple example are also used as illustrations.



### 1.1.3 Part C: Present and Future: EU Solvency II — Phase 2: Groups and Internal Modeling in Brief (Chapters 12–14)

Insurance groups, financial conglomerates, and reinsurance are discussed in brief in Chapter 12. In Chapter 13 we discuss the current status of the second phase of the European Solvency II project. The importance of internal modeling and stress testing is highlighted in the final chapter.

### 1.1.4 Part D: Appendices

The fourth part starts with the basic model for the standard approach discussed in Chapters 10 and 11. The other eight appendices include excerpts from several EU directives.

---

## 1.2 Organizations

Many organizations have played an important part in discussions on solvency and its development. Some of the ones mentioned in this book are presented in brief below.

### 1.2.1 BIS and BCBS

The *Bank for International Settlements* (BIS) was established in 1930 and is the oldest international financial institution. As the center for international central bank cooperation, BIS hosts the regular meetings of the central banks in Basel, Switzerland.

The governors of the central banks of the Group of Ten (G10) established the *Basel Committee on Banking Supervision* (BCBS) in 1974 as a result of the disturbances in international currency and banking markets. One important objective of the BCBS's work was to close gaps in international supervision. An outcome of the collaboration was the introduction of the *1988 Basel Capital Accord*, a solvency system for banks. This Basel Accord was revised in what was called the *New Basel Capital Accord*, *Basel II* (2001–2006). A framework for a new capital adequacy system was published in 2004 and will be implemented at the end of 2006 (see Section 5.1).

For more information, see the BIS Web site: <http://www.bis.org/index.htm>, and the Basel II Web site, <http://www.basel-ii.info/>.

### 1.2.2 CEA

The *Comité Européen des Assurances* (CEA) was established on March 5, 1953. The idea was that European insurers should exchange information and be represented on the Insurance Committee of the Organization for European

Economic Cooperation (later the OECD Insurance Committee). Its work in the 1960s helped to bring about the first EU insurance directive. Today CEA consists of 32 national associations of insurance companies. Its mission is to resolve issues of strategic interest to all European insurers, focusing on the regulatory environment.

More information can be found on the CEA Web site: <http://www.cea.assur.org/>.

### 1.2.3 CEIOPS and EIOPC

The *Insurance Committee* (IC) of the European Union (EU) was a regulatory and legislative policy body created in December 1991 under Council Directive 91/675/EEC.

To simplify and improve decision making and implementation in the financial services sector, the European Commission launched a package of seven measures in 2003: a proposal for a directive (COM/2003/659) and six commission decisions. With this package, the approach that was already used in the securities sector was extended to the insurance sector through the establishment of two new committees:

1. The *European Insurance and Occupational Pensions Committee* (EIOPC<sup>1</sup>) (2004/9/EC), which was set up to replace the Insurance Committee and to assist the commission in adopting implementing measures for EU directives
2. The *Committee of European Insurance and Occupational Pensions Supervisors* (CEIOPS) (2004/6/EC; see below), which was established to act as an independent advisory group on insurance and occupational pensions (formerly the Insurance Conference)

CEIOPS was established in 2003 as the successor to the Insurance Conference, the Conference of Insurance Supervisory Authorities of the European Union, established in Paris in 1958. CEIOPS, located in Frankfurt am Main, Germany, acts as an independent advisory group on issues related to insurance and occupational pensions for the European Commission.

Similar organizations for the banking and securities sectors are the Committee of European Banking Supervisors (CEBS) and the Committee of European Securities Regulators (CESR).

More information can be found on the CEIOPS Web site: <http://www.ceiops.org>.

### 1.2.4 Groupe Consultatif

The *Groupe Consultatif* was established in 1978 to bring together the actuarial associations in the European Union to represent the actuarial profession in

---

<sup>1</sup> EIOPC was formally organized in April 2005.

discussions with the European Union institutions on existing and proposed EU legislation that has an impact on the profession. The name of the organization was originally Groupe Consultatif des Associations d'Actuaires des Etats Membres des Communautés Européennes. In 2002 the name was changed to Groupe Consultatif Actuariel Européen. The Groupe Consultatif was one of the leading players in formulating the third life directive.

For more information, see the Groupe Consultatif Web site: <http://www.gactuaries.org/>.

### 1.2.5 IAA

The *International Actuarial Association* (IAA) was founded in 1895 as a world-wide association of individual actuaries. Since 1895, when IAA held its first International Congress of Actuaries (ICA) in Brussels, its congresses have provided a platform for actuaries from all over the world to meet and discuss actuarial research. The 29th ICA will be held in Paris in 2006.

In 1995 an International Forum of Actuarial Associations (IFAA) was set up within the IAA. Three years later, the IAA was reorganized as an association of associations and subsequently replaced the IFAA. The IAA issues international actuarial principles, guidelines, and standards.

For more information, see the IAA Web site: <http://www.actuaries.org/>.

### 1.2.6 IAIS

The *International Association of Insurance Supervisors* (IAIS) was created in 1994 and represents insurance supervisory authorities in about 100 jurisdictions. The aim of the IAIS is to promote cooperation among the authorities and to set international standards for insurance supervision and regulation. The IAIS also provides training to members and coordinates work with regulators in other financial sectors and institutions. IAIS issues international insurance principles, standards, and guidance papers.

Since 1999, IAIS has welcomed other insurance professionals (e.g., IAA) as observer members. The IAIS is a member of IAA.

For more information, see the IAIS Web site: <http://www.iaisweb.org/>.

### 1.2.7 IASC and IASB

In May 1973 the *International Accounting Standards Committee* (IASC) was founded as a result of an agreement by accounting bodies in 10 countries, 5 of which are European countries.

In 1974 IASC published its first exposure draft (ED) and the first International Accounting Standard (IAS 1, "Disclosure of Accounting Policies").

In 1977 the International Federation of Accountants (IFAC) was set up to expand international accounting activities. In 1981 it was decided that IASC

would have full and complete autonomy in the setting of international accounting standards. The membership link between IASC and IFAC was discontinued from 2000, when the IASC constitution was changed.

In the same year, 2000, the European Commission announced its plan to require IASC standards for all EU listed companies by no later than 2005.

A new structure came into effect on April 1, 2001, with the establishment of the *International Accounting Standards Board* (IASB). The board is responsible for setting accounting standards, which are designated *International Financial Reporting Standards* (IFRS). In 2004 IASB published "IFRS 4 Insurance Contracts."

For more information, see the IASB Web site: <http://www.iasb.org/>.

---

## 1.3 A Selection of Solvency Readings

A large number of papers and books have been written on solvency. Some of the main sources of information are reviewed below.

### 1.3.1 The 1980s

At the beginning of 1980, a research group (RG) was established to review the Finnish rules concerning the equalization reserve and to conduct a general study of solvency. This pioneering work in the field of non-life insurance was summarized by the two books edited by Pentikäinen (1982) and Rantala (1982). At the end of 1982, a solvency working party (SWP) of the General Insurance Study Group was established under the chair of Chris Daykin to develop a solvency assessment approach for the U.K. similar to the one developed by the Finnish RG. In the 1980s, close cooperation between the two groups resulted in a considerable number of papers.

