GROUPE CONSULTATIF DES ASSOCIATIONS D'ACTUAIRES
DES PAYS DES COMMUNAUTÉS EUROPÉENNES

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THE SECOND ACTUARIAL STUDY OF MORTALITY IN EUROPE

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Foreword by the Chairman of the Groupe Consultatif

The first *Actuarial Study of Mortality in the Countries of the European Communities* was published by the Groupe Consultatif in 1986 under the editorship of Professor J J McCutcheon of Heriot Watt University in Edinburgh. It presented in one volume the more important mortality data used for life assurance in 9 countries of the European Communities. The present study covers all Members States of the European Union apart from Luxembourg, and also includes Iceland, Norway and Switzerland, where the actuarial associations are Observer Members of the Groupe Consultatif.

The Groupe Consultatif attaches much importance to the contribution it can make to the development of the actuarial profession in Europe through its programme of Colloquia and Summer Schools, and publications of actuarial interest. I am sure this latest publication will make a valuable addition to that programme.

The Groupe Consultatif would like to thank, in particular, the editor, Angus Macdonald, a Fellow of the Faculty of Actuaries and a lecturer in actuarial science at Heriot Watt University in Edinburgh, for the considerable amount of work he has undertaken in completing this study. The Groupe is also grateful to those of its members and other distinguished colleagues who have contributed to this study on behalf of their national association.

Dirk van Berlaer
Chairman, Groupe Consultatif

July 1997

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Chapter 1

Editorial commentary

1.1 Introduction

This is the second survey of mortality to be compiled on behalf of the Groupe Consultatif des Associations d'Actuaries des Payes des Communautés Européennes. The first was published in 1986, edited by Prof. J. J. McCutcheon, and is now out of print. This survey owes much to the lead given by the previous edition. There are also some important differences.

1. The number of contributing associations is much greater than in 1986, both because of the enlargement of the European Union, and because of the participation of the actuarial associations in Iceland, Norway and Switzerland. Thus the scope of the survey has expanded considerably, and its title has changed to reflect the fact that non-member states are included. Not yet included are the countries of Central Europe, some of which are likely to join the E.U. in future.

2. The development of desktop computing since 1986 means that data are most conveniently presented in digital form. Instead of printed tables of mortality rates, this volume is accompanied by a disk (in IBM-PC format) which contains most of the tables referred to in the text, in a simple text format which can be read by most spreadsheet and text-processing packages.

3. A larger number of the associations contributing to this edition carry out investigations of insured lives mortality than was the case in 1986 (many have done so for a long time but were not contributers in 1986).

4. In some E.U. member states, the Third Life Directive has loosened the regulatory control of the mortality bases for tariffs and for reserving. This is especially important in the case of pensions and annuity business, where the risk arises from longevity and not mortality. The practice of projecting future improvements in mortality to offset longevity risk is more widespread than in 1986.

5. Two developments have taken place since 1986: the appearance of AIDS, and advances in genetic science which might lead to very specific tests of susceptibility to disease in asymptomatic persons.

   In retrospect, the impact of AIDS on life insurers has been much less than its impact on the population at large might have suggested. The relative importance of drug abuse in its spread has undoubtedly been a factor, since the participating lives are relatively unlikely to buy life assurance. Consequently, this survey has very little to say on AIDS.

   The possible effect of genetic testing on the conduct of life assurance is as uncertain now, as perhaps the effect of AIDS was 10 years ago, and for that reason there is no comment in this survey. The interested reader is referred to Chuffart (1996) [1] and Macdonald (1997) [3]. The European Commission, and individual governments, are certainly concerned about the possible consequences for reasonable access to insurance, especially where private insurance plays a larger rôle than the state in providing basic services; perhaps genetics will be a major focus of the third edition of this survey, if that should be written.

The remainder of this editorial chapter presents a short comparison of the data submitted by the contributors. The comparisons made are not precise: different investigations, in different countries, relate to different periods; perhaps more important, the data are mostly tables of graduated rates of mortality, produced using many different methods and adjustments.

The 1986 edition included a comparison of the mortality of the general populations of the contributing countries, based mainly on the data in the United Nations Demographic Yearbooks. This has not been done for this edition, partly because it was long enough already, and partly because such a survey, in respect of the world and not only of Europe, is being prepared by a Faculty of Actuaries Research Group for the International Congress of Actuaries in Birmingham in 1998, and should appear in due course in *British Actuarial Journal*.

Country	Last Census	Mid-1994 Estimate
Austria	1989	8,031,000
Belgium	1991	10,080,000
Denmark	1991	5,205,000
Finland	1990	5,095,000
France	1990	57,747,000
Germany	1987	81,410,000
Greece	1991	10,426,000
Iceland	1970	266,000
Ireland	1991	3,571,000
Italy	1991	57,193,000
Luxembourg	1991	401,000
Netherlands	1971	15,380,000
Norway	1990	4,325,000
Portugal	1991	9,830,000
Spain	1991	39,143,000
Sweden	1990	8,780,000
Switzerland	1990	6,995,000
United Kingdom	1991	58,091,000

Table 1.1: **Estimated mid-1994 populations of Western European countries (source: United Nations Ststiatical Yearbook, 41st Issue).**

1.2 Population Mortality

Table 1.1 shows the numbers of persons enumerated at the most recent censused in the countries covered by this survey.

Figures 1.1 and 1.2 show mortality rates q_x (on a logarithmic scale) in respect of male and female populations, respectively, for all countries for which these were supplied[1][2][3]. These are meant to give an overall impression

[1]All countries are represented except France and Ireland, for which no population mortality data were supplied.

[2]In the case of the Netherlands, the data supplied were graduated rates prepared for insurance purposes, but based on population mortality.

[3]These data all relate to the late 1980s or early 1990s, with the exception of Greece, Spain, Switzerland and the U.K..

		Males		Females	
	Period	Age 0	Age 1	Age 0	Age 1
Aus	1990–92	0.008469	0.000535	0.006710	0.000468
Den	1991–92	0.008420	0.000730	0.006260	0.000560
Fin	1986–90	0.006650	0.000360	0.005550	0.000440
Ger	1990–92	0.007392	0.000604	0.005761	0.000539
Gre	1980	0.022660	0.001040	0.018400	0.000910
Ita	1991	0.008800	0.000470	0.007020	0.000430
Por	1994	0.009058	0.000987	0.000689	0.000458
Spa	1982	0.012964	0.001011	0.010140	0.000839
Swe	1993	0.009392	0.000903	0.007257	0.000704
Swi	1978–83	0.009487	0.000887	0.007073	0.000677
UK	1980–82	0.012710	0.000850	0.009840	0.000720

Table 1.2: **Comparison of infant mortality, q_x at ages 0 and 1.**

only, being rather crowded; more detailed examination follows.

It is interesting to look in more detail at ages 1–30, because this includes two major features of most modern experiences: the decline of mortality after the first year of life, and the 'accident hump'. Further, insured lives data usually yields no information at very low ages. Figures 1.3 and 1.4 show mortality rates q_x at these ages, where supplied[4] The first year of life (q_0) has been omitted to make the scale clearer.

More information can be gained by comparing mortality rates at the ages of most financial importance. Figures 1.5 and 1.6 show q_x at ages 25–85, as a proportion of the rates for West Germany in 1990–92 (the ADSt 1990/92 tables). These were chosen as a basis for comparison because they are relatively recent, and lie roughly in the middle of the range.

Table 1.2 compares rates of mortality at ages 0 and 1, the latter for comparison with truly infant mortality[5]. q_0 is conspicuously high in Greece, followed by Spain and the U.K., but these are based on slightly older tables.

Tables 1.3 and 1.4 show, for males and females respectively, sample values

[4]Rates from age 20 only in the cases of Belgium and Iceland.

[5]The Netherlands is omitted because the mortality table provided assumes level mortality at low ages. Norway is omitted because the graduated data apply to ages 15–89 only.

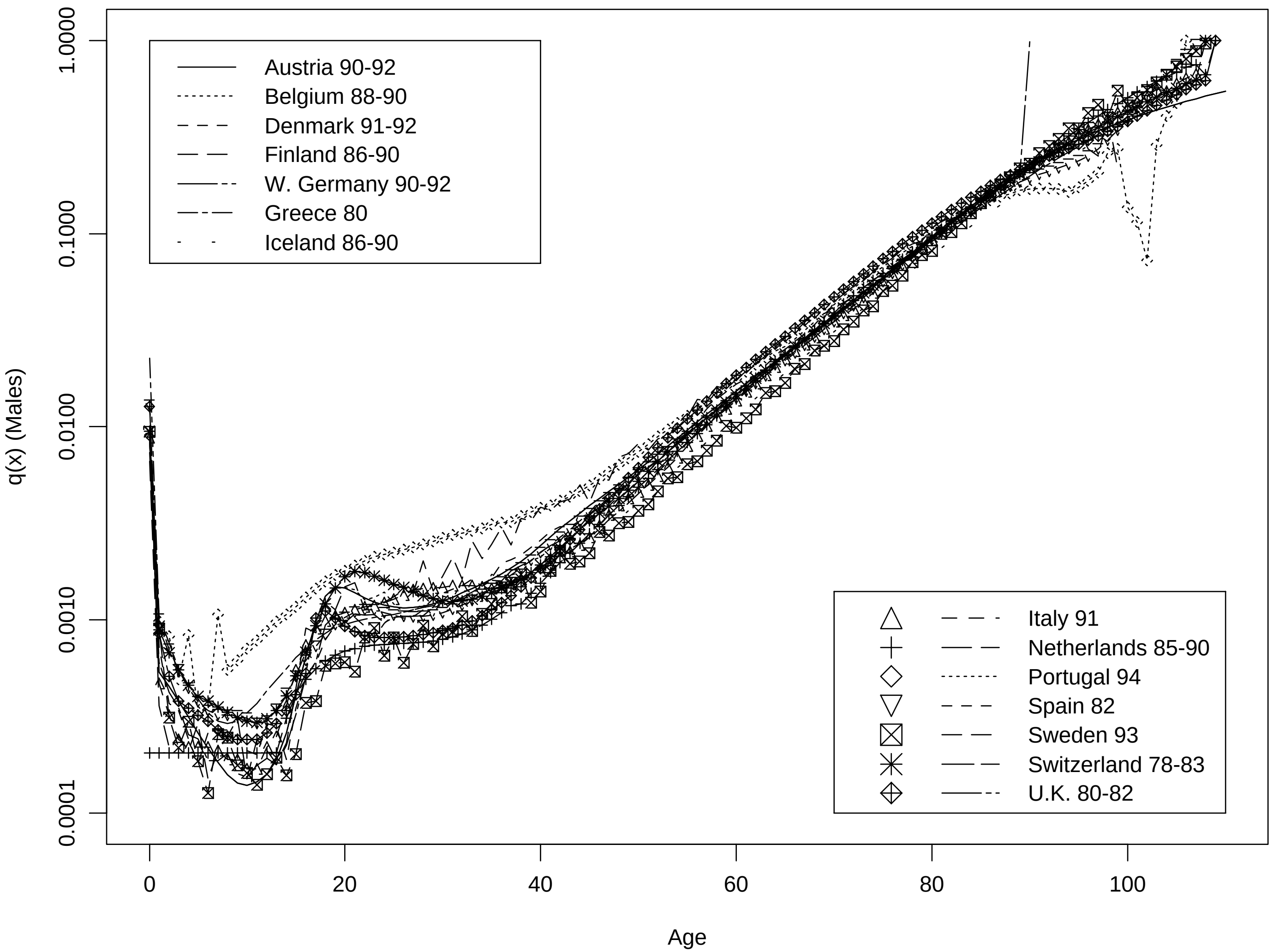

Figure 1.1: **Population mortality rates (log scale), Males.**

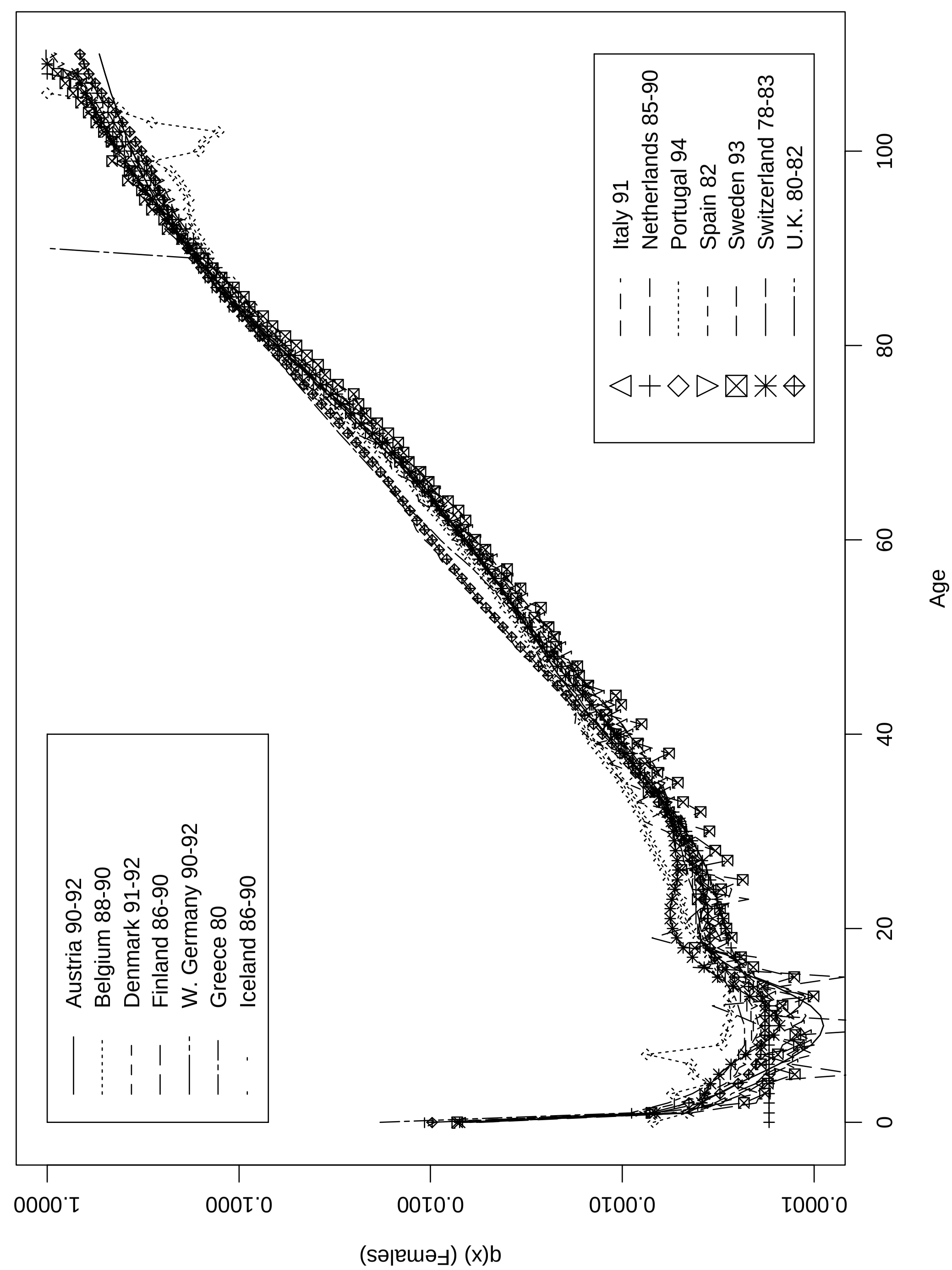

Figure 1.2: **Population mortality rates (log scale), Females.**

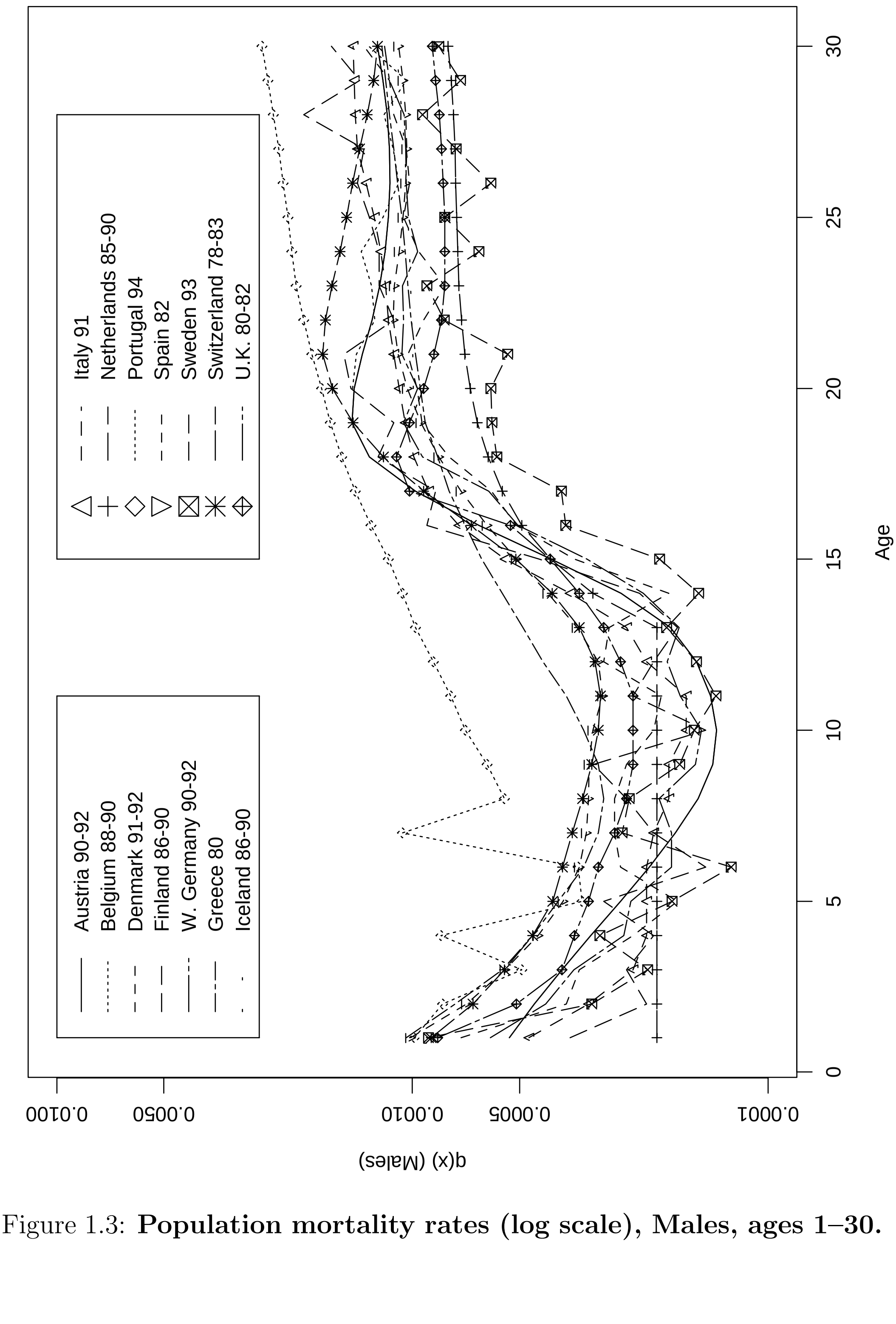

Figure 1.3: **Population mortality rates (log scale), Males, ages 1–30.**

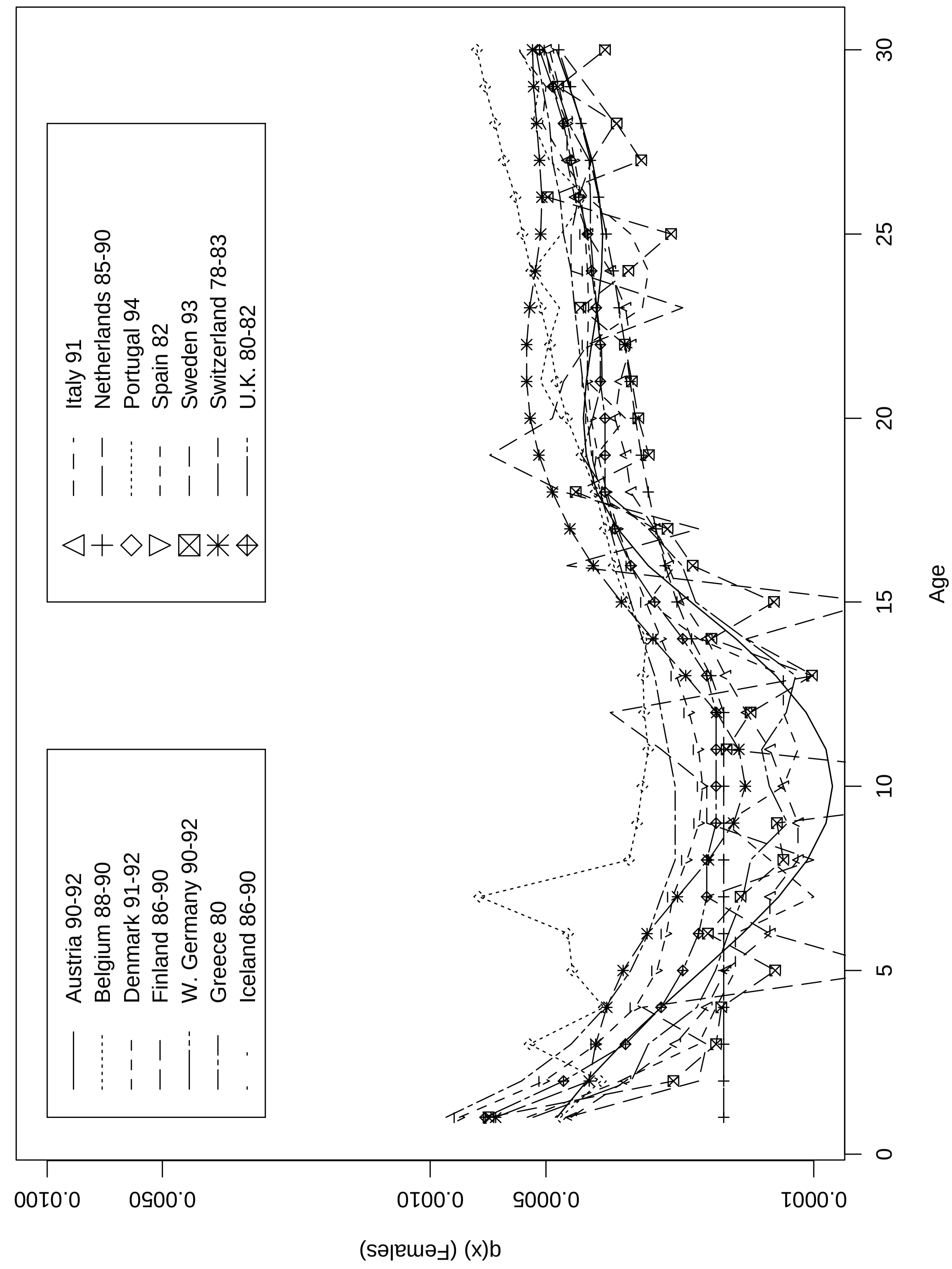

Figure 1.4: **Population mortality rates (log scale), Females, ages 1–30.**

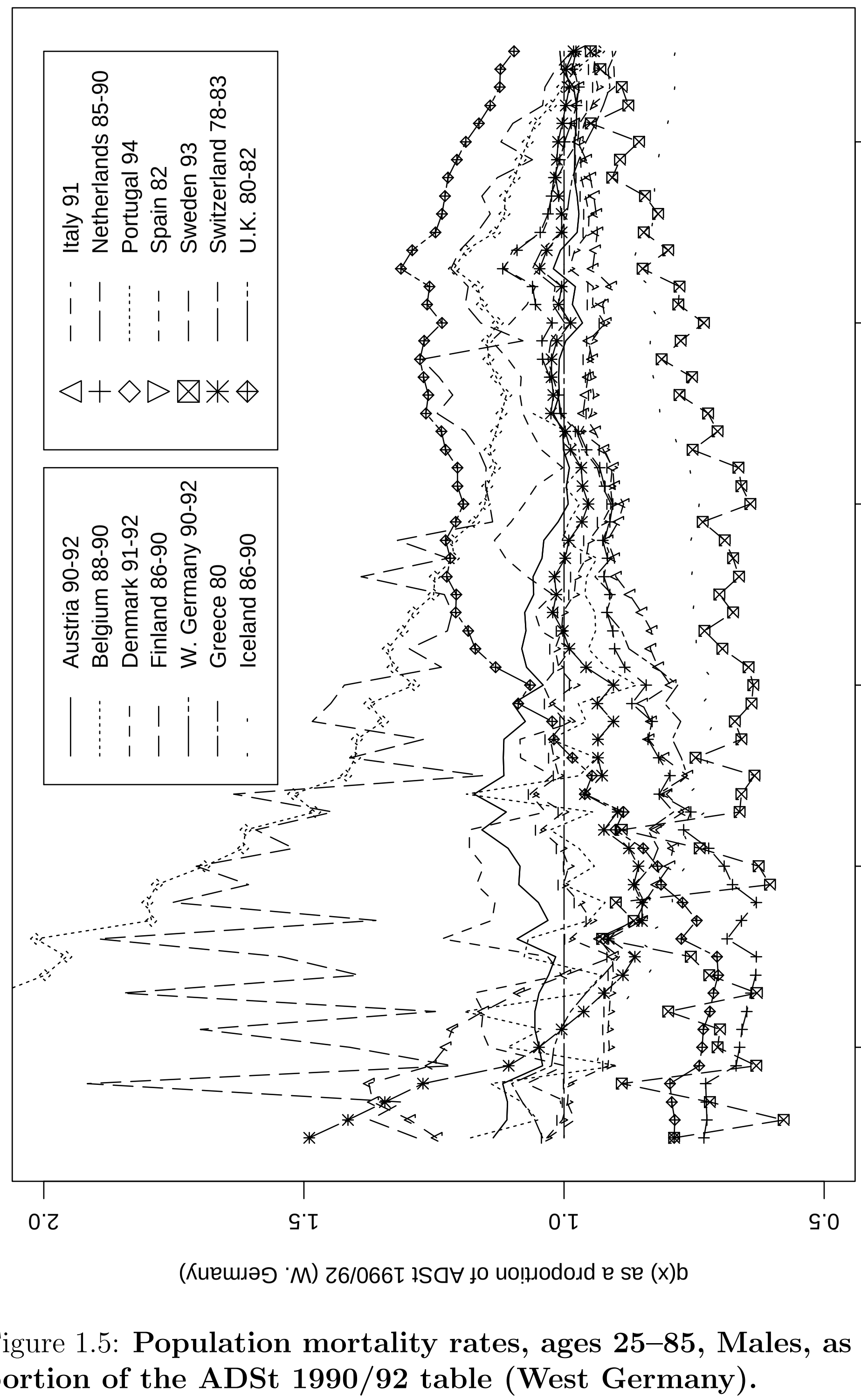

Figure 1.5: **Population mortality rates, ages 25–85, Males, as a proportion of the ADSt 1990/92 table (West Germany).**

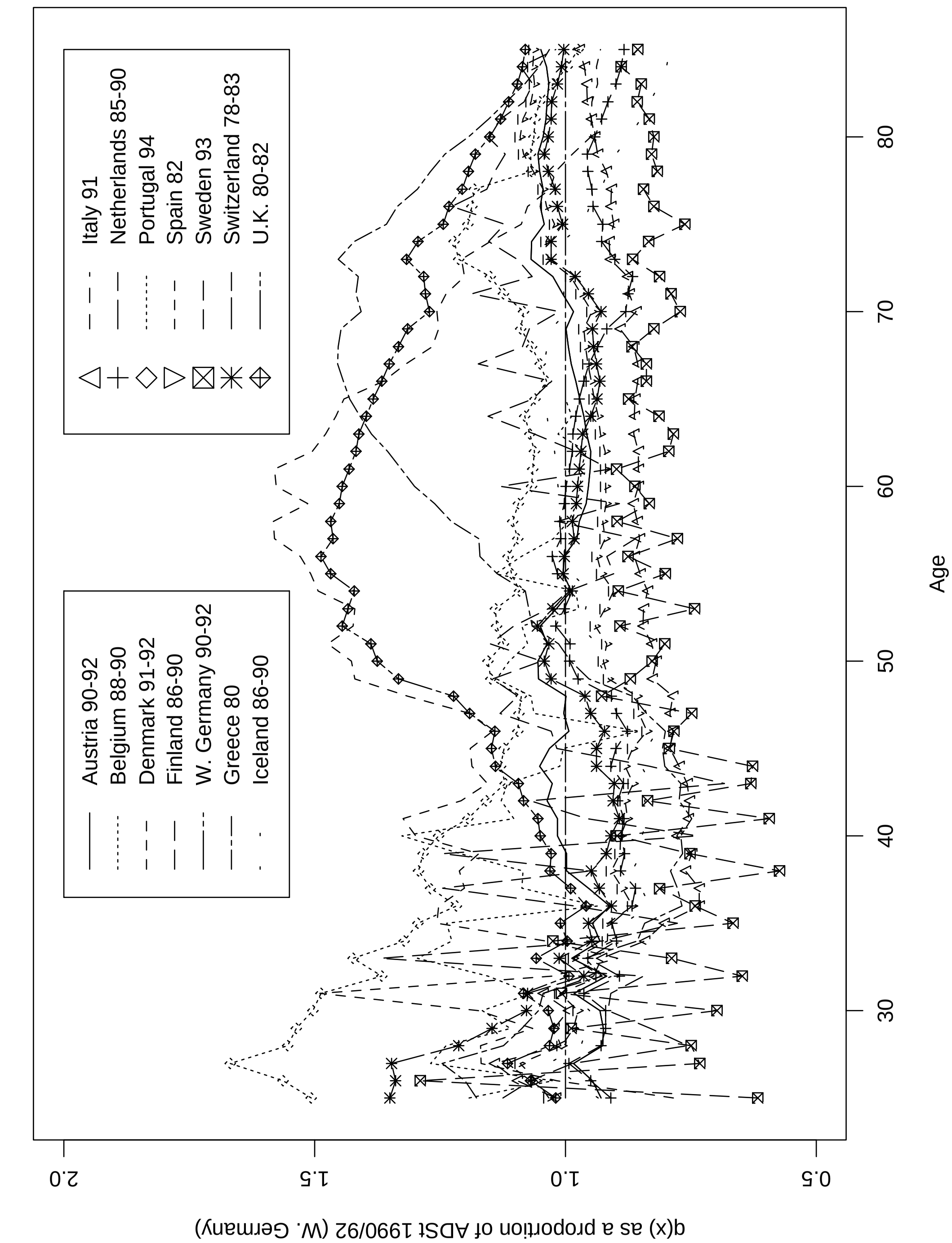

Figure 1.6: **Population mortality rates, ages 25–85, Females, as a proportion of the ADSt 1990/92 table (West Germany).**

of q_x from the national mortality tables. Comparisons should be made with caution, for the reasons mentioned before.

1.3 Assured lives mortality

Tables 1.5 and 1.6 show sample rates of mortality from the tables identified by correspondents as being most often or always used for basic assurance tariffs, where these were also supplied[6]. These vary as widely as the practices in the different countries, a brief summary of which follows (note that as the contributions were written while the Third Life Directive was being adopted, the situation is rather fluid). In some cases, different tables are used for particular types of business, such as pure endowments or deferred annuities during deferral; see the individual articles for detail.

Austria Most insurance companies use the OEV 1980-82 table (population data smoothed between ages 18–32).

Belgium The MK and FK tables are the minimum rates which may be used (Makeham formula).

Denmark The G82 table is used for all business (Makeham formula).

Finland All companies use the given tables, based on an analysis of their pooled experience (Makeham formula).

France The TD 88–90 tables are those laid down by statute, but since 1993 companies have been able to substitute an experience table provided it is certified by an actuary.

Germany The DAV Mortality Table 1994T was prepared following the cessation of the licencing requirement by the BAV. It was based on a spline graduation of 1986–88 population data.

Greece In the past, the French table PM 60–64 MKH was used, but companies now use a variety of tables. There is no Greek assured lives table.

[6]The rates shown for The Netherlands apply to mid-years of age; for example the entry under age 50 is in fact $q_5 0.0$ and so on.

	Period	Age 10	Age 20	Age 30	Age 40	Age 50	Age 60
Aus	1990–92	0.000140	0.001461	0.001254	0.002434	0.006004	0.015316
Bel	1988–90		0.001475	0.001327	0.002114	0.004964	0.014979
Den	1991–92	0.000210	0.000970	0.001370	0.002590	0.006000	0.016620
Fin	1986–90	0.000150	0.001490	0.001690	0.003830	0.008210	0.017650
Ger	1990–92	0.000154	0.000968	0.001197	0.002244	0.005771	0.015442
Gre	1980	0.000330	0.000950	0.001220	0.001870	0.004510	0.014040
Ice	1986–90		0.000994	0.001113	0.001717	0.004067	0.011431
Ita	1991	0.000170	0.001090	0.001470	0.001790	0.004590	0.013670
Net	1985–90	0.000205	0.000689	0.000794	0.001552	0.004859	0.013999
Nor	1993		0.000700	0.001000	0.001900	0.004300	0.011300
Por	1994	0.000711	0.001799	0.002653	0.003794	0.007436	0.017786
Spa	1982	0.000311	0.001034	0.001093	0.002224	0.005650	0.014012
Swe	1993	0.000161	0.000603	0.000844	0.001404	0.003669	0.009914
Swi	1978–83	0.000300	0.001676	0.001255	0.001923	0.005225	0.014712
UK	1980–82	0.000240	0.000930	0.000880	0.001840	0.006150	0.018430

	Period	Age 70	Age 80	Age 90	Age 100	Age 110	
Aus	1990–92	0.036769	0.093411	0.228967	0.388045	0.548035	
Bel	1988–90						
Den	1991–92	0.042050	0.092840	0.205160			
Fin	1986–90	0.044210	0.106900	0.212080			
Ger	1990–92	0.038108	0.095367	1.000000			
Gre	1980	0.038060	0.091360	0.198780	0.401230		
Ice	1986–90	0.031016	0.077472	0.179245			
Ita	1991	0.035060	0.092870	0.220200	0.452510		
Net	1985–90	0.038977	0.095276	0.228921	0.505631		
Nor	1993	0.031100	0.087200				
Por	1994	0.042934	0.101975	0.170160	0.137255		
Spa	1982	0.035124	0.092575	0.194370	0.391292		
Swe	1993	0.027852	0.081601	0.229911	0.461390		
Swi	1978–83	0.037614	0.096444	0.218595	0.429449		
UK	1980–82	0.047030	0.113340	0.226930	0.380870		

Table 1.3: **Comparison of population mortality, q_x Males.**

	Period	Age 10	Age 20	Age 30	Age 40	Age 50	Age 60
Aus	1990–92	0.000089	0.000399	0.000468	0.001227	0.002899	0.006514
Bel	1988–90		0.000457	0.000586	0.001603	0.003056	0.006623
Den	1991–92	0.000120	0.000310	0.000590	0.001570	0.003920	0.010760
Fin	1986–90	0.000190	0.000480	0.000460	0.000890	0.002880	0.007710
Ger	1990–92	0.000130	0.000377	0.000503	0.001209	0.002748	0.006824
Gre	1980	0.000230	0.000390	0.000530	0.000930	0.002720	0.008880
Ice	1986–90		0.000286	0.000479	0.001025	0.002569	0.006925
Ita	1991	0.000120	0.000330	0.000500	0.000940	0.002250	0.005830
Net	1985–90	0.000172	0.000292	0.000462	0.001075	0.002727	0.006818
Nor	1993		0.000300	0.000400	0.000800	0.001900	0.005400
Por	1994	0.000280	0.000440	0.000756	0.001514	0.003171	0.007289
Spa	1982	0.000195	0.000381	0.000490	0.001076	0.002541	0.006281
Swe	1993	0.000021	0.000287	0.000351	0.001084	0.002272	0.005882
Swi	1978–83	0.000151	0.000549	0.000542	0.001099	0.002863	0.006662
UK	1980–82	0.000180	0.000350	0.000520	0.001270	0.003780	0.009860

	Period	Age 70	Age 80	Age 90	Age 100	Age 110	
Aus	1990–92	0.018895	0.063345	0.188577	0.359620	0.534809	
Bel	1988–90						
Den	1991–92	0.024140	0.057620	0.178650			
Fin	1986–90	0.019450	0.070050	0.197970			
Ger	1990–92	0.019213	0.060659	1.000000			
Gre	1980	0.027030	0.072410	0.174780	0.386140		
Ice	1986–90	0.019151	0.052941	0.142390			
Ita	1991	0.016520	0.057120	0.178410	0.433420		
Net	1985–90	0.016904	0.057114	0.157473	0.362898		
Nor	1993	0.016500	0.051300				
Por	1994	0.020813	0.064511	0.152169	0.161832		
Spa	1982	0.018199	0.066172	0.175363	0.344688	0.954907	
Swe	1993	0.014811	0.050007	0.176616	0.420792		
Swi	1978–83	0.017860	0.062718	0.180658	0.421087		
UK	1980–82	0.024430	0.069820	0.184680	0.322520	0.673910	

Table 1.4: **Comparison of population mortality, q_x Females.**

Ireland U.K. tables are usually used, mainly the '80' series tables but in some cases the older tables based on the 1967–70 experience.

Italy Tariffs are based on the SIM81 table of population mortality based on the 1981 census.

The Netherlands Population mortality tables smoothed by Makeham formulae are used. The GBM 1961–65 tables were adopted in the mid 1980s, and some companies have adopted the GBM/V 1976–80 tables (GBM 76–80 is shown in the Tables 1.5 and 1.6).

Norway The T1984 table based on insured lives data was that used in the last revision of the common tariff, but companies now are not obliged to follow a common tariff (Makeham formula).

Portugal Until 1994, the French tables PM/F-60/64 were used in the obligatory tariff. There is no Portuguese assured lives table.

Sweden The M64 table is used for all business (Makeham formula). For technical calculations, selection is represented by omitting the constant term in the Makeham formula for durations 0–4.

Switzerland Tariffs are deregulated from 1995. The GKM/F 1980 tables are based on group life experience in 1971–75 (polynomial formula below age 50, logit-Makeham formula above age 50). A table based on the individual assured lives experience of 1986–90 was under preparation at the time of writing.

United Kingdom There is no regulation of tariffs. The AM80 and AF80 tables were based on the pooled experience of offices in 1979–82 (generalised Gompertz-Makeham formulae, with adjustments). The usual select period is 2 years, though an AM80 5-year select table was prepared. A separate table for term assurance business was also prepared.

There is a striking contrast between (i) the practice of using population mortality data, often from some previous period, smoothed in a very simple way (usually a Makeham formula); and (ii) the practice of constructing tables from experience data for different classes of business, and applying more elaborate methods of graduation. Clearly, the former practice works best with regulated, conservative tariffs. As a consequence of the Third Life

Directive, and de-regulation in general, there is a move towards the latter in several countries.

1.4 Annuitants' and Pensioners' mortality

Tables 1.7 and 1.8 show sample rates of mortality from the tables identified by correspondents as being most often or always used for basic annuity tariffs, where these were also supplied[7].

The figures shown in respect of Austria, France, Germany, Italy and the U.K. are base tables used to project future mortality improvement. This is described in Section 1.5. Some comments on the tariffs follow (note that as the contributions were written while the Third Life Directive was being adopted, the situation is rather fluid).

Austria The EROM/F G 1950 tables represent the mortality of lives born in 1950, projected into the future. It is used with a table of age adjustments for other generations.

Belgium The MR and FR tables are the maximum rates which may be used (Makeham formula).

Denmark The G82 table is used for all business (Makeham formula).

Finland All companies use the given tables, based on an analysis of their pooled experience (Makeham formula).

France The TPRV 93 represent the mortality of lives born in 1950, projected into the future. It is used with a table of age adjustments for other generations.

Germany The DAV Mortality Table 1994 R is a projected table appropriate for lives born in 1952–58 (males) and 1952–57 (females).It is used with a table of age adjustments for other generations.

Ireland U.K. tables are usually used, mainly the '80' series tables but in some cases the older tables based on the 1967–70 experience.

[7]The rates shown for The Netherlands apply to mid-years of age; for example the entry under age 50 is in fact $q_5 0.0$ and so on.

	Table	Age 20	Age 30	Age 40	Age 50	Age 60
Aus	OEV 1980–82	0.001755	0.001755	0.003077	0.008138	0.018408
Bel	MR	0.000743	0.001042	0.001825	0.003873	0.009217
Den	G82	0.000956	0.001593	0.003120	0.006250	0.015484
Fin	1988	0.001559	0.002807	0.005601	0.011855	0.025857
Fra	TD88–90	0.001425	0.001674	0.002850	0.006687	0.015656
Ger	DAV 1994T	0.001476	0.001476	0.002569	0.006751	0.017625
Ita	SIM81	0.001100	0.000980	0.002090	0.006430	0.017560
Net	GBM 76–80	0.001050	0.000870	0.001890	0.005850	0.017380
Nor	T1984	0.000740	0.000970	0.001681	0.003875	0.010623
Swe	M64	0.000835	0.001219	0.002227	0.004880	0.011858
Swi	GKM80	0.000480	0.000670	0.001164	0.002878	0.005949
UK	AM80(2) Ult	0.000791	0.000554	0.001141	0.003813	0.011739
	Table	Age 70	Age 80	Age 90	Age 100	
Aus	OEV 1980–82	0.045680	0.117993	0.247976	1.000000	
Bel	MR	0.023079	0.058474	0.145224	0.336415	
Den	G82	0.036069	0.083711	0.188617		
Fin	1988	0.057202	0.127375	0.284473	0.636172	
Fra	TD88–90	0.032080	0.082401	0.207796	0.448669	
Ger	DAV 1994T	0.043127	0.112477	0.253691	0.527137	
Ita	SIM81	0.042140	0.107580	0.240160	0.472750	
Net	GBM 76–80	0.045500	0.012310			
Nor	T1984	0.031190	0.092086	0.257120	0.600357	
Swe	M64	0.030213	0.078490	0.205470	0.539464	
Swi	GKM80	0.016219	0.047677	0.114061	0.270024	
UK	AM80(2) Ult	0.032718	0.085053	0.198405	0.394496	

Table 1.5: **Comparison of mortality tables commonly used for assurance tariffs, q_x Males.**

	Table	Age 20	Age 30	Age 40	Age 50	Age 60
Aus	OEV 1980–82	0.000721	0.001755	0.001980	0.005024	0.012441
Bel	FR	0.000382	0.000486	0.000801	0.001749	0.004606
Den	G82 - 4 yrs	0.000821	0.001270	0.002347	0.004925	0.011083
Fin	1988	0.001125	0.001835	0.003424	0.006982	0.014947
Fra	TD88–90	0.001425	0.001674	0.002850	0.006687	0.015656
Ger	DAV 1994T	0.000560	0.000689	0.001524	0.003425	0.008240
Ita	SIM81 - 5 yrs	0.000690	0.001010	0.001220	0.003630	0.011070
Net	GBM 76–80 - 8 yrs	0.000320	0.000940	0.000950	0.002390	0.007360
Nor	T1984	0.000740	0.000970	0.001681	0.003875	0.010623
Swe	M64	0.000760	0.001020	0.001706	0.003508	0.008249
Swi	GKF80	0.001238	0.001847	0.005000	0.013231	0.035111
UK	AF80 Ult	0.000287	0.000361	0.000867	0.002340	0.006455

	Table	Age 70	Age 80	Age 90	Age 100	
Aus	OEV 1980–82	0.027869	0.075040	0.176795	0.338076	
Bel	FR	0.013178	0.038605	0.111439	0.299472	
Den	G82 - 4 yrs	0.025699	0.059886	0.137085	0.297411	
Fin	1988	0.032777	0.072696	0.162061	0.362127	
Fra	TD88–90	0.032080	0.082401	0.207796	0.448669	
Ger	DAV 1994T	0.021861	0.072101	0.206375	0.462967	
Ita	SIM81 - 5 yrs	0.026570	0.068880	0.163210	0.343540	
Net	GBM 76–80 - 8 yrs	0.021100	0.054690	0.118780		
Nor	T1984	0.031190	0.092086	0.257120	0.600357	
Swe	M64	0.020719	0.053519	0.139791	0.366710	
Swi	GKF80	0.089548	0.203986	0.377576	0.543677	
UK	AF80 Ult	0.017741	0.048121	0.126777	0.310770	

Table 1.6: **Comparison of mortality tables commonly used for assurance tariffs, q_x Females.**

Italy The SIM71 and SIF71 population mortality tables are used as the basis for projecting future improvements in mortality, and are further adjusted to allow for selection.

The Netherlands Population mortality tables smoothed by Makeham formulae are used. The GBM 1961–65 tables (age adjusted) were adopted in the mid 1980s, and some companies have adopted the GBM/V 1976–80 tables (GBM 76–80 is shown in the Tables 1.7 and 1.8).

Norway The RM/K 1963 tables, based on experience data, were those used in the last revision of the common tariff, but companies now are not obliged to follow a common tariff (Makeham formula). They are suitable for longevity risk only; different tables are used for the life assured under a reversionary annuity.

Portugal Until 1994, the French tables PM/F-60/64 or the Swiss tables GKM/F-70 were used. There is no Portuguese experience table.

Sweden The M64 table is used for all business (Makeham formula). For technical calculations, selection is represented by omitting the constant term in the Makeham formula for durations 0–4. Mortality losses do arise under annuity business, but other aspects of the tariff are very conservative.

Switzerland Tariffs are deregulated from 1995. The ERM/F 1990 tables are based on pooled experience in 1981–85 (spline graduation).

United Kingdom There is no regulation of tariffs. The IM80 and IF80 tables were based on the pooled experience of offices in 1979–82 (generalised Gompertz-Makeham formulae, with adjustments). The select period is 1 year. Separate non-select tables were prepared in respect of pensioners, an unusual feature being that tables were prepared based on numbers of lives and on amounts of pension.

Table 1.9 shows selected values of $\ddot{a}_x$ calculated at 5% interest, for those countries in which projected improvements in mortality are not taken into account[8].

[8] Figures for the Netherlands are omitted as the available tables do not extend beyond age 90.

	Table	Age 50	Age 60	Age 70	Age 80
Aus	EROM G 1950	0.005360	0.011035	0.027873	0.075003
Bel	MK	0.007388	0.018234	0.046770	0.119345
Den	G82M	0.006774	0.015484	0.036069	0.083711
Fin	1988	0.005839	0.012388	0.027049	0.059872
Fra	TPRV 93	0.002246	0.003709	0.007405	0.027205
Ger	DAV 1994 R	0.002952	0.007196	0.018427	0.056731
Ita	SIM 70–72	0.007130	0.017960	0.044300	0.105770
Net	GBM 76–80 + 1 yr	0.006610	0.019110	0.049860	0.109980
Nor	RM 1963	0.003563	0.009343	0.024388	0.062879
Swe	M64	0.004880	0.011858	0.030213	0.078490
Swi	ERM 1990	0.002878	0.005949	0.016219	0.047677
UK	IM80Base Ult	0.004456	0.013706	0.035084	0.081362

	Table	Age 90	Age 100	Age 110	
Aus	EROM G 1950	0.156054			
Bel	MK	0.288010	0.597663	0.913085	
Den	G82M	0.188617			
Fin	1988	0.133352	0.297854	0.666128	
Fra	TPRV 93	0.088835	0.240848	0.660000	
Ger	DAV 1994 R	0.133522	0.199193	0.275955	
Ita	SIM 70–72	0.252680	0.438360		
Net	GBM 76–80 + 1 yr				
Nor	RM 1963	0.157024	0.361922	0.693263	
Swe	M64	0.205470	0.539464		
Swi	ERM 1990	0.114061	0.270024	0.639245	
UK	IM80Base Ult	0.182617	0.380688	0.679708	

Table 1.7: **Comparison of mortality tables commonly used for annuity tariffs, q_x Males.**

	Table	Age 50	Age 60	Age 70	Age 80
Aus	EROF G 1950	0.002168	0.004612	0.010290	0.040880
Bel	FK	0.003812	0.010096	0.029064	0.084831
Den	G82F	0.004925	0.011083	0.025699	0.059886
Fin	1988	0.002887	0.005778	0.012252	0.026746
Fra	TPRV 93	0.002246	0.003709	0.007405	0.027205
Ger	DAV 1994 R	0.001369	0.002633	0.009379	0.034237
Ita	SIF 70–72	0.003800	0.008890	0.025240	0.084040
Net	GBM 76–80 - 7 yrs	0.002700	0.008160	0.023340	0.059330
Nor	RK 1963	0.002667	0.006999	0.018303	0.047427
Swe	M64	0.003508	0.008249	0.020719	0.053519
Swi	ERF 1990	0.001490	0.002550	0.006655	0.028122
UK	IF80BASE Ult	0.002341	0.006750	0.019539	0.055867

	Table	Age 90	Age 100	Age 110	
Aus	EROF G 1950	0.142921			
Bel	FK	0.236235	0.560631	0.918966	
Den	G82F	0.137085	0.297411		
Fin	1988	0.059193	0.131832	0.294451	
Fra	TPRV 93	0.088835	0.240848	0.660000	
Ger	DAV 1994 R	0.110913	0.198722	0.302175	
Ita	SIF 70–72	0.208700	0.361450		
Net	GBM 76–80 - 7 yrs	0.127900			
Nor	RK 1963	0.119971	0.285483	0.586939	
Swe	M64	0.139791	0.366710	0.963568	
Swi	ERF 1990	0.108099	0.231226	0.494596	
UK	IF80BASE Ult	0.153049	0.323415	0.624154	

Table 1.8: **Comparison of mortality tables commonly used for annuity tariffs, q_x Females.**

Tables	Belgium MK/FK	Denmark G82	Finland 1988	Norway RM/K 1963	Sweden M64	Switzerland ERM/F 90
Age	Males					
50	13.79	14.38	15.08	15.48	15.14	16.25
60	10.94	11.81	12.76	12.98	12.30	14.02
70	7.78	8.90	10.04	9.96	9.20	11.02
80	4.89	6.06	7.21	6.84	6.06	7.81
90	2.77	3.72	4.66	4.16	3.44	5.05
Age	Females					
50	15.08	15.27	16.90	16.10	15.77	17.29
60	12.36	12.89	15.10	13.79	13.41	15.34
70	9.05	10.08	12.79	10.90	10.48	12.42
80	5.73	7.16	10.07	7.75	7.29	8.68
90	3.14	4.58	7.23	4.89	4.39	5.33

Table 1.9: **Comparison of annuity values $\ddot{a}_x$ at 5% interest, for annuitants.**

1.5 Projected mortality for annuities

We can identify two approaches to the setting of tariffs for annuity business.

1. If the tariff is regulated, and the interest basis in particular is very strong, then technical mortality losses are likely to be of comparatively little significance, and the mortality basis can be chosen in a pragmatic way. An example is provided by Sweden, where the M64 table is used for all business.

2. At the other extreme, where competetion on the basis of price is allowed, offices often set their own tariffs using current interest rates, particularly if long-term fixed interest assets are available to allow a degree of cash-flow matching. Then the avoidance of technical mortality losses is a critical matter, so it is necessary to allow for future improvements in mortality, and possibly temporary initial selection as well. An example is provided by the U.K., where all the above conditions hold.

Austria, France, Germany, Italy and the U.K. all make use of projected mortality for annuity business. In the Netherlands, also, a group of Group Life insurers has published mortality projections. As this is likely to be a subject of growing interest, as the effects of the Third Life Directive are felt, we summarise the approaches used.

Austria The forecasting model was:

$$q_x(t) = q_x(t_0)e^{-\lambda_x(t-t_0)}$$

where the functions $\ln q_x(t_0)$ and λ_x were modelled using splines. Two sets of data were used: population mortality from 1865–75 to 1990–92 (suitable for long-term projections) and population mortality for each year 1947–92 (suitable for short-term projections). For each age x, the optimum projection period (before which the short-term data should be used, and beyond which the long-term data should be used) and the earliest year in either set of data which should be included in the fitting, were determined by considering the confidence intervals of projected mortality rates. This resulted in four graduations for men, three for women, which were then combined in a weighted average.

The published table was that of the 1950 generation, called EROM/F G 1950. incorporating further reduction factors to allow for the difference between population mortality and annuitants' mortality. Age adjustments for different generations were recommended (the latter were updated in 1995).

France Following liberalisation of tariffs, the TPRV 93 table was established as a minimum basis for annuity business sold after 1 July 1993. Female mortality data of 1961–87, in 5-year age groups, were used. For fixed ages x, the crude rates were interpolated and extrapolated, giving mortality rates by functions of the form:

$$q_x(t) = \exp(f(t))/(1 + \exp(f(t)))$$

where $f(t)$ is a polynomial (in fact a linear function was used). Mortality rates at individual ages were obtained by assuming an exponential progression between each 5-year age group, for each fixed time. Finally, the table for the 1950 cohort was published with age adjustments for other generations which closely reproduce the results of the full table.

Germany The projection of mortality for annuity business by age-shifting has been used for many years in Germany (see the article by L. Seidel and Dr. H. Storck in [2]) where it was developed by Rueff [4]. For the DAV 1994R tables, West German population mortality was projected to the year 2000, and adjusted as follows:

$$q'_x = f_x q_x - s_x^\alpha$$

where f_x is a piecewise linear adjustment, ranging from 0.9 to 0.75, to allow for the lower mortality of annuitants, and s_x^α is a safety loading calculated to keep the actual number of deaths above the expected number (on the basis of q'_x) with probability $1-\alpha$. The resulting basic rates apply to the 1952–58 cohorts (male) and the 1952–57 cohorts (female) and age adjustments are used for other cohorts.

Italy The first Italian annuity table was constructed in the early 1980s; see the article by Dr. F. Pietrobono in [2]. It was a select table based on adjustments to population mortality data, and its most distinctive feature was that only mortality due to non-accidental causes was subject to the adjustment. The more recent tables follow the same principle, adjusting the 1970–72 population data to allow for both future improvements and selection. Overall and accident-only mortality rates are projected using exponential factors, based on 1961, 1871 and 1978 tables:

$$q_x(1971+n) = q_x(1971) r(x)^n \qquad q_x^a(1971+n) = q_x^a(1971) r^a(x)^n.$$

Then a selection factor $g(x,t)$ depending on age and duration is applied to rates of mortality excluding accidental deaths, giving as a final result:

$$q_{x+t}(1971+n) = q_{x+t}^a(1971+n) + g(x;t)[q_{x+t}(1971+n) - q_{x+t}^a(1971+n)].$$

The Netherlands A group of group life insurers has projected a mortality table for 2006–10, based on data from 1920–1990, also allowing for the difference between population and insured lives mortality. This is called the 'Collectief 1993' table.

United Kingdom Projection of improving mortality has been required in the U.K. for many years, because of intense price competition in the annuity market. The a(55) tables, based on 1949–52 experiences, were single entry tables judged suitable for persons buying annuities in 1955. The a(90) and PA(90) tables based on 1967–70 experiences were the first to introduce a full double-entry table, as well as a single-entry table which was simply projected mortality in 1990.

The most recent projected mortality tables were based on the experience data of 1979–82. The cross-sectional tables resulting from the graduation of these data were called the 'Base' tables, representing 1980. They were projected by applying 'reduction factors':

$$q_{x,1980+t} = q_{x,1980} \times RF(x,t)$$

where $RF(x,t)$ modelled an exponential decrease to a non-zero limiting value. The dependence on age resulted from investigations suggesting that age-independent reduction factors understated the improvement at younger ages and overstated it at older ages. For the first time, no separate single entry table was published, the use of computers having removed the need.

Table 1.10 shows sample annuity values for use in 1997; for example the values given for age 50 are applicable to lives born in 1947, and so on[9].

1.6 AIDS

Different countries have approached the problem of AIDS in different ways. Where all business is written on a participating basis (for example, in Denmark) there was little perceived need for immediate and explicit allowances in tariffs and reserves. Where life cover was available on a non-profit basis, there was more concern. The extreme case was probably the U.K., where non-profit term assurance business is very competitively priced. The relative lack of concern over AIDS, as far as it affects life insurance, is reflected in the small number of countries where any action is recommended, apart from underwriting. The comments are summarised below:

[9] Figures for Italy are omitted as the full basis is not available.

Tables	Austria EROM/F G 1950	France TPRV 93	Germany DAV 1994 R	United Kingdom IM/F 80 Ult.
Age	Males			
50	15.26	17.16	15.76	15.58
60	12.59	14.86	13.05	12.92
70	9.45	11.54	9.53	9.83
80	6.76	7.57	6.19	6.72
90	4.25	4.24	4.28	4.12
Age	Females			
50	16.63	17.16	16.91	16.63
60	14.21	14.86	14.16	14.27
70	10.63	11.54	10.56	11.14
80	6.42	7.57	6.99	7.63
90	3.66	4.24	4.46	4.59

Table 1.10: **Comparison of annuity values $\ddot{a}_x$ at 5% interest, suitable for use in 1997, allowing for projected improvements in mortality.**

Denmark No allowance is made in tariffs or reserves. An HIV test is required for large sums assured.

Finland No extra premiums are charged or reserves held.

Germany Studies have been published on the effect of AIDS on rating, but no applications are known. There is no apparent trend in losses due to AIDS.

Italy The National Association of Italian Insurance Companies has suggested requiring an AIDS test for sums assured over 300 million Lira. In addition, it has suggested that benefits would not be paid if the life assured died (i) within 5 years, with sum assured less than 300 million Lira, not having taken an HIV test; or (ii) within 7 years, with sum assured over 300 million Lira, having refused to take an HIV test.

The Netherlands No explicit allowances are made in tariffs or reserves.

Norway An applicant who is HIV-positive but has not progressed to AIDS will have their application postponed for 5 years, then to be medically tested again.

Portugal A few companies do charge an extra premium, on what bases is not known, but the continuing use of very conservative mortality tables probably makes explicit allowance unnecessary.

Switzerland No explicit allowance is made in tariffs or reserves. Experience data is collected from companies.

United Kingdom A working party of the Institute of Actuaries published projections of AIDS-related mortality, beginning in 1987, and based upon these, the Government Actuary made recommendations regarding the minimum margins that should be allowed in reserving. In the event, AIDS-related deaths have had only a small impact on life assurers, and the both the projections and the recommended margins have been scaled down very considerably.

1.7 Smoker/non-smoker mortality

Smoker/non-smoker differentials are most likely to arise where term assurance business is priced very competitively, so perhaps inevitably it is most strongly established in the U.K., and very few comments were received.

Germany There are some tariffs for smokers and non-smokers in Germany, but their basis is not known. There are no German data yet.

Italy A few companies have launched smoker/non-smoker tariffs, on empirical bases. There is no published table but some studies are being done.

United Kingdom Smoker/non-smoker rates have been common since the early 1980s, and most if not all companies now use them. The first insured lives investigation, covering 1989–90, was published in 1993, and showed that smokers' mortality was generally twice or more that of non-smokers.

1.8 The companion disk

The 1986 edition of this survey included the tables provided by contributors as a printed appendix. However, the number of tables provided for this survey is very much greater, both because of the larger number of contributing states and because in many states insured lives mortality is analysed by class of business. In addition, most if not all users will find the data most useful in computer-readable form. It has therefore been decided to provide the tables on disk only.

This volume is accompanied by a companion IBM-PC disk, containing the mortality tables sent by the contributors. Each country's tables are stored in a separate directory. The file *INDEX.TXT* on the disk lists all the tables provided, including the following information.

1. The name of the disk file containing the table.
2. The lowest and highest ages tabulated.
3. The function tabulated (almost always q_x).
4. The number of decimal places given. This is always fixed, so for example if 6 decimal places are given, a rate of 0.0123 would be expressed as 0.012300.
5. A brief description of the table, sufficient to locate any discussion of the table in the relevant chapter.

Each mortality table is given in a plain text (ASCII) file, with the rate or force of mortality for each age or age group on a separate line. The files can be inspected with any text editor. In the case of select tables, the rates of mortality for each select duration are given in separate files. The tables have been formatted in this 'lowest common denominator' fashion so that any user should be able to import the data into any spreadsheet, word processor or database with reasonable ease.

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[4] Rueff, F. (1955). *Ableitung von Sterbetafeln für die Rentenversicherung und sonstige Versicherungen mit Erlebensfallcharakter.* Special publication No.2 of the German Society for Actuarial Science, Konrad Triltsch Verlag, Würzburg.

Chapter 2

Austria

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2.1 Population mortality

National life tables are compiled by the Statistisches Zentralamt (Central Statistical Office). At the time of writing, the tables based on the 1990 – 92 experience were almost complete, subject to minor amendments due to incomplete migration data. The provisional tables of q_x, both graduated and ungraduated, are given in the companion disk for both males and females.

2.2 Insured lives mortality

Currently, nearly all Austrian insurance companies use the male population table for the period 1980 – 82 for participating endowment and whole-life business. For this purpose, the population experience is smoothed between ages 18 and 32 (in fact, assumed to be constant). Values of q_x are given in the companion disk. For women, the same table is used with a 5 year deduction from the age.

2.3 Pensioners' mortality

In 1986, the generation tables EROM G 1950 (males) and EROF G 1950 (females) were prepared, taking into account projected improvements in mortality, using information up to and including the 1980–82 experience. The tables were described in [1], and the projection method was described fully in [2].

The EROM G 1950 and EROF G 1950 tables each represent the mortality of the generation born in 1950. To obtain estimates of the mortality of geberations born in other years, age adjustments were recommended.

In 1995, the projections were reviewed in the light of the provisional results of the 1990–92 experience, and certain adjustments were recommended. This was described in [3] and [4], and the following account is based on those references.

2.3.1 The forecasting model

The forecasting model used in [3] and [4] was the same as that used to establish the EROM G 1950 and EROF G 1950 tables. It is described briefly here.

Let q_x^τ represent the one-year mortality rate in respect of a life ages x born in calendar year τ. This is the generational mortality table. Let t_0 be an arbitrarily chosen calendar year, which will act as an origin for calendar time. The forecasting model is:

$$q_x^\tau = q_x(x+\tau)$$

where:

$$q_x(t) = q_x(t_0)e^{-\lambda_x(t-t_0)}.$$

Thus, from the baseline calendar year t_0, secular changes in mortality at any given age are modelled by an exponential function, with a parameter λ_x depending on age.

There are two components of this model depending on the age x, namely the baseline mortality table $q_x(t_0)$ and the parameters λ_x. $\ln q_x(t_0)$ and λ_x were both graduated with respect to x using splines. Considering for the moment only a fixed age x, denote the order of the splines graduating $\ln q_x(t_0)$ and λ_x n and m respectively. Then for suitable parameters:

$$\begin{aligned}
\ln q_x(t_0) &= \alpha_0 + \alpha_1 x + \ldots + \alpha_n x^n \\
\lambda_x &= \beta_0 + \beta_1 x + \ldots + \beta_m x^m
\end{aligned}$$

from which the projection model has the form:

$$\ln q_x(t) = \sum_{i=o}^{i=n} \alpha_i x^i + \sum_{i=o}^{i=m} \beta_i x^i (t - t_0)$$

and the generation mortality rate is given by:

$$\ln q_x^\tau = \sum_{i=o}^{i=n} \alpha_i x^i + \sum_{i=o}^{i=m} \beta_i x^i (x + \tau - t_0).$$

2.3.2 The graduation

Two data sets were available. Database I included population mortality tables for the following periods: 1865–75, 1870–80, 1901–05, 1906–10, 1930–33, 1949–51, 1959–61, 1970–72, 1980–82 and 1990–92 (provisional). This was regarded as the most suitable basis for long-term projections. Database II included the mortality rates for each year 1947–92, estimated from on the annual updating of census data. This was regarded as most suitable for short-term projections.

Two questions had to be considered:

1. For each age x, what was the optimum projection period, denoted t_{switch}, beyond which the model fitted using database I should be preferred to the model fitted using database II?

2. For each age x, what was the earliest time point in the data, denoted $t_{\text{min}}^{(I)}$ and $t_{\text{min}}^{(II)}$ depending on the database used, which should be used in the fitting process?

These questions were addressed by considering, for fixed ages, the confidence intervals for projected mortality rates over different future periods, and choosing values for t_{switch} and t_{min} which resulted in the smallest confidence intervals. The results were quite variable, especially the values of t_{switch}, so averaged results were used as follows for men:

$$\begin{aligned} t_{\text{min}}^{(I)} &= \begin{cases} 1970 & x \in [67, 82] \\ 1950 & \text{otherwise} \end{cases} \\ t_{\text{min}}^{(II)} &= \begin{cases} 1870 & x \in [10, 85] \\ 1950 & \text{otherwise} \end{cases} \\ t_{\text{switch}} &= 18 \qquad x \in [1, 100] \end{aligned}$$

and for women:

$$\begin{aligned} t_{\min}^{(I)} &= 1950 \qquad y \in [0, 100] \\ t_{\min}^{(II)} &= \begin{cases} 1903 & y \in [10, 95] \\ 1950 & \text{otherwise} \end{cases} \\ t_{\text{switch}} &= 16 \qquad y \in [1, 100]. \end{aligned}$$

There were therefore four graduations of $q_x(t_0)$ and λ_x for men, and three for women, each resulting in a different projection model for $q_x(t)$. The final step was to choose suitable weighting functions (of age) that took the values of $t_{\min}^{(I)}$, $t_{\min}^{(II)}$ and t_{switch} into account, and to combine the separate models for $q_x(t)$ into a weighted average, the weights varying with age. This was taken to be the final result.

2.3.3 The EROM/F G 1950 tables

For convenience in practice, the mortality rates q_x^{1950} of the generation born in 1950 formed the basis of the published tables. Mortality rates for other generations were represented in a straightforward way by age adjustments.

Because the estimates q_x^{1950}, obtained as above, were based on population mortality, the EROM G 1950 and EROF G 1950 tables incorporated reduction factors to allow for the lower mortality of pensioners. At ages up to 85, factors of 0.75 (men) and 0.85 (women) were used; at ages 96–99 a factor of 0.8 was used for both men and women; these factors were interpolated at ages 86–95.

The age adjustments recommended originally are shown in Table 2.1.

2.3.4 Revised age adjustments for males

As a result of the review of the projection model carried out by Jörgen [4], it was decided that the age adjustments recommended for males should all be decreased by 1 year; that is, 1 year was to be deducted from the figures shown for males in Table 2.1. This was consistent with an apparent change in the trend of male mortality before and after 1970 (roughly), which had continued through the 1980s, especially at higher ages. There was less evidence of a changing trend in the case of females, so the age adjustments for females given in Table 2.1 were left unchanged. See [3] for details.

Males		**Females**	
Year of Birth	Adjustment	Year of Birth	Adjustment
– 1915	+2	– 1917	+3
1916–1940	+1	1918–1934	+2
1941–1959	0	1935–1944	+1
1960–1979	−1	1945–1955	0
1980–1999	−2	1956–1967	−1
2000 –	−3	1968–1979	−2
		1980–1990	−3
		1990–	−4

Table 2.1: **Age adjustments originally recommended for use with the EROM/F G 1950 tables.**

2.4 Bibliography

[1] Liebmann, F.G., Schachermayer, W. & Willomitzer, M. (1986). *Zur Erstellung von Sterbetafeln EROM 85 und EROF 85*, sowie *Die Generationen-Sterbetafeln EROM G 1950 und EROF G 1950*. Mitteilungen der Aktuarvereinigung Österreichs **4**.

[2] Jörgen, S. Diplomarbeit *Progsosemodelle für Sterbeflächen — Erstellung von Generationentafeln für Österreich*, verfertigt am Institut für Analysis, Technische Mathematik und Versicherungsmathematik der TU Wien unter der Betreuung von MR UnivDoz Dr Franz G. Liebmann.

[3] Liebmann, F.G., Schachermayer, W. & Willomitzer, M. (1995). *Die Sterbetafeln EROM/EROF G 1950 und die Sterblichkeitsentwicklung des Vergangenen Jahrzehnts.* Paper dated 29 January 1995.

[4] Jörgen, S. (1995). *Zur Angwendung der Tafeln EROM/F G 1950.* Paper dated 25 January 1995.

Chapter 3

Belgium

Contributor: P. De Vos

3.1 Introduction

In Belgium, population mortality tables are constructed by the "Institut National de Statistiques - Nationaal Instituut voor de Statistiek"; an Institute connected with the Ministry of Economical Affairs. The most recent tables relate to the period 1988 – 1990. Values of q_x for males, females and for the combined population are given in the companion disk.

These tables of the I.N.S. have been used to establish the reference tables given in the Royal Decree of 19 December 1992 on life insurance. The reference tables are called MR-FR and MK-FK (MR and MK for male insured lives, MK and FK for female insured lives). For insurance involving death risks the mortality rates used may not be lower than those of tables MK-FK. For insurance providing a benefit payable in case of survival, mortality rates may not be higher than those of tables MR-FR. The tables MR-FR and MK-FK are given by the formula

$$l_x = ks^x g^{c^x}$$

where $x =$ age, with the parameters shown in Table 3.1. The tables MR-FR and MK-FK are included in the companion disk.

The Belgian actuaries meet at the "Association Royale des Actuaires Belges-Koninklijke Vereniging van Belgische Actuarissen" (A.R.A.B. - K.V.B.A.). Members of the A.R.A.B. have of course contributed to the study of mortality

	MR	FR	MK	FK
k	1 000 266, 63	1 000 048, 56	1 000 450, 59	1 000 097, 39
s	0,999 441 703 848	0,999 669 730 966	0,999 106 875 782	0,999 257 048 061
g	0,999 733 441 115	0,999 951 440 172	0,999 549 614 043	0,999 902 624 311
c	1,101 077 536 030	1,116 792 453 830	1,103 798 111 448	1,118 239 062 025

Table 3.1: **Parameters for Tables MR, FR, MK and FK.**

by publishing articles, but there does not exist in Belgium an organised body that can be compared to the Continuous Mortality Investigation Bureau in the United Kingdom.