One paper, Daykin et al. (1984), reviewed the uncertainty affecting non-life insurance undertakings and the adequacy for technical provisions. After this, the SWP started to adapt the Finnish solvency approach to the British environment. In its first stage the group modeled a run-off situation where no further business was written. The working party then developed a simulation model of a non-life undertaking — a model that could be used not only for solvency purposes, but also as an analytical tool for assessing the financial strength of a company (see Daykin et al., 1987). It also became clear that the model could be used as a management tool for use in conjunction with a company viewed as a going concern. This is discussed in Daykin and Hey (1990).

Greater flexibility in modeling can be achieved by using simulation methods. This was studied by a Finnish working group that presented a new report in 1989 (see Pentikäinen et al., 1989).

The third edition of Beard et al. (1984) contained a number of new approaches, which were later summarized in Daykin et al. (1994).

Kastelijn and Remmerswaal (1986) have reviewed a large number of solvency studies. They present a comparison of 19 different approaches, of which 14 are based on a going-concern approach, 4 on a run-off approach, and 1 on both approaches.

During this period, Norwegian actuaries were also working on solvency modeling (see, for example, Norberg and Sundt, 1985; Norberg, 1986). Other studies from this period include Ramlau-Hansen (1988).

### **1.3.2 The 1990s**

During this period many studies were carried out in many different countries both outside and within the EU; see Chapters 5 and 6 for references to further reading.

A large number of papers were presented at congresses and colloquiums in the 1990s; see, for example, Norberg (1993) on life insurance.

### **1.3.3 Since 2000**

In early 2000, the EU Commission Services and EU member states jointly initiated a new solvency project (Solvency II). The first phase in this project was devoted to gathering information and facts about systems used worldwide. In May 2002, KPMG presented a report (KPMG, 2002) that discussed a range of issues, including risks and risk models, technical liabilities, asset valuation, reinsurance, and the impact of future accounting changes. Other documents of interest may be found on the Web site of the Insurance Unit of the Commission: [http://europa.eu.int/comm/internal\\_market/en/finances/insur/index.htm](http://europa.eu.int/comm/internal_market/en/finances/insur/index.htm).

In 2002 the IAIS asked IAA for support on solvency assessment. IAA's Insurance Regulation Committee formed the Insurer Solvency Assessment Working Party (WP) chaired by Stuart Wason. This WP published its final report in 2004 (IAA, 2004), when the IAA's Insurance Regulation Committee also formed a Solvency Subcommittee (SSC).

Other literature, books, and papers will be referred to in the following chapters. For the Basel Accord, i.e., the banking solvency rules, the reader should refer to the BIS and Basel II Web sites (see above).

# 2

---

## *Solvency: What Is It?*

---

The insurance sector is moving from a system of direct supervisory control to a more deregulated environment. This step requires new systems of risk control and risk management. The supervisors also need new and improved techniques to control the insurance companies. As these institutions are also large and major investors, their soundness has a clear impact on the financial market. The key benchmark of an insurance business is its *solvency* or its *financial strength*. Other terms that have been used are *financial health* or *solidity*.

The main liabilities of an insurance undertaking are its anticipated insurance claims and associated costs. These are usually calculated using actuarial methods, guided by regulations. These calculations are, of course, only estimates, with some probability of error.

In order to *protect the policyholders* and to *ensure the stability of the financial markets*, it has been required that insurance undertakings should hold a certain amount of additional assets as a buffer. This buffer, the so-called solvency margin, is the main concern of this book.

The concept of solvency is old. According to *Webster's Ninth New Collegiate Dictionary*, it originates from ca. 1727 as "the quality or state of being solvent." But the latter concept goes back 100 years earlier (1630) and is defined as "able to pay all legal debts." We illustrate this by an example from the 18th century when a man from Germany wanted to start a company in Sweden. In the second part of this chapter we will discuss the concept of solvency a bit closer. As just a buffer, it does not say anything about its nature. It is when we say that this buffer should be in place to protect the policyholders that we give it any substance. This gives rise to several questions, such as:

- How large should it be?
- For what time horizon should it be calculated?
- What kind of assets could be included in the buffer?

---

## 2.1 In the 18th Century

Sweden became a seafaring nation during the 17th century (Hägg, 1998). Risks such as storms, robbery, captivity, and diseases always threatened the sea expeditions and their cargo. As there was no way to transfer the risks to a third party, the sea companies were organized as shipping corporations. Out in Europe, e.g., in London, Amsterdam, and Hamburg, there were underwriters offering international marine insurance. Underwriters were the winners, as the establishment of insurance companies usually failed.

In 1724 a merchant from Hamburg proposed to establish a Swedish marine insurance company in Stockholm (Hägg, 1998, p. 116). The German presented his proposal to the government, and following his business idea, the company should be well established with large capital stock, and thus it would be *solvent*. The company should have better security and superior service than others, and hence it could attract both Swedish and foreign merchants to buy policies at even higher premiums than elsewhere. According to the German, the company would, for example, outdo Dutch insurers.

The proposal was never realized. But 9 years later, Swedish merchants brought up the proposal in a newspaper that highlighted the large amount of money that flew out of Sweden only because of marine insurance. They knew how to organize a marine insurance company, but needed help from the central government to realize the project. Four reasons for getting help from the government were presented (Hägg, 1998, p. 117):

1. The Bank of Sweden had refused to allow investors to deposit a planned fund of 250,000 daler silvermynts (the currency at the time) in the bank.
2. The merchants demanded a new marine act that replaced the former one of 1667.
3. The merchants wanted a monopoly.
4. The merchants wanted the right to be excused from taxes.

As a matter of fact, in 1739–1740 the marine insurance company Assecurance-Compagniet was established as a sort of stock company (with limited liability for investors). The business, according to Hägg (1998, p. 116), was regulated by a royal company code. One explanation for the approving of the royal privilege was the concern about the balance of trade.<sup>1</sup>

The concept of solvency, although perhaps in other terms, is not new, as could be seen from this story. When the Swedish regulatory system was set up in 1903, it was established on a *solvency principle*; i.e., it “should safeguard the performance of all entered insurance agreements” (Hägg, 1998, p. 264).<sup>2</sup>

---

<sup>1</sup>For example, in 1743 the total liability of marine insurance was 35% of the sum of Swedish export and import (Hägg, 1998, p. 119).

2.2 What Does Solvency Mean?

The solvency margin is a buffer in a company’s assets covering its liabilities. For the supervisor, it is important that the policyholders are protected, but it is also important for him to ensure the stability on the financial market. In view of this, the definition of the *solvency margin* (SM) given by Pentikäinen (1952) is our benchmark (see also Figure 2.1):

The solvency margin, *SM*, is the difference between assets, *A*, and liabilities, *L*:  $SM = A - L$ .

If we put some restrictions on the assets, e.g., that they should be of good quality, we have by this definition what could be called the *available solvency margin* (ASM). Note that in this definition there is no discussion on either the time horizon or the relative size of the buffer. The definition of solvency is also discussed in Campagne (1961, chap. 1).