The "U.P.E.A." is the Professional Union of Insurance Companies operating in Belgium and it represents nearly all the insurance companies operating in this country. Representatives of Life Insurance Companies meet regularly in the Life Division of the U.P.E.A. In this Division, all problems related to life insurance are examined and the Experienced Mortality is one of the subjects that are dealt with. Although many members of the Life Division are actuaries, there is no link between the U.P.E.A. and the A.R.A.B.

In Luxembourg, because of the small population, the Belgian mortality tables are used.

3.2 Experience tables

(a) Use of experience tables in Belgium. It might be useful to point out that in Belgium the insurance companies all adopt the tariffs given in the legislation on life insurance and that they are mainly in competition on the level of profit sharing.

(b) The 1973-1975 U.P.E.A. table. In 1977 a new experience table was constructed by the U.P.E.A., based on the observation on the mortality for the period 1973 – 1975 for ordinary life only, excluding group insurance. The tables were graduated by the Makeham formula $l_x = ks^x g^{c^x}$, where

$$k = 1\ 002\ 768{,}257$$
$$s = 0{,}999\ 807\ 559$$

	Age 0 – 65		Age 65 – 69	
	Male	Female	Male	Female
c	1,135 578 2057	1,110 085 2547	1,082 954 488	1,085 778 597
g	0,999 974 4102	0,999 928 929	0,999 085 746	0,999 599 653
s	0,999 149 9702	0,999 723 054	0,999 149 702	0,999 723 054

Table 3.2: **Makeham coefficients for 1987 – 1991 U.P.E.A. tables for insurances providing a benefit in case of survival.**

$$g = 0{,}999\ 691\ 616$$
$$c = 1{,}107\ 498\ 763$$

(c) The 1987 – 1991 U.P.E.A. tables. In recent years new experience tables have been constructed by the U.P.E.A. in order to compare the experience with the mortality rates of the tables given by legislation. The comparison resulted in an adjustment being made to table FK, so that insurance companies now use an adjusted table FK determined by the Makeham coefficients.

$$c = 1\ 000\ 097{,}39$$
$$g = 0{,}999\ 257\ 048\ 061$$
$$s = 0{,}999\ 902\ 624\ 311$$
$$k = 1{,}122$$

The experience table for insurances providing a benefit in case of survival was established with the Makeham coefficients shown in Table 3.2. The values of q_x for males and females are given in the companion disk..

(d) Comparison of population mortality and experienced mortality. Table 3.3 shows a comparison of Belgian Male population mortality and experienced mortality (100.000 q_x).

(e) Mortality rates according to O.C.A. statistics. Every year insurance companies communicate to the O.C.A. the number of insureds

Age	Table 68-72 (1)	Table MK (2)	Exp. 73–75 (3)	Exp. 87–91 (4)	$\frac{(2)}{(1)}\%$	$\frac{(4)}{(3)}\%$	$\frac{(3)}{(1)}\%$	$\frac{(4)}{(2)}\%$
20	113	123	45	90	109	200	40	73
30	166	180	90	101	108	112	54	56
40	326	332	216	142	102	66	66	43
50	799	739	564	289	92	51	71	39
60	2191	1823	1525	813	83	53	70	45

Table 3.3: **Comparison of Belgian Male population mortality and experienced mortality (100.000 q_x).**

and the number of deceased of their life insurance portfolios. The companion disk includes, for males and females, the mortality rates for the year 1993.

Chapter 4

Denmark

Contributor: A. Deis

4.1 Introduction

4.1.1 Standard mortality tables

The Standard mortality tables used in Denmark are denoted G82. The tables are common for all classes of business and have been approved by the supervisory authorities. All classes of insurance are always written with bonus.

Until recently the interest rate was fixed at 5% p.a., with 0,5% used as a safety loading, but now an interest rate of 3% is commonly used.

Since their introduction in 1982, all companies have adopted the tables, and competition is now entirely on the level of profit sharing.

4.1.2 The Danish Committee for the Assessment of Sub-Standard Lives

The Danish Committee for the Assessment of Sub-Standard Lives (FBP) carries out assessments of substandard risks for the major life insurance companies in Denmark.

FBP was founded in 1985 as an independent society with the purpose of taking over the register containing substandard lives and the health assessments from a former reinsurance company.

Another function of FBP is to conduct statistical investigations, e.g. evaluations of the assessments by means of public registers and other investigations of common interest to the member life companies.

Since 1987 FBP has collected data of the populations of standard lives from the majority of the Danish life assurers and has published a series of reports describing different mortality studies.

4.1.3 Danish life tables

A Danish life table is constructed every year based on the Central Person Register (CPR). The register is considered to be so comprehensive that national censuses have not been carried out since 1970.

The life tables are given in the Statistical Yearbook published by The Danish Central Bureau of Statistics, while a population account has been published since 1931 in the annual publication "Befolkningens Bevægelser" (Vital Statistics). The most recent tables covering 1991–92 are published in "Statistical Yearbook 1994" [1] respectively "Befolkningens Bevægelser 1992" [2].

4.1.4 AIDS

Danish life assurers have not taken any precautions regarding AIDS, except in the acceptance of the policy. An amount limit has been introduced, above which a HIV-test is required. Attention is also paid to the occurrence of other risk factors.

4.2 Standard mortality tables

The Standard Mortality Table (G82) for males is given by the Gompertz-Makeham force of mortality

$$\mu_x^{G82} = 0.0005 + 10^{5.88-10+0.038x},$$

where x denotes the attained age. The female table is calculated by subtracting 4 years of age.

These tables are common for all classes of business and for all companies. Since the same mortality table is used, the safety margin deliberately varies according to age. It is positive at younger ages (where positive death risk is dominating) and negative at higher ages, where annuities (with negative death risk) are dominating. The table of the standard male mortality (G82M) is given in the companion disk.

4.3 The 1987–91 experience

4.3.1 Collection of data

In 1987 FBP started the collection of data from 1985 and onward. The study comprises data from eight major Danish life assurers for all individual life and pension insurances underwritten on standard terms.

The data are collected by policies and comprise, in addition to information about the sex and the date of birth of the insured and the status of the policy, information about the premium reserve, and eventually the capitalised reserve after death or disability. For the changes of state, a date of occurrence is given.

Results given in this section originate from an investigation (DUS 1987–91) [3] which relates mortality to policies, including all classes of business and where data are not separated for duration in force. The report [3] also includes an investigation of mortality sub-divided by amounts of benefit and by capital at risk.

An investigation where data are collected by lives and where the mortality is modelled by age and duration in force by means of kernal smoothing is given in [4].

4.3.2 Graduation of the 1987–91 experience

Two types of graduations were used, a Gompertz-Makeham force of mortality and a model based on the Standard Mortality Table (G82). The later type of model is used as a second-order mortality.

By means of maximum likelihood estimation parametric forces of mortality were fitted to the observations. Further details on the procedure are given in Deis (1992) [5]. The two forces of mortality used in the graduation are given by a Gompertz-Makeham force of mortality of the form

$$\mu_x = \alpha + 10^{\beta - 10 + \gamma x},$$

Table	Deaths	Exposure
DUS91M	15,027	4,013,111
DUS91K	4,397	2,083,902

Table 4.1: **DUS 1987–91: Number of deaths and exposed to risk in the 30–64 years age group.**

and a force of mortality given by the G82 table multiplied by an age dependent factor $a + bx$

$$\mu_x \ (a + bx)\mu_x^{G82}$$

.

Since the data is not collected by duration in force and class of business, a division into age groups has been made in order to separate the non beneficial age group. Estimations of the parameters in the two models have been restricted to the 30–64 years of age group.

The mortality tables resulting from the Gompertz-Makeham estimation are denoted DUS91M and DUS91K, for males and females respectively. Tables of the corresponding q_x are given in the companion disk for males and females.

Table 4.1 shows the number of deaths and the exposed to risk in the 30–64 years of age group contributing to the estimation of the DUS91 mortality tables. It should be noticed that deaths and time at risk are related to policies and not lives.

Figure 4.1 shows the male and the female mortality rates on a logarithmic scale based on the two models. The figure shows that the second order model can be used as simple description of the estimated Gompertz-Makeham mortality, giving the simple expressions

$$\begin{aligned} \mu_x &= (0.103 + 0.0077x)\mu_x^{G82} \qquad (30 \leq x < 65) \\ \mu_y &= (0.121 + 0.0053x)\mu_y^{G82} \qquad (30 \leq y < 65) \end{aligned}$$

for the male and female force of mortality, respectively.

Figure 4.2 shows the DUS91K mortality rates as a proportion of the DUS91M mortality rates in the 30–64 age group. The proportion ranges from 0.3 to 0.7, with a slight decrease after 45 years of age.

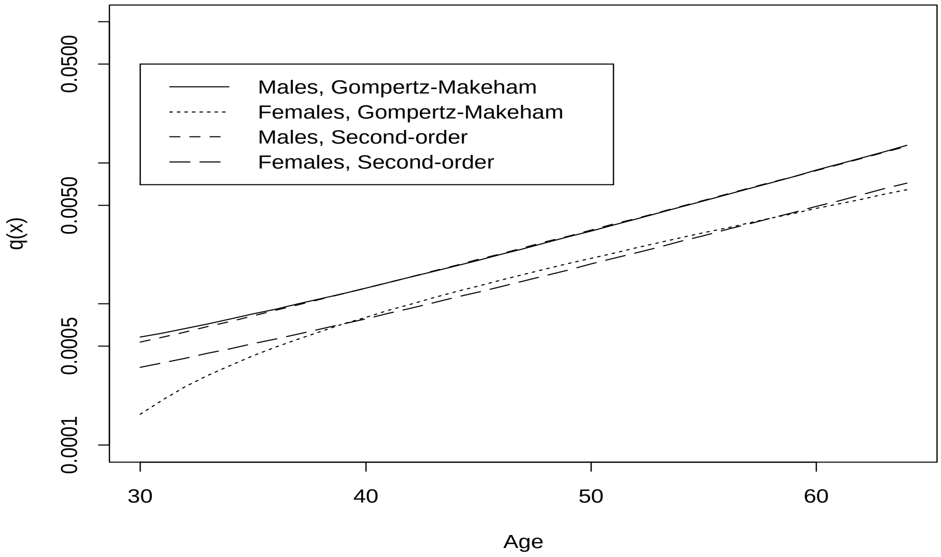

Figure 4.1: **DUS91 tables: male and female q_x on a log scale.**

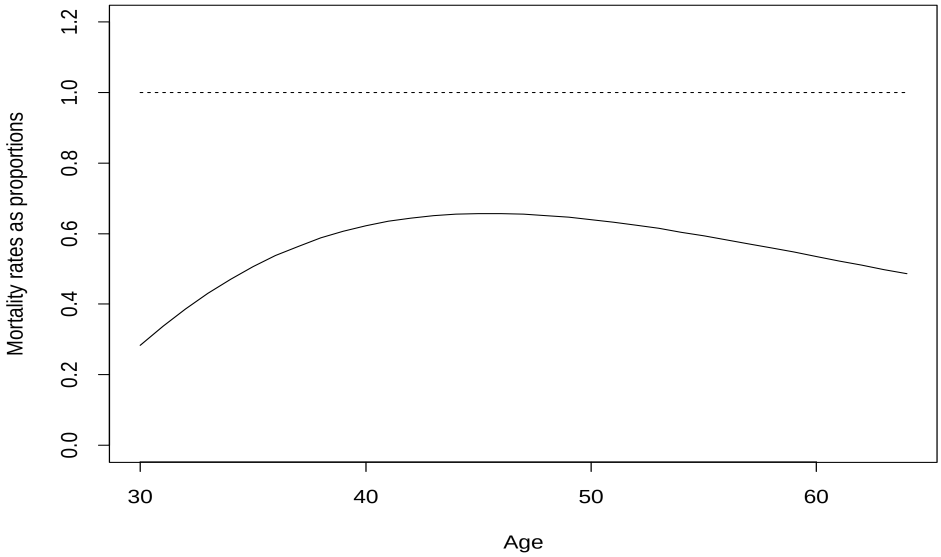

Figure 4.2: **DUS91K mortality rates as a proportion of DUS91M mortality rates.**

Age group	Males	Females
10–19	136%	168%
20–29	60%	36%
30–39	39%	23%
40–49	42%	39%
50–59	54%	44%
60–69	59%	40%
70–79	68%	46%
80–89	84%	80%
90–99	61%	50%
10–99	61%	50%

Table 4.2: **DUS 1987 – 91: SMRs for the 1987 – 91 experience, with expected deaths based on the Standard Mortality rates (G82).**

4.3.3 Comparison with the Standard Table G82

The standard mortality ratio (SMR) expresses the number of deaths as a proportion of the number of expected deaths (in percent). In Table 4.2 the SMR is calculated for the 1987–91 experience data. In each 10 years age group the SMR is calculated as the ratio of the experienced number of deaths and the expected number of deaths based on the standard mortality (G82).

For both males and females the SMRs show a considerable safety margin, most pronounced for females. The SMR is increasing from the age of 30, which fits the intention mentioned in Section 4.2, with a large safety margin in the youngest age groups, where positive death risk is dominating.

The increasing SMR can be seen as a result of the selection mechanism, as the insured population only includes persons insured on standard terms, and the duration in force is in average increasing with age.

Figure 4.3 shows the fitted rates of mortalities (DUS91) as a proportion of the Standard mortality (G82). The proportion ranges from 0.4 to 0.6 for males and from 0.2 to 0.4 for females.

4.3.4 Trends in mortality

The data for this investigation are collected over a relative short period and changes in mortality are consequently difficult to detect. This is demon-

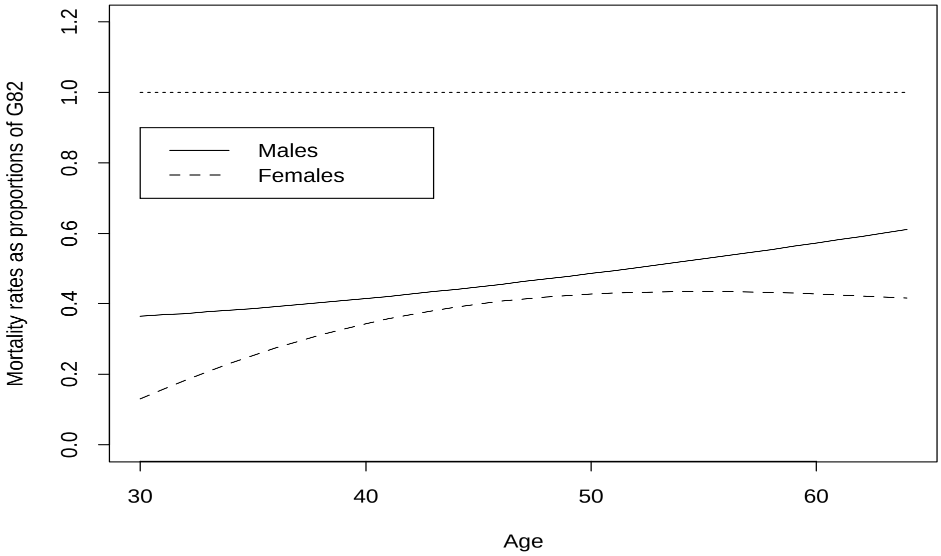

Figure 4.3: **DUS91 mortality rates as a proportion of G82 mortality rates: males and females.**

strated in Table 4.3 where the observation period is devided into the two periods 1987–89 and 1990–91. The change in the male mortality is expressed by the ratio between the SMR's, both calculated relatively to the standard mortality (G82). In the most important age interval between 30–79 years of age there are no changes in the male mortality. For all other ages only minor changes are seen in the male mortality.

Despite the short period of data collection, a considerable increase in the female mortality is observed in the 30–59 years of age group. The change

Age Group	Males 1987 – 89 to 1990 – 91	Females 1987 – 89 to 1990 – 91
10–29	91%	110%
30–59	100%	113%
60–79	100%	100%
80–99	103%	98%
10–99	102%	104%

Table 4.3: **DUS 1987 – 91: Mortality in 1990–91 relative to 1987–89.**

	Males		Females	
Experience	Deaths	Exposure	Deaths	Exposure
1965–70	9,343	2,666,827	1,062	633,765
1987–91	38,984	5,164,917	14,890	2,911,677

Table 4.4: **Numbers of deaths and exposed to risk at all ages, in the 1965–70 experience and the 1987–91 experience.**

can partly be explained by an older population and slightly longer duration in force in average.

In order to investigate the changes over a longer period of time, the mortality rates are compared to an older Danish mortality study [6]. The study from 1974 describes the observation period 1965–70 and comprises data from 6 major life companies. The population investigated includes not only standard lives, but also policies accepted with a minor addition to the premium due to the health. These non-standard lives are included with the given age addition. The Gompertz-Makeham force of mortalities fitted to these observations are denoted respectively DUS70M and DUS70K, for males and females.

Table 4.4 shows the size of the 1987–91 experience compared to the 1965–70 experience. The exposure for males is doubled, while the exposure for females is almost 5 times greater. This indicates a relatively high proportion of newly assured females, and consequently a lower duration in force in average than males. The overall mortality found in the latest investigation is much increased as a result of a higher age and longer duration in force in average.

Table 4.5 shows the mortality in the 1987–91 experience relative to the mortality in the 1965– 70 experience, expressed in SMR, where the mortality rates from the 1965–70 experience are used for calculating the expected number of deaths.

The observed number of deaths among males in the 1987–91 experience are only 69% of the number expected from the 1965–70 experience. The improvement in the mortality is increasing with age. The female mortality is 62% compared to the 1965–70 experience, with a considerable improvement in the mortality in all ages over 30. This could as mentioned be a result of a much lower duration in force.

Figure 4.4 shows the DUS91 mortality rates as a proportion of the DUS70

Age group	Males	Females
10–29	109%	174%
30–39	87%	50%
40–49	74%	66%
50–59	74%	60%
60–69	64%	50%
70–79	63%	55%
80–99	96%	71%
10–99	69%	62%

Table 4.5: **SMRs for the 1987 – 91 experience, with expected deaths based on the 1965–70 experience.**

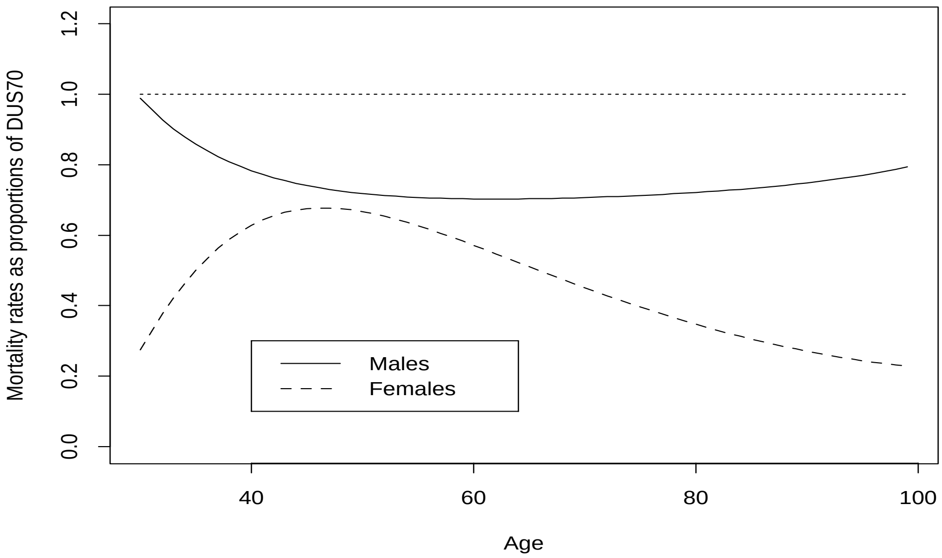

Figure 4.4: **DUS91 mortality rates as a proportion of DUS70 mortality rates: males and females.**

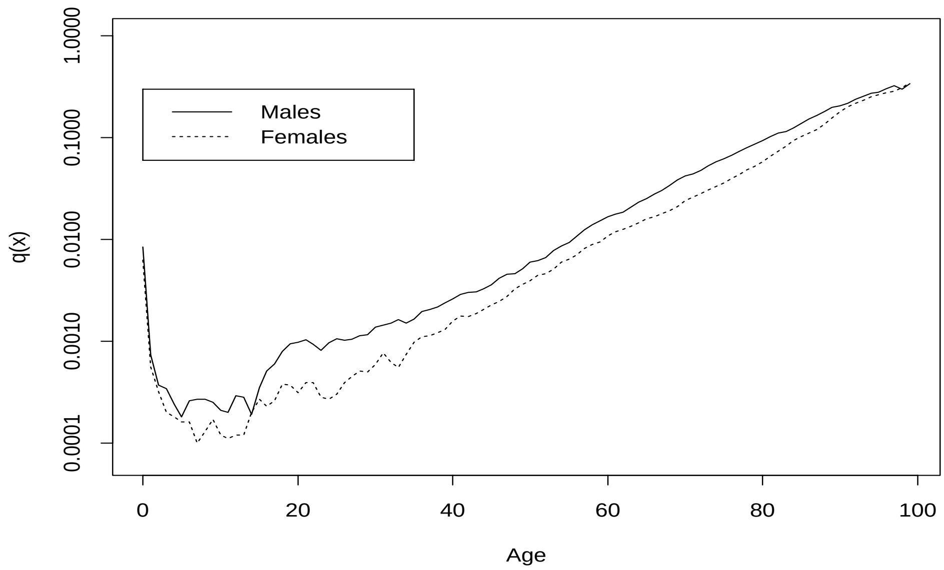

Figure 4.5: **DBD92 table: q_x on a log scale.**

mortality rates. The male mortality shows an improvement of 20–30% at all ages, while the female mortality shows an improvement of 40% in the 40–50 age group and higher in the older ages.

4.4 The Danish Life Tables

4.4.1 The 1991–92 mortality tables

The Danish Central Bureau of Statistics publishes mortality tables every year in the Statistical Yearbook, the most recent from 1994 [1] shows the tables covering 1991–92. The tables of the q_x denoted DBD92M and DBD92K ("Dansk BefolkningsDødelighed") for male and females, respectively, are given in the companion disk.

Figure 4.5 shows the rates of mortality of the Danish population 1991–92 on a logarithmic scale.

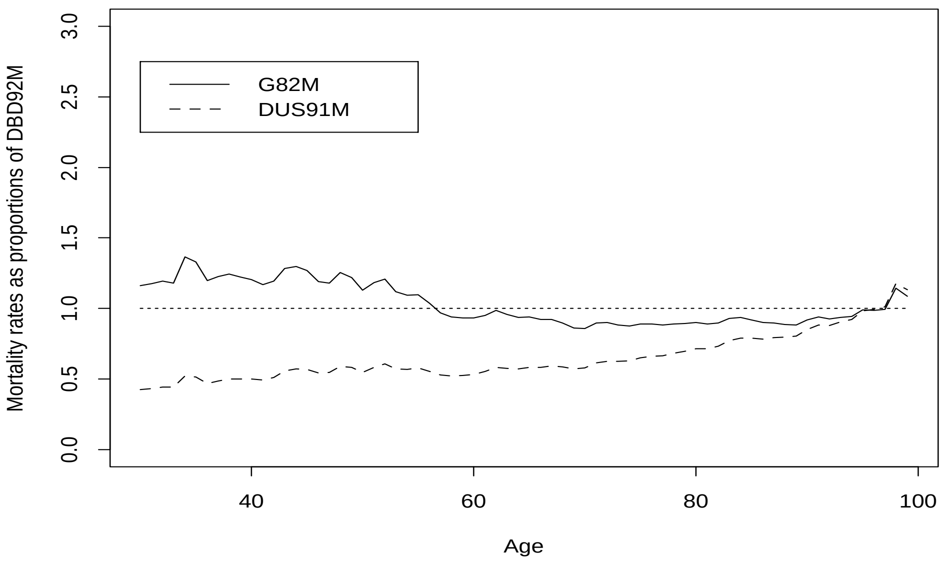

Figure 4.6: **G82 and DUS91 male mortality rates as a proportion of the Danish male mortality rates 1991–92.**

4.4.2 Comparison with the Standard Mortality

Figure 4.6 shows the standard mortality rates G82M and the mortality rates DUS91M from the 1987–91 experience, as a proportion of the mortality rates of the Danish male population 1991–92. The standard mortality (G82M) is higher than the population mortality before the retirement age of 60 years, and lower after. This gives a safety loading on the risk of death before the age of 60, and on survival after. The DUS91M mortality is below the population mortality, but the effect of the selection decreases over the ages.

Figure 4.7 shows the standard mortality rates G82K and the mortality rates DUS91K from the 1987–91 experience, as a proportion of the mortality rates of the Danish female population 1991–92. Before the retirement age of 60 the standard female mortality (G82K) is higher than the population mortality, and even higher than the corresponding relative male mortality.

4.4.3 Trends in mortality

Since the late seventies the life expectancy in Denmark has not increased as much as it has in the neighbouring countries. From being the country

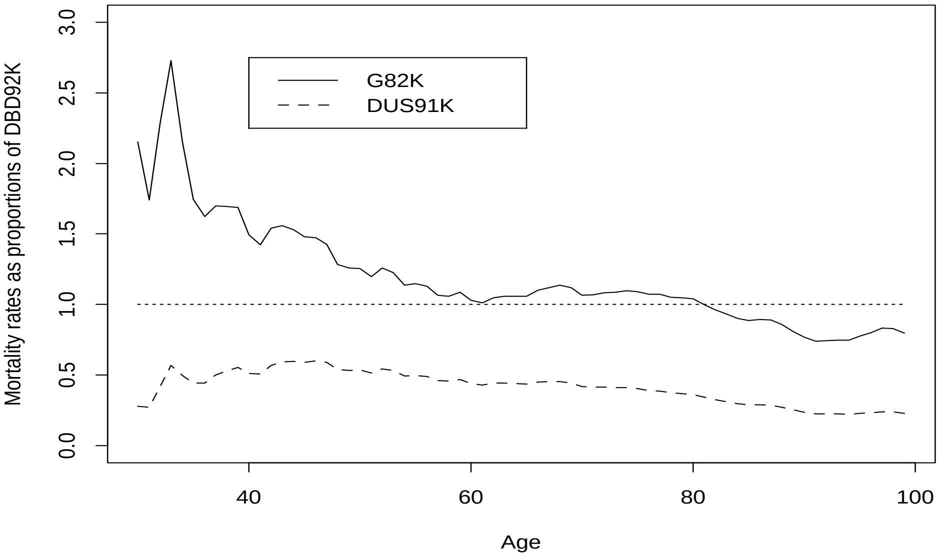

Figure 4.7: **G82 and DUS91 female mortality rates as a proportion of the Danish female mortality rates 1991–92.**

with the fifth longest average life expectancy, Denmark had in 1988 only the seventeenth longest.

This knowledge caused the Danish Health ministry to set up in 1992 a working party to investigate this lack of improvement in the mortality. The first report from this working party [7] states that in 1990–91 life expectancy in Denmark was 72.2 years for males and 77.7 years for females compared with, for example, 73.4 and 79.8 in Norway and 76.1 and 82.1 in Japan, which has the highest life expectancy globally. Among the 23 OECD countries (excluding Luxembourg) Denmark in 1990 was only number 18 on the list for males and number 21 for females.

Both Danish males and females between 25 and 64 years old had in 1985–89 an excess mortality compared to the other Scandinavian and EEC countries, most pronounced for females. On average there was a 10% excess mortality among persons under 75 years of age, while the difference was negligible for older persons. The excess mortality could mainly be explained by an excess mortality from lung cancer, intestinal cancer, breast cancer, heart disease, chronic bronchitis and suicide. If the mortality from these causes were reduced to the level found in other European countries, excess mortality would drop to 1%.

The working party has until now produced 14 reports, which beside describing the overall mortality, investigate a number of major death causes.

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Chapter 5

Finland

Contributor: V.-A. Antila

5.1 Population mortality

In Finland the Central Bureau of Statistics collects population mortality data annually. The latest survey covers the years 1986 – 1990. Tables of q_x, for males and females, are given on the accompanying disk. Table 5.1 shows examples of the mean expectation of life in 1988 at selected ages. Provisional figures for 1994 indicate that the mean expectations of life have continued to improve, to 72.79 and 80.15 years at birth, for males and females respectively; to 34.94 and 41.29 years at age 40, and to 6.50 and 7.89 years at age 80.

Infant mortality fell steeply from 1946–50 to 1981–85. q_0 fell from 0.0565 to 0.0069 for males, and from 0.0451 to 0.0057 for females. There was little evidence of further improvement during 1981–88, but provisional estimates of q_0 for 1994 are 0.00502 for males and 0.00432 for females. More details, and expectations of life at birth, are shown in Table 5.2.

5.2 Mortality rates used by life companies

All Finnish life insurance companies use mortality tables based on a statistical analysis of their pooled experiences. The data are collected and analyzed by a committee of representatives of all the companies. The most recent study was made in the mid-1980s.

Since 1 January 1988, the following formulae have been in use.

Age x	Males	Females
0	70.66	78.69
10	61.28	69.26
20	51.58	59.44
30	42.25	49.66
40	33.16	40.00
50	24.57	30.64
60	16.88	21.71
70	10.58	13.72
80	6.08	7.46
90	3.34	3.62
100	0.96	2.20

Table 5.1: **Mean expectations of life in 1988.**

	Mortality rate q_0		Expectation of life e_0	
Period$x$	Males	Females	Males	Females
1946–50	0.0565	0.0451	58.6	65.9
1951–55	0.0357	0.0283	63.4	69.8
1956–60	0.0273	0.0215	64.9	71.6
1961–65	0.0211	0.0164	65.4	72.6
1966–70	0.0160	0.0128	65.9	73.6
1971–75	0.0128	0.0096	66.7	75.2
1976–80	0.0092	0.0074	68.5	77.2
1981–85	0.0069	0.0057	70.1	78.4
1981	0.0074	0.0055	69.5	77.8
1982	0.0064	0.0057	70.1	78.1
1983	0.0065	0.0059	70.2	78.0
1984	0.0072	0.0058	70.4	78.8
1985	0.0066	0.0057	70.1	78.5
1986	0.0070	0.0047	70.5	78.7
1987	0.0069	0.0054	70.7	78.7
1988	0.0067	0.0056	70.7	78.7

Table 5.2: **Mortality rates in the first year of life, and expectation of life at birth.**

- **Individual life**

$$\begin{array}{lll} \text{Men} & \mu(x+h) & = & 1.15(0.00048 + 10^{0.055(x+h-94.5)}\zeta(x+h)) \\ \text{Women} & \mu(x+h) & = & 1.15(0.00048 + 10^{0.055(x+h-101.5)}\zeta(x+h-7)) \end{array}$$

- **Individual pension**

$$\begin{array}{lll} \text{Men} & \mu(x+h) & = & 1.15(0.00048 + 10^{0.055(x+h-100.5)}\zeta(x+h)) \\ \text{Women} & \mu(x+h) & = & 1.15(0.00048 + 10^{0.055(x+h-109.5)}\zeta(x+h-7)) \end{array}$$

where h is the duration since the beginning of the insurance (or policy) year $(0 \leq h \leq 1)$ and $\zeta(x+h) = 10^{-0.02(x+h-72)}$.

5.3 Experience risk study

Every year the experience of all life companies is collected and compared with the tariff assumptions. The companies carry out this work for the supervisory authorities. Tables 5.3 and 5.4 show the results for males and females respectively in 1993. Note that the expected and observed claims are in monetary amounts (MK) but the sums at risk are in units of 1,000 MK.

5.4 AIDS

In Finland, no extra premiums are charged or extra reserves held in respect of additional mortality due to AIDS.

5.5 Mortality studies

For the COINTRA conference held in 1993 in Helsinki a Finnish substandard risk study was made. The author (Ms Hillevi Mannonen) said in the summary that the observed mortality was compared with the calculated mortality for standard life assurance and with the calculated mortality for substandard risks.

On average, the observed mortality in substandard risk classes proved to be lower than the expected mortality of these classes. Observed mortality within the substandard classes was highly age-dependent; while the observed

Age Range	Expected Claims (MK)	Observed Claims (MK)	O/E Claims (%)	No.of Claims	Sums at Risk (1,000 MK)
0–4	326,322	66,705	20	4	528,420
5–9	305,572	58,010	19	3	509,235
10–14	167,970	0	0	0	279,490
15–19	175,938	320,214	182	25	293,211
20–24	166,046	440,583	265	5	248,886
25–29	569,832	849,064	149	16	712,557
30–34	1,943,043	1,611,796	83	26	1,943,292
35–39	4,499,437	2,230,464	50	34	3,330,174
40–44	8,775,825	5,144,300	59	66	4,287,530
45–49	13,249,594	11,291,173	85	86	4,040,241
50–54	9,274,571	4,004,648	43	54	1,634,921
55–59	5,655,211	1,722,790	30	50	573,533
60–64	3,264,471	2,282,645	70	41	194,410
65–69	499,524	327,710	66	18	27,308
70–74	−175,413	4,939	−3	2	1,089
75–79	−61,208	200	0	1	1,514
80+	−101,431	−1,779	2	0	−707
Total	48,535,124	30,353,462	63	431	18,605,104

Table 5.3: **Comparison of observed and expected mortality (males) in 1993.**

Age Range	Expected Claims (MK)	Observed Claims (MK)	O/E Claims (%)	No.of Claims	Sums at Risk (1,000 MK)
0–4	292,104	149,997	51	7	487,051
5–9	284,686	75,278	26	4	474,172
10–14	154,224	14,217	9	1	256,734
15–19	163,298	60,071	37	5	273,497
20–24	131,220	10,897	8	1	217,555
25–29	445,444	377,833	85	5	670,534
30–34	1,075,165	305,451	28	8	1,454,177
35–39	1,773,673	1,507,638	85	14	2,011,270
40–44	2,407,957	1,618,148	67	14	2,075,231
45–49	2,926,099	2,294,662	78	36	1,747,912
50–54	1,894,709	2,079,664	110	34	711,426
55–59	1,084,330	689,492	64	13	243,187
60–64	630,861	99,480	16	8	79,505
65–69	137,911	317,727	230	7	15,231
70–74	48,967	17,708	36	1	4,961
75–79	15,205	4,289	28	1	2,111
80+	−97,758	0	0	0	−1,189
Total	13,368,095	9,622,552	72	159	10,723,365

Table 5.4: **Comparison of observed and expected mortality (females) in 1993.**

mortality was extremely high in the young age groups, hardly any extra mortality was observed among the oldest applicants.

The study is published in Volume 1 of the 17th International Conference of COINTRA (page 111).