Benjamin (1977) refers to the *Oxford Dictionary*, where the definition of solvency is “having money enough to meet all pecuniary liabilities.” In an insurance context, this definition gives rise to two concepts of solvency (see Benjamin, 1977, p. 267). They are the two extremes of a range of possibilities; i.e., at one end the liabilities are those paid on an immediate liquidation of the company (*break-up* or *run-off* approach). At the other end, cf. also the

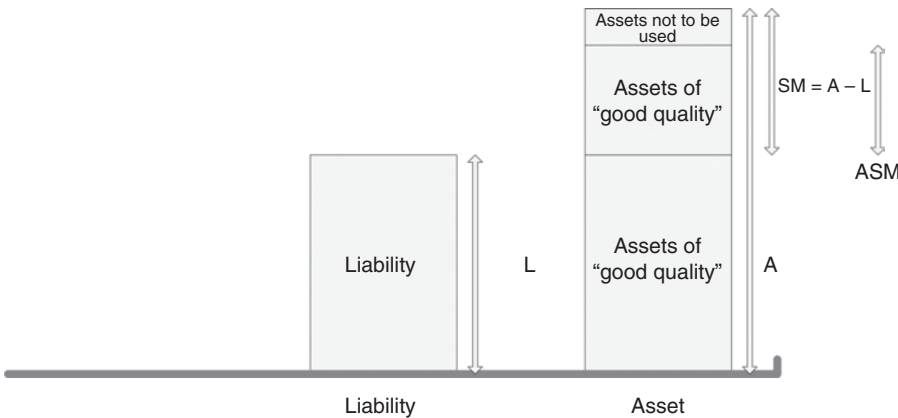


FIGURE 2.1  
A short depiction of the solvency margin (SM) and the available solvency margin (ASM).

<sup>2</sup>The Swedish concept that was used was *soliditet*, i.e., “solidity.” The principle stated that insurance should be organized and managed so that all insurance agreements entered could be correctly performed. In brief, the solvency principle was used as a generic term embracing all measures motivated to safeguard that insurance businesses under all circumstances were solvent (Hägg, 1998, p. 89).



definition by the *Investor Dictionary* below, a company could be regarded as solvent if it pays all its debts as they mature (*going-concern* approach). This means that a company is solvent when its solvency margin is positive. The so-called *ruin problem* would thus be the probability that the solvency margin of a company at any time in the future would become negative (cf. Pentikäinen, 1952).

According to the *Investor Dictionary*<sup>3</sup> on the Internet, solvency is defined as “the financial ability to pay debts when they become due. The solvency of a company tells an investor whether a company can pay its debts.”

There are various other ways of looking at solvency. Pentikäinen (1967) presents two different ways of looking at the concept:

1. *From the point of view of the management of the company.* The continuation of the function and existence of the company must be secured.
2. *From the point of view of the supervising authorities.* The benefits of the claimants and policyholders must be secured.

Definition 2 is narrow, as it does not demand continuity of the company but allows it to be wound up. Definition 2 can be approved as a basis of the legal system: “the supervising authorities and the legal security measures shall be restricted to the minimum, i.e., to secure the insured benefits only, but otherwise each company shall have freedom to develop its function as it itself desires.” As stated in Pentikäinen (1984), the latter case indicates the maintenance of the insurer’s ability to meet his obligations for a short period, say, 1 year. In the former case, the objective is to guarantee the continued existence of the insurer. This is a more complex situation than the latter, and it includes this latter case as well.

If we take definition 2 as the basis of the legal system, then the company’s existence can be left to management. This could be done by means of adequate reserves, loadings of premiums, and reinsurance. In the new environment, as proposed by EU (see Section 5.5), the second pillar with supervisory qualitative measures will build a bridge between the two approaches.

In the new three-pillar system of the EU (see Section 5.5), these two ways of looking at solvency are combined through the internal models, but also through the pillar system per se.

### 2.2.1 International Association of Insurance Supervisors

The International Association of Insurance Supervisors (IAIS) defined solvency as follows: “An insurance company is solvent if it is able to fulfil its obligations under all contracts under all reasonably foreseeable circumstances” (IAIS, 2002). The definition was later slightly changed to the “ability

---

<sup>3</sup><http://www.investordictionary.com/>.

of an insurer to meet its obligations (liabilities) under all contracts at any time" (IAIS, 2003a).

In its definition it is also stated:

Due to the very nature of insurance business, it is impossible to guarantee solvency with certainty. In order to come to a practicable definition, it is necessary to make clear under which circumstances the appropriateness of the assets to cover claims is to be considered, e.g., is only written business (run-off basis, break-up basis) to be considered, or is future new business (going-concern basis) also to be considered. In addition, questions regarding the volume and the nature of an insurance company's business, which time horizon is to be adopted, and what is an acceptable degree of probability of becoming insolvent should be considered.

### 2.2.2 The EU Directives

The concept of solvency margin has changed with the development of the EU directives. From the beginning it was seen as a *supplementary reserve*. In the Solvency I non-life directive it is defined "to act as a buffer."

In the first non-life directive of 1973 (EEC, 1973) it is said that "it is necessary that insurance undertakings should possess, over and above technical reserves of sufficient amount to meet their underwriting liabilities, a supplementary reserve, to be known as the solvency margin, and represented by free assets, in order to provide against business fluctuations." A similar statement was also made in the first life directive of 1979 (see EEC, 1979).

The third non-life directive (EEC, 1992a) introduced a change in the introduction of its Article 16 (see Appendix C) and is now focused on the solvency margin for the entire business, which was not expressed in the first directive. The introduction now states: "The home Member State shall require every insurance undertaking to establish an adequate solvency margin in respect of its entire business. The solvency margin shall correspond to the assets of the undertaking free of any foreseeable liabilities less any intangible items."

In the Solvency I non-life directive (COM, 2002b), the definition of the solvency margin is described in terms to *act as a buffer against adverse business fluctuations*: "The requirement that insurance undertakings establish, over and above the technical provisions to meet their underwriting liabilities, a solvency margin to act as a buffer against adverse business fluctuations is an important element in the system of prudential supervision for the protection of insured persons and policyholders." In this directive the *time horizon* is set to "all times," i.e., for a going concern.

A similar approach is given in the Solvency I life directive (COM, 2002c):

It is necessary that, over and above technical provisions, including mathematical provisions, of sufficient amount to meet their underwriting liabilities, assurance undertakings should possess a supplementary reserve, known as the solvency margin, represented by free assets and,

with the agreement of the competent authority, by other implicit assets, which shall act as a buffer against adverse business fluctuations.

The time horizon is the same here as in the non-life directive.

The time horizon in the Solvency I directives is for “all times,” i.e., for a going concern. There are other ways to define solvency in terms of the time horizon; e.g., the Dutch supervisory authority (see Section 6.5) proposed in its first outline of a new solvency system a three-part assessment:

1. On the balance sheet date, the financial position is such that the book is closed and sold to another willing partner.
2. On the balance sheet date, the financial position is such that it will be able to hold its position during the following 12 months and also that during this period there will be an adverse scenario emerging so that on the balance sheet day 12 months later, the book will be closed and transferred to another willing partner.
3. The going-concern approach.

In the Swiss proposal (see Section 6.8), the solvency requirement is thought of as consisting of two parts above the technical provisions: a risk margin reflecting a run-off situation plus a margin reflecting a going-concern approach.

An extensive discussion on solvency and the capital requirements is given in IAA (2004, chap. 3).

In the literature there have been other terms used as synonyms of solvency; e.g., in Campagne (1961) the term *dynamic solvency* is used as a synonym for the going-concern approach and *static solvency* is used for the break-up situation (see also Kastelijn et al., 1986, p. 8, footnote).

Some other related concepts are discussed in Kastelijn et al. (1986, chap. 1.5); e.g., the *guarantee fund* in the EU solvency directives is one third of the minimum solvency margin and is the *absolute minimum capital* for a company if it is continuing to trade business. The term *minimum free reserve* can either mean solvency margin or guarantee fund. In some reviews the term *solidity* is used. See Kastelijn et al. (1986) for more terms used.

---

## Summary

The *available solvency margin* is a capital buffer of free assets covering the liabilities. The buffer should be positive and consist of “good quality” assets. Its relative size depends on the time horizon. You could either define its size according to an immediate liquidation (run-off approach) or a situation where all payments are done as the debts mature (going concern approach).

## Part A

# Past and Present: A Historical Review and Different Approaches to Solvency (Chapters 3–6)

In Chapters 3 to 6 we discuss the models, assessment, and regulations from a historical perspective.

In Chapters 3 and 4 we consider the solvency regulation and accounting within EU. We briefly present the theory behind the non-life and life directives, the accounting directive, and the works of Professor Campagne, which are central to this area.

Chapters 5 and 6 present a smorgasbord<sup>1</sup> of different approaches to modeling and assessment.

Chapter 5 describes different organizations and their approaches. First we discuss the 1988 Basel Accord for banks and its credit risk assessment. We also look at the new Basel II Accord and its three-pillar system, including its risk charges for credit and operational risks.

This is followed by the new accounting standard proposed by the International Accounting Standard Board, where we move from an institutional view (insurance companies) to a functional view (insurance contracts). Fair valuation is also discussed.

This chapter and Appendix E also include a summary of the insurance principles and guidelines presented by the International Association of Insurance Supervisors. The fifth principle deals with capital adequacy and the solvency regime.

The International Actuarial Association (IAA) presented in 2004 a report on insurance solvency assessment. A brief summary of this report is given, where different risk categories are discussed.

In the final section we introduce the first phase of the European Union Solvency II project. A comparison is made between the Basel II project and the Lamfalussy procedure. We also give brief summaries of the KPMG report

---

<sup>1</sup> Smorgasbord: Swedish *smörgåsbord*, from *smörgås* (“open sandwich”) + *bord* (“table”) (approximately 1919); 1: luncheon or supper buffet offering a variety of foods and dishes (as *hors d’oeuvres*, hot and cold meats, smoked and pickled fish, cheeses, salads, and relishes); 2: heterogeneous mixture (*Webster’s Ninth New Collegiate Dictionary*).

and the three supervisory reports on life insurance, non-life insurance, and the Sharma report on failures, as well as their causal chain and diagnostic and preventive tools.

In Chapter 6 we study different models and assessments used in a number of countries. We have chosen certain issues and characteristics that can inspire new models.

- *Australia*: The ideas are similar to those behind Solvency II. Liability valuation, risk categories, a factor-based prescribed method, and internal models.
- *Canada*: A factor-based system. Risk categories, the minimum capital test, dynamic capital adequacy testing, and minimum continuing capital and surplus requirements on ratings.
- *Denmark*: Fair valuation and a traffic light test system.
- *Finland*: A risk theoretical transition model and equalization reserve.
- *The Netherlands*: Fair valuation and minimum solvency and continuity analysis.
- *Singapore*: Valuation of assets and liabilities, risk categories, and two requirements in a risk-based system.
- *Sweden*: Valuation of assets and liabilities, risk categories, and a simple model.
- *Switzerland*: Valuation of assets and liabilities, risk categories, standard model, scenario tests determining the target capital, and internal models.
- *U.K.*: A twin peaks' approach under pillar I, individual capital adequacy standards under pillar II, and risks.
- *U.S.*: Risk-based capital model, correlation structure, and different intervention levels.

The German and Norwegian approaches are also touched upon.

# 3

---

## *The European Union: Solvency 0 and Accounting*

---

The first non-life and life directives of EU, at that time the European Economic Community (EEC), were published July 24, 1973, and March 5, 1979, respectively (see EEC, 1973, 1979). These two directives marked the first steps toward the establishment of the free market in insurance within the European Community (see, e.g., Pool, 1990). Included in the directives are the requirements that the companies within the EEC should be able to meet in order to fulfill the solvency assessment. The works by Campagne (1961) are the main base for these requirements. We will therefore start this chapter with a summary of his proposals before we look closer at the directives. A very good description of the early works that were made within different organizations on the solvency assessment is given in Daykin (1984). He notes that at the time of signing the Treaty of Rome in 1957, OEEC<sup>1</sup> had already initiated discussions to harmonize the controls on international insurance operations. This discussion included not only the founder member states of the European Community, but also such countries as the U.K., Sweden, and Switzerland (cf. also Schlude,<sup>2</sup> 1979). The disagreement whether an insurance undertaking should be allowed to carry on both life and non-life business is the main reason for the lag of nearly 6 years between the first two directives.

Reserving and solvency assessment in different EU countries are discussed and compared in Wolthuis and Goovaerts (1997).

In Section 3.6 we will discuss the first accounting directive on insurance.

---

<sup>1</sup> At that time OEEC, the Organization for European Economic Cooperation, now OECD, the Organization for Economic Cooperation and Development.

<sup>2</sup> Administrator in the Division Insurance of the EEC, Brussels.

### 3.1 The Works of Campagne

In 1948, Professor Campagne published a report on solvency assessment for life insurance companies. It was based on data from 10 Dutch life companies for the years 1926 to 1945 ("Contribution to the Method of Calculating the Stabilization Reserve in Life Assurance Business"; see Kastelijn and Remmerswaal, 1986).

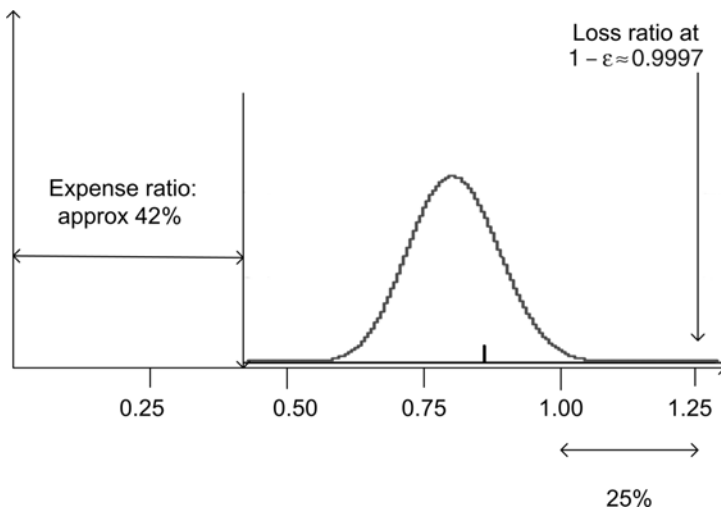
On the request of the OEEC Insurance Committee, Professor Campagne<sup>3</sup> presented a report on solvency in 1957 ("Minimum Standards of Solvency for Insurance Firms"; see Daykin, 1984). In the report he recognized, as Teivo Pentikäinen (1952) had done earlier, that in assessing the solvency position of a company, risk theoretical considerations should be made. The report made some simplifying assumptions about the distribution function underlying the solvency. He did not claim that the model should give any information about the solvency position of a company, but only provide an early warning system (Daykin, 1984). The data used in this first non-life report were taken from 10 insurance companies operating in Switzerland during 1945 to 1954. In this and the second non-life study, Campagne proposed that the probability of ruin over 3 years should be 1/1000, taken as approximately 3/10,000 in 1 year. Because expenses and commissions, in an average account, stand for 42% of the retained premiums, some 58% were available for claims (in relation to retained premiums). This is illustrated in Figure 3.1. From this and the model used, it was recommended that a solvency margin of 25% of the retained premiums was enough to meet the requirement of avoiding ruin. To this end, it was suggested that an additional 25% of the ceded reinsurance premiums should be added to cover against the risk of reinsurance failure.