Chapter 6

France

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6.1 Introduction

Sous l'influence de la troisième directive européenne, la réglementation a subi récemment de nombreuses modifications entrées en vigueur le 1er juillet 1993. Elles ont pour objectif essentiel l'adaptation des règles techniques, de distribution des excédents, mais aussi la recherche d'une meilleure transparence des contrats et d'un renforcement de l'information du client dans le cadre d'une harmonisation européenne.

Cette réforme technique de la réglementation française est donc un nouveau pas vers un code des assurances adapté au contexte européen, dans le respect des recommandations de Bruxelles. Elle ne modifie pas en principe les contrats en cours à cette date.

Les décrets et arrêtés précisant les termes de la réforme sont les suivants.

Décret en Conseil d'Etat n^o 93-384 du 19 mars 1993 (JO du 20 mars). Modifie et compléte certaines dispositions du Code des Assurances en matière d'assurance vie et de capitalisation.

- **Décret n^o 93-383 du 19 mars 1993 (JO du 20 mars).** Modifie certaines dispositions de Code des Assurances relatives au rachat des contrats d'assurance vie et de capitalisation.

- **Arrêté du 19 mars 1993 (JO du 20 mars 1993).** Modifie et complète certaines dispositions du Code des Assurances en matière d'assurance vie et de capitalisation.

- **Arrêté du 27 Avril 1993 (JO du 2 juin 1993).** Homologue les tables de mortalité officielles visées au premier tiret du 2ème alinéa de l'article A 335-1 de Code des Assurances (TV 88 – 90, TD 88 – 90).

- **Arrêté du 28 juillet 1993 (JO du 30 juillet 1993).** Modifie et complète le Code des Assurances et homologue les tables de mortalité pour les rentes viagères (tables de génération).

6.2 Les tables de mortalité

Cette mesure est largement justifiée par la dérive constatée entre les anciennes tables TD et TV 73 – 77 et la mortalité réelle. De plus, le législateur innove en autorisant l'assureur à choisir la table de mortalité.

Tables INSEE officielles. La table TD 88 – 90 pour la mortalité et la table TV 88 – 90 pour la longévité reposent sur les observations de l'INSEE au cours de cette période sur la population masculine et féminine.

Tables d'expérience. Elles peuvent être établies au niveau de la profession, au niveau des Sociétés si celles-ci ont un portefeuille suffisamment important permettant des statistiques valables. Elles devront toutefois être validées, par un actuaire indépendant agréé par une commission adéquate.

Dans le passé, la table d'expérience était employée par les grandes Sociétés en Assurances Collectives. Pour celles-ci, la nouvelle réglementation n'est que l'institutionalisation d'une pratique ancienne, à la différence que l'agrément d'un actuaire sera dorénavant requis.

Tables prospectives (TPG — 1887 à 1993). Elles deviennent obligatoires pour les rentes viagères souscrites à compter du 1^{er} juillet 1993. Elles anticipent la baisse des taux de mortalité génération par génération. L'effet le plus important devrait être un meilleur provisionnement des engagements futurs de l'assureur. En tout état de cause, les bases tarifaires ne doivent pas être inférieures au tarif obtenu par la table prospective TPRV 93, qui n'est autre que la table propsective de la génération de l'année 1950. En effet, l'utilisation de 107 tables de génération aurait induit des difficultés pratiques évidentes pour les assureurs, aussi le contrôle a-t-il autorisé l'emploi de la TPRV 93. En pratique, il s'avère d'ailleurs que la tarification obtenue par cette méthode est sensiblement voisine de celle basée sur l'application des tables par génération, si l'on applique un correctif d'âge (annexe).

6.3 Les tables de mortalité prospectives

6.3.1 Introduction

Les tables de mortalité prospectives sont depuis longetemps un travail classique de la Mathématique des Assurances. Ce travail peut être renouvelé sans cesse, dès que les dernières données démographiques sont connues.

Au delà du problème de l'extrapolation de la mortalité, ce travail relève d'une grande responsabilité car il produit la base de calcul des rentes.

Pour la sécurité des Assurés, ainsi que pour celle des Assureurs, la connaissance des taux de mortalité séculaires est primordiale étant donné l'espérance de vie sans cesse croissante de la population.

Il se pose alors la question fondamentale suivante: "Doit on utiliser des tables de mortalité de génération?". Dans une table de génération la probabilité de décès ne dépend plus seulement que de l'âge x mais également de l'année de naissance.

6.3.2 Mortalité de période, mortalité de génération

A une date t_0 nous travaillons ainsi avec une probabilité de décès dans la période étudiée $q_x(t)$ où x est l'âge et t le temps. On peut alors définir la surface de mortalité où l'on a:

1. **La table de mortalité de période.** "Observée" si $t \leq t_0$, prospective si $t > t_0$:

$$q_x(t) \quad \text{avec } t \text{ constant.}$$

2. **La courbe des taux de mortalité.**

$$q_x(t) \quad \text{avec } x \text{ constant.}$$

3. **La table de mortalité de génération.** "Observée" si $x + \tau \leq t_0$, prospective si $x + \tau > t_0$:

$$q_x(t) \quad \text{avec } t - x = \tau = \text{ constante où } \tau \text{ est l'année de naissance.}$$

Ces tables de génération sont les seules capables de répresenter l'évolution de la mortalité. L'inconvénient réside dans le fait qu'il faut utiliser près d'une cinquantaine de tables de génération. Ce qui présente une certaine lourdeur. Nous présentons donc *une* table de génération "moyenne" acceptable pour les vingt prochaines années et calculons un décalage d'âge applicable aux autres générations selon la méthode RUEFF.

6.3.3 Extrapolation

Présentation des données

Nous utilisons les données nationales féminines publiées par l'INSEE. Les taux étudiés sont les taux de mortalité par tranches de cinq ans. Ces taux sont disponibles sur une longue période et sont réactualisés chaque année par l'INSEE. Nous préférons utiliser ces taux qui sont bruts et non travaillés alors que les taux de mortalité par âge q_x sont interpolés en l'absence de recensement.

Choix de la période d'interpolation

Il faut tenir compte pour le choix de plusieurs contraintes. La première étant les baisses considérables de mortalité durant ces deux dernières décennies. En prenant une courte période (1970 – 1990) on a une bonne approximation de l'accélération de la baisse de mortalité aux âges élevés. En prenant une période plus longue on surestime certainement la mortalité future. La seconde contrainte est le choc tarifaire sur les rentes.

Extrapolation des données

Plusieurs essais d'ajustement des taux à âge fixe en fonction du temps ont été tentés.

$$q_x(t) = a + b/t$$

$$\begin{aligned} q_x(t) &= a + bt + ct^n + \ldots + c_{n-1}t^n \\ q_x(t) &= K_{t_0}\exp(\lambda_x(t - t_0)) \\ q_x(t) &= \exp(f(t))/(1 + \exp(f(t))) \quad \text{où } f(t) = \sum_k c_k t^k \end{aligned} \tag{6.1}$$

Les fonctions (6.1) évoluent entre 0 et 1 et tendent vers 0. Elles se linéarisent par la transformation suivante: $\ln(q_x(t)/p_x(t)) = f(t)$.

Nous avons choisi cette dernière solution pour nos interpolations. Elle appartient aux équations du type *logistique*. La transformation précise utilisée la transformation *logit* où:

$$\begin{aligned} \ln(\sqrt{q_x(t)/p_x(t)}) &= a_x t + b_x \\ \Rightarrow q_x(t) &= \frac{\exp(a_x t + b_x)}{1 + \exp(a_x t + b_x)} \end{aligned}$$

Ce choix de fonction est basé sur une comparaison entre les différentes fonctions et par son évolution qui représente convenablement l'évolution de la mortalité.

Nous avons donc choisi la période 1961 – 1987 pour ajuster les taux de mortalité. Nous obtenons ainsi les taux prospectifs de mortalité par tranches de cinq ans. Pour créer les taux de décès annuels nous supposons, a période fixée, une évolution exponentielle des probabilités de décès entre deux tranches d'âge quinquennales. Les probabilités de décès prospectives de période à 110 ans sont trouvées avec Gompertz, il aurait cependant été préférable d'utiliser les courbes de taux de mortalité aux âges éléves, telles qu'elles peuvent être obtenues par la méthode des générations éteintes. Nous fabriquons ainsi des tables prospectives de période jusqu'en 2100 desquelles on déduit les tables de génération jusqu'a la génération 1990.

6.3.4 Utilisation simplifiée des tables prospectives

Choix de la table de génération de référence

De l'étape précédente nous extrayons une table de génération de référence. Pour l'application de cette table à la tarification de rentes, nous devons choisir une génération *moyenne* correspondant aux souscripteurs de rentes pour les vingt prochaines années. En 1990 les générations de souscripteurs sont celles de 1920 à 1950. En l'an 2010 les souscripteurs seront les générations de 1940 à 1970. Nous prenons donc comme génération de référence celle de 1950.

Correction de génération $\Delta\tau$ de RUEFF

Soit τ l'année de naissance (indice de génération). Pour inclure la baisse de mortalité dans les calculs de rente, il faudrait utiliser les tables prospectives de chaque génération. Ceci est trop lourd à gérer par les compagnies car elles devraient connaître chaque année près de 40 tables de génération. Une solution approchée, évitant ce désagrément, consiste donc à calculer les décalages des générations de 1900 à 1990 par rapport à la génération de référence 1950 (Table No. 6.2).

6.4 Taux d'intérêt technique

Un arrêté du 28 mars 1995 modifie les règles concernant les taux d'intérêt en matière de contrat d'assurance vie et capitalisation. Il modifie de fait le régime des taux garantis en faisant appel à plus de prudence dans la gestion des contrats à long terme.

Ces nouvelles dispositions seront applicables à l'ensemble des contrats souscrits à compter du 1er juin 1995.

Les tarifs pratiqués pas les entreprises d'assurance sur la vie et de capitalisation doivents êtres établis d'après un taux au plus égal à 75% du taux moyen des emprunts (TME) de l'Etat français calculé sur une base semestrielle sans pouvoir dépasser, au-delà de huit ans, le plus bas des taux suivants: 3,5% ou 60% du taux moyen indiqué ci-dessus. Pour les contrats à primes périodiques ou à capital variable, quelle que soit leur durée, ce taux ne peut excéder le plus bas des deux taux suivants: 3,5% ou 60% du taux moyen indiqué ci-dessus.

En ce qui concerne les contrats libellés en divises étrangères, le taux d'intêrét technique ne sera pas supérieur à 75% du taux moyen des emprunts d'Etat à long terme du pays de la devise concernée calculé sur base semestrielle ou, à défaut, de la référence de taux à long terme pertinente pour la devise concernée et équivalente à la référence retenue pour le franc français.

Pour les contrats au-delà de huit ans, le taux du tarif ne pourra en outre être supérieur au plafond établi par les réglementations en vigueur dans le pays de chaque devise concernée, pour les garanties de même durée, sans pouvoir excéder 60% du taux moyen visé à l'alinéa précédent. Il en est de même pour les contrats à primes périodiques.

contrats	**Maximum du taux d'intêrét techniques**	
	Durée < 8 ans	**Durée > 8 ans**
Contrats à prime unique	75% TME	Le plus faible de 3,50% et 60% TME
A prime périodique	Le plus faible de 3,50% et 60% TME	
A capital variable	Le plus faible de 3,50% et 60% TME	
Libellé en devises étrangères	75% TME local	plafond fixé par chacque pays
Libellé en écu	75% TME en ecu	Le plus faible de 3,50% et 60% TME

Table 6.1: **Taux d'intêrét technique à compter du 1er juin 1995.**

Pour ce qui est des contrats libellés en écus, le taux d'intêrêt technique ne doit pas être supérieur à 75% du taux moyen des emprunts de l'Etat français libellés dans cette référence monétaire et calculé sur base semestrielle. Le taux du tarif ne peut en outre excéder, au-delà de huit ans, le plus bas des deux taux suivants: 3,5% ou 60% du taux moyen des emprunts de l'Etat français libellés dans cette référence monétaire, indiqué ci-dessus. Il en est même pour les contrats à primes périodiques.

Le taux moyen des emprunts d'Etat á retenir est le plus élevé des deux taux suivants: taux à l'émission et taux de rendement sur le marché secondaire.

En résumé, le tableau suivant (No. 6.1) montre, en fonction du type de contrat et de sa durée, les taux d'intêrêt autorisés à compter du 1er juin 1995.

6.5 Provisionnement

- Les provisions mathématiques des contrats sont calculées en utilisant le taux d'intérêt technique du tarif.
- Le principe de zillmérisation des provisions est conservé.
- Si 80% du taux de rendement réel des actifs est inférieur au ratio (moyenne pondérée) des intérêts techniques de tous les contrats, une "provision pour aléa financier" doit être constituée à due concurrence.

- Une “provision globale de gestion” distincte des provisions mathématiques doit être constituée en fonction des charges de gestion futures des contrats, lorsque les charges excèdent les chargements prévus dans le calcul des primes, notamment par un prélèvement sur les revenus des placements.

- Les entreprises sont autorisées à calculer les provisions mathématiques des contrats en cours sur les nouvelles bases tarifaires.

- Pour les contrats autres que les rentes viagères les effets des modifications peuvent être étalés sur un délai de 8 ans.

- Pour les contrats de rentes viagères, les effets des modifications peuvent être étalés en deux étapes:

  1. Absorption des effets du passage à la table TV 88 – 90 dans un délai de 8 ans.
  2. Absorption du passage à la table prospective TPVR 93 dans un délai supplémentaire de 7 ans. La mise à niveau des provisions pour Rentes Viagères s’étalera donc sur 15 ans au maximum.

- La valeur actuelle des garanties de fidélité fait partie intégrante de la provision mathématique, en revanche elle n’est pas prise en compte dans le calcul de la valeur rachat.

6.6 Participation aux excedents

Rendue obligatoire par l’Article L132-29 de Code des Assurances, elle permet aux assurés de participer aux bénéfices techniques et financiers réalisés par la Société d’assurances.

La Société est tenue de redistribuer au minimum 90% de ses bénéfices techniques et 85% de ses résultats financiers, déterminés dans un compte de Participations aux Résultats; ces participations viennent augmenter les Provisions suivant des règles fixées dans les conditions générales des contrats, en respect de la reglementation en vigueur.

Les articles A.132 et suivant du Code des Assurances permettent aux Sociétés d’assurances sur la vie et de capitalisation, de garantir un taux annuel global de rendement incluant le taux d'intérêt technique et la participation aux bénèfices qui, rapporté aux provisions mathématiques, ne sera pas inférieur à taux minimum garanti.

Ce taux minimum peut être fixé annuellment pour l'année suivante. Il ne peut excéder 90% de la moyenne des taux de rendement des actifs de l'entreprise calculés pour les deux derniers exercices.

Enfin, la loi autorise dorénavant une prime de fidélité (Terminal Bonus) pour les contrats dont la durée de vie est supérieure à 8 ans. Contrairement au Terminal Bonus, cette prime fait l'objet d'un provisionnement. Cette nouvelle mesure a pour objet favoriser la collecte de l'épargne dans une période ou le client raisonne de plus en plus à court terme.

6.7 Conclusion

En conclusion, il est intéressant de noter l'importance de ces modifications techniques dont le principal objectif est la protection des intérêts de l'assuré, mais aussi de la pérénité des Sociétés d'assurances. Elles sont accompagnées aussi de mesures prudentielles en matière de placement des engagements et de décisions tendant à une plus grande transparence des contrats et une information rigoureuse des assurés.

6.8 Annexe

Selon l'année de naissance "n" de l'assuré ce tableau indique le nombre d'années, en plus ou en moins, qui doit lui être attribué avant d'effecteur la tarification du contrat en prenant pour référence la table TPRV 93.

Exemple: une personne née en 1928, donc âgé de 65 ans en 1993, doit être vieillie de trois ans selon ce tableau. On considère qu'elle est âgée de 68 ans, les calculs sont ensuite effectués à l'aide des éléments de la table TPRV 93 qui permettent d'établir les nombres de commutations nécessaires.

Attention: le tableau proposé est applicable lorsque le taux d'intérêt technique utilisé pour la tarification est égal à 4,50%.

Le décalage proposé est commun aux contrats de rente immédiate ou différée.

Année de naissance	Décalage
n < 1900	+6
1900 ≤ n < 1910	+5
1909 < n < 1920	+4
1919 < n < 1931	+3
1930 < n < 1939	+2
1938 < n < 1947	+1
1946 < n < 1953	0
1952 < n < 1960	−1
1959 < n < 1966	−2
1965 < n < 1971	−3
1970 < n < 1979	−4
n > 1978	−5

Table 6.2: **Tableau de décalages d'age.**

Extrait du J.O. de 30 Juillet "Lois et Décrets" n^o 174

Arrêtté du 28 Juillet portant homologation de tables de mortalité pour les rentes viagères

NOR *ECOT9390044A*

Le ministre de l'économie,

Vu le code des assurances (troisieme partie: Arrêtés), notamment son article A.335-1,

Arréte :

Art. 1er. – Pour les contrats de rentes viagères, les tables prévues au premier tiret de 2^o de l'article A.335-1 du code des assurances, tables de génération 1887 à 1993, sont homologuées telles qu'annexées au présent arréte[1]

Art. 2. – Le deuxième alinéa de l'article A.331-1-2 est rédigé comme suit:

" les entreprises peuvent répartir sur une période de quinze ans au plus les effets sur le provisionnement résultant de l'utilisation

[1] Les annexes au présent arrêté font l'objet d'une publication au *Journal officiel* de ce jour dans l'édition.des Documents administratifs n^o 58.

> des tables de génération homologuées par arrêté du ministre de l'économie."

Il est ajouté à ce même article un troisieme alinéa comme suit:

> "Les entreprises devront néanmoins avoir, dans un délai d'au plus huit ans, un niveau de provisionnement des rentes viagères supérieur au égal à celui obtenu avec la table TV 88-90 homologuée par arrêté de 27 avril 1993."

Art. 3. – Le directeur de Trésor est chargé de l'exécution du présent arrêté, qui sera publié au *Journal officiel* de la République française.

Fait à Paris, le 28 juillet 1993.

Chapter 6

France

Contributor: M. Horiot
Translator: Mrs. E. Currie

6.1 Introduction

In accordance with the Third European Life directive, numerous changes have been made to insurance regulations, coming into force on 1st July 1993. Their basic purpose is the adaptation of the technical rules and of the distribution of surpluses, but also to promote a greater clarity in contracts and a strengthening of client information within the framework of European harmonisation.

This technical reform of French regulation is therefore a new step towards an assurance code adapted to the European context, with respect to the Brussels recommendations. It does not modify in principle the contracts in force at present.

The decrees and orders specifying the precise terms of the reform are the following.

Decree of the State Council No.93-384 of 19 March 1993 (Official Journal of 20 March). Modifies and completes certain arrangements of the Assurance Code with regard to life assurance and capitalisation contracts.

- **Decree No.93-383 of 19 March 1993 (Official Journal of 20 March).** Modifies certain arrangements of the Assurance Code relating to the surrender of life assurance and capitalisation contracts.

- **Order of 19 March 1993 (Official Journal of 20 March 1993).** Modifies and completes certain arrangements of the Assurance Code with regard to life assurance and capitalisation contracts.
- **Order of 27 April 1993 (Official Journal of 2 June 1993).** Sanctions the official mortality tables in respect of the first dash of the 2nd indented line of the article A335-1 of the Assurance Code (TV 88 – 90, TD 88 – 90).
- **Order of 28 July 1993 (Official Journal of 30 July 1993).** Modifies and completes the Assurance Code and sanctions the mortality tables for life annuities (generation tables).

6.2 Mortality tables

This measure is largely justified by the discrepancy observed between the old tables TD and TV 73 – 77 and true mortality. Moreover, the legislation introduces a new feature, in that it authorises the assurer to choose his mortality table.

Official INSEE tables. The table TD 88 – 90 for mortality and the table TV 88 – 90 for longevity are based on the observations of INSEE during this period, in respect of the male and female populations.

Experience tables. These can be established at the level of the profession, or at the level of individual Companies if the latter have a sufficiently large portfolio to allow valid statistics. They will however have to be validated by an independent actuary approved by the appropriate commission. In the past, experience tables were used by large Collective Assurance Companies. For them, the new regulation merely institutionalises established practice, with the difference that validation by an actuary will be required from now on.

Prospective tables (TPG 1887 to 1993). These became obligatory for life annuities taken out on or after 1st July 1993. They anticipate falling mortality rates generation by generation. The most important consequence ought to be stronger reserving for the assurer's future liabilities. Whatever the case, the tariff bases must not be weaker than the tariff obtained by the prospective table TPRV 93, which is in fact the prospective table of the 1950 generation. The use of 107 generation tables would have led to obvious practical difficulties for assurers, so the supervisor authorised the use of the TPRV 93 table. In practice, it is found that the tariff obtained by this method is noticeably close to that based on the application of the full set of generation tables, if one corrects for age (see the annex).

6.3 Prospective mortality tables

6.3.1 Introduction

Constructing prospective mortality tables has been a classic problem of Actuarial Mathematics for a long time. Such tables must be updated frequently, as soon as the latest demographic results are known. Over and above the technical problem of extrapolating rates of mortality this work carries a great responsibility, since it forms the basis for calculation in respect of pensions. For the security of the assured as well as that of the assurers, knowledge of secular mortality rates is of prime importance, given the continually increasing expectation of life of the population. So the following fundamental question must be asked: "Must one use generation mortality tables?" In a generation table, the probability of death no longer depends solely on the age x but also on the year of birth.

6.3.2 Period mortality, generation mortality

At any date t_0 we work with probabilities of death in the period under study $q_x(t)$, where x is the age and t the time. So we can define the surface of mortality rates where we have:

1. **The period mortality tables.** "Observed" if $t \leq t_0$, prospective if $t > t_0$:

$$q_x(t) \quad \text{with } t \text{ constant.}$$

2. **The curve of the mortality rates.**

$$q_x(t) \quad \text{with } x \text{ constant.}$$

3. **The generation mortality table.** "Observed" if $x+\tau \leq t_0$, prospective if $x+\tau > t_0$:

$$q_x(t) \quad \text{with } t - x = \tau = \text{ constant if } \tau \text{ is the year of birth.}$$

Only such generation tables are capable of modelling the evolution of mortality. Their disadvantage is that one has to use nearly fifty such generation tables. This is rather cumbersome, so instead we will use one "mean" generation table, acceptable for the next twenty years, and then we calculate an age discrepancy applicable to the other generations following the RUEFF method.

6.3.3 Extrapolation

Presentation of data

We use the national data on females published by INSEE. The rates studied are the mortality rates in five-year groups. These rates are available over a long period and are revised every year by INSEE. We prefer to use crude rather than graduated rates, when interpolating mortality rates by age q_x in inter-census years.

Choice of interpolation period

In choosing the interpolation period, we have to take account of certain constraints. The first is the considerable drop in mortality over the last two decades. Taking a short period (1970 – 1990), we have a good approximation of the acceleration in the drop in mortality among advanced ages. By taking a longer period, we certainly overestimate future mortality. The second constraint is the effect of tariffs on pensions.

Extrapolation of data

Several attempts have been made to graduate mortality rates, for fixed age, as a function of time.

$$\begin{aligned} q_x(t) &= a + b/t \\ q_x(t) &= a + bt + ct^n + \ldots + c_{n-1}t^n \end{aligned}$$

$$\begin{aligned} q_x(t) &= K_{t_0} \exp(\lambda_x(t-t_0)) \\ q_x(t) &= \exp(f(t))/(1+\exp(f(t))) \quad \text{where} f(t) = \sum_k c_k t^k \end{aligned} \tag{6.1}$$

The functions 6.1 lie between 0 and 1 and tend to 0. They are linearised by the following transformation: $\ln(q_x(t)/p_x(t)) = f(t)$. We have chosen this last solution for our interpolations. It is an equation of the *logistic* type. The precise transformation uses the *logit* transformation where :

$$\begin{aligned} \ln(\sqrt{q_x(t)/p_x(t)}) &= a_x t + b_x \\ \Rightarrow q_x(t) &= \frac{\exp(a_x t + b_x)}{1 + \exp(a_x t + b_x)} \end{aligned}$$

This choice of function is based on a comparison between the different functions, and on its form which conveniently represents the evolution of mortality.

We have therefore chosen the period 1961 – 1987 to construct the mortality rates. In this way we obtain prospective mortality rates in five-year groups. To create annual death rates we assume, at a fixed period, an exponential progression of the probabilities of death between two five-year age blocks. The prospective probabilities of death in periods up to 110 years are calculated using Gompertz formulae, although it would have been preferable to use the mortality rate curves for increased ages, as they can be obtained by the method of extinct generations. In this way, we produce period prospective tables until the year 2100, from which one deduces the generation tables up until the 1990 generation.

6.3.4 Simplified utilisation of prospective tables

Choice of the reference generation table

From the previous stage we extract a reference generation table. To apply this table in order to fix pension rates, we have to choose a mean generation corresponding to the experience of pensioners over the next twenty years. In 1990 the generations of pensioners are those of 1920 – 1950. In the year 2010 the pensioners will be the generations of 1940 – 1970. So we take the generation of 1950 as our reference generation.

Correction of generation $\Delta\tau$ of RUEFF

We take the year of birth as an index of each generation. To allow for falling mortality in the calculation of pensions, we would have to use the prospective tables for each generation. This is too cumbersome for companies to manage, since they would have to use nearly 40 generation tables every year. One suggested solution, avoiding this difficulty, is to calculate age adjustments for the generations from 1900 – 1990 based upon the reference generation 1950 (Table 6.2 in the annex).

6.4 Technical interest rates

An order of 28 March 1995 modifies the rules concerning the interest rates with regard to Life Assurance and Capitalisation contracts. In fact it modifies the system of guaranteed rates by calling for greater prudence in the management of long-term contracts.

These new arrangements is applicable to all contracts taken out on or after 1st June 1995.

The tariffs used by assurance businesses on life and capitalisation contracts must be based upon a rate not exceeding 75% of the average borrowing rate (TME) of the French state calculated on a half-yearly basis and without exceeding, at the end of eight years, the lowest of the following rates: 3.5% or 60% of the average rate given below. For regular premium or variable capital contracts, of whatever term, the rate must not exceed the lowest of the two following rates: 3.5% or 60% of the rate given above.

As far as contracts drawn up in foreign currency are concerned, the technical interest rate must not be more than 75% of the average yield of long term government loans in the country of the currency concerned, calculated on a half-yearly basis, or, failing that, of the long term reference rate relevant to the currency concerned and equivalent to the reference maintained in respect of the French franc.

For contracts of terms over eight years, the tariff rate must not be higher than the ceiling established by the regulations in force in the country of every currency concerned, for guarantees of the same duration, without exceeding 60% of the average rate referred to in the preceding paragraph. The same applies to regular premium contracts.

For contracts denominated in ecus, the technical interest rate must not

contrats	**Maximum technical interest rates**	
	Duration < 8 years	**Duration > 8 years**
Single premium contracts	75% TME	The smaller of 3.50% and 60% TME
Regular premium contracts	The smaller of 3.50% and 60% TME	
Variable capital contracts	The smaller of 3.50% and 60% TME	
In foreign currency	75% local TME	Ceiling fixed by each country
In ecus	75% TME in ecus	The smaller of 3.50% and 60% TME

Table 6.1: **Technical interest rates as of 1st June 1995.**

be more than 75% of the average rate of French government loans drawn up within this monetary frame of reference and calculated on a half-yearly basis. The tariff rate may not exceed, at the end of eight years, the lower of the two following rates: 3.5% or 60% of the average rate of French government loans drawn up within this monetary frame of reference, indicated above. The same applies to regular premium contracts.

The average rate of government loan to be retained is the higher of the two following rates: issue rate and rate of return on the secondary market. In summary: the Table 6.1 shows, as a function of the type of contract and its duration, the interest rates authorised as from 1st June 1995.

6.5 Reserving

- Mathematical reserves are calculated using the technical interest rate of the tariff.

- The principle of zillmerisation of the reserve is adhered to.

- If 80% of the real return on the assets is less than the ratio (weighted mean) of the technical rates of interest of all the contracts, a "provision for financial risk" must be drawn up.

- A "global management provision" distinct from the mathematical reserves must be drawn up to allow for expenses of future management of the contracts, when these expenses exceed the costs allowed for in the calculation of the premiums, notably by a deduction from the revenues from investments.

- Companies are allowed to calculate the mathematical reserves for existing contracts on the new tariff bases.

- For contracts other than life annuities the effect of the changes may be spread over 8 years.

- For life annuity contracts, the effect of the changes may be spread in two stages:

  1. Absorption of the effects of the change to the table TV 88 – 90 over a period of 8 years.
  2. Absorption of the change to the prospective table TPVR 93 over a supplementary period of 7 years. So the equalisation of reserves for life annuities will extend over 15 years at most.

- The present value of guarantees on maturity is an integral part of the mathematical reserve, but it is not, however, taken into account in the calculation of the surrender value.

6.6 Surplus distribution

Made obligatory under Article L132-29 of the Assurance Code, distribution of surplus allows the assured to participate in the technical and financial profits earned by Assurance Companies.

A Company is bound to redistribute at least 90% of its technical profits and 85% of its financial results, calculated in a participating fund; these distributions will increase the reserves in line with the regulations laid down in the general conditions of contracts, with respect to the regulation in force.

With respect to life assurance and capitalisation contracts, the articles A.132 and following of the Assurance Code allow Companies to guarantee a global annual rate of return, including the technical interest rate and the participation in surplus, which, added to the mathematical provisions, will be not less than the minimum guaranteed rate.

This minimum rate may be fixed annually for the following year. It may not exceed 90% of the average of the rate of return of the assets of the company calculated for the last two fiscal years.

Finally, the law authorises from now on a Terminal Bonus for contracts which last for over 8 years. Unlike the Terminal Bonus, this bonus is the subject of a special fund. This new measure is intended to favour the retention of savings at a time when the client is thinking more and more in the short term.

6.7 Conclusion

In conclusion, it is interesting to note the importance of these technical modifications, whose principal aim is the protection of the interests of the person assured, but which also have in mindthe solvency of Assurance Companies. They are, in addition, accompanied by measures requiring prudent investment of funds, and by rules leading to a greater openness in contracts, and strictly ensuring the person assured has access to all necessary information.

6.8 Annexe

With regard to the year of birth of the annuitant, Table 6.2 shows the number of years to be added to the annuitant's age before the rate of premium is fixed by reference to table TPRV 93.

For example: a person born in 1928, and so aged 65 in 1993, must have 3 years added to his age according to this table. The calculations are then carried out using Table TPRV 93, taking his age as 68, which allows the necessary commutation functions to be found.

Warning: Table 6.2 is based upon a technical interest rate in premium calculations of 4.50%.

The proposed adjustment is the same for immediate or deferred annuity contracts.

Year of birth	Adjustment
n $<$ 1900	+6
1900 $\leq$ n $<$ 1910	+5
1909 $<$ n $<$ 1920	+4
1919 $<$ n $<$ 1931	+3
1930 $<$ n $<$ 1939	+2
1938 $<$ n $<$ 1947	+1
1946 $<$ n $<$ 1953	0
1952 $<$ n $<$ 1960	−1
1959 $<$ n $<$ 1966	−2
1965 $<$ n $<$ 1971	−3
1970 $<$ n $<$ 1979	−4
n $>$ 1978	−5

Table 6.2: **Table of age adjustments.**

Chapter 7

Germany

Contributors: Dr. A. Weidner and B. Weidner

7.1 Introduction

The reunification of Germany occurred on 3 October 1990. Thus the population increased by 25%. This new part of population had and still has a different mortality. We shall assume that — for the medium term — mortality in both parts of Germany will converge through convergence of living conditions.

German population mortality tables have been established at regular intervals since 1870, first by the Imperial Statistical Office and since 1949/1951 by the Federal Statistical Office. The Tables ADSt 1871/72 (ADSt stands for Allgemeine Deutsche Sterbetafel), ADSt 1881/90, ADSt 1891/1900, ADSt 1901/10, ADSt 1910/11, ADSt 1924/26, ADSt 1932/34, ADSt 1949/51, ADSt 60/62, ADSt 1970/72 and ADSt 1986/88 have been constructed based on national censuses. Seperate tables are published for males and females.

Since 1870 the territory of Germany has changed several times. The mortality, however, has developed steadily and quite consistently.

Under a supplementary act of the assurance Supervision Act, since 1994 the actuary has to determine mortality tables. In calculating tariff rates up to 1994 the actuary was not permitted to use mortality tables deviating from the rules sanctioned by the Insurance Supervisory Authority (Bundesaufsichtsamt für das Versicherungswesen, BAV) or even to use company internal tables (see [MC] p age 38).

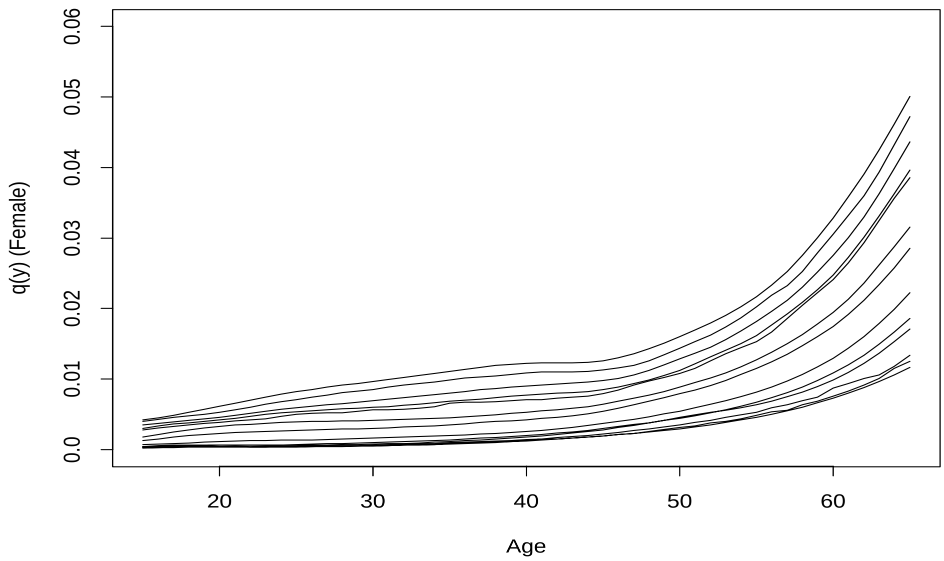

Figure 7.1: **Female mortality q_y at ages 15–65, from 1870–1988.**

The “Deutsche Akuarvereinigung” (DAV, German Federation of Actuaries) advised upon the principles of calculation in respect of premium rating and reserving standards. Here we shall just sketch the new items of the basis of calculation and their derivation.

In respect of the basis of calculation each individual item of the basis of calculation must be determined with sufficient prudence, in order to comply with the requirement of a permanent ability to meet all liabilities of even long-term assurance contracts, i.e. that in all probability the circumstances to be expected will not be less favourable than those assumed under the corresponding basis of calculation.