The OEEC Insurance Committee set up a working party (WP) chaired by Professor Campagne. The WP consisted of 14 members from 10 countries, and Professors de Mori and Grossmann compiled the data based on a questionnaire. In the report to the OEEC, Campagne (1961) used data for the years 1952–1953 to 1957 from eight European countries for the non-life insurance industry and from five countries for the life insurance industry.

#### 3.1.1 Campagne's Non-Life Approach

Campagne's approach is simple in its nature (see Campagne, 1961; Kastelijn and Remmerswaal, 1986, pp. 32–33; de Wit et al., 1980, p. 138). Let the net retained premium be 100%. From this we deduct a constant fraction equal to the average expense ratio of each country. The remaining part is what remains for claims payment. Calculate the *value at risk* of the loss ratio distribution (VaRLR) in each country and add this to the difference between

<sup>3</sup>Professor Campagne was the chairman of the *Verzekeringskamer* in the Netherlands.



**FIGURE 3.1**

Illustration of Campagne's non-life approach. In the combined ratio the expense ratio is assumed constant and equal to 42%, and the loss ratio follows a beta distribution. At the 0.9997 percentile the loss ratio is approximately 83%. Thus, the combined ratio will be 125%. The company needs 25% of the premiums during 1 year to meet the requirement.

100 and the expense ratio. The part that is above 100 would constitute a solvency margin expressed in percent of the net premium income according to this approach.

Let  $X_i$  be the net claims incurred during a year (for a country),  $P_i$  the net retained premium income during the same period, and  $E_i$  the net operating expenses during the same period. The ratios  $ER_i = E_i / P_i$  and  $LR_i = X_i / P_i$  are the net expense ratio and the net loss ratio, respectively.

We also define, for each country, the average net expense ratio

as  $\overline{ER} = \frac{1}{n} \sum_{i=1}^n ER_i$ . Campagne assumed that the net loss ratios are distributed

according to a beta distribution (see below). For each country the VaRLR is calculated. The solvency margin in percent of the net premium income is now defined as  $[\text{VaRLR} + \overline{ER} - 100]$ .

The beta distribution, with parameters  $\alpha$  and  $\beta$  is

$$f(x; \alpha, \beta) = \frac{x^{\alpha-1}(1-x)^{\beta-1}}{B(\alpha, \beta)} \quad \text{for } 0 < x < 1$$

$$= 0 \text{ otherwise}$$



with  $B(\alpha, \beta) = \int_0^1 u^{\alpha-1} (1-u)^{\beta-1} du$ , i.e., the beta function.

Here  $x$  equals the loss ratio. Hence, these ratios cannot be larger than 100% in this approach. The maximum net loss ratio observed by Campagne was 97%. De Wit et al. (1980) used a beta distribution for  $x/1.5$ , as their maximum LR was 130%.

Campagne assumed that the probability that the sum of the average net expense ratio and the loss ratio is larger than a solvency margin is equal to a small value  $\varepsilon$ , i.e.,

$$P(\overline{ER} + LR > 1 + msm) = \varepsilon$$

where  $msm$  is the minimum solvency margin in terms of the net premium income.

This probability could be written as  $P(LR > msm + 1 - \overline{ER}) = \varepsilon$ . Letting  $msm = LR_\varepsilon - (1 - \overline{ER})$ , we get the value at risk, VaRLR, defined as the  $\varepsilon$ -quantile  $LR_\varepsilon$ , which is the smallest value satisfying  $P[LR > LR_\varepsilon] = \varepsilon$ , where LR is beta distributed. The VaRLR is computed as the empirical VaR based on the empirical distribution.

The parameters of the beta distribution were estimated by the method of moments. From the observed net loss ratios we can calculate its mean ( $m$ )

and variance ( $s^2$ ). The mean of the beta distribution is  $\mu = \frac{\alpha}{\alpha + \beta}$  and the

variance  $\sigma^2 = \frac{\alpha\beta}{(\alpha + \beta)^2(\alpha + \beta + 1)}$ . If we calculate the mean and variance from

the observed net loss ratios and let  $z = (1 - m) / m$ , then the parameters of the beta distribution are

$$\alpha = \frac{z - s^2(1 + z)^2}{s^2(1 + z)^3} \quad \text{and} \quad \beta = z\alpha$$

Some of the results presented by Campagne (1961, p. 60) are

As stated by Kastelijn and Remmerswaal (1986, p. 33), Campagne used these results to propose a minimum solvency margin for the EEC of 25% of the net retained premium (and in addition 25% of premium ceded; see also Campagne, 1961, p. 59), because such a margin would not lead to unacceptable high ruin probabilities and most companies would be able to meet this standard, particularly if hidden reserves are taken into account. In addition to this, a concept of a minimum margin in absolute monetary units was

$\varepsilon = 0.000$	Denmark	France	Germany	U.K.	Italy	The Netherlands	Sweden	Switzerland
NRR%	100	100	100	100	100	100	100	100
$\overline{ER}$	35	38	35	41	44	53	32	42
$\overline{LR}$	51	49	44	50	43	43	61	46
VaRLR	74	97	68	72	83	78	90	83
$\overline{LR} + VaRLR$	109	135	103	113	127	131	122	125
msm	9	35	3	13	27	31	22	25

Notes: NRR% = net retained premium ratio, in %;  $\overline{ER}$  = mean net expense ratio, in %;  $\overline{LR}$  = mean net loss ratio, in %; VaRLR = value at risk of the loss ratio distribution; msm = minimum solvency margin

introduced. This amount was set to 250,000 u/c A.M.E. (European Monetary Agreement units of account) (see Campagne, 1961, p. 73). One u/e A.M.E. was equivalent to one U.S. dollar.

The minimum solvency margin was thus proposed to be:

- 25% of the net retained premiums
- 25% of the ceded premiums
- 250,000 u/c A.M.E

De Wit et al. (1980, p. 142) used Dutch data from 71 companies in the years 1976 to 1978 to update the results. The following table is based on their results.