7.1.1 General development — Comparison of Mortality Tables West and East

In the ten years after World War II, at first mortality developed equally in both parts of Germany. Then, with the improving economy, mortality in the western part reduced more than in the eastern, socialist part (GDR). We may assume that the mortality in the former GDR will soon converge to the level of the western mortality.

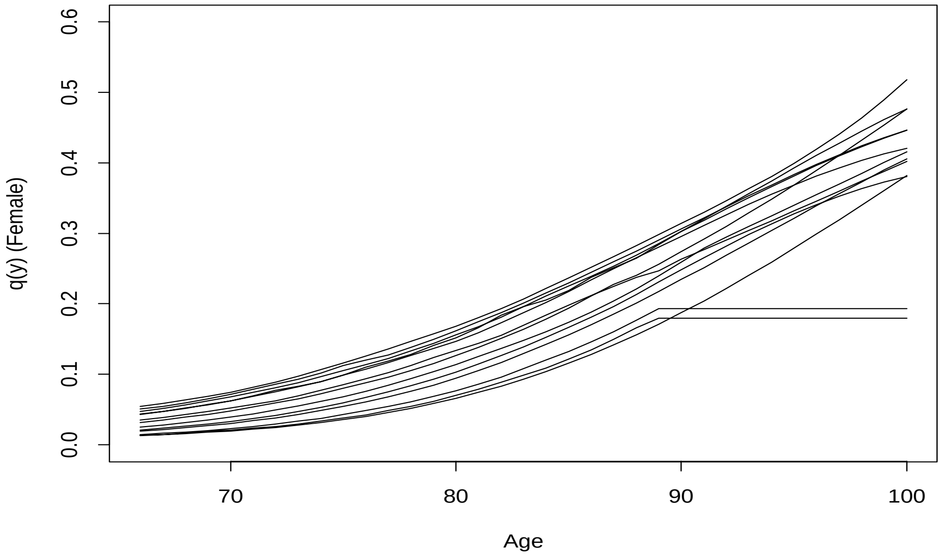

Figure 7.2: **Female mortality q_y at ages 66–100, from 1870–1988.**

Figure 7.1 shows the development of mortality since 1870 for women of the ages from 15 to 65 years. It is evident that mortality decreased steadily.

Figure 7.2 shows two striking features: The curve runs level at the highest ages, where the values q_y were not calculated from the data in the mortality tables 1960/62 and 1970/72. Also at the high ages there are two curves where the trend does not fit. These are for the years 1932/34 and 1949/51, that is, the time before and after World War II. Otherwise mortality developed rather steadily, and in particular the improvement of mortality at high ages was especially great. Development of male mortality is more complex because of the many combatants, but it also is explainable.

Today mortality decreases steadily, especially in the higher ages. Middle expectation of life increases round about one month per year for male and female.

Based on the mortality tables, which themselves were based on national censuses, the German Population Mortality Tables (ADSt) were calculated, referred to as the mortality tables 1966/68, 1967/69, . . . 1990/92. Special mention should be made of the Mortality Table St 1981/83, which was used as the basis for several tariff calculations.

7.2 Assurances with death risk prevailing

7.2.1 Authorised/Regulated assurances — Mortality Table 1986

The regulated assurances are calculated on the basis of the Mortality Table 1967 (V67) and the mortality table of the association of life assurers from 1986 (V86), both of which are mandated for the calculation of the new tariff by the BAV. As by far the majority of the group assured in German assurance was calculated with the V86 table as a technical basis, we describe it briefly.

The V86 table is used for such insurances, which were authorised by the Supervisory Authority up to 1994 or were directly derived form such assurances . Data for this table was provided by the population mortality table St 1981/83. All values are supplied with the following safety addition [DAV1]

$$\text{Male:} \quad q_x^{V86} = \begin{cases} 0.001 & x \leq 14 \\ q_x + 0.0005 & 15 \leq x \leq 17 \\ 0.00168 + 0.00001x & 18 \leq x \leq 33 \\ \max(q_{x+1}, q_x + 0.0005) & 34 \leq x \leq 100 \end{cases}$$

$$\text{Female:} \quad q_y^{V86} = \begin{cases} 0.001 & y \leq 13 \\ 0.001 + 0.0002(y-14) & 14 \leq y \leq 28 \\ 1.2\max(q_{y+1}, q_y + 0.0005) & 29 \leq y \leq 70 \\ q_{y+1}(1 + 0.01(90-y)) & 71 \leq y \leq 90 \\ q_{y+1} & 91 \leq y \leq 100 \end{cases}$$

7.2.2 DAV Mortality Table 1994T — DAV 1994T

In view of the cessation of the licensing requirement by the BAV the DAV-committee "Life Assurance" formed a working group with the brief to construct an appropriate mortality table for whole life assurances. At first a mortality table — the DAV Mortality Table 1994T — was constructed.

The latest German Population Mortality Table 1986/88 was taken as a basis, as in Germany up to now there does not exist any useful statistical material about mortality of assured lives for this purpose. The German Population Mortality Table 1986/88 itself had been established by the so-called death rate method based on the national census of 1988. Unlike past tables this table was not smoothed by a mechanical method of graduation, but by the method of Reinsch, which uses Spline-interpolation [M]. The age of 0 was not taken into consideration.

To use this table for assurance calculations the values must be augmented with surcharges for the statistical variation, s_x^α. These surcharges must be set sufficiently high that the expected number of deaths, based upon these adjusted decrement rates, for the lives assured of a medium-sized company (using a model group) is an upper confidence limit for the expected number of deaths calculated with the unadjusted decrement rates. This probability of safety has to be very high, DAV requires $(1-\alpha)$ with $\alpha = 0.01$.

Let M refer to a model group of 300,000 people of the same sex and let L_x^M be the population of age x: then the basic equation for determination of s_x^α is

$$P\left[\sum_x q_x^M L_x^M \leq \sum_x (q_x + s_x^\alpha) L_x^M\right] \geq 1-\alpha.$$

Further for the risk of future changes a charge of r_x is imposed. In total we then get

$$q'^{\alpha}_x = r_x(q_x + s_x^\alpha).$$

as the rate of mortality DAV 1994T. r_x is given as

$$r_x = \begin{cases} 1.2 & x \leq 20 \\ 1.2 - 0.01(x-20) & 21 \leq x \leq 33 \\ 1.07 & x \geq 34 \end{cases}$$

For assurances with death risk prevailing it is regarded as sufficiently prudent to use this aggregate mortality table. If the assurance company observes that they have a lower mortality experience and therefore want a lower rating, they have to prove this lower mortality statistically. The resulting mortality rates are then

$$q'^{\alpha U}_x = r_x(q_x^U + 0.2 q_x^\alpha + s_x^{U\alpha})$$

where superscript U indicates quantities based upon the company's own experience.

Figure 7.3 shows the q_x of the DAV 1994T-table as a percentage of the q_x of the ADSt 1986/88 table.

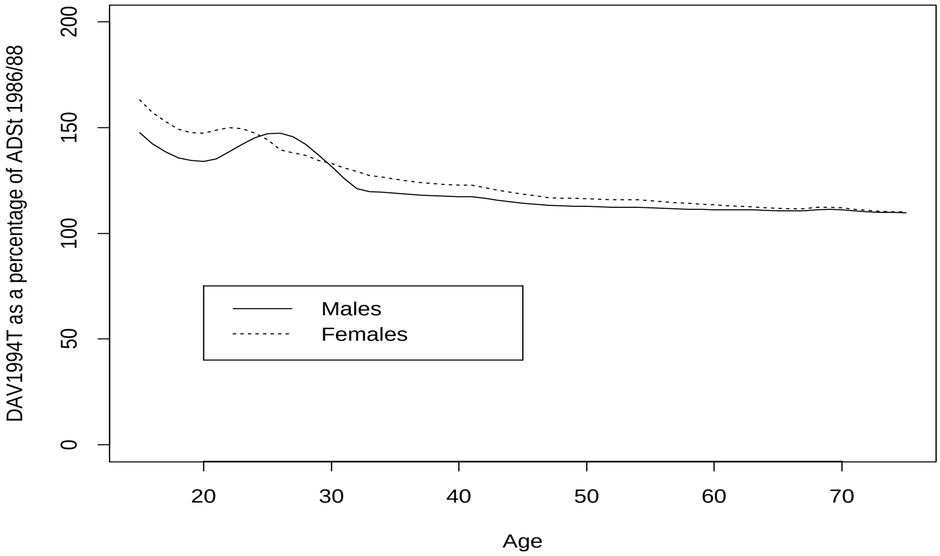

Figure 7.3: **DAV1994T mortality rates as percentages of ADSt 1986/88.**

7.2.3 Burial Funds (Sterbekassen)

Burial funds are mutuals (Versicherungvereine auf Gegenseitigkeit), which just insure small sums and as a rule only for a well defined group of persons and without any selection of risks. Most of the tariffs used by these institutions are regulated. Therefore until recently mainly old tables, as for instance ADSt 1949/51, were used.

In 1994 the BAV introduced a new mortality table [V1]. It may be used if the company's experienced mortality of the burial fund in the last three years for all members and for the several classes of different ages is lower than 95% of this new mortality table.

The Mortality Table 1994T is derived form the ADSt 1986/88. Figure 7.4 shows the mortality of the table 1994T as a percentage of that of the ADSt 1986/88 table.

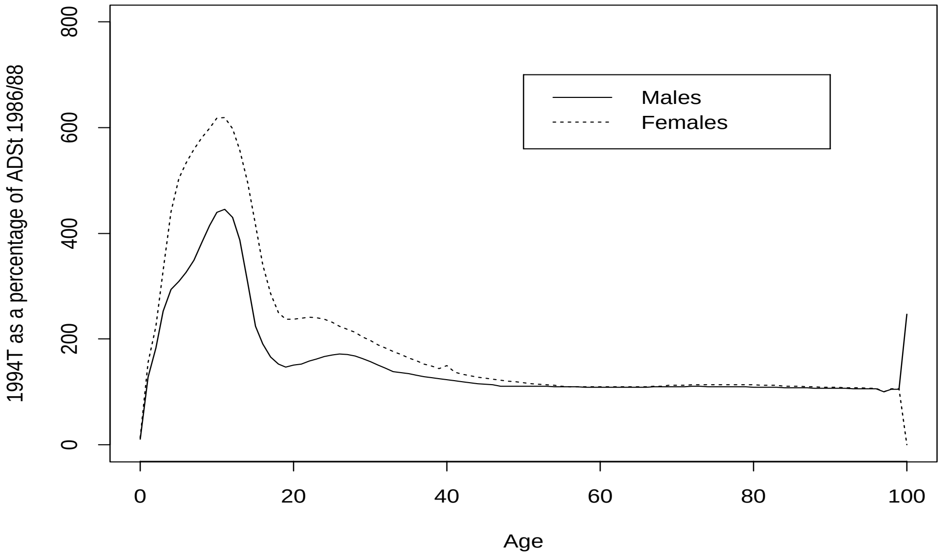

Figure 7.4: **1994T mortality rates as percentages of ADSt 1986/88.**

7.3 Endowment Assurance — Annuities and Pensions

In Germany, no distinction is made (nor was made in former times) between tables for insurances with immediate or deferred commencement of payment of annuities. The reason is that usually pensions will be granted with the option of a lump-sum at the end of the deferral period. Because of this the selection of pensions is practically the same as of immediate annuities.

7.3.1 Annuities and Pensions — Regulated Tariffs

In the year 1987, the Supervisory Authority fixed new mortality tables as the basis of calculation for annuities and pensions assurances (Mortality Table 1987R) [L]. These replaced the table of 1957, which did not differentiate between males and females.

Most pensions in respect of lives currently assured are calculated with the table 1987R. Though this basis cannot be called old, it is today considered to be no longer adequate.

7.3.2 DAV Mortality Table 1994R

A comparison of the mortality tables of the last century generally reveals a decrease of mortality. Remarkable is the accelerated decrease of mortality at high and at very high ages.

For those actuaries who don't base their calculations on their company's own experience, the DAV has recommended a new mortality table called DAV-Sterbetafel 1994R [DAV4].

Since there are annuities both with immediate and deferred commencement of payment, calculation bases are required which are suitable for the present as well as for the future. The decrement rates, therefore, do not depend on the age alone, but also on the calendar year.

The projection of future mortality assumes an annual improvement rate, depending on age, which is based on the trend of mortality in the population. In contrast to earlier models, the basis to which the improvement rate has been applied, is not a life table of the past but rather a projected table in the immediate future, using the most up-to-date information.

For the base table mortality-West was selected, projected with the well known trend to the year 2000 as well as provided with a surcharge f_x for the lower mortality in the group assured and a safety rebate s_x^α for the statistical risk of variation:

$$q'_x = f_x q_x - s_x^\alpha$$

with

$$f_x = \begin{cases} 0.9 & 0 \leq x \leq 20 \\ 0.9 - 0.01(x-20) & 21 \leq x \leq 29 \\ 0.8 & 30 \leq x \leq 50 \\ 0.8 - 0.02(x-50) & 51 \leq x \leq 59 \\ 0.6 & 60 \leq x \leq 65 \\ 0.6 + 0.015(x-65) & 66 \leq x \leq 74 \\ 0.75 & 75 \leq x \leq 110 \end{cases}$$

The addition for statistical variation s_x^α is calculated so that a lower confidence limit is kept within with the mortality probability $q_x - s_x^\alpha$. This means:

$$P\left[T \geq \sum_x (q_x - s_x^\alpha) L_x\right] \geq 1 - \alpha.$$

Male			Female		
Year of birth			Year of birth		
From	To	Age shift	From	To	Age shift
1900	1906	7	1900	1902	6
1907	1910	6	1903	1907	5
1911	1913	5	1908	1930	4
1914	1920	4	1931	1938	3
1921	1934	3	1939	1945	2
1935	1943	2	1946	1951	1
1944	1951	1	1952	1957	0
1952	1958	0	1958	1963	−1
1959	1966	−1	1964	1968	−2
1967	1973	−2	1969	1974	−3
1974	1981	−3	1975	1978	−4
1982	1988	−4	1979	1983	−5
1989	1996	−5	1984	1987	−6
1997	2003	−6	1988	1991	−7
2004	2010	−7	1992	1996	−8
			1997	2000	−9
			2001	2004	−10
			2005	2009	−11
			2010	2010	−12

Table 7.1: **Age adjustments for long term development of endowment assurance (annuities and pensions) mortality.**

where

$$T = \sum_x T_x$$

is the random number of deaths.

The projection of the long term development of the mortality probabilities — in German tradition — is performed by an approximation method called age-shifting. This means that for every assured person a notional age is calculated. The result is shown in Table 7.1.

For the calculation of this age-shifting see [DAV4] and [L]. For further explanations see the comprehensive and thorough presentation in [DAV4].

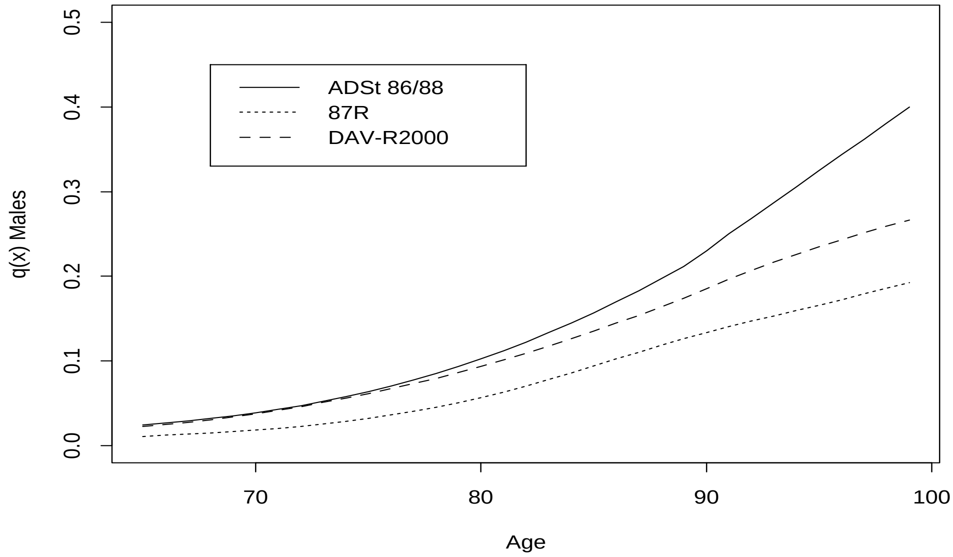

Figure 7.5: **Comparison of projected mortality with other tables, males.**

	In the year 2000			In the year 2030		
Age	40	60	80	40	60	80
Male	42.36	21.62	7.34	46.20	24.97	8.61
Female	47.37	25.50	8.50	53.27	30.16	10.25

Table 7.2: **Projected expectation of life in 2000 and 2030.**

Figures 7.4 and 7.5 show the comparison between the three relevant tables.

But these mortality tables just seem to be chosen sufficiently prudently. Table 7.2 shows the (projected) middle expectation of life of a person aged x in the years 2000 and 2030:

7.3.3 "Pensionskassen"

"Pensionskassen" are a German kind of external pension fund. They are treated like external captive companies, meaning special insurance companies for the employees of a single employer or a homogeneous occupation

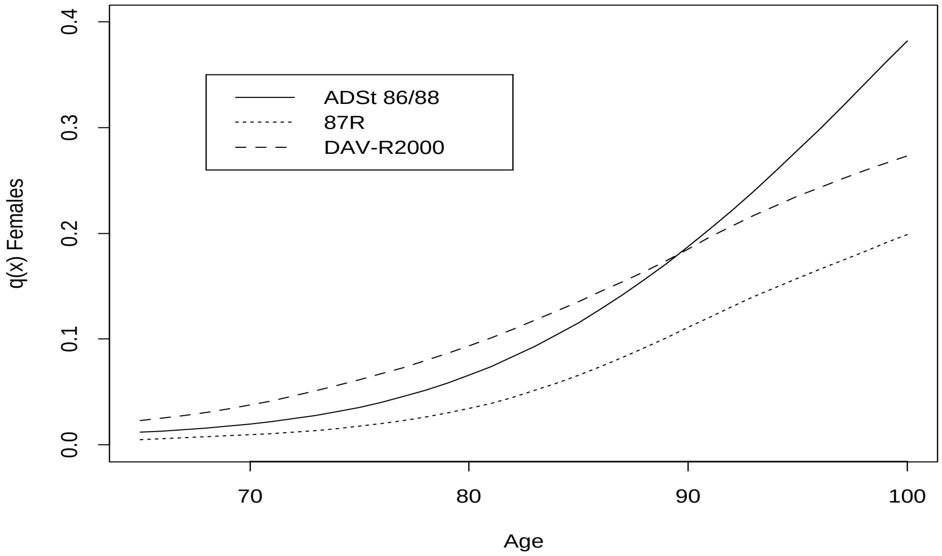

Figure 7.6: **Comparison of projected mortality with other tables, females.**

group, especially professions. Such "Pensionskassen" calculate with their own mortality tables. In practice, they make use of the "Richttafeln" (RT) of K.Heubeck [H] and restrict to check whether the RT are appropriate. If necessary, the RT values are modified, often by a fixed coefficient f or by age-shifting.

The RT consider the following decrement rates: i_x disability rate; q_x^a mortality of actives; q_x^i mortality of disabled; q_x aggregate mortality. They also pay regard to h_x, the probability of being married in case of death at age x, and $y(x)$ or $x(y)$, the collective age of a surviving spouse of a man who dies at age x or a woman who dies at age y, respectively. Table 7.3 shows a comparision between the RT with the present table 86/88.

The RT had been developed in 1982 mainly for the purpose offering modern tables for providing actuarial valuations for occupational pension schemes. The aggregate mortality is derived from the mortality table 1970/72. The values of this mortality table are smoothed with spline functions and an addition is made to allow for the trend, which is supposed to cope with the improvement of the mortality during the next 20 to 30 years. The values of i_x, q_x^i, $y(x)$ and $x(y)$ are derived from ample statistical material provided by

	Age						
	20	30	40	50	60	70	80
Males							
q_x^a	111.08	80.75	73.86	59.34	49.11		
q_x^i	1,562.70	1,962.76	1,268.94	514.94	155.64		
q_x	111.17	90.02	96.56	86.94	81.21	90.07	82.62
Females							
q_y^a	101.26	75.43	54.70	46.56	49.61		
q_y^i	5,877.28	3,376.09	1,341.50	680.18	138.38		
q_x	101.26	88.93	77.10	80.47	79.60	94.29	97.94

Table 7.3: **Mortality of the "Richttafeln" (RT) tables as a percentage of the ADSt 86/88 tables.**

the social security authorities. The probability h_x of being married in case of death at age x is based on total population statistics.

At present it is being checked whether or not these decrement rates will still be applicable after the reunification.

7.3.4 Widows of Pensioners

For survivor's pensions the same mortality tables are used as for the original insurance, that is, the aggregate table.

7.4 Further Topics

7.4.1 Insurance for Cases of Disability

In the latest approved tariffs for the "active" decrement rates the normal mortality table of long term insurance was chosen. For the mortality of disabled lives a select table was developed [R]. During the first few months of disability the mortality is rather high, while it declines to a normal value afterwards.

Figures 7.7 and 7.8 show, for males and females respectively, the mortality rates for disabled lives at select durations 0 – 4, and at durations 5 and over, as a percentage of the ADSt 86/88 mortality.

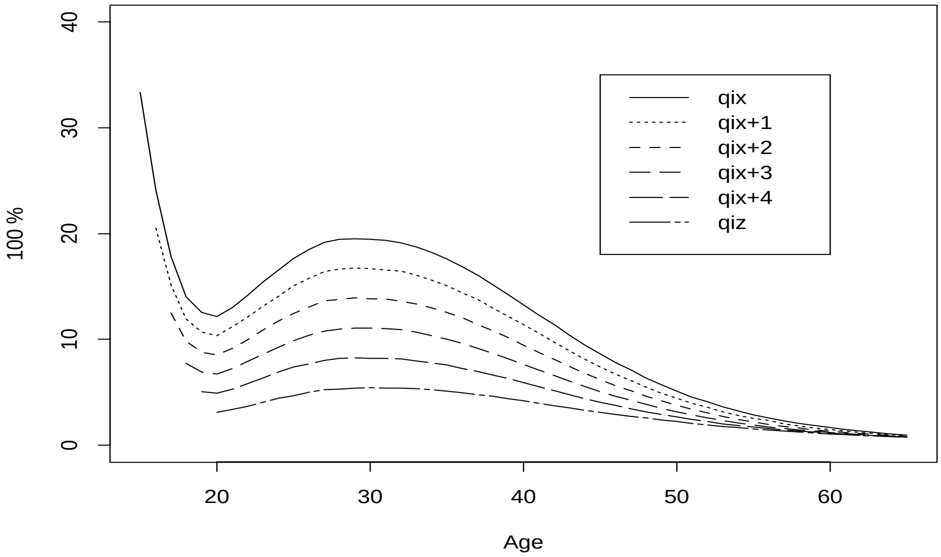

Figure 7.7: **Mortality rates for disabled lives, males.**

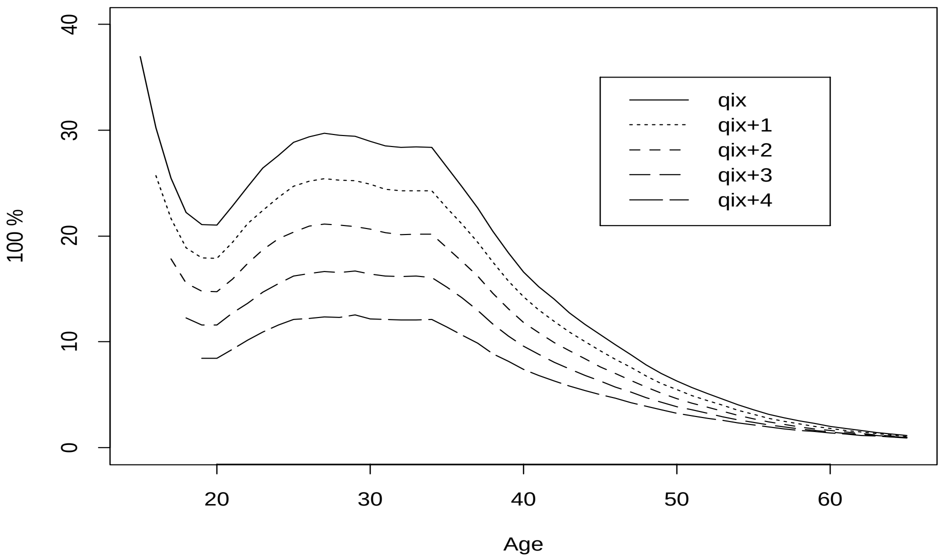

Figure 7.8: **Mortality rates for disabled lives, females.**

7.4.2 Smoker/Non-smoker Mortality

It has been proposed [K] that to cope with the mortality of smokers/nonsmokers each company should make its own observations, upon which it can base its own assumptions. The probability of the aggregate mortality will be known. Also will be known the relations between the mortality of smokers and the mortality of non-smokers. Depending on the share of the smokers in the total portfolio there should be a different mortality for smokers. Values for the mortality of smokers/nonsmokers are not available yet.

The same proposal is made by the Kölnischen Rück [S]; they propose to introduce different tariffs for smokers and non-smokers as described above. Meanwhile there are some tariffs for smokers/non-smokers in Germany, but it is unknown, how far they followed the described proposals.

On the whole it is recommended to find the mortality as follows: Let

$$\begin{aligned} {}_{ns}q_x &= \text{required mortality for non-smokers} \\ {}_{s}q_x &= \text{required mortality for smokers} \\ {}_{ns}mr_x &= \text{proportion of non-smokers in assured group} \\ f_x = {}_{s}q_x / {}_{ns}q_x &= \text{presumed relation of mortality} \\ q_x &= \text{aggregate mortality rate} \end{aligned}$$

Then

$${}_{ns}q_x = \frac{q_x}{{}_{ns}mr_x + f_x(1 - {}_{ns}mr_x)}$$

as well as

$${}_{s}q_x = {}_{ns}q_x f_x.$$

It is evident that mortality for calculations depends very strongly on the composition of the actual group insured.

7.4.3 Long-term care benefits (Pflegefallversicherung)

For the development of these tables see [G]. Three decrement rates were treated:

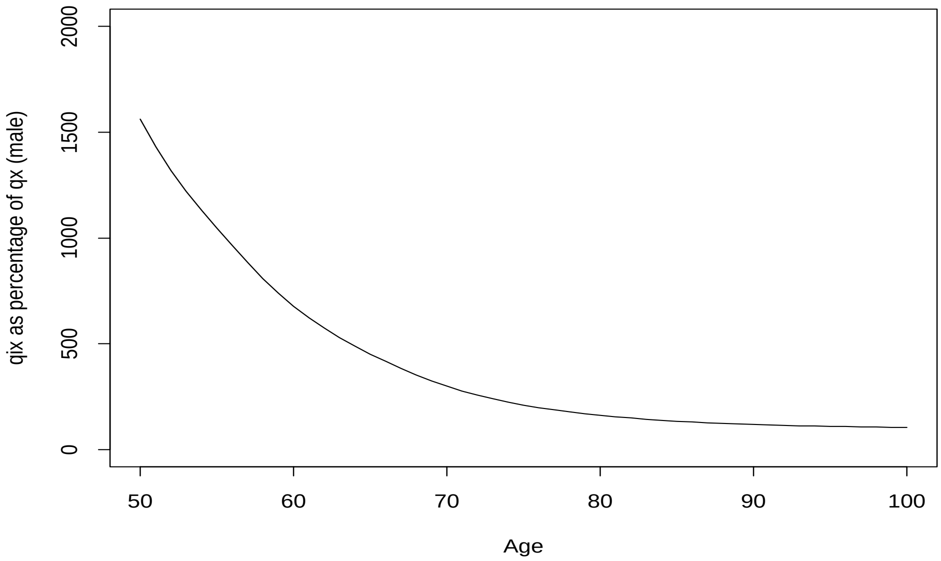

Figure 7.9: **Mortality rates for lives requiring long-term care, as a percentage of Table 1987R (males).**

$$
\begin{aligned}
q_x^{(1)} &= i_x \quad \text{probability of requiring care} \\
q_x^{(2)} &= q_x \quad \text{probability of death} \\
q_x^{(3)} &= q_x^i \quad \text{probability of death while requiring care.}
\end{aligned}
$$

The mortality of those requiring care is far higher than the mortality of "normal" people. Therefore it must be calculated with a charge, which is taken the same for males and females:

$$q_x^i = q_x + 0.085 e^{-((x-40)/52.2819)4}.$$

Figure 7.9 shows the mortality of those requiring care compared with the aggregate mortality. The situation is rather the same for males and females. The following figure relies on the Mortality Table 1987R (see Section 7.3.1).

It should be mentioned that long-term care benefit has not yet achieved a significant market share. That might be due to the rather high premiums.

7.4.4 Dread Disease

Insurance of dread disease in Germany is only offered as a supplementary insurance for partial or total prepayment of a lump-sum or an annuity.

For dread disease three decrement rates are used:

$q_x^{(1)}$	$=$	dd_x	probability of suffering from an insured sickness
$q_x^{(2)}$	$=$	q_x^{aa}	probability of death within one year without having suffered one of the insured sicknesses
$q_x^{(3)}$	$=$	q_x^{i}	probability of death of ill persons.

References are [D1],[D2],[LL] and [A].

For the decrement rates dd_x, English statistics were used and modified; for q_x^{aa} the unmodified mortality table St 81/83 is used. While security additions or reductions of q_x^{aa} hardly influence the premium rates, loadings must be included in the q_x^i according to the actual conditions of insurance.

7.4.5 AIDS

The latest publication is [W]. There is given a description of an epidemic model. The influence of the rating is explored. The model does not fit the real development of the AIDS epidemic; today 0.2% – 0.3% of the deaths in continental Europe are caused by AIDS. In Germany AIDS shows no remarkable features in trend of loss.

Applications in pricing or setting up reserves are not known.

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Chapter 8

Greece

Contributor: J. Koutsopoulos

8.1 Current Practice

For the last 15 years or so, Greek life insurance companies have used the French mortality table PM 60–64 MKH. However, tariffs have recently been deregulated, and it is evident that this table is not suitable for endowments and pension plans (which are the main products sold) so life insurance companies are now beginning to use a variety of mortality tables. There are no tables based on Greek assured lives.

8.2 Population Mortality

The most recent national life tables were based on the 1981 census. These are included on the accompanying disk.

Chapter 9

Iceland

Contributor: B. Thordarson

9.1 Icelandic Life Tables 1986–90

The Society of Icelandic Actuaries (Félag íslenskra tryggingastærdfrædinga) compiled life tables for males and females based on the years 1986–90; tables for 1991–95 should be published in 1997. No tables based on insurance data have yet been compiled. This description of the 1986–90 tables is based on Gudmundsson (1992).

9.1.1 The Data

The data were the national mortality data for males and females in 1986–90, at ages 20–99. These provided:

- $DF(j, f)$ = the number of deaths occurring in year j among lives born in year f, where death took place before the birthday in year $j (j = 1986, \ldots, 1991)$.

- $DE(j, f)$ = the number of deaths occurring in year j among lives born in year f, where death took place after the birthday in year $j (j = 1986, \ldots, 1991)$.

- $L(j, f)$ = number of lives alive in year j, born in year f $(j = 1986, \ldots, 1991)$.

	Males	Females
a_1	0.000976257	0.00018014
b_1	−4.220563	−4.007561
b_2	5.835074	5.201932
b_3	−0.680853	
b_4	0.262924	

Table 9.1: **Coefficients of GM formulae used in graduation of 1986–90 population data.**

The number of deaths at age x last birthday was therefore given by:

$$A(x) = \sum_j DE(j, j - x) + DF(j, j - x - 1)$$

and the exposures were given by:

$$R(x) = \sum_j R(j, x)$$

where the central exposure to risk in year j was approximated by:

$$R(j, x) = \frac{L(j, j - x - 1) + L(j + 1, j - x)}{2} + \frac{DE(j, j - x) - DF(j, j - x - 1)}{4}.$$

9.1.2 The Graduation

A Poisson model was used for the force of mortality at individual ages, and the graduation used the maximum likelihood methods described in Forfar, McCutcheon & Wilkie (1988). Curves of the Generalised Gompertz-Makeham family were fitted, that is, of the form:

$$\mu(x) = a_1 + a_2 x + \ldots + a_r x^{r-1} + \exp(b_1 + b_2 x + \ldots + b_s x^{s-1}).$$

A GM(1,4) formula was found to be satisfactory for males, and a GM(1,2) formula for females. The coefficients are shown in Table 9.1.

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Chapter 10

Ireland

Contributor: D. Harney

10.1 Introduction

Life offices in Ireland may choose the mortality basis they use for pricing and valuation purposes.

In practice life offices use mortality rates based on U.K. standard tables adjusted to suit the requirements and experience of each office.

The most commonly used tables are the "80" series tables produced by the Continuous Mortality Investigation Bureau in the U.K. These published standard tables are based upon U.K. life office experience in the period 1979–82. Irish life offices also use mortality rates based upon the older U.K. standard tables A1967–70 for assured lives, PA(90) and a(90) for annuitants.

10.2 Experience tables

The Continuous Mortality Investigation Bureau collects mortality statistics for U.K. life offices. Mortality statistics for some Irish life offices have also been submitted.

The latest results for Permanent Assured Lives in Ireland relating to the periods 1983–86 and 1987–90 compared with U.K. standard tables are shown in Table 10.1.

However, as stated this does not include the experience of all life offices and it only includes the experience of Whole Life and Endowment policies.

	Period	Actual/Expected	Comparison Table
Males	1983–86	108%	AM80 Select
Females	1983–86	96%	AF80 Select
Males	1987–90	89%	AM80 Select
Females	1987–90	76%	AF80 Select

Table 10.1: **Experience of Irish Permanent Assured Lives, 1983–90.**

The majority of life office policies in Ireland are unit-linked and the experience of these is not included above.

There is no standard table for Irish assured lives or for Irish annuitants.

Chapter 11

Italy

Contributor: Dr. C. Tomassini

11.1 Introduction

Because of the Third Life Directive, since 1 July 1994 Italian insurance companies are no longer obliged to send the supervisory authority (ISVAP) any previous communication on the introduction in the insurance market of a new tariff or the change in some components related to existing tariffs, in order to obtain *a priori* authorization (as was the case in the past).

Nowadays, life tariffs are calculated, in general terms, with reference to the mortality tables based on the general Italian population at a specified census date.

Mortality tables based on the experience of specific groups of insured persons have not been used to date, except for some new insurance coverages, for which the mortality experience of other countries has been used. This is, for example, the case for dread disease coverage.

11.2 Tariffs and Mortality Tables

11.2.1 Endowment Assurance; Whole Life Assurance; Term Assurance

These tariffs are calculated by using the SIM 81 (table of male mortality based on the population, drawn from the 1981 population census). The rate of tariff for females is calculated by using this table modified in the following way:

$$l(y) = l(x - 5)$$

where $l(y)$ denotes the number of surviving females of age y and $l(x-5)$ the number of surviving males of age $x - 5$.