Probability of ruin	0.01	0.001	0.0003
NRR %	100	100	100
$\overline{ER}$	30	30	30
VaRLR	115	126	130
$\overline{ER} + VaRLR$	145	156	160
msm	45	56	60

Notes: NRR% = net retained premium ratio, in %;  $\overline{ER}$  = mean net expense ratio, in %; VaRLR = value at risk of the loss ratio distribution; msm = minimum solvency margin

As a comparison, we can look at Swedish data for the years 1996 to 2003. Companies that are in run-off are excluded. Captives and what is called labor market companies are also excluded. Looking at individual companies, there are data from 116 companies (658 data points), and in the case of groups of companies, there were 17 companies (groups) (92 data points). The maximum LR for the individual companies was 1.82 and for the groups 1.37. In the first case, we divided all loss ratios by 2, and in the second case, by 1.5. This has been done arbitrarily, as in de Wit et al. (1980).

Swedish Data, 1996–2003	Individual Companies	Groups and Individual Companies
Number of data points	658	92
Loss ratio (LR)	LR/2.0	LR/1.5
Mean	0.363	0.558
Variance	0.020	0.025
Max LR	0.910	0.916
Max LR, not divided	1.820	1.374

This gives us the following minimum solvency margin as percent of the net retained premium.

	I.C.	I.C.	I.C.	G.C.	G.C.	G.C.
Probability of ruin	0.01	0.001	0.0003	0.01	0.001	0.0003
NRR %	100	100	100	100	100	100
$\overline{ER}$	34	34	34	28	28	28
VaRLR	142	160	167	132	141	143
$\overline{ER + VaRLR}$	176	194	201	160	169	171
msm	76	94	101	60	69	71

Note: I.C. = individual companies; G.C. = group and individual companies. NRR% = net retained premium ratio, in %;  $\overline{ER}$  = mean net expense ratio, in %; VaRLR = value at risk of the loss ratio distribution; msm = minimum solvency margin

The Dutch data show an increase in the VaRLR, or *estimated* maximum loss ratio, from 78 to 130 during the 20 years from the first study and from 90 to 167 in Sweden during the last 40 years. We will not use the data for any deeper analysis, but they could be an indication that the impact of the investments yield has increased.

De Wit et al. (1980) points out the arbitrariness in dividing the loss ratios with a number (above the maximum registered loss ratio) and weakness of this method when the loss ratios are higher than 1. This is also one of the main remarks against this method in the criticism made by Ramlau-Hansen (1982). Ramlau-Hansen also points out that the observations cannot be assumed to be identical and independently distributed (i.i.d.), and the fact that the variation between companies increases with the number of companies involved. In the study by de Wit et al. (1980), a comparison is made by estimating the VaRLR using a Weibull distribution, and in Ramlau-Hansen (1982) a credibility approach is used (cf. also Kastelijn and Remmerswaal, 1986).

### 3.1.2 Campagne's Life Approach

In the report to the OEEC, Campagne (1961) used the same approach as in his study at the end of the 1940s. As the risk on investments is the most important factor for life insurance companies, and as the technical provisions (tp) are the most important invested amount, Campagne considers a minimum solvency margin (msm) as given by a percentage of the tp. He also discusses other possibilities, e.g., the msm as a percentage of the sum insured or of the sum at risk (Campagne, 1961, pp. 20–21; Kastelijn and Remmerswaal, 1986, p. 27). In the first case, the method of calculation can differ from one country to another and its meaning as a criterion is not clear. The sum at risk could be difficult to calculate, and it is not obvious how a negative sum at risk should be taken into account.

One main objection of the approach used by Campagne is that the more prudence there is in the technical provisions, the higher the msm will be. In other words, *the more prudent a company is, the more it has to pay for the solvency*.

From Campagne (1961, p. 53) we have the following table of characterization ratios from five European countries (1952 to 1957). The three ratios are the free assets (A) in relation to the technical provisions (A/tp), to the sum at risk (A/sr), and to the sum insured (A/si).

Ratios	France	Germany	Italy	The Netherlands	Sweden	Mean
A/tp = FR	324	3.5	46.1	11.5	136	214
A/sr	26	0.6	6.4	22	5.4	34
A/si	23	0.5	5.5	1.8	3.8	28

A loss ratio, LR, is defined as the loss (L) in a year as a percentage of the technical provisions (tp),  $LR = L/tp$ . A profit is a negative loss, and as cited by Kastelijn and Remmerswaal (1986, p. 28), “on the whole changes in the capital position of the company have been listed as profit or loss, the respective book-profits or book-losses have been considered without going into detail” (from the 1948 report of Campagne). The LR's are assumed to be i.i.d. for different years and companies.

The free reserve ratio of the technical provisions ( $FR = A/tp$ ) must be such that

$$P(LR > FR) \leq \varepsilon$$

This can be defined as the value at risk of LR, VaRLR, defined as  $\varepsilon$  – quantile  $LR_\varepsilon$ , which is the smallest value satisfying  $P(LR > LR_\varepsilon) = \varepsilon$ , where LR is distributed according to a Pearson type IV distribution (see Campagne, 1961, p. 62).

For the data that were used, this led to the following frequency function (estimation is made by the method of moments),  $x = LR$  (Kastelijn and Remmerswaal, 1986, p. 28):

$$f_x(x) = 31.73 \left( 1 + \frac{x^2}{5.442^2} \right)^{-4.850} e^{2.226 \operatorname{arctg} \left( \frac{x}{5.442} \right)}$$

The VaRLR was calculated both as the margin for 1 year and as margins that should be sufficient to keep the probability so that after 2, 3, 5, and 10 years, the total loss in this period exceeds the VaRLR is less than  $\varepsilon$ . Campagne used two different methods to calculate the VaRLR. The first was made by convolution of the 1-year frequency function and the second by fitting the same distribution to the accumulated loss data (of 4 years) divided by the average reserve. For the 1-year period the two methods are identical.

The minimum solvency margins, as a percentage of the technical reserves, are given in the following table (Campagne, 1961, p. 65).

VaRLR	1 year	2 years	3 years	5 years	10 years
$\varepsilon = 0.001$	9	10	10	12	14
$\varepsilon = 0.01$	7	7	7.5	8	9
$\varepsilon = 0.05$	3.5	4	4	4	3
$\varepsilon = 0.1$	2.5	2.5	2	2	1

Campagne proposed  $\varepsilon = 0.05$ , and therefore a necessary minimum solvency margin of 4% of the technical reserves.

---

### 3.2 Other Steps toward the First Directives

The description of the developments on solvency in this chapter is mainly based on a paper by Daykin (1984), but also on the description made by Pool (1990). The establishment of the European Economic Community (EEC) in 1957 also started cooperation between the supervisory authorities. The Conference of EEC Insurance Supervisory Authorities<sup>4</sup> began to discuss the steps toward a free insurance market. From the very beginning they discussed the technical reserves, assets backing these reserves, and control over the assets. Discussions between the supervisors and the industry, with the aid of OECD, ended up with a plan to pursue the work of Campagne. The working group that was set up, the Study Commission, gave its report to OECD in 1963. A member of Campagne's working group and this Study Commission, Professor de Mori, summarized the developments in a paper published in 1965 (de Mori, 1965).