11.2.2 Pure Endowment

These contracts are deferred capital with or without coverage in case of death. The SIM 71 table is used without any distinction between males and females in the rating of this tariff.

11.2.3 Deferred Annuities

During the deferred period, the table used is the SIM 71 for males and SIF 71 for females. After this period, the calculation of the annuities proceeds using a projected select table in order to have a proper estimate of the "risk of life" of insured persons in the future. The base tables for the projection are the SIM 70–72 and the SIF 70–72. The model used is the following:

1. Projection of the 1971 general mortality, q_x:

$$q_x(1971 + n) = q_x(1971)r(x)^n \tag{11.1}$$

   where $q_x(1971 + n)$ is an estimate of the probability of death in the year $(1971 + n)$, for a person of age x (male or female); $q_x(1971)$ is the probability of death, obtained from SIM 71 or SIF 71; $r(x)$ is the average annual rate of variation of mortality during the projection period (calculated on the basis of mortality variations with reference to the 1961, 1971 and 1978 mortality tables); and n is the number of years of the projection period (20 years for males and 25 years for females).

2. Projection of the 1971 probability of death by accidental factors, $q^a(x)$:

$$q_x^a(1971 + n) = q_x^a(1971)r^a(x)^n \tag{11.2}$$

   with the same meaning as equation (11.1).

3. A "selection" factor, denoted $g(x;t)$, to be used in formula (11.3), depending on age x and time t, where the latter is used to express the weight of actuarial "selection". As can be seen by the $h(t)$ parameter shown below, its effect is uniform if t is at least 5 years. The factor is defined by the formula:

$$g(x;t) = \begin{cases} 0 & t = 0 \\ s(x) + h(t) & 1 \leq t \leq 4 \\ 0.85 & t \geq 5 \end{cases}$$

where:

$$s(x) = 0.03(x-60) = \begin{cases} 0 & x \leq 60 \\ \neq 0 & x > 60 \end{cases}$$

$$h(t) = \begin{cases} 0.100 & t = 1 \\ 0.200 & t = 2 \\ 0.333 & t = 3 \\ 0.600 & t = 4 \\ 0.850 & t = 5 \end{cases}$$

The final formula is:

$$q_{x+t}(1971+n) = q^a_{x+t}(1971+n) + g(x;t)[q_{x+t}(1971+n) - q^a_{x+t}(1971+n)]. \tag{11.3}$$

Table 11.1 shows the values of the annuity rate a_x calculated by this method, with a technical rate of 0% and 3%, and with 0 years of "notice" ($t = 0$).

Furthermore, Tables 11.2 and 11.3 give a comparison of the annuities calculated on the basis of:

1. ordinary mortality tables (the 1961, the 1971 and the 1978);

2. an empirical correction used by the companies before the introduction of the mortality tables projected and selected, defined as follows: for Males:

	Males	Males	Females	Females
Age	0%	3%	0%	3%
40	35.253	20.806	41.541	23.008
50	26.645	17.441	32.219	19.887
60	18.938	13.695	23.427	16.122
70	12.209	9.676	15.116	11.555
80	6.939	5.957	8.405	7.026

Table 11.1: **Annuities projected and selected**

$$a_x^{SimC} = a_{x-3.5}^{Sim1971} f(x)$$

where:

$$f(x) = \begin{cases} 1 & x \leq 55 \\ -0.00016(x-55)^2 + 0.0032(x-55) + 1 & 56 \leq x \leq 59 \\ 1.012 & x \geq 70 \end{cases}$$

and for Females:

$$a_y^{SifC} = a_{y-4}^{Sif1971}.$$

The last column shows the values obtained through the new method, considering 0 "years of notice" ($t = 0$). It is useful to compare the good approximation between the rates calculated by the old and new methods (see the last two columns).

Tables 11.4 and 11.5 give an idea of the weight represented by the $g(x;t)$ selection factor in the projected mortality tables. The following annuities are calculated using a 3% technical rate.

11.3 Other Items

11.3.1 The 1991 Mortality Tables

The National Institute of Statistics – ISTAT – has recently published a draft of the latest mortality tables, the SIM 91 and SIF 91, related to the last

Age	SIM 61	SIM 71	SIM 78	Empirical Correction	Projected & Selected Tables
40	19.759	19.814	19.971	20.992	20.805
50	15.998	16.079	16.203	17.440	17.441
60	11.974	11.986	12.168	13.602	13.695
70	8.061	7.972	8.194	9.457	9.676
80	4.545	4.642	4.650	5.782	5.957

Table 11.2: **Annuities calculated using different mortality tables – MALES (3%)**

Age	SIF 61	SIF 71	SIF 78	Empirical Correction	Projected & Selected Tables
40	21.300	21.681	22.099	22.874	23.008
50	17.771	18.208	18.686	19.676	19.887
60	13.577	14.079	14.595	15.812	16.122
70	9.012	9.451	9.994	11.332	11.555
80	5.052	5.331	5.552	6.825	7.026

Table 11.3: **Annuities calculated using different mortality tables – FEMALES (3%)**

Age	$t = 5$	$t = 4$	$t = 3$	$t = 2$	$t = 1$	$t = 0$
40	20.695	20.702	20.718	20.740	20.769	20.805
50	17.086	17.114	17.173	17.250	17.339	17.441
60	13.050	13.099	13.204	13.341	13.504	13.695
70	8.960	8.961	9.042	9.175	9.343	9.676
80	5.382	5.382	5.382	5.409	5.490	5.957

Table 11.4: **Annuities projected and selected through the $g(x;t)$ factor – MALES (3%)**

Age	$t=5$	$t=4$	$t=3$	$t=2$	$t=1$	$t=0$
40	22.949	22.953	22.962	22.975	22.989	23.008
50	19.715	19.728	19.757	19.794	19.837	19.887
60	15.790	15.816	15.871	15.942	16.025	16.122
70	11.174	11.174	11.215	11.284	11.379	11.555
80	6.549	6.549	6.549	6.571	6.389	7.026

Table 11.5: **Annuities projected and selected through the $g(x;t)$ factor – FEMALES (3%)**

general population census. The two tables confirm in general terms the trend of decreasing mortality in the Italian population.

11.3.2 Smoker and Non-Smoker Tables

At the present time there are studies focused on this field, but no table has been published. In any case, a very small number of life insurance companies have launched tariffs on the basis of the "smoker/ non-smoker" principle, based only on empirical methods.

11.3.3 Dread Diseases Coverage

This type of coverage is today not sold stand-alone but as a supplementary coverage to an endowment policy. At the moment it is sold only by one big company and its market penetration is modest (as happens anyway in Italy for any product covering the demographic risks only).

The rates of tariffs are based on morbidity and death rates related to the main dread diseases (such as heart attacks, transplants, brain traumas, and so on). The benefit paid is a lump sum in the case of serious sickness of the insured person. Additionally, the policyholder can ask for a waiver of premium in case of serious sickness of the insured person.

The processing of dread disease tariffs refers mainly to statistical experiences related to the U.K. population.

11.3.4 AIDS

ANIA, the National Association of Italian Insurance Companies, making reference to the AIDS problem, has suggested the adoption of some prudential underwriting criteria in the acceptance of death coverages. At the present time, the acceptance of the risk is constrained on the filling in of a medical questionnaire up to 300 million Italian Lire as sum assured. If required by specific reasons expressed by the company, the questionnaire can be supplemented by reports on medical examinations.

To prevent the effects related to the risk of AIDS it is suggested that there is applied a 'lack' period of 5 years is the sum assured is under 300 million Lire and no AIDS test is requested by the company. During these years, no benefit is paid if the insured person dies of any sickness related to the HIV virus. If the sum assured is more than 300 million Lire, the AIDS test is mandatory and the 'lack' period is of 7 years if the insuring person refuses to take the test.

Chapter 12

The Netherlands

Contributor: D. den Heijer

This article consists of parts of the article by Drs. J.J. van Oosterwijk Bruijn, which appeared in the previous edition of this survey, updated by the present contributor.

12.1 Tables Used by Insurance Companies

In the Netherlands the calculation of life assurance and annuity premiums and reserves has always been based on mortality data for the general population. From 1840 to 1940 mortality tables based on the experience of the general population during 10-year periods were published by the Central Bureau of Statistics and its predecessors. Subsequently, a table based on the experience of the 3 years 1947 – 49 was published, and starting with the period 1951 – 55 tables have been published based on the experience of each quinquennium. The latest tables are for the period 1986-90.

For life insurance use, special versions of all the tables since 1921 – 30 have been prepared by Makeham graduation. Until 1955 these were published in "Het Verzekerings Archief". Beginning with the table for 1956 – 60 the graduated tables, prepared by a committee of the Actuarieel Genootschap, have been added to its publications by the Central Bureau of Statistics.

Not all of the available mortality tables have been widely used by life insurance companies. The following tables are the ones that have been used most frequently by Dutch life insurance companies, both as a basis for premium calculations and for valuation.

12.1.1 Gehele Bevolking Mannen (GBM) 1921 – 1930

This table has been used for a long period by many companies for ordinary and industrial assurances. It is still used by a number of companies for the valuation of some parts of their life assurance and industrial assurance portfolios.

12.1.2 Gehele Bevolking Mannen (GBM) 1947 – 1949

This table has been used by nearly all life assurance companies for part or all of their portfolio, both for ordinary and group life assurances and for annuities. Usually, for assurances the age of the insured has been increased by 2 or 3 years. For annuities a decrease of 2 years has been applied in the case of deferred annuities and pensions on male lives and a decrease of 5 years in the case of annuities and pensions on female lives. Its companion table based on female mortality, Gehele Bevolking Vrouwen (GBV) 1947 – 1949 has been only sporadically used.

12.1.3 GBM 1961 – 1965 and GBV 1961 – 1965

These tables were the successors of the GBM 1947 – 1949 table, and in the mid-1980s were the tables that were most in use both as a basis for premium calculations and for reserves.

Before the mid-1980s, the same premiums were charged for assurances on male and female lives. Then a distinction began to be made, and for male lives premiums were based on the table GBM 1961 – 1965 with an age adjustment of −2 years; for female lives the same mortality table was used, with an age adjustment which was originally −2 years, later changed to −4 years because of continuing improvement in female mortality.

For group life deferred and immediate annuities the premiums for male lives in the mid-1980s were usually based on the table GBM 1961 – 65 with an age adjustment of −2 years. For female lives the premiums were based on the table GBV 1961 – 65, originally with an age adjustment of −1 year, later changed to −2 years.

Age	GBM 1980 – 1985	GBM 1985 – 1990	GBV 1980 – 1985	GBV 1985 – 1990
0	73.6	74.2	80.1	80.5
20	54.1	54.6	60.4	60.8
40	34.9	35.3	40.9	41.3
60	17.6	17.9	22.7	23.1
80	6.3	6.3	8.3	8.4

Table 12.1: **Expectation of life, 1980 – 1985 and 1985 – 1990 tables.**

12.1.4 GBM 1976 – 1980 and GBV 1976 – 1980

Some insurance companies in the second half of the 1980s adopted the tables Gehele Bevolking Mannen 1976-1980 (GBM 1976–1980; males) and Gehele Bevolking Vrouwen 1976-1980 (GBV 1976–1980; females). In most cases age adjustment for annuities is + 1 year and −2 years respectively. If the male table is used for females the age adjustment nowadays is mostly −8 years.

12.1.5 Recent tables

Four new mortality tables have been published: GBM 1980–1985, GBV 1980–1985, GBM 1985–1990 and GBV 1985–1990. During these two recent observation periods mortality was again slightly improving. However for females between age 40 and age 55 the improvement of 1985–1990 in relation to 1980–1985 was of small importance.

Expectations of life for the new tables are shown in Table 12.1, which updates Table 2 of the previous report.

The gap in expectations of life for males and females has not widened further, except for ages 60 and 80.

12.2 Comparison of Actual and Expected Mortality

Tables 12.2 – 12.4 are based on data published in the report 'Financial Data of the Life Insurers 1993', and show specimen values of the graduated observed mortality rates, based on the 1989–93 experience, and those expected on the

Age	GBM 1947–49	GBM 1961–65	GBM 1966–70	GBM 1976–80	Observed 1989–93
10.5	0.64	0.41	0.44	0.29	0.17
15.5	0.89	0.57	0.78	0.60	0.31
20.5	1.15	1.04	1.09	1.01	0.42
25.5	1.43	1.07	0.95	0.84	0.40
30.5	1.47	1.04	1.06	0.87	0.47
35.5	1.76	1.38	1.39	1.19	0.68
40.5	2.54	2.11	2.25	1.89	1.07
45.5	3.90	3.59	3.66	3.56	1.85
50.5	6.46	6.25	6.37	5.85	3.10
55.5	9.72	10.79	11.03	10.01	5.62
60.5	15.19	17.53	18.68	17.38	9.71
65.5	24.91	27.84	29.59	28.38	19.59
70.5	41.19	40.98	44.80	45.50	29.70
75.5	68.47	64.38	68.39	69.47	46.67
80.5	111.71	105.16	102.69	102.31	71.76
85.5	170.30	164.53	161.68	148.54	102.48

Table 12.2: **Comparison of graduated observed mortality and expected mortality, males, assurance contracts. Table shows** $1000q_x$**.**

basis of example population mortality tables. Table 12.2 refers to assurance policies, males only, while Tables 12.3 and 12.4 refer to annuity contracts, for males and females respectively.

12.3 Projections of Future Mortality

In 1993, a group of actuaries of group life insurers published a mortality table relating to the period 2006–2010, based on mortality data from 1920–1990, and incorporating projected improvements in mortality. They also analysed the differences between the mortality of the general population and the insured population, and made allowances for these differences. The resulting tables, for males and females, are included in the accompanying disk.

Age	GBM 1961–65	GBM 1971–75	GBM 1976–80	GBM 1980–85	Observed 1989–93
50.5	6.25	6.37	5.85	5.57	3.63
55.5	10.79	11.30	10.01	9.48	7.11
60.5	17.53	18.29	17.38	15.96	9.37
65.5	27.84	29.89	28.38	26.84	17.97
70.5	40.98	45.91	45.50	43.15	33.84
75.5	64.38	70.51	69.47	68.71	55.75
80.5	105.16	104.60	102.31	102.68	90.70
85.5	164.53	159.04	148.54	152.11	139.35

Table 12.3: **Comparison of graduated observed mortality and expected mortality, males, annuity contracts. Table shows $1000q_x$.**

Age	GBV 1961–65	GBV 1971–75	GBV 1976–80	GBV 1980–85	Observed 1989–93
50.5	3.59	3.57	3.33	3.06	5.65
55.5	5.36	5.28	4.82	4.63	6.02
60.5	8.78	8.03	7.44	7.14	7.22
65.5	15.86	13.48	11.96	11.40	8.96
70.5	28.22	23.87	21.10	19.15	16.22
75.5	50.92	44.20	37.84	34.45	28.80
80.5	90.22	79.90	67.84	61.79	55.86
85.5	148.21	134.13	116.56	109.29	96.82

Table 12.4: **Comparison of graduated observed mortality and expected mortality, females, annuity contracts. Table shows $1000q_x$.**

12.4 AIDS

In general no explicit allowances are made for AIDS in pricing, reserves or in the construction of mortality tables.

Chapter 13

Norway

Contributor: G. Vale

13.1 Introduction

The first public registration of deaths in Norway goes as far back as 1685, when the Church became responsible for recording known births, marriages and deaths. The official registration of deaths started in 1801, and is today carried out by Official Statistics of Norway. From 1870 to 1950, as a rule, mortality tables were published for each 10-year period. From 1950 to 1975 "The Statistical Yearbook" contained mortality tables for 5-year periods, and since then also for every single year.

The oldest Norwegian life insurance company was founded in 1844, and until the 1920s life insurers in Norway based their mortality tables on death experiences from abroad. In 1919 the first step towards cooperation between the Norwegian life insurance companies was taken, and soon the first hypothetical mortality table, based on the experiences in the cooperating companies, was constructed. Since then, a joint bureau of the life insurance companies in Norway has been carrying out mortality studies based on the experiences of the companies.

Because the system of data-delivery from the companies to this bureau is being reorganized, mortality investigations based on the population of insured persons have not been carried out since 1989. However, it is hoped to recommence the collection of data during 1995, and to provide each contributing company with an analysis of its own experience compared with a

Deaths per 100,000 population					
Age group	Males	Females	Age group	Males	Females
0 – 4	143	116	50 – 54	521	292
5 – 9	16	11	55 – 59	861	480
10 – 14	22	12	60 – 64	1,635	801
15 – 19	74	29	65 – 69	2,585	1,306
20 – 24	82	29	70 – 74	4,436	2,094
25 – 29	86	35	75 – 79	7,108	3,997
30 – 34	118	51	80 – 84	11,485	7,379
35 – 39	150	70	85 – 89	19,252	13,577
40 – 44	221	127	90 –	31,823	25,890
45 – 49	334	181			

Table 13.1: **No. of deaths per 100,000 of population, Norway 1993.**

suitable reference table.

The last studies were carried out for each of the following life insurance branches:

1. Individual life insurance.
2. Individual pension insurance.
3. Group life insurance.
4. Group pension insurance.

While the mortality tables in use were the same in all Norwegian insurance companies until the 1980s, today this is not necessarily so. The life insurance mortality tables referred to below are from the last common tariff-revision.

13.2 National life tables

The most recent national life tables are based on the distribution of the population in 1993. Table 13.1 shows the observed numbers of deaths per 100,000 of the population in 1993.

Smoothing of the data for age groups 15 – 89 of this table by the minimum χ^2 method of Cramér and Wold [1] resulted in the following Gompertz-Makeham formulae for the force of mortality:

$$\begin{aligned} \text{Males} &: \quad 1000\mu_x = 0.5067 + 0.0210 \times 10^{0.0452x} \\ \text{Females} &: \quad 1000\mu_x = 0.2733 + 0.0052 \times 10^{0.0499x} \end{aligned}$$

13.3 Assured lives tables

The following formulae for forces of mortality were introduced in connection with the last common tariff revisions in Norway. The year of each revision is seen from the name of each formula.

13.3.1 Individual life assurance

The N1963 formula is based on individual life insurance policies other than those payable on death only. Whole of life policies are not included; age 90 is the highest age at expiry which is accepted. The same formula applies to males and females, namely

$$1000\mu_x = 0.9 + 0.044 \times 10^{0.042x}$$

For ages 0 – 13, which are relevant only in connection with children insurances, a constant hypothetical rate of mortality given by

$$1000q_x = 0.1$$

is used. For individual life insurance policies with payment only on death (again, with a maximum age at expiry of 90) the T1984 formula is used, for males and females alike, as follows:

$$1000\mu_x = 0.63 + 0.0109 \times 10^{0.049x}$$

13.3.2 Individual pension insurance

Different formulae are used for males and females, and allowance is made for the status of each life in a supporter/supported constellation. (The insurance will come to a payment when the "supporter" dies, and the benefit will be payable to the "supported" life.)

1. The RM1963 formula is used for males, except males who are supporters in a supporter/supported constellation.
2. The RK1963 formula is used for females, except when a supporter in a supporter/supported constellation.
3. The RM1963F formula is used for male supporters in a supporter/supported constellation.
4. The RK1963F formula is used for female supporters in a supporter/supported constellation.

The formulae are as follows:

$$\begin{aligned} \text{RM1963} &: 1000\mu_x = 0.027 \times 10^{0.042x} \\ \text{RK1963} &: 1000\mu_x = 0.027 \times 10^{0.042(x-3)} \\ \text{RM1963F} &: 1000\mu_x = 0.9 + 0.044 \times 10^{0.042x} \\ \text{RK1963F} &: 1000\mu_x = 0.9 + 0.044 \times 10^{0.042(x-3)} \end{aligned}$$

13.3.3 Group life insurance

The following formulae are used: GM1979 for males and GK1979 for females.

$$\begin{aligned} \text{GM1979 } (x < 32) &: 1000\mu_x = 0.05 + 0.0215 \times 10^{0.046\times 32} \\ \text{GM1979 } (x \geq 32) &: 1000\mu_x = 0.05 + 0.0215 \times 10^{0.046x} \\ \text{GK1979 } (x < 32) &: 1000\mu_x = 0.03 + 0.0129 \times 10^{0.046\times 32} \\ \text{GK1979 } (x \geq 32) &: 1000\mu_x = 0.03 + 0.0129 \times 10^{0.046x} \end{aligned}$$

13.3.4 Group pension insurance

The K1963(M) formula is used for males, except in the case of widower's pension. The K1963(K) formula is used for females, except in the case of widower's pension. The KM1973EM formula is used for males ("supported") and females ("supporters") in the case of widower's pension.

$$
\begin{aligned}
\text{K1963(M) } (x < 65) &: \quad 1000\mu_x = 0.9 + 0.044 \times 10^{0.042x} \\
\text{K1963(M) } (x \geq 65) &: \quad 1000\mu_x = 0.027 \times 10^{0.042x} \\
\text{K1963(K)} &: \quad 1000\mu_x = 0.027 \times 10^{0.042(x-3)} \\
\text{KM1973EM} &: \quad 1000\mu_x = 0.027 \times 10^{0.042x}
\end{aligned}
$$

13.4 The 1985 – 1989 experiences

For each of the four branches (individual life insurance, individual pension insurance, group life insurance and group pension insurance) comparisons have been made between the combined experience of one or more "tariff groups" in each branch, and a suitablly chosen reference table. The results are shown for 5-year age groups in Tables 13.2 – 13.5. Each table shows (i) a crude rate of mortality for the age group, q_x, and (ii) the actual deaths as a percentage of the expected deaths according to the reference table. Except for individual pension insurance, the expected deaths is calculated as the sum of the expected deaths at each age within the age group. For individual pensions, the expected deaths are based on the tabulated rate of mortality at the middle age within the age group.

Insured persons in high risk groups have been excluded from the experiences.

13.5 AIDS

A person suffering from AIDS will be denied life and disability insurance in Norway.

A person infected by HIV and not free of the symptoms of ARC (AIDS related complex) will be denied life insurance. If, however, the person is infected by HIV but free of the symptoms of ARC, the decision whether or not the person will be offered life insurance is postponed for 5-years, after which time another medical examination will be made. Eventually the person will be accepted under the normal tariff conditions.

Individual life : $100\frac{\textbf{Actual}}{\textbf{Expected}}$ deaths 1985 –89					
Age group	$1000q_x$	100 A/E	Age group	$1000q_x$	100 A/E
Males					
0 – 19	0.72	103	50 – 54	4.23	93
20 – 24	0.81	105	55 – 59	7.50	100
25 – 29	0.53	61	60 – 64	12.25	97
30 – 34	0.72	68	65 – 69	20.31	98
35 – 39	0.86	63	70 – 74	28.52	81
40 – 44	1.55	82	75 – 79	52.92	82
45 – 49	2.67	94	80 –	105.67	73
			All ages	3.90	91
Females					
0 – 19	0.18	26	50 – 54	2.21	49
20 – 24	0.26	34	55 – 59	3.66	49
25 – 29	0.19	21	60 – 64	5.91	47
30 – 34	0.29	27	65 – 69	8.76	42
35 – 39	0.40	29	70 – 74	15.76	44
40 – 44	0.77	41	75 – 79	20.41	32
45 – 49	1.48	52	80 –	63.82	41
			All ages	1.11	42

Table 13.2: **Individual life insurance:** $1000q_x$ **and** $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths in 1985 – 89, based on the T1984 table.**

Individual pension : $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths 1985 –89**					
Age group	$1000q_x$	100 A/E	Age group	$1000q_x$	100 A/E
Males					
0 – 19	0.89		50 – 54	3.32	70
20 – 24	0.15	56	55 – 59	5.15	67
25 – 29	0.44	102	60 – 64	8.18	66
30 – 34	0.52	75	65 – 69	14.86	74
35 – 39	0.51	45	70 – 74	22.95	71
40 – 44	1.25	69	75 – 79	41.59	80
45 – 49	2.21	75	80 –	98.30	92
			All ages	7.45	76
Females					
0 – 19	0.00		50 – 54	1.42	40
20 – 24	0.32	167	55 – 59	1.87	32
25 – 29	0.33	103	60 – 64	3.80	41
30 – 34	0.06	12	65 – 69	7.48	50
35 – 39	0.26	30	70 – 74	15.45	63
40 – 44	0.82	60	75 – 79	28.11	72
45 – 49	0.63	28	80 –	96.82	102
			All ages	10.26	78

Table 13.3: **Individual pension insurance:** $1000q_x$ **and** $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths in 1985 – 89, based on the RM1963 table (males) and the RK1963 table (females).**

Group life : $100\frac{\textbf{Actual}}{\textbf{Expected}}$ deaths 1985 –89					
Age group	$1000q_x$	100 A/E	Age group	$1000q_x$	100 A/E
Males					
0 – 19	1.64	238	45 – 49	2.84	89
20 – 24	1.28	185	50 – 54	4.71	87
25 – 29	0.59	85	55 – 59	9.55	104
30 – 34	0.75	101	60 – 64	15.97	103
35 – 39	0.89	77	65 – 69	24.55	100
40 – 44	1.74	92	70 –	96.39	120
			All ages	4.43	100
Females					
0 – 19	0.00		45 – 49	1.50	72
20 – 24	0.22	29	50 – 54	2.75	68
25 – 29	0.29	69	55 – 59	4.98	73
30 – 34	0.22	58	60 – 64	6.38	52
35 – 39	0.40	51	65 – 69	9.78	56
40 – 44	0.95	71	70 –	41.78	27
			All ages	1.55	63

Table 13.4: **Group life insurance:** $1000q_x$ **and** $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths in 1985 – 89, based on the GM1969 table (males) and the GK1969 table (females).**

Group pension : $100\frac{\textbf{Actual}}{\textbf{Expected}}$ deaths 1985 –89					
Age group	$1000q_x$	100 A/E	Age group	$1000q_x$	100 A/E
Males					
0 – 19	1.40	119	50 – 54	4.64	60
20 – 24	0.48	37	55 – 59	8.86	74
25 – 29	0.46	30	60 – 64	14.01	75
30 – 34	0.58	30	65 – 69	22.89	131
35 – 39	1.01	40	70 – 74	39.86	140
40 – 44	1.48	42	75 – 79	65.72	144
45 – 49	2.25	44	80 –	130.56	134
			All ages	9.10	97
Females					
0 – 19	0.00		50 – 54	2.23	71
20 – 24	0.14	77	55 – 59	3.63	72
25 – 29	0.27	95	60 – 64	5.71	69
30 – 34	0.27	60	65 – 69	10.47	79
35 – 39	0.25	33	70 – 74	20.77	97
40 – 44	0.88	75	75 – 79	32.38	93
45 – 49	1.45	75	80 –	91.00	117
			All ages	9.03	99

Table 13.5: **Group pension insurance:** $1000q_x$ **and** $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths in 1985 – 89, based on the K1963(M) table (males) and the K1963(K) table (females).**

High-risk groups : $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths 1985 –89**		
High-risk group	Males	Females
All groups	119	137
Tuberculosis	96	186
Heart diseases	101	87
Digestion	143	290
Diabetes	167	216
Overweight	119	184
Alcoholism	308	

Table 13.6: **High risk groups:** $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths in 1985 – 89, based on observed deaths among "normal lives" during the same period.**

13.6 Mortality of impaired lives

Insured persons who have been offered insurance subject to an extra premium, because of considerably higher expected mortality on medical grounds, are the subject of regular mortality studies. The most recent study was based on observations in the years 1985 – 89, and included individual insurances (both life and pensions). Table 13.6 shows the numbers of deaths among certain high-risk groups of policyholders, classified by the condition which led to their being charged an extra premium, expressed as a percentage of the deaths expected according to the experience of the "normal lives" during the same period. Note that the "normal" lives were based on individual life insurances only.

During 1985 – 89, 522 males and 56 females died in the high-risk groups, compared with 17,667 males and 2,608 females among the normal lives.

13.7 Reference

[1] Cramér, H. and Wold, H. (1935) *Mortality variations in Sweden: A study in graduation and forecasting.* Skand. Aktuarietidskr. **18**, 161 – 241.

Chapter 14

Portugal

Contributor: F. J. S. Cruz Alves

14.1 The Portuguese Life Tables

Portuguese life tables based on national censuses have been published every 10 years since the beginning of the 20th century, separate tables being issued for males and females and for the whole population. Although standard mortality tables by individual age describing the experience in each quadrennium (e.g. 1969-72, 1979-82 and so on) are usually published after each census, some abridged tables organised by 5-year age groups were also published in some decades (1950, 1960 and 1990).

The Portuguese mortality tables presently available for public consultation date from 1930 onwards. The official entity responsible for the gathering of statistical information on the Portuguese population and for the construction of life tables, among other statistics, is the "Instituto Nacional de Estatmstica" (National Statistics Institute).

In the past these life tables have not been used for the major classes of life assurance, although there have been some recent attempts based on such tables to derive projected mortality rates and construct mortality tables for annuitants.

14.2 Auto-corrective tables

In 1995 the Faculty of Science and Technology of "Universidade Nova de Lisboa" published the first "auto-corrective" mortality tables by sex known in Portugal. The mortality rates of these tables have regard to the year 1994. The tables were constructed using a method of double exponential fitting to the past trends of mortality and birth observed in the Portuguese population over the years 1940 to 1992 and by extrapolating the fitted curves by reference to their parameters in order to calculate rates expected in the future. The statistical tests for comparing the past mortality experience of the Portuguese population with the projected values obtained with this method yielded very good results up to this moment.

The underlying method of forecasting devised by this university was based on a mathematical model that should be fed with new data from predefined cohorts of individuals, available on an annual basis, and refitted every year, the forecasting period being limited to a maximum of one or two years, thus producing reliable forecasts.

14.3 Tables used in Life Assurance

Between 1984 and 1994 life assurance business in Portugal was subject to prior approval and regulated by the Portuguese insurance supervisory authority, the "Instituto de Seguros de Portugal". Technical rules regarding actuarial basis for the calculation of premiums, reserves, surrender values, paid-up policies and compulsory profit-sharing schemes, as well as some technical practices and contractual clauses were set up and assembled in one basic document — the "Plano de Exploragco do Ramo Vida". Although subject to revisions over the years, this document has been in force for most of the period mentioned above. For technical purposes related to the definition of actuarial bases, this document classified life assurance products into individual and group business, each of them being divided into two major classes, which were then subdivided into sub-classes or modalities. The criterion adopted to define the two major classes was based on the predominant demographic risk of the contract (e.g. the life risk or the death risk); term assurances and whole life policies would, for example, be classified as "death risk contracts" and, on the other hand, pure endowments and annuities would be classified as "life risk contracts". Predefined mortality tables, the French standard tables PF-60/64 and PM-60/64, were obligatory for premium rating and for reserves, respectively, for the life risk and the death risk contracts.

As Third Life Directives were transposed to the Portuguese legislation in July 1994, mortality tables became a subject of free choice for the actuaries, but two special constraints resulting from the particularities of Portuguese legislation must be referred here as they strongly affect the choice of the tables:

- At the moment of underwriting and with the exception of the cases of extra risk, the mortality tables adopted for each class of risk must be the same for every life assurance contract;

- The companies should be able to justify adequately the choice of the mortality tables used in their insurance products, according to the provisions of the Third Life Directive.

14.4 AIDS

A special consideration must be made with respect to the AIDS risk for no actuarial studies of the potential impact of this syndrome on the mortality of assured lives in Portugal are known to have been published so far. The fact that some life assurance companies operating in our country do actually cover the AIDS risk for impaired lives by charging an extra premium leads us to believe that they must have developed some studies on this subject.

The need to implement special measures with respect to the extra mortality of assured lives is strongly related to the particularities of the actuarial practice in each country. It is thus possible that the common use of the French standard mortality table PM-60/64, associated with the traditional practice of pre-contractual medical selection in Portuguese life assurance contracts where the main risk is the contingency of death, should be considered by most Portuguese actuaries as more than sufficient to make up for some extra mortality due to the emergence of AIDS and other dread diseases in assured lives for, until recently, the mortality rate for male assured lives in Portugal was estimated to be about 70% of that of PM-60/64. The safety margin of this mortality table is so large that most "death risk contracts" include profit-sharing schemes.

14.5 Pensioners' tables

For the sole purposes of this report we shall adopt the concept of "pensioners" as corresponding to lives in receipt of pensions paid by pension schemes managed by or insured with life offices and by pension schemes managed by pension schemes management societies. The development of privately managed pension schemes is quite recent in Portugal, dating from the end of 1986, as the first Decrees of Law regulating this matter came into force in 1985 and 1986. Since then pension funds have experienced a rapid growth, reaching an amount of Escudos 1,000 thousand million (approximately £4,000 million) by the end of 1994. As a substantial number of new lives begun to enter the demographic experience of pension schemes a new class of life was expected to emerge. This experience is, however, much too short to allow for an adequate study and to establish adequate projections of future mortality. Some regulatory measures regarding the establishment of actuarial bases for the calculation of contributions and liabilities towards and from pension schemes had nevertheless to be taken. Pension funds and pension schemes' regulations form a special regime apart from E.E.C. Directives. Until now only 4 mortality tables have been legally authorised for the calculation of contributions to pension funds - the French standard tables PM 60/64 and PF-60/64 and the Swiss standard tables GKM-70 and GKF-70. The minimum funding level has been set in accordance with the PF-60/64.

14.6 Annuitants' tables

Presently and for statistical purposes, the concept of "annuitants" corresponds to lives in receipt of immediate annuities purchased from life assurers, excluding the annuities purchased by pension schemes. Before 1992 the concept of "annuitants" corresponded to lives in receipt of immediate annuities purchased from life assurers including annuities purchased by pension schemes. This change of definition led to some problems regarding the mortality data of annuitants, for it is only natural that between 1986 and 1992 the available data from life offices should comprise both "annuitants", as defined in 1992, and "pensioners".

Until July 1994, the mortality table used for the calculation of annuities' premiums and reserves was the French standard table PF-60/64 (as referred before in 14.3).

Ideal solutions being hard to find, given the problem stated above, some efforts towards the calculation of new tables with projected mortality for "annuitants" are presently under way. The lack of adequate data makes it impossible to construct mortality tables from the experience of assured lives and the resort to the mortality experience of the population, with the inclusion of some prudential measures based on the mortality experience of some sets of assured lives, seems inevitable. We hope that, after an extensive discussion of these new tables, their inclusion in a further report on mortality will become possible.

Chapter 15

Spain

Contributor: Prof. E. Navarro

15.1 The Spanish Life Tables 1981–82

This section is a summary of Navarro (1991) [5] in which a full account can be found of the construction of the Spanish population life tables PEM-82 (males) and PEF-82 (females).

15.1.1 The Data

The data were based on census estimates of the Spanish population on 1 July 1981 and 1 July 1982, and on deaths during 1981 and 1982 ([2], [3], [4]). The crude rates showed some suspected anomalies, such as an apparent cyclic trend in the male data at ages 25–45. Older censuses had shown very clear overstatement at quinquennial ages, but the most recent censuses (1970 and 1981) appear to be free of this problem.

The function to be graduated was q_x, so initial exposed-to-risk were calculated as:

$$E_x \approx [P_x^{81} + P_x^{82}] + 0.5[\theta_x^{81} + \theta_x^{82}] \qquad (x \geq 1)$$

where P_x^y is the population enumerated or estimated at age x on 1 July in calendar year y, and θ_x^y is the corresponding number of deaths. At age 0, the majority of deaths are in the first months of life so:

$$E_x \approx [P_x^{81} + P_x^{82}] + 0.7[\theta_x^{81} + \theta_x^{82}] \qquad (x = 0)$$

was used instead.

15.1.2 Procedure

The methodology mainly followed that of Forfar, McCutcheon & Wilkie (1988) [1]. Deaths at each age were assumed to follow a Binomial(E_x,q_x) distribution, and a range of statistical tests was devised accordingly (confidence intervals, standardised deviations, signs, changes of sign and χ^2).

The data were divided into three age ranges; younger ages up to about 22–28, then middle ages up to 80–81, and older ages above that. There were some irregularities at the older ages which might have led to distortions at the middle ages (which were of greatest actuarial interest) had these been graduated together. At younger ages, the well-known pattern of infant and young adult mortality justified a separate graduation.

15.1.3 The Main (Middle) Age Group

Initially a large number of possible formulae were considered, namely $GM^{r,s}$ and $LGM^{r,s}$ functions of the following orders: (0,3), (1,2) , (3,0); (0,4), (1,3), (2,2), (4,0); (0,5), (1,4), (2,3), (3,2), (5,0); (0,6), (1,5), (2,4), (3,3), (4,2), (6,0). First, formulae were fitted between lowest age 30, and highest ages 80, 85 and 90, for males and females separately. Thus there were 108 candidate formulae for each sex. These were then narrowed down by fixing the highest age as $m = 80$, and rejecting formulae of all orders except the following: (0,5), (1,4), (2,3), (3,2), (3,3). Further GM and LGM formulae were fitted, this time with a range of lowest ages, $n = 22, 23, \ldots, 30$. This left 90 possible graduations for each sex. The final choice was made after the graduation of the younger age group had been considered.

15.1.4 The Younger Age Group

For each upper age $n = 22, 23, \ldots, 30$, q_x in the range $[2, n]$ was graduated by fitting a pair of cubic polynomials. In each case an age β was chosen in the range $[2, n]$, and the cubics were fitted by least squares (in this case, equivalent to maximum likelihood), constrained by being differentiable at ages $x = \beta$ and $x = n$. This was done for all 90 candidate formula for the 'main ages' graduation (males and females) to obtain the age n which minimised the χ^2 statistic over both age groups. Then the final formula for the main ages graduation was chosen by considering the statistical tests mentioned previously; the formula chosen was the $LGM^{3,3}$:

$$q_x = \frac{GM^{3,3}}{1 + GM^{3,3}}.$$

15.1.5 The Older Age Group

The irregularities observed in the progression of q_x were first removed by a moving average method:

$$Q_x = k_0 q_x + k_1[q_{x-1} + q_{x+1}] + \ldots + k_4[q_{x-4} + q_{x+4}]$$

with coefficients:

$$k_i = 0.2554112554 - \frac{15i^2}{693}$$

chosen to have optimal error-reducing properties. Then the same procedure was used as for the younger age group, namely to choose an age τ between 83 and 92, and fit a pair of cubic polynomials to Q_x, using a minimum χ^2 criterion.

At ages over 96, statistical methods were not used; the curve of q_x was simply extrapolated by a quadratic polynomial, constrained by differentiability at $x = 96$, and by the values $q_{105} = 0.75$ (males) and $q_{105} = 0.65$ (females).

15.1.6 Fitted Parameters

The main age age groups are 23.29 – 80 (males) and 22–80 (females). The formula is:

$$q_x = \frac{GM^{3,3}}{1 + GM^{3,3}}$$

where:

$$GM^{3,3} = \alpha_1 + \alpha_2 x + \alpha_3 x^2 + e^{\alpha_4 + \alpha_5 x + \alpha_6 x^2}$$

with the parameters of Table 15.1.

	Males	Females
α_1	$2.9046\ 10^{-3}$	$8.8948\ 10^{-4}$
α_2	$-2.3360\ 10^{-4}$	$-7.3341\ 10^{-5}$
α_3	$2.9849\ 10^{-6}$	$1.3927\ 10^{-6}$
α_4	$-6.4128\ 10^{0}$	$-7.55609\ 10^{0}$
α_5	$-8.0091\ 10^{-3}$	$-3.3895\ 10^{-2}$
α_6	$7.4029\ 10^{-4}$	$1.1818\ 10^{-3}$

Table 15.1: *LGM* **parameters, main age groups, Spanish population mortality 1981–82**

	Males	Females
a	$1.1937590996\ 10^{-3}$	$1.0274043915\ 10^{-3}$
b	$-3.1410908438\ 10^{-4}$	$-3.6241959711\ 10^{-4}$
c	$3.7731261469\ 10^{-5}$	$5.6752319700\ 10^{-5}$
d	$-1.5145657503\ 10^{-6}$	$-3.0258141257\ 10^{-6}$
a'	$4.6939744500\ 10^{-3}$	$8.7674566476\ 10^{-4}$
b'	$-9.3800014707\ 10^{-4}$	$-1.6176890704\ 10^{-4}$
c'	$6.2504254567\ 10^{-5}$	$1.1872146366\ 10^{-5}$
d'	$-1.2376999584\ 10^{-6}$	$-2.5117566945\ 10^{-7}$

Table 15.2: **cubic parameters, young age groups, Spanish population mortality 1981–82**

	Males	Females
a	$-6.5971666045\ 10^{+1}$	$-1.7073405108\ 10^{+2}$
b	$2.4224325683\ 10^{0}$	$6.3081492264\ 10^{0}$
c	$-2.9707904748\ 10^{-2}$	$-7.7755971936\ 10^{-2}$
d	$1.2187544190\ 10^{-4}$	$3.1989551881\ 10^{-4}$
a'	$-3.7453719960\ 10^{+1}$	$5.9980407945\ 10^{-1}$
b'	$1.2224168964\ 10^{0}$	$-4.3506445153\ 10^{-2}$
c'	$-1.3313603576\ 10^{-2}$	$6.8404490239\ 10^{-4}$
d'	$4.8656732444\ 10^{-5}$	$-2.8115564093\ 10^{-6}$

Table 15.3: **cubic parameters, old age groups, Spanish population mortality 1981–82**

	Males	Females
a	$3.6286943077\ 10^{+1}$	$2.2117957139\ 10^{+1}$
b	$-7.6914512522\ 10^{-1}$	$-4.7114589718\ 10^{-1}$
c	$4.1018861742\ 10^{-3}$	$2.5341320721\ 10^{-3}$

Table 15.4: **Quadratic parameters, extrapolation to oldest ages, Spanish population mortality 1981–82**

For the young age group, a cubic $a+bx+cx^2+dx^3$ was fitted from age 0 to age β, and another cubic $a'+b'x+c'x^2+d'x^3$ from age β to the lowest age in the main age group. The age β was 10.68 for males and 7.62 for females, and the parameters are shown in Table 15.2.

For the old age group, a cubic $a+bx+cx^2+dx^3$ was fitted from age 80 to age τ, and another cubic $a'+b'x+c'x^2+d'x^3$ from age τ to age 95. The age τ was 85 for males and 83 for females, and the parameters are shown in Table 15.3.

Finally, the extrapolation beyond age 95 was by quadratic polynomials $a+bx+cx^2$, as shown in Table 15.4.

15.2 Region of Valencia Life Tables

The Institut Valenciá d'Estadistica published life tables for the region of Valencia, based on the years 1990–91.

15.2.1 Methodology

The approach to graduation (of q_x) was similar to that of the Spanish Life Tables 1981–82, and was described in Navarro *et al.* [6]. There were differences of detail:

1. The (initial) exposures to risk were based on the census of 1 March 1991, adjusted using the numbers of deaths in 1990 and 1991 and births in 1991.

2. In the main age groups, the formulae used were $GM^{2,3}$ for males and $LGM^{3,2}$ for females.

3. In the younger age group, for males only, three cubic polynomials were needed to reproduce adequately the main features.

15.2.2 Comparison with other regions

Mortality data from two other regions were graduated using the Valencia tables as a standard, and the linear formula:

$$q_x^{reg} = \alpha + \beta q_x^{Valencia}$$

with the results shown in Table 15.5. The entries for Valencia show the effect of fitting the crude rates to the graduated rates using the same formula.

15.2.3 Comparison with Spanish mortality, 1981–82

Assuming that the mortality of the Valencia region in 1990–91 is reasonably similar to that of the whole country, there have been some very striking increases in male mortality at younger ages, illustrated in Table 15.6. The reason for this increase is not known, but the fact that Spain has the highest incidence of AIDS in Europe might suggest an explanation.

	Males		Females	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Alicante	$3.1105\ 10^{-4}$	0.97016	$-1.4951\ 10^{-5}$	0.96562
Castellón	$-2.6433\ 10^{-4}$	0.94662	$-1.9472\ 10^{-6}$	0.98835
Valencia	$1.1486\ 10^{-5}$	1.0313	$1.4697\ 10^{-5}$	1.0139

Table 15.5: **Graduation of other regions' mortality data using Valencia as a standard.**

Age	q_x Spain 1981–82	q_x Valencia 1990–91
20	0.00103	0.00142
25	0.00106	0.00185
30	0.00109	0.00196
35	0.00145	0.00202
40	0.00222	0.00241
45	0.00355	0.00323

Table 15.6: **Comparison of male mortality, Spain 1981–82 and Valencia 1990–91.**

15.3 References

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Chapter 16

Sweden

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16.1 Population mortality

Population mortality statistics are collected and published by the National Central Bureau of Statistics in Stockholm. Rates of mortality (unsmoothed) for 1993 are included in the companion disk.

Although this study is primarily concerned with recent mortality statistics and trends, it is worth noting that quite reliable statistics have been collected in Sweden for an unusually long time, and have provided actuaries and demographers with a rare opportunity to study generational mortality over a large number of completed cohorts. For example, Cramér and Wold [2] in 1930 used a bivariate Makeham formula

$$\mu(x,\tau) = \alpha_\tau + \beta_\tau c_\tau^x$$

in which x = age and τ = year of birth to model mortality between 1800 and 1930 for the purpose of studying the adequacy of the projected reduction in mortality in the R32 table for annuity business.

16.2 Mortality for life insurance business

Mortality statistics from life insurance companies are analysed and published by the Försäkringstekniska Forskningsnämnden (Research Council for Actuarial Science and Insurance Statistics), founded in 1950 shortly after the passage of the Swedish Insurance Act of 1948. Mortality statistics by cause of death have been collected since 1966. One company underwrites most of the policies on impaired lives (the Sverige Reinsurance Company).

16.2.1 Calculation of tariffs

The M64 life table

Swedish life insurance companies use common technical bases, based upon the M64 mortality table given by the Makeham formulae

$$\begin{array}{llcl} \text{Males} & \mu_x & = & 0.0006 + 0.000034 \times 10^{0.042x} \\ \text{Females} & \mu_x & = & 0.0006 + 0.0000231 \times 10^{0.042x}. \end{array}$$

The lower value of second parameter in the female case corresponds to a reduction of 4 years in the age. The same table is used for assurance and annuity business; in 1964 there was very little data on annuitants' mortality (a total of 184 deaths), and experience shows there to be very little difference between the mortality under contracts with a sum assured payable on death and annuity contracts. It would appear that the selection introduced by the medical underwriting of the former class is similar in effect to the self-selection of the latter class. For technical calculations, selection is represented by omitting the constant Makeham parameter (0.0006) for the first 5 years of the policy term, for both assurances and annuities. Jung [3] described the introduction of the 1964 technical bases.

In 1964, the M64 table provided a satisfactory margin. As a comparison, Makeham formulae were fitted to the 1964 endowment assurance data (which contributed 85% of the total assurance policy data) using the same exponential parameter $c = 10^{0.042}$ with the following results:

$$\begin{array}{llcl} \text{Males} & \mu_x & = & 0.0001 + 0.0000314 \times 10^{0.042x} \\ \text{Females} & \mu_x & = & 0.0001 + 0.0000187 \times 10^{0.042x}. \end{array}$$

Differences between male and female mortality

Since the constant Makeham parameter a is very small when the endowment mortality experience is graduated (with the same value of c) it is possible to express the difference between the male and female experiences in terms of an age difference

	Age group							
	1–39		40–64		65+		All	
Duration	M	F	M	F	M	F	M	F
1–5	49%	48%	42%	48%	58%	61%	48%	53%
6–10	64%	38%	52%	63%	66%	77%	61%	68%
11+	76%	101%	66%	75%	79%	73%	74%	74%

Table 16.1: **1986–1990 mortality as a percentage of population mortality during the same period.**

$$\text{Age difference } = \frac{\log b_m - \log b_f}{\log c}.$$

In 1964, this age difference was 5.4 years.

Selection due to medical underwriting

Endowment mortality has been analysed according to policy duration, and has shown clear evidence of selection in the first 10 years of assurance. The most recent figures, on a "lives" basis, for 1986–1990, are shown in Table 16.1.

Trends since 1964

With the passage of time, the M64 table has come to incorporate greater margins for assurance business. Table 16.2 shows the effect of fitting Makeham formulae with the same exponential parameter ($10^{0.042}$) to later generations of policyholders. (The 10^3a and 10^6b in the heading refers to the parameters a and b in the Makeham formula $a + bc^x$.)

The equivalent difference in ages between males and females, based Makeham graduations of their respective assured lives experiences with $c = 10^{0.042}$, has increased slightly since 1964 as shown by Table 16.3.

Wikstad [7] noted that by 1976–1980, the mortality experienced by contracts with negative risk sums (principally annuities) was lower than that assumed in the tariffs, especially in respect of females. The supervisory authorities have criticised the use of the M64 tables for annuity business but

	Males		Females	
Period	10^3a	10^6b	10^3a	10^6b
1966–1970	0.2	32.4	0.1	20.1
1971–1975	0.1	31.1	0.2	17.8
1976–1980	0.1	29.6	0.2	16.3
1981–1985	−0.1	27.0	0.1	15.5
1986–1990	−0.1	24.7	0.0	13.7

Table 16.2: **Makeham graduations of assured lives mortality with** $c = 10^{0.042}$ **1966–1990**

Period	Age difference
1966 – 1970	4.94
1971 – 1975	5.77
1976 – 1980	6.17
1981 – 1985	5.74
1986 – 1990	6.09

Table 16.3: **Equivalent age difference between males and females, based on assured lives mortality 1966–1990**

have not so far taken any action. In practice other features of annuity business in Sweden counteract the technical losses caused by the use of the M64 tables:

1. The interest basis is sufficiently conservative to create a technical profit which exceeds the mortality losses.
2. Under deferred annuities, no bonus is paid during the period of deferral; thus there is a substantial surplus at the vesting date. The reserve plus the surplus are applied as a single premium using updated mortality rates, on a basis conservative enough to permit further surpluses to be distributed during the payment term.

Sweden's entry into the E.U.

No major changes in insurance regulation are yet envisaged as a result of Sweden's entry into the European Union, and the Third Life Directive.

16.2.2 Comparison of observed and expected mortality

The Försäkringstekniska Forskningsnämnden periodically compares the experienced mortality of insured lives with the mortality of the tariff, the M64 table. The comparison is made on both a "lives" (in fact, policies) basis, and on a "sums at risk" basis. Tables 16.4 – 16.7 show the results of the "lives" investigation for 1986–1990. Mortality on the "sums at risk" basis is consistently lower than on the "lives" basis, which might be attributable in part to the combined effects of inflation, which results in greater weight being given to policies of short durations in force, and of the selection due to medical underwriting.

Comparing the mortality of lives with negative risk sums (predominantly annuitants) with that of lives with positive risk sums (predominantly endowment policyholders) it is found that the former is heavier than the latter, especially among males and at younger ages. Table 16.8 gives the results.

16.3 Impaired lives mortality

Bergelv [1] described the experience of the Sverige Reinsurance Company for 1985–1990. As mentioned before, this company handles most of the substandard risks is Sweden.

Age group	Exposure	Expected Deaths	Observed Deaths	O/E (%)
1–4	2,626	1.3	0	0
5–9	6,223	3.5	0	0
10–14	11,829	6.1	2	33
15–19	25,228	13.8	17	124
20–24	63,962	40.2	53	132
25–29	138,485	99.8	117	117
30–34	288,175	289.1	178	62
35–39	501,856	757.0	433	57
40–44	783,229	1,807.2	824	46
45–49	751,131	2,645.6	1,281	48
50–54	575,214	3,179.3	1,773	56
55–59	468,863	4,112.8	2,516	61
60–64	358,645	4,991.1	3,358	67
65–69	156,631	3,407.9	2,512	74
70–74	75,988	2,690.9	2,013	75
75–79	43,205	2,473.8	2,138	86
80–84	22,813	2,096.4	2,036	97
85–89	9,362	1,373.6	1,426	104
90–94	1,153	253.2	221	87
95+	91	34.9	17	49
1–14	20,679	11	2	18
15–39	1,017,706	1,200	798	67
40–64	2,937,082	16,736	9,752	58
65+	309,243	12,330	10,363	84
Total	4,284,710	30,277	20,915	69

Table 16.4: **Comparison of observed and expected (M64) mortality, positive risk sums, males, 1986–1990**

Age group	Exposure	Expected Deaths	Observed Deaths	O/E (%)
1–4	2,507	1.3	2	159
4–9	5,637	3.1	0	0
10–14	11,180	5.5	0	0
15–19	23,394	11.5	7	61
20–24	61,060	31.0	16	52
25–29	121,119	69.8	29	42
30–34	206,166	164.3	85	52
35–39	318,271	369.6	155	42
40–44	454,561	775.6	335	43
45–49	413,213	1,043.9	555	53
50–54	297,637	1,156.8	615	53
55–59	229,208	1,395.8	777	56
60–64	159,960	1,531.5	793	52
65–69	81,455	1,224.6	573	47
70–74	44,524	1,076.5	595	55
75–79	25,090	978.4	672	69
80–84	13,065	813.6	625	77
85–89	5,176	515.0	543	105
90–94	884	138.3	133	96
95+	96	23.8	20	84
1–14	19,324	10	2	20
15–39	730,010	646	292	45
40–64	1,554,579	5,904	3,075	52
65+	170,291	4,770	3,161	66
Total	2,474,204	11,330	6,530	58

Table 16.5: **Comparison of observed and expected (M64) mortality, positive risk sums, females, 1986–1990**

Age group	Exposure	Expected Deaths	Observed Deaths	O/E (%)
1–4	51	0.0	2	n/a
5–9	154	0.0	0	n/a
10–14	278	0.1	0	0
15–19	540	0.2	0	0
20–24	2,033	1.3	1	76
25–29	4,925	4.1	0	0
30–34	7,438	8.4	2	24
35–39	8,290	13.2	6	46
40–44	11,217	26.6	22	83
45–49	11,448	40.6	24	59
50–54	9,226	50.8	46	91
55–59	10,013	88.4	81	92
60–64	16,730	234.9	190	81
65–69	23,853	529.7	387	73
70–74	19,811	703.0	536	76
75–79	19,545	1,123.1	1,024	91
80–84	18,839	1,740.4	1,713	98
85–89	15,182	2,241.2	2,177	97
90–94	4,631	1,057.8	1,259	119
95+	828	302.8	272	90
1–14	483	0	2	1,818
15–39	23,226	27	9	33
40–64	58,634	441	363	82
65+	102,689	7,698	7,368	96
Total	185,031	8,167	7,742	95

Table 16.6: **Comparison of observed and expected (M64) mortality, negative risk sums, males, 1986–1990**

Age group	Exposure	Expected Deaths	Observed Deaths	O/E (%)
1–4	67	0.0	7	n/a
5–9	297	0.1	0	0
10–14	401	0.2	0	0
15–19	657	0.3	0	0
20–24	1,725	0.9	0	0
25–29	3,597	2.2	1	46
30–34	5,183	4.1	5	122
35–39	6,550	7.4	6	81
40–44	9,668	16.4	1	6
45–49	11,108	27.7	23	83
50–54	10,391	40.5	22	54
55–59	12,400	76.0	47	62
60–64	18,494	181.4	134	74
65–69	28,845	444.6	267	60
70–74	22,260	544.5	347	64
75–79	22,739	903.6	630	70
80–84	21,773	1,388.1	1,185	85
85–89	15,259	1,548.3	1,675	108
90–94	6,726	1,091.1	1,181	108
95+	2,871	811.1	621	77
1–14	765	0	7	2,414
15–39	17,711	15	12	80
40–64	62,060	342	227	66
65+	120,473	6,731	5,906	88
Total	201,010	7,089	6,152	87

Table 16.7: **Comparison of observed and expected (M64) mortality, negative risk sums, females, 1986–1990**

Age group	Expected Deaths	Observed Deaths	O/E (%)
Males			
40–44	12	22	187
45–49	20	24	123
50–54	28	46	162
55–59	54	81	151
60–64	157	190	121
65–69	383	387	101
70–74	525	537	102
75–79	967	1,024	106
80–84	1,681	1,713	102
85–89	2,312	2,177	94
Total	6,139	6,201	101
Females			
40–44	7	1	14
45–49	15	23	155
50–54	22	22	102
55–59	42	47	112
60–64	92	134	146
65–69	203	267	132
70–74	297	347	117
75–79	609	630	103
80–84	1,042	1,185	114
85–89	1,600	1,675	105
Total	3,950	4,331	110

Table 16.8: **Observed mortality, negative risk sums, compared with expected mortality on the basis of the experience with positive risk sums, 1986–1990**

16.4 References

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Chapter 17

Switzerland

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17.1 Preamble

Mortality investigations in Switzerland can be subdivided into three categories:

- General mortality studies into the Swiss population developed periodically by the Federal Office for Statistics.
- Investigations into the mortality of Swiss insureds prepared by the Swiss Union of Private Life Insurers.
- Other mortality investigations: on one hand, governmental offices (for Statistics, for Public Health, etc.) examine special mortality conditions, e.g. by cause of death, marital status, etc., on the other hand, some important insurance companies and pension funds analyze their experience figures and publish the results.

Even if the aim of this contribution is to present general conclusions thus implying that we have primarily to report about the first two of the above categories, we however cannot ignore completely the third one that gives interesting indications, too.

The mortality tables referred to in this chapter can be found in the directory "CH" of the companion disk (see Section 1.8). The text file "INDEX.TXT" on the disk will enable you to locate any table.

17.2 Mortality of the Swiss population

17.2.1 Introduction

During more than 100 years the Federal Office for Statistics studied the mortality of the population domiciled in Switzerland and published mortality tables, the first one having been for the period 1876 – 80.

Obviously, it would be ideal to measure the mortality continuously, on the basis of the observations collected during two consecutive years. However, our country is small and the sets of persons of the same age are limited, so that the deviations due to accidental factors can be relevant from one year of measurement to the next one. Even when 5 years are taken together, discontinuities between two consecutive ages can be significant; adjustments of the crude mortality rates are needed and mathematical graduation methods applied.

To take as an observation basis the best information available about the Swiss population, the Federal Office of Statistics considers for its investigation 5-year periods centred on the year of a national census. The national census being performed only every 10 years, unadjusted mortality rates, for age groups, are published additionally every year to allow a continuous, even if only rough assessment of the trends.

17.2.2 The Swiss Mortality Table 1978 – 1983

Based on the national census of 1st December 1980, this table, established separately for the two sexes, was published in 1985 [1] and completed with more details in 1988 [2]. Male and female rates of mortality are included in the companion disk. The next table, centred on the national census of 4th December 1990, will appear before the end of 1995.

With a view to maintaining comparability, the same statistical and mathematical methodology was applied as for the former tables, even if the development of the data processing systems would have allowed new procedures. For the main interval from age 16 to 80 the graduation was done following the method of King. The details, as well as the tests introduced, to choose the variant nearest to the crude mortality rates are described in [3].

For the ages 0,1 and 2 the crude probabilities were taken; it follows, for the period between ages 2 and 16 an adjustment by orthogonal polynomials. Finally, for ages over 80 the graduation was performed with an exponential function according to the Gompertz-Makeham method. Details referring to this part of the adjustment as well as a general description of the methodology can be found in [4].

17.2.3 Reduced Mortality Table 1992/93

On the basis of the population movements announced by the municipal, cantonal and federal offices for population registration and the immigration authorities, the Federal Office for Statistics publishes every year a number of preliminary statistics of those movements and their consequences.

The observed population is estimated through progressive statistics that, starting from the population at the 31st December of the year before, add or subtract the movements announced with the purpose of obtaining the new estimation at the end of the year considered. The estimation is readjusted to the reality every time a national census is organised.

One of the analyses presented is a reduced mortality table by sex and groups of ages limited to the crude probabilities, without graduation. The last of these tables, which are included in the companion disk, were published in 1994 [5] and refer to the years 1992/93.

17.2.4 Trend

Globally considered, the trend is a continuous improvement of mortality, as it is best shown by the Table 17.1, which gives a comparison of the expectation of life at birth.

The contributions to this important increase of expectation of life at birth are not equally distributed over all the ages. The Federal Office for Statistics made comparisons between two intervals, from the table 1939/44 to the table 1968/73 and from the table 1968/73 to the table 1978/83, with the results in Table 17.2 [1].

During the first interval, characterized by a strong increase of life expectation, for men the by far most important contribution came from children (43%) while for women the contribution was equally spread over all age groups except young adults. For the second interval between 1968/73 and 1978/83, however, for men as well as for women the highest contribution to

[1] The preliminary results of the investigation for the period 1988/93, presented in July 1995, indicate an expectation of life at birth of 74.19 years for men and 81.05 years for women.

Mortality Table	Expectation of life at birth	
	Men	Women
1876/80	40,64	43,24
1881/88	43,29	45,70
1889/1900	45,69	48,47
1910/11	50,65	53,89
1920/21	54,48	57,50
1929/32	59,17	63,05
1939/44	62,68	66,96
1948/53	66,36	70,85
1958/63	68,72	74,13
1968/73	70,29	76,22
1978/83[1]	72,40	79,08
1992/93 (reduced)	74,7	81,4

Table 17.1: **Expectation of life at birth in Switzerland: sources [2] and [5].**

	From 1939/44 to 1968/73				From 1968/73 to 1978/83			
	Men		Women		Men		Women	
Age group	abs.	%	abs.	%	abs.	%	abs.	%
0 – 16	3,25	43	2,86	31	0,76	36	0,63	22
17 – 29	0,86	11	0,99	11	−0,06	−2	−0,02	−1
30 – 64	2,36	31	2,91	31	0,60	28	0,60	21
65+	1,14	15	2,50	27	0,81	38	1,65	58
Total	7,61	100	9,26	100	2,11	100	2,86	100

Table 17.2: **Changes in expectation of life at birth in Switzerland, 1939/44 to 1978/83.**

the increase of life expectation comes from the old ages, 65 and more, while young adults of both sexes have a negative impact: the mortality of these latter is slightly increasing.

17.3 Mortality of the Insureds

17.3.1 Introduction

For a long time the Swiss Union of Private Life Insurers, through its Technical Committee, collected the mortality experience of its member companies (they represent more than 90% of the market) in their group portfolio. Based on these data, the Technical Committee published regularly mortality tables and prepared complete tariffs for the group life business that were submitted for approval to the Supervisory Authority and applied uniformly in the market. With deregulation entering also the Swiss market, the newest table 1995 will represent a technical guideline but the final tariffs have to be prepared by each company with the loadings corresponding to their own costs.

Separate mortality investigations were shown for the insurances for the case of death ("capital insurances") and for pensioners ("annuities").

For annuities it was distinguished as from the beginning between men and women, and separate mortality tables were established. For "capital insurances" until 1960 a combined table was used. With the tariff 1970 the criterium of "age differentials" was introduced: the mortality of women was approximated by the mortality of men who were 5 years younger than they were. Ten years later, with the table 1980, this difference was increased to 7 years. Finally, as a result of the newest investigation, two independent tables for men and women were prepared in 1995.

For individual life insurance, the Technical Committee has presented until now only pensioners' mortality tables, separated by sex. For insurances for the case of death a number of companies were basing their tariffs on the group mortality tables. At this time, the Technical Committee is preparing for the first time a mortality table for individual life insurances for the case of death, based on the experience of the member companies during the period 1986 – 90. The tables, separated by sex, should be published before the end of 1995.

17.3.2 Group life mortality tables for the case of death

For this year (1995), the Swiss insurance companies will use the tables GKM 1980 for men and GKF 1980 for women. Male and female rates of mortality are included in the companion disk. They are based on the experience observed during the period 1971 – 75 in the group portfolio of the member companies. The number of persons at risk observed was about 1.900.000 men and 260.000 women. More details can be found in [6], while in [7] and [8] studies of the mortality evolution in the same portfolio from 1971 – 75 to 1976 – 80 respectively to 1981 – 84 are presented, too. The table GKM 80 has been adjusted according to the following formulae:

$$\begin{array}{lrcl} x < 31 & 1000q_x & = & a_0 + a_1 x \\ 31 \leq x < 50 & 1000q_x & = & b_0 + b_1 x + b_2 x^2 + b_3 x^3 \\ x \geq 50 & 1000q_x & = & \frac{c_0 + c_1 c^{x-65}}{1 + c_2 c^{x-65}} \end{array}$$

where the parameters have following values:

$$\begin{array}{llll} a_0 = 0.896 & a_1 = 0.0122 & & \\ b_0 = 0.6970 & b_1 = 0.2638 & b_2 = -0.01571 & b_3 = 2.517.10^{-4} \\ c_0 = 0.3790 & c_1 = 26.84 & c_2 = 0.03722 & c = 1.108 \end{array}$$

The table GKF 80 is based on GKM 80, considering the mortality of a woman equal to the mortality of a 7 years younger man; $q_y = q_x$ with $x = y - 7$.

In 1996 the new mortality tables GKM 1995 for men and GKF 1995 for women will be introduced; they are based on the experience observed during the period 1986 – 90 with a number of risks of 3.800.000 men and 1.540.000 women. The probabilities of second order were adjusted by spline functions. Both are included in the companion disk.

The details are expected to be published in the Bulletin of the Swiss Association of Actuaries at the end of 1995.

17.3.3 Individual life mortality tables for annuities

The mortality tables applied today are ERM 1990 for men and ERF 1990 for women. Both are included in the companion disk. They were based on the experience observed from 1981 to 1985 in the portfolio of individual life annuities of the member companies of the Union of Private Life Insurers.

The pensioners at risk observed were about 135.000 men and 170.000 women. The graduation was by spline functions, the extrapolation by the method of the half-value period.

17.3.4 Group life mortality tables for annuities

The situation is similar as for group life mortality for the case of death. During 1995 the insurance market will still utilize the tables GRM 1980 for men and GRF 1980 for women. Both are included in the companion disk. Like the tables GKM 1980 and GKF 1980, they are based on the observation during the period 1971 – 75 of the experience of the group annuities portfolio of the member companies; about 450.000 male and 160.000 female pensioners were followed (for details see [6]). The graduation was performed with formulas similar to those applied for GKM 1980 and GKF 1980 (for details see [9], page 61).

As from 1996, new tables based on the experience for 1986 – 90 will be introduced, GRM 1995 for men and GRF 1995 for women. Both are included in the companion disk. The probabilities of second order were fitted with the same procedure as for GKM 1995 and GKF 1995; here, too, we expect the publication of more details before the end of 1995 in the Bulletin of the Swiss Association of Actuaries.

17.3.5 Trend

As was expected, taking into account the high degree of penetration of group insurance in Switzerland, the evolution of insureds' mortality is very similar to that of the population's mortality. When considered in general terms, it presents a continuous improvement over the last decades, but the distribution of this improvement over the different groups of ages is not uniform.

A significative comparison can be done between the tables GKM 80 and GKM 95 for males (for the corresponding female tables it has to be remembered that GKF 80 was only an approximation based on the male table and an age difference of 7 years), corresponding to the observation periods 1971 – 75 and 1986 – 90 respectively. During this 15 years period, the expectation of life at age 15 (the youngest of the tables) increased from 57,6 to 60,2 years, but on the other hand the mortality increased for all ages up to 33. Only at age 34 began an improvement that, in percentage, increased continuously until age 50 where it reached 29,3%. For the following ages the relative decrease was less favourable, going down to 27,6% at age 56. Then a new push of improvement is observed until age 65, when the lowest percentage of mortality, if compared with GKM 80, was registered: 68,9%, i.e. a mortality decrease of about one third.

At the age of retirement (65), the expectation of life for a man increased between 1971 – 75 and 1986 – 90 from 13,6 to 15,7 years; a woman at age of retirement (62) had, according to GKF 95, an expectation of life of 23,5 years. In comparison: if we take the pensioners' mortality, the corresponding expectations of life at retirement ($x = 65$, $y = 62$) increased from 17,1 to 20,5 for men and from 22,6 to 29,8 for women.

17.4 Other mortality investigations

17.4.1 Mortality of the Swiss population by marital status and by cause of death

When the Federal Office for Statistics prepares a complete mortality table based on a national census, the investigations are extended to a number of other demographic and public health elements.

Some of them can also be interesting for insurance purposes, giving reference values for the assumptions, in particular those related to the compulsory pension schemes. Among other data, mortality tables by sex and marital status are published, as well as mortality tables by sex and cause of death. The results of the last investigation for the years 1978 – 83 are presented in [2].

Married persons of both sexes have, in every group of age, the lowest mortality; the mortality of single men and women is always higher as the average (except for women age 80 – 89), but always lower than the mortality of widowers/widows and divorced persons (with the exception of widows at age 60 – 69). Among the married men of age 40, around 86% can expect to survive age 65, among the unmarried only 75%. For women the corresponding figures are 93% (married) and 89% (unmarried).

The trend to mortality improvement, if compared with the mortality tables for 1968/73, is almost general for ages over 30: the only exception are widowers and widows of age 30 – 39. This depends probably on the increase of death by accident: if both partners are killed in the same accident, the second to die is considered widower/widow.

In the group of ages 20 – 29, on the other hand, only divorced men, unmarried and married women show a decrease of mortality, in the last case only small (−2,5%), all other categories present important increases up to 79,2% for widowers and +121,3% for widows (probably the reason is the same as mentioned above, accident mortality increase.)