The Study Commission developed the work started by Campagne and proposed alternative criteria for the minimum solvency margin based on three ratios, or yardsticks, according to Schlude (1979):

<sup>4</sup>From 2004 this organization was named CEIOPS (Committee of European Insurance and Occupational Pensions Supervisors).

- Free assets to premiums received during the last year
- Free assets to average incurred claims over the last 3 years
- Free assets to technical reserves

Data from five countries for a period of 10 years (1951 to 1960) were used. It was assumed that the gross loss ratio (gross claims paid divided by gross premiums earned) was following a normal distribution. The pragmatic solution for the solvency margin was to calculate it as  $\bar{x} + 3s$  (mean + 3 standard deviations). The results from different countries were weighted proportionally to their market share. This procedure gave the following standards of solvency margin (see, e.g., de Mori, 1965; Kastelijn and Remmerswaal, 1986):

- 24% of gross premiums written
- 34% of incurred claims
- 19% of technical reserves

These percentages were also calculated for different branches as transport, cars, and others.

The method of using the technical reserves presupposes that they are set up in a uniform manner in various countries. However, as this was not the case, this approach was not used further. As claims payment fluctuates between years, it was proposed that an average over the last three financial years should be used.

Some further work by Professor de Mori was carried out for CEA (the Comité Européen des Assurances) in the mid-1960s. The discussions were also going on in two working groups set up in 1965 by the OECD. One considered additional guarantees of security (the de Florinier group) and one the estimation of technical reserves (the Homewood group). Reports from these two working groups were published in 1969 and 1976.

The OECD framework was built on solvency margins for insurance companies operating on an international market, and many countries wanted the solvency margin to be applicable for companies operating only on domestic markets. In 1976 the Conference of EEC Insurance Supervisory Authorities set up a working group to study the harmonization of technical reserves (the Angerer group). A report from this group was published in 1979.

---

### 3.3 The Non-Life Directives (First, Second, and Third)

Some countries thought that the proposed percentages for solvency made by the Study Commission were too high, and some countries thought that they were only sufficient; a compromise was eventually achieved (Schlude,

1979). The (required) solvency margin should be the higher of two indices, viz., the *premium index* and the *claims index*.

For the premium index:

- 18% of gross premiums up to 10 million units<sup>5</sup>
- 16% of gross premiums in excess of 10 million units

For the claims index:

- 26% of gross average incurred claims up to 7 million units
- 23% of gross average incurred claims in excess of 7 million units

The average in the claims index is usually taken over the last 3 years (7 years for certain risks, such as storms and hail). The result is reduced for reinsurance by the ratio (net paid claims)/(gross paid claims), with a maximum reduction of 50%. The shift from the premium index to the claims index will normally take place when the loss ratio is approximately 69% ( $18 / 26 \approx 16 / 23 \approx 69\%$ ).

As stated by Schlude (1979, p. 28), one objection against this system is that it does not take account of the structure of a company's losses. One could argue that the solvency requirement for a company with 10 claims each amounting to 100,000 units should be higher than the requirement for a company with 1000 claims each amounting to 1000 units.

It must also be decided which assets should be used to cover the solvency margin when it has been calculated. This is stated in the directive.

There are also two concepts of *guarantee funds*:

- The relative guarantee fund is one third of the minimum solvency margin and termed the *minimum guarantee fund*.
- The *absolute guarantee fund*, or minimum fund, is a fixed amount categorized according to branches of insurance, e.g., 300,000 units of account in the case where all or some of the risks included in one of the classes listed in point A of Appendix B under numbers 1 to 8 and 16 are covered.<sup>6</sup>

If the net worth of a company is less than its minimum solvency margin, the supervisory authority must ask the company to set up a plan to restore sound financial relations (the *solvency plan*). If the company's net worth is less than the absolute guarantee fund, the supervisory authority must require a *finance plan* for a short-term procurement of net worth. It is then

<sup>5</sup> Article 5(a) of the first non-life directive defines the units of account: "means that unit which is defined in Article 4 of the Statute of the European Investment Bank."

<sup>6</sup> If the insurer is authorized to only write property damage or legal expense insurance, the minimum was set to 200,000 units of accounts, and if it is authorized to write any class of liability, credit, or suretyship insurance, the minimum was set to 400,000 units of accounts.

also possible for the supervisory authority to restrict or suspend the company from disposal of its assets.

The purpose of this first directive was to remove restrictions on the opening of branches and agencies by insurance undertaking in other member states. In order to do so, it was essential to eliminate differences in national supervisory legislations and to coordinate provisions relating to financial guarantees. It was important to have a clear definition of an insurance undertaking, and this is done in this first directive. As noted by Pool (1990), there was no definition of insurance, a fact that produced difficulties later. The structure of this first non-life directive (EEC, 1973) is given below:

Title I: General provisions

Articles 1 to 5

Title II: Rules applicable to undertakings whose head offices are situated within the community

Section A: Conditions of admission

Articles 6 to 12

Section B: Conditions for exercise of business

Articles 13 to 21

Article 15: Technical reserves

Article 16: Solvency (paragraph 1-4 is given in Appendix C)

Article 17: Guarantee fund (see Appendix C)

Article 20: The solvency plan and the financial plan

Section C: Withdrawal of authorization

Article 22

Title III: Rules applicable to agencies or branches established within the community and belonging to undertakings whose head offices are outside the community

Articles 23 to 29

Title IV: Transitional and other provisions

Articles 30 to 32

Title V: Final provisions

Articles 33 to 38

Annex

- A. Classification of risks according to classes of insurance (see below)
- B. Description of authorizations granted for more than one class of insurance
- C. Ancillary risks



The calculation of solvency is stated in Article 16, paragraph 1-4, and the guarantee fund is defined in Article 17 (see Appendix C).

The last sentence of Article 16, paragraph 1 ("at the report of ..."; see Appendix C) was a nonharmonization item, which produced differences between the member states. The hidden reserves, mentioned in this first paragraph, are usually the difference between the current market value and the purchase price of investments. The solvency margin, which does not include the technical provisions (reserves), is a sort of free reserve held above the technical provisions.

The commission invited Groupe Consultatif (GC) to comment on a report on the experience of the first non-life directive in 1979. The 1-year-old GC did not, at that time, feel able to prepare a report (Henty, 2003). At its meeting in 1980 it was decided to establish a Solvency Margin Committee. A solvency report was submitted to the GC's meeting in 1986, but as it included sensitive issues, it was not published. The technical annexes were made available to the member associations, including a note on the shortcomings of the solvency margins as defined in the first directives (both non-life and life directives). In 1988 the solvency issues were taken over by GC's new Insurance Committee.

One main feature of the directive was that it called for close cooperation between the national supervisory authorities within the member states. The directive was not intended to deal with *freedom of services*, which means the right of an insurance undertaking established in one member state to cover risks and policyholders in another member state without making an establishment in that state. As early as 1975 the commission had put forward a proposal for a second non-life insurance directive. It proposed an early expression of the principle of *home country control* with mutual recognition of standards (Pool, 1990). This means that an insurer established in country A but wishing to cover risks in country B would have to apply to its own supervisory authority in A for getting permission. The freedom of services would mean that the insurer could insist that the law of his country should be used to interpret contracts. In the European Parliament the main objection in 1978 against this was that all policyholders, even the small ones, would find themselves having contracts that followed an unfamiliar law from another country. The proposal from 1975 was amended as the commission accepted this argument and decided that a distinction between *large and small risks* should be made. Large risks should follow the law in the country of the insurer, but small risks should follow the law of the country where the risk is situated. The negotiations about this proposal were discontinued in 1985.

In 1987 the council working party on economic questions met and discussed the proposed second non-life directive. This led to the adoption of the second non-life insurance coordination directive on June 22, 1988 (EEC, 1988). The solvency rules defined in the first directive were not changed.

The structure of this second directive is as follows:

Title I: General provisions (Articles 1 to 4)

Definitions

Title II: Provisions supplementary to the first directive (Articles 5 to 11)

Large risks are defined in terms of the risks classified in the annex of the first directive

Title III: Provisions peculiar to the freedom to provide services (Articles 12 to 26)

Title IV: Transitional arrangements (Article 27)

Title V: Final provisions (Articles 28 to 35)

Annex 1: Matching rules

Annex 2A and B: Underwriting account

This was an important step toward the internal market in insurance, as this was established for large risks, but the commission was not satisfied with it, as it did not make the internal market complete for all insurance risks. In 1989 it was announced that the policy of the commission was to achieve freedom of services with home country control and using a single-license concept. This means that an insurance undertaking within the community only needed to have one authorization, i.e., the one from the state of its head office.

The structure of the third non-life directive followed a structure that had already been adopted by the second banking directive and is as follows (EEC, 1992a):

Title I: Definition and scope (Articles 1 to 3)

Title II: The taking up of the business of insurance (Articles 4 to 8)

Title III: Harmonization of conditions governing pursuit of business (Articles 9 to 31)

Article 24 replaces Article 16(1) from the first directive; for the new article, see Appendix C

Title IV: Provisions relating to freedom of establishment and freedom to provide services (Articles 32 to 46)

Title V: Transitional provisions (Articles 47 to 50)

Title VI: Final provisions (Articles 51 to 58)

### **3.3.1 Equalization Reserves**

According to the credit insurance directive (EEC, 1987), all insurance companies underwriting credit insurance have to set up an equalization reserve. It cannot be used for calculation of the solvency margin. In the directive, there are four methods for the calculation of the reserve that can be used by the member states. A summary of the methods and how they are used in

EU countries is given in Wolthuis and Goovaerts (1997). The credit insurance and the equalization reserve were introduced in the third non-life directive in Article 18 on the amendment of Article 15a from the first non-life directive.

### Article 15a

1. Member States shall require every insurance undertaking with a head office within their territories which underwrites risks included in class 14 in point A of the Annex (hereinafter referred to as “credit insurance”) to set up an equalization reserve for the purpose of offsetting any technical deficit or above-average claims ratios arising in that class in any financial year.
2. The equalization reserve shall be calculated in accordance with the rules laid down by the home Member State in accordance with one of the four methods set out in point D of the Annex, which shall be regarded as equivalent.
3. Up to the amount calculated in accordance with the methods set out in point D of the Annex, the equalization reserve shall be disregarded for the purpose of calculating the solvency margin.
4. Member States may exempt insurance undertakings with head offices within their territories from the obligation to set up equalization reserves for credit insurance business where the premiums or contributions receivable in respect of credit insurance are less than 4% of the total premiums or contributions receivable by them and less than ECU 2,500,000.

Equalization reserves are also used for other lines of business (LOBs) in different countries. In some countries the reserve is accepted by the tax authority, meaning that it is tax deductible; in others they are not allowed according to the local tax authorities. In Germany we have the *Schwankungsrückstellung*, and in Finland (see Section 6.4), the equalization reserve has been the main solvency pillar since the beginning of the 1950s. In Sweden there is a similar system that is prescribed by the supervisory authority and accepted by the tax authority as tax exempted.

---

### 3.4 The Life Directives (First, Second, and Third)

The two first non-life and life directives have a similar structure, reflecting the same approach to the problem they dealt with. The solvency approaches were also both mainly based on the Campagne (1961) proposals. As the member states had differing positions on both the composition and the amount of the solvency margin, the final result was a collection of compro-

mises (Pool, 1990, p. 36). The first two articles of the directive defines, in a broad sense, what insurance activities should be defined as life insurance, e.g., Article 1(1)(d): “the type of insurance existing in Ireland and the United Kingdom known as permanent health insurance not subject to cancellation.” It was up to the member states to decide if pension funds should be included in the directive.

The basic formula for the (required) solvency margin for life insurance companies was set up in the first life directive (EEC, 1979), mainly as:

First result: 4% of the mathematical reserves (gross of reinsurance)

+

Second result: 0.3% of the capital sum at risk

According to Kastelijn and Remmerswaal (1986, p. 30), this base formula could be used and accepted for:

- *Reinsurance*: The maximum allowance can be 15% of the mathematical reserves and 50% of the capital sum at risk.
- *Short-term temporary insurance*: A reduction of the 0.3% margin is possible.
- *Supplementary insurance and accidental death benefit*: The coverages of the non-life margins apply (see Section 3.3).

Zillmer adjustments of beyond 3.5% of the capital sum at risk are not allowed (see below).

According to Article 18 of the directive, the solvency margin shall consist of:

1. The assets of the undertaking (free of all liabilities, less intangibles), especially:
  - The paid-up share capital (or the paid-up amount of the mutual's fund)
  - One half of the unpaid-up share capital/fund once 25% of such capital/fund is paid up
  - Statutory reserves and free reserves not corresponding to the liabilities
  - Any carry forward of profits
2. Profit reserves, appearing in the balance sheet
3. With the agreement of the supervisory authority:
  - An amount equal to 50% of future profits: a factor (<10) times the estimated annual profit. The factor represents the average remaining duration left for the policies. The estimated annual profit is the average over the last 5 years for some activities (see Article 1)

- The difference between a non- or partially zillmerized reserve and a zillmerized reserve at a rate equal to the loading for acquisition costs included in the premium; the rate must not be >3.5%
- Hidden reserves

The minimum solvency margin defined above (and in Article 19) is, however, not a wind-up barrier, but an *early warning signal*. The guarantee fund (see Article 20) gives the wind-up barrier.

The structure of the first life directive (EEC, 1979) is given below. Note that the calculation of solvency is stated in Articles 18 and 19, and the guarantee fund is defined in Article 19; see Appendix D for the full text of these articles.

#### Title I: General provisions

Articles 1 to 5

Articles 1 and 2: The diversity of operations

#### Title II: Rules applicable to undertakings whose head offices are situated within the community

##### Section A: Conditions of admission

Articles 6 to 14

Article 13: The separation of life and non-life insurance undertakings

Article 14: Separate accounting for life and non-life insurance undertakings

##### Section B: Conditions for carrying on activities

Articles 15 to 25

Article 17: Technical reserves

Articles 18 and 19: Solvency (see Appendix D)

Article 20: Guarantee fund (see Appendix D)

Article 24: The solvency plan and the financial plan

##### Section C: Withdrawal of authorization

Article 26

#### Title III: Rules applicable to agencies or branches established within the community and belonging to undertakings whose head offices are outside the community

Articles 27 to 32

#### Title IV: Transitional and other provisions

Articles 33 to 37