For the investigation of the mortality by cause of death, these are classified in 9 groups: the principal causes continue to be tumours (malignant and benign), ischemic heart diseases and other cardio-vascular diseases, that together represent 62,8% of all deaths for men and 61,7% for women (1968/73: 56,2% and 57,1% respectively). But at young ages, the most important factor is violent death (accident, suicide, homicide); at ages 15-39 70% of deaths of men and 50% of women were violent. Compared with 1968/73, even an absolute increase of mortality was registered for some specific causes, ages and sexes, e.g. tumours for males ages 46 – 56, 61 – 66 and 74 and more, cerebro-vascular diseases for young persons (men age 30 – 36, women 27 – 41), ischemic heart diseases (men age 28 – 32 and 56 and more, women age 74 and more) and, as mentioned, violent death (men 20 – 31 and women 16 – 49).

The results of similar investigations for the period 1988/93 should be published before the end of 1995, at the same time as the general mortality table.

17.4.2 Mortality experience of companies and pension funds

Many life insurers and pension funds investigate the mortality experiences of their own portfolio and some of them publish the results periodically.

For instance, Swiss Life, the first company in the ranking of life insurers, analyses since 1920 the mortality of its individual life portfolio (only Swiss business) and publishes every 10 years the corresponding mortality tables (RAEM for men, RAEF for women and RAE combined). Until now, they were the only mortality tables for individual life capital insurances published in Switzerland. The last one, referring to the years 1981 – 90, has been published in [10]; the values of RAE 1981 – 90 are presented in the companion disk.

Furthermore the most important pension fund, which is the one for the federal employees (more than 700.000 members in total), publishes since 1950 every 10 years its mortality experience (tables EVK for men and women).

The last table — it appeared in 1991 and referred to the observation period 1982 – 87 — is presented in the companion disk. In a similar form, the pension fund of the town of Zurich (including since 1985 also the figures of the pension fund of the canton of Zurich and reaching now more than 300.000 members) investigated since 1950 its own experience and publishes every 10 years mortality tables for both sexes (tables VZ). The last one, for the observation period 1978 – 89, appeared in March 1991 and is described in [11].

All these tables represent obviously very interesting references as to the evolution of mortality for the whole insurance industry.

17.4.3 AIDS

As well Public Health Authorities as insurance industry are constantly following the evolution of HIV epidemic and trying to quantify its impact on mortality. An obstacle is represented by the difficulty of recognizing from the death certificates all cases caused by AIDS or HIV infection, because sometimes these are not mentioned explicitly. If public health authorities, when analysing the death certificates, have some doubt, they are in a good position to get more details from the attending physicians; this is more difficult for insurers.

An interesting study on the development of mortality caused by AIDS/HIV infection in the years 1982 – 93 for persons of both sexes at ages from 25 to 44 was performed by the Federal Office for Statistics and published by the Federal Office for Public Health [12]. It shows that the mortality due to AIDS/HIV infection has steadily increased year by year for this group of age and reached 1993 0,317 per 1.000 for men and 0,115 per 1.000 for women. In the same year, 18,3% of all deaths of men in this group of age were due to AIDS/HIV infection, that represented the second cause of death after accident. For women the percentage was 15,0% and AIDS/HIV infection was ranking at the third place after cancer and suicide. If the trend will not change, in a few years AIDS/HIV infection will be the first cause of death for men of ages 25 to 44 and the second for women of the same ages.[2]

[2] The preliminary results of the investigation for the period 1988/93, presented in July 1995 by the Federal Office for Statistics, indicate that the cause of death "AIDS" reduces the expectation of life at birth of the Swiss population by 0.20 year for men and 0.05 year for women.

The Technical Commission of the Union of Private Life Insurers, too, collects data of the experience of member companies, to make sure that the evolution remains within the limits forecasted.

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Chapter 18

United Kingdom

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18.1 Introduction

Parts of this chapter are based upon the corresponding contribution to the 1986 Groupe Consultatif study [18] by Prof. J. J. McCutcheon.

18.1.1 The Continuous Mortality Investigation Bureau (CMIB)

U.K. life offices have cooperated in the collection of mortality statistics for almost 180 years. Since 1924 the Continuous Mortality Investigation Bureau (the "CMIB") has collected data continuously from the majority of U.K. life assurers, and from time to time has published graduated mortality tables relating to different groups of lives. A brief history of the CMI Bureau can be found in CMI Report No.1 [7].

Two modern features of life assurance business — much increased volumes, and more diverse types of business — have led the CMIB to investigate the experiences of 10 separate classes of business, as shown in Table 18.1. Each investigation is subdivided by sex; further sub-divisions are shown in the table. In each of the select investigations, data are collected separately for durations in force (in years) 0, 1, 2, 3, 4, and 5 and over. In each of the annuitants' and pensioners' investigations, data are collected both by lives (strictly, by policies) and by amounts of benefit. The types of contract in-

Investigation	Type	Subdivisions
Permanent assurances, U.K.	Select	Medical/Non-medical
Level temporary assurances, U.K.	Select	Medical/Non-medical
Decreasing temporary assurances, U.K.	Select	Medical/Non-medical
Linked assurances, U.K	Select	Medical/Non-medical
Permanent assurances, Republic of Ireland	Select	Medical/Non-medical
Linked assurances, Republic of Ireland	Select	Medical/Non-medical
Immediate annuitants	Select	pre-1957/post-1956
Retirement annuitants	Non-select	Deferred/Vested
Life Office Pensioners	Non-select	Early/Other retirements
Widows of Life Office Pensioners	Non-select	None

Table 18.1: **CMIB investigations, 1979-82**

cluded under each class of business listed in Table 18.1 are described later in this chapter, with the exception of linked assurances and retirement annuities (for which separate graduated tables were not constructed). "Linked assurances" are assurance contracts the value of whose benefits is determined by the value of a segregated fund of assets. "Retirement annuities" are deferred annuities purchased by self-employed persons. To some extent the separation of classes of pensioners and retirement annuitants has been blurred by the personal pensions legislation introduced from 1988 onwards, and by changing practices in respect of pension provision.

The work of the CMIB also encompasses:

1. analysis of the data by cause of death;
2. an investigation into the claims experience under Permanent Health Insurance contracts;
3. an investigation into the mortality of impaired lives (begun in 1982);
4. an investigation into the differences between smokers' and non-smokers' mortality (begun in 1988 and described in Section 18.5.1);
5. occasional special investigations (an example is the investigation into duplicate policies in the 1979-82 Assured lives experience).

The CMIB publishes a series of reports, describing the experiences in each quadrennium, (e.g. 1979-82, 1983-86 and so on). When changes in the patterns of mortality seem to justify doing so, the CMIB graduate and publish "standard tables" for use by insurance companies. The most recent set of standard tables, known as the "80" series, was based on the 1979-82 experience, and their construction was described in CMI Reports No.9 and No.10 [10], [11]. Section 18.2 below is a shorter description of the tables, based on these reports.

18.1.2 The English Life Tables

Life tables have been constructed based on national censuses in the U.K. every 10 years since 1841, with occasional breaks during wartime. Although these are not often used for the major classes of life assurance, they are sometimes used in connection with "industrial" or home-service insurance, friendly societies and sickness insurance.

Separate tables are published for males and females in England & Wales — the "English Life Tables" — in Scotland and in Northern Ireland, but none are published for the whole of the U.K..

The most recent national tables are the English Life Tables No.14 ("ELT14") based on mid-year population estimates, and registrations of deaths, in the years 1980, 1981 and 1982. Their construction is described in [6]. Section 18.3.2 below compares the ELT14 tables with the "80" series of standard tables for insurance use.

18.1.3 AIDS

In 1987 the Institute of Actuaries set up a Working Party to consider the potential effect of AIDS on rates of mortality and assurance business. Since 1987 the Working Party has issued 5 reports ([13], [14], [15], [16], [17]) and several articles including Daykin *et al* [2] and Wilkie [21], describing projections of extra mortality due to AIDS for homosexual males. These have formed the basis of recommendations made to Appointed Actuaries by the Government Actuary's Department, in respect of premium rating and reserving standards. Section 18.5.2 describes the Working Party's approach.

Name	Investigation	Select period
AM80	Permanent assurances, U.K., Males	2 years
AM80(5)	Permanent assurances, U.K., Males	5 years
AF80	Permanent assurances, U.K., Females	2 years
TM80	Level temporary assurances, U.K., Males	5 years
IM80	Immediate annuitants, Lives, Male	1 year
IF80	Immediate annuitants, Lives, Female	1 year
PML80	Life Office Pensioners, Lives, Male	Non-select
PMA80	Life Office Pensioners, Amounts, Male	Non-select
PFL80	Life Office Pensioners, Lives, Female	Non-select
PFA80	Life Office Pensioners, Amounts, Female	Non-select
WL80	Widows of Life Office Pensioners, Lives, Female	Non-select
WA80	Widows of Life Office Pensioners, Amounts, Female	Non-select

Table 18.2: **The "80" series of mortality tables.**

18.2 The "80" series of tables

18.2.1 Graduation of the 1979-82 experiences

After consultation with the Institute of Actuaries and the Faculty of Actuaries, the CMIB published standard tables based upon those of the 1979-82 experiences for which there were sufficent data and for which there was a demand. The resulting "80" series of tables is listed in Table 18.2.

Temporary initial selection is often found to be an important feature of the data, either because of medical underwriting or self-selection. The CMIB collect data separately for curtate policy durations 0, 1, 2, 3, 4 and 5 and over years, but the choice of the select period for the graduated tables (i.e. the period during which the effect of selection persists) is assisted by a statisical analysis of the effect of combining the experience of later durations, and is also strongly influenced by practical considerations (for example, assured lives mortality tables with a 2-year select period have been in use since the A1949-52 table was published). Note that the Life Office Pensioners' experience is analysed on a select basis although the select period chosen for the graduated tables is 0 years.

The methods of graduation are described in Forfar, McCutcheon & Wilkie [3]. A notable feature was the adoption of the multiple-state model (or its Poisson approximation) instead of the Binomial model used for previous CMIB graduations. Formulae of the "Gompertz-Makeham" family, i.e. of the type:

$$\mu_x = polynomial_1 + exp(polynomial_2)$$

were fitted to the crude occurrence/exposure rates by maximum likelihood methods. Polynomials of no higher than quadratic order gave satisfactory results for individual graduations, but on comparing (i) the graduated tables with the ELT14 tables, and (ii) the graduations of different experiences, and in some cases (iii) the graduated rates at different durations, anomalies were found. In many cases the graduated rates were adjusted to remove these anomalies; the adjustments used and the final parameters for each table are given in CMI Report No.10 [11].

Mortality rates q_x, $q_{[x]}$ etc. were calculated from the graduated μ_x, $\mu_{[x]}$ etc. by numerical integration, and finally the tabulated values of μ_x, $\mu_{[x]}$ etc. were calculated from the resulting rates q_x, $q_{[x]}$ etc. using formulae given in CMI Report No.10 [11], so that all tabulated functions could be computed exactly from the basic mortality rates. Thus the *tabulated* forces of mortality are not exactly equal to the *graduated* forces of mortality.

Table 18.3 shows the numbers of deaths and the exposed to risk comprising the ultimate data at all ages for each table. "Deaths" should strictly be described as "claims", since the data relate to policies and not lives. The ultimate Assured Lives data were multiplied by "variance ratios" (see Forfar *et al* [3]) before graduation to allow for the presence of duplicates, i.e. more than one policy on the same life. The "amounts" data in the annuitants', pensioners' and widows' experiences were similarly adjusted before graduation.

18.2.2 Assured Lives tables

For males, the differences between the experiences at different durations appeared to justify a select period of 5 years, but for practical reasons a table with a select period of 2 years was also desirable. Therefore two tables were prepared; the AM80(5) table with select period 5 years and the AM80 table with select period 2 years. Figure 18.1 shows the rates of the AM80 table on a logarithmic scale.

For durations 2+, the formula was fitted using data for ages 17 – 90. Below age 17 the mortality rates were based on the ELT14 table; there was no attempt to smooth the resulting discontinuity. At high ages the

Table	Deaths	Exposure
AM80	90,941	22,239,148.0
AM80(5)	83,438	17,313,471.2
AF80	6,368	3,375,844.5
TM80	4,968	2,038,825.5
IM80	4,771	61,503.5
IF80	9,789	142,137.5
PML80	85,426	1,377,059.5
PMA80	20,021,034 (£)	446,740,045.5 (£)
PFL80	10,536	336,887.0
PFA80	1,445,796 (£)	64,781,941.0 (£)
WL80	692	28,386.5
WA80	238,438 (£)	15,892,759.0 (£)

Table 18.3: **The "80" series of mortality tables: numbers of deaths and the exposed to risk comprising the ultimate data at all ages**

extrapolated rates seemed too high in comparison with the ELT14 table, and an adjustment was needed. For duration 1, an adjustment was needed at low ages to keep the select rates below the ultimate rates.

For the AM80(5) table, the rates at durations 0, 1 and 2+ from the AM80 table were used for durations 0, 1 and 5+, and the data at durations 2 – 4 years were combined.

For female Assured Lives only a 2-year select table was prepared, although the data suggested that a 5-year select table with durations 1 – 4 combined would have been justified. Figure 18.2[1] shows the AF80 ultimate rates as a proportion of the AM80 ultimate rates. Below about age 80 the AF80 rates are only 40% – 60% of the AM80 rates; moreover the shape of the AF80 experience is different from that of the AM80 experience so that a constant deduction from the AM80 mortality rates does not represent female mortality accurately at all ages. Above age 110, the AF80 rates exceed the AM80 rates, which is not a feature of the extrapolated formulae but is caused by the adjustment of the AM80 ultimate rates at high ages.

[1]Note that for reasons of clarity in reproducing this and subsequent figures in the size used for this survey, the scales of the vertical axes are not all the same, and are not based at zero.

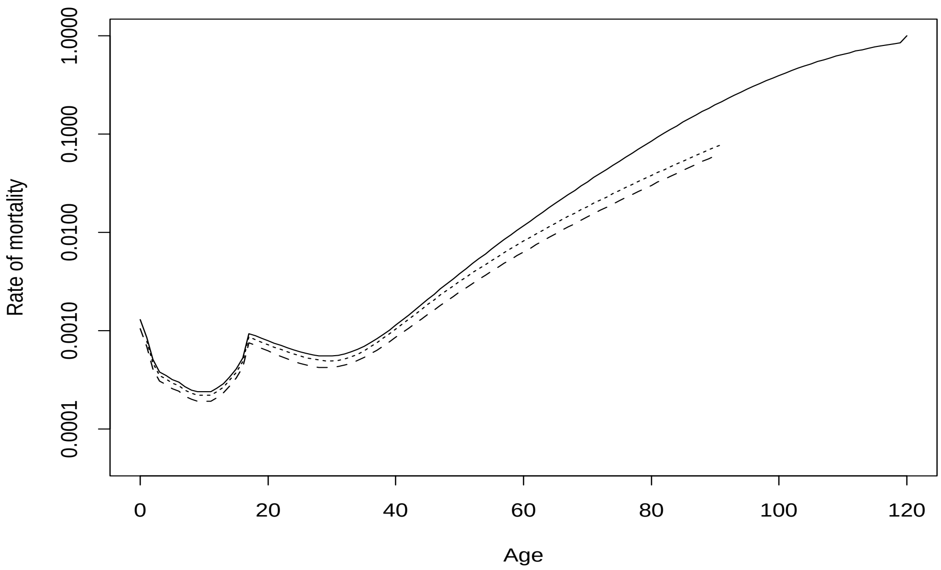

Figure 18.1: **AM80 table : $q_{[x]}$, $q_{[x-1]+1}$ and q_x on a log scale.**

The TM80 table for Temporary Assurances was based on the combined data of the level and decreasing temporary assurance investigations, and since 1988 only the combined data have been collected. Temporary assurance premium rates are lower in the U.K. than in most other member states, and are not subject to any tariff; the fact that Temporary Assurances appear to experience lower mortality than Permanent Assurances therefore justifies the preparation of a separate table. Figure 18.2 shows the TM80 ultimate rates as a proportion of the AM80 ultimate rates.

18.2.3 Pensioners' tables

"Pensioners" are lives in receipt of pensions from pension schemes insured with life offices. There is little likelihood of self-selection by such lives, so tables on a non-select basis are sufficient; there is however evidence of "reverse selection" in that the experience of those who retire early is worse than that of normal and late retirements, so early retirements are excluded from the graduations. The combined experience (early, normal and late retirements) was later analysed in CMI Report No.13 [12].

Rates based on amounts of pension were generally below rates based on

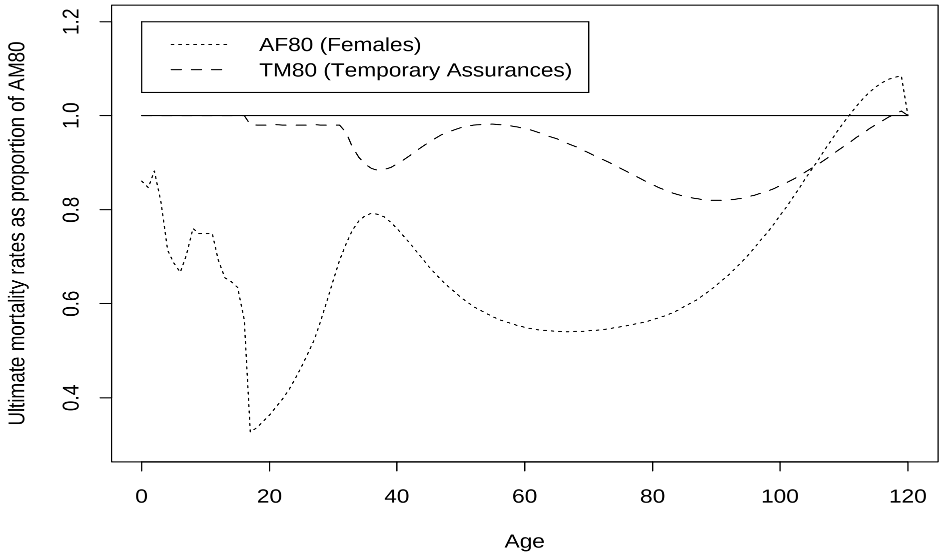

Figure 18.2: **AF80 and TM80 ultimate rates as a proportion of AM80 ultimate rates.**

lives; moreover, the Amounts experience had shown more rapid improvements than the Lives experience in the past, so graduations of both Lives and Amounts data were made. For males, at ages 16 – 55, rates were based on the AM80 ultimate table, for use in calculating death-in-service benefits. The rates derived from Amounts data were adjusted after comparison with the AM80 ultimate rates, and the Lives graduation was then based on the Amounts graduation at low and high ages.

The resulting tables were called the "PMA80Base" and "PML80Base" tables. Base tables for females, "PFA80Base" and "PFL80Base" were produced by similar means. These base tables were taken to represent the experience in 1980, and were then used to project future improvements in mortality. The improvements were modelled by age-dependent reduction factors so that (with an obvious notation)

$$q_{x,1980+t} = q_{x,1980} \times RF(x,t)$$

The reduction factors $RF(x,t)$ modelled a geometric decrease to a limiting value. A study of past mortality improvements (see Section 18.4.1) suggested that reduction factors independent of age (such as were used in

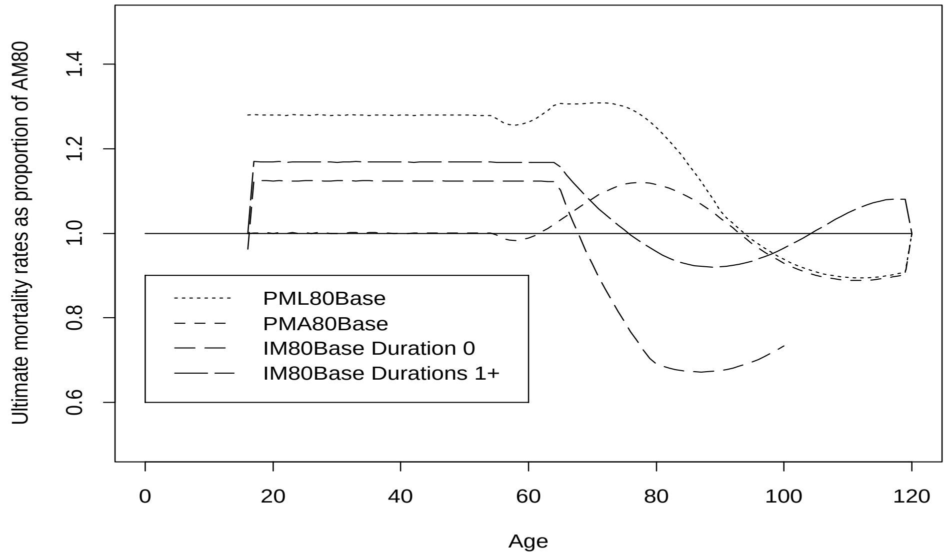

Figure 18.3: **Male pensioners' and annuitants' rates as a proportion of AM80 ultimate rates.**

the preparation of the previous PA(90) standard tables) understated the improvement at younger ages and overstated it at older ages. Indeed, the PA(90) tables, which were based on the 1967-70 experience but projected to represent mortality in 1990, were already heavier than the 1979-82 experience at younger ages. Projected mortality rates were prepared for calendar years 1981 – 2079, providing double-entry tables from which rates appropriate to a calendar year, year of birth or "year of use" could be extracted.

Figure 18.3 shows, *inter alia* the PML80Base and PML80Base tables as a proportion of the AM80 Ultimate table, and Figure 18.4 shows the PFL80Base and PFA80Base tables as a proportion of the AF80 Ultimate table. Note that these figures are not to the same scale.

18.2.4 Annuitants' tables

"Annuitants" are lives in receipt of immediate annuities purchased from life assurers. The data indicate strong initial selection, and would justify a select period of 5 years, but for practical reasons a select period of 1 year was used. The Lives experiences were similar to the Amounts experiences so only the former were graduated. Figure 18.3 shows the IM80Base mortality rates at

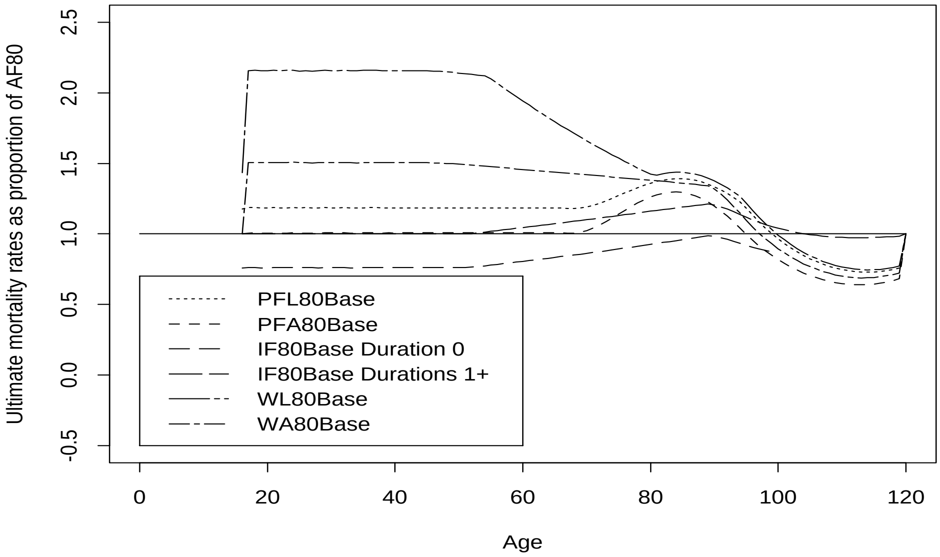

Figure 18.4: **Female pensioners', annuitants' and widows' rates as a proportion of AF80 ultimate rates.**

select and ultimate durations as a proportion of the AM80 Ultimate rates.

The female experience required considerable adjustment as the rates were much higher than the AF80 ultimate rates at high ages. Projected mortality rates were calculated using the same reduction factors as for the Pensioners' tables. Figure 18.4 shows the IF80Base mortality rates at select and ultimate durations as a proportion of the AF80 Ultimate rates.

18.2.5 Widows of Pensioners' tables

In this case the Amounts experience was much higher than the Lives experience, so tables on both bases were prepared. At young and old ages the Amounts table was based on the PFA80Base ultimate rates, and the Lives table was then based on the Amounts table. The most striking feature is the excess mortality of widows. In fact, the experience of female pensioners who retired early (for which no table was produced) was similar to that of widows. Projected mortality rates were calculated using the same reduction factors as for the Pensioners' tables. Figure 18.4 shows the WL80Base and WA80Base mortality rates as a proportion of the AF80 Ultimate rates.

18.2.6 The Standard Tables Program

Until the publication of the "80" series tables, the practice of the CMIB was to publish extensive tables of financial functions at a wide range of rates of interest, terms and ages. In view of the almost universal use of computers, however, the CMIB produced a computer program — the "Standard Tables Program" (STP) — capable of calculating a wider range of functions than had traditionally been made available, and printed only a small volume of sample functions based on the "80" series tables, intended mainly for checking purposes.

18.3 The English Life Tables No.14

18.3.1 Construction

Previous English Life Tables were based on the decennial censuses, carried out in April of 1971, 1961 and so on, adjusted to estimate the exposure to risk during 3 calendar years. Accurate mid-year population estimates were available for 1980, 1981 and 1982, however, and these were used to estimate the exposure to risk by fitting a quadratic function to the population at each age, regarded as a function of time. Adjustments were made in respect of generations born in 1915 – 1923 to allow for the uneven incidence of births caused by war and epidemic.

Except at ages 0 and 1, crude values of m_x were based on the deaths in 1980, 1981 and 1982, and the exposed to risk above. Infant mortality was estimated from the registrations of births and deaths. The crude rates were graduated using cubic spline methods. At ages over 92 (men) and 95 (women) rates were obtained by extrapolation. A full account of the process can be found in [6].

18.3.2 Comparison with the "80" series tables

Figure 18.5 compares the ELT14 male and female tables with the ultimate AM80 and AF80 assured lives tables. Over most of the age range (that for which assured lives tables were based on adequate data) the ELT tables are considerably heavier than the assured lives tables. At the youngest ages the assured lives tables were based upon the ELT tables, while at the oldest

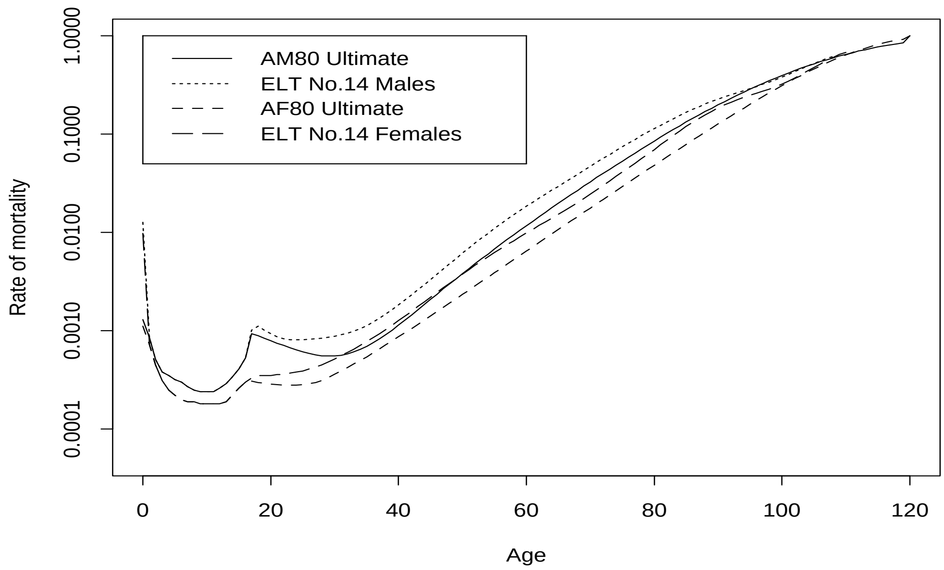

Figure 18.5: **Comparison of male and female Assured Lives mortality with English Life Tables No.14 (log scale).**

ages the adjustments applied to the assured lives tables make comparisons difficult.

Figures 18.6 and 18.7 show the rates of mortality of the main "80" series tables as a proportion of the ELT14 rates of mortality, for males and females respectively. The main features are:

1. There is some appearance of "roughness" in the proportions at ages 17–30. This is caused by the different approaches used in the graduation of the two experiences. The "80" series data were graduated by fitting a very smooth curve to data which were very sparse at these ages. More adequate data were available at these ages in the ELT14 investigation, and they were graduated by choosing closely-spaced spline knots in order to reproduce the "accident hump".

2. At age 0 the assured lives mortality rates are much lower than the ELT14 mortality rates. This is because, although the assured lives tables are based on the ELT14 tables at the youngest ages, deaths during the first month of life were excluded when calculating q_0.

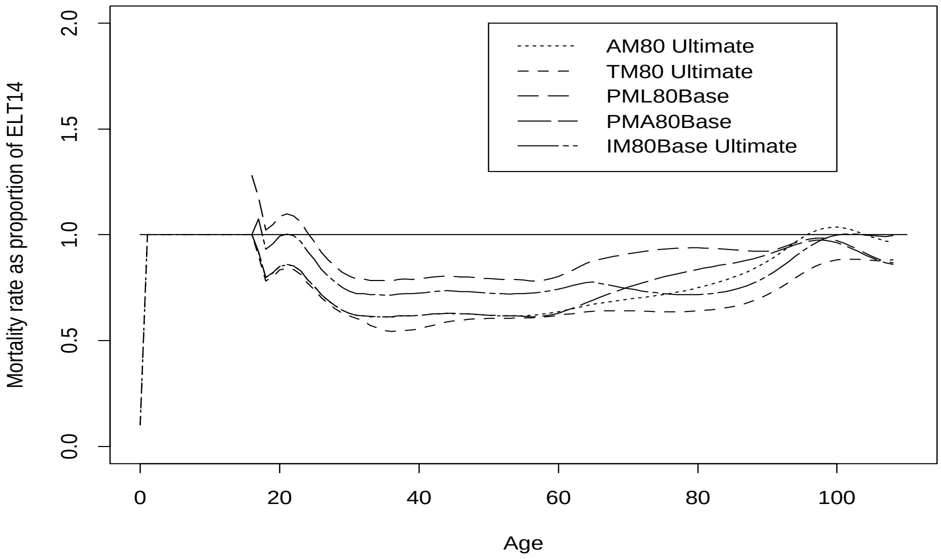

Figure 18.6: **"80" series male mortality rates as a proportion of English Life Tables No.14. (Males) mortality rates.**

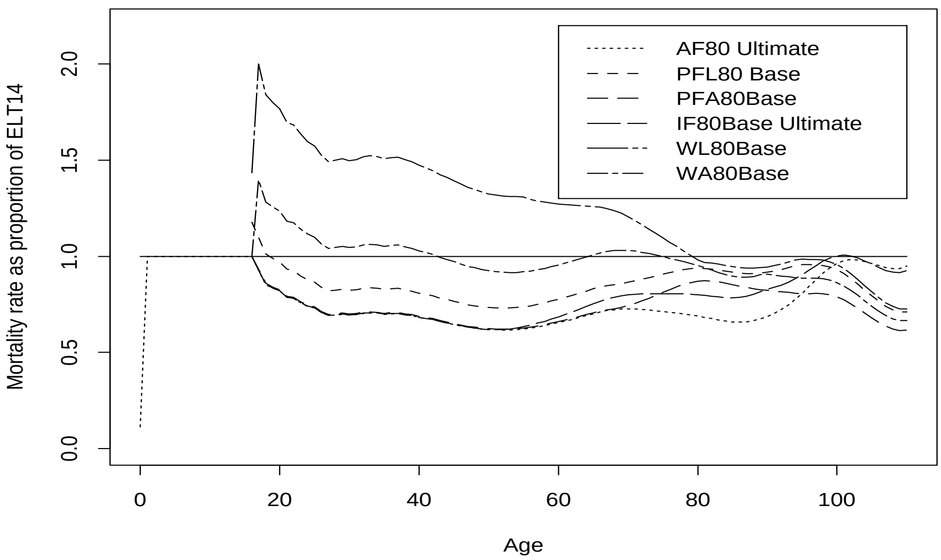

Figure 18.7: **"80" series female mortality rates as a proportion of English Life Tables No.14. (Females) mortality rates.**

Age	1924 – 29 to 1949 – 52	1949 – 52 to 1967 – 70	1967 – 70 to 1979 – 82
20	0.61	0.65	0.82
40	0.60	0.70	0.68
60	0.88	0.83	0.71
80	0.89	0.86	0.80

Table 18.4: **20-year improvement factors, Male Assured Lives.**

18.4 Trends in mortality

18.4.1 Life office policyholders

The CMIB considered the improvements on mortality during the years preceding 1979 – 82, particularly in order to project future improvements in pensioners' and annuitants' mortality (see Section 18.2.3). In CMI Report No.10 [11] comparisons between the 1979 – 82 experience and the mortality at different epochs were made by calculating "20-year reduction factors" as shown by the following example.

Let q_x^1 be the rate of mortality at age x in the 1979 – 82 experience, and let q_x^2 be the rate of mortality at age x in the corresponding 1967 – 70 experience. The two experiences are separated by 16 years, so the factor $\frac{q_x^1}{q_x^2}$ is the "16-year reduction factor" at age x. To provide a uniform basis for comparison, the CMIB calculated the corresponding 20-year reduction factors on the assumption that rates of mortality at any age reduce *geometrically* over time. Thus the 20-year reduction factor, denoted r^{20}, is $\left(\frac{q_x^1}{q_x^2}\right)^{20/16}$ in this example. In other words, r^{20} shows the factor by which the rate of mortality at a given age would be reduced every 20 years, if the rate of decrease was geometric.

Table 18.4 shows factors r^{20} in respect of Assured Lives at ultimate durations. Note that these are based on regraduations of the 1924 – 29 and 1949 – 52 experiences using the same formula as was used for the A1967 – 70 tables (see CMI Report No.3 [9]); the 1979 – 82 experience is represented by the AM80 table.

Tables 18.5 and 18.6 show factors r^{20} in respect of male and female Im-

Age	Males 1947 to 1967 – 70	Males 1967 – 70 to 1979 – 82	Females 1947 to 1967 – 70	Females 1967 – 70 to 1979 – 82
60	1.02	0.84	0.73	0.70
70	0.89	0.91	0.78	0.99
80	0.85	0.90	0.76	1.03
90	0.88	0.94	0.78	1.05

Table 18.5: **20-year improvement factors, Immediate Annuitants.**

Age	Males 1955 – 58 to 1971 – 74	Males 1967 – 70 to 1979 – 82	Females 1959 – 62 to 1971 – 74	Females 1967 – 70 to 1979 – 82
60	0.71	0.49	0.78	0.73
70	0.84	0.74	0.72	0.68
80	0.98	0.95	0.68	0.89
90	1.12	0.97	0.67	0.82

Table 18.6: **20-year improvement factors, Life Office Pensioners.**

mediate Annuitants and Life Office Pensioners (Amounts data) at ultimate durations. The 1967 – 70 experiences are those of the "aeg 1967 – 70" and "Peg 1967 – 70" tables, i.e. the graduated tables before projection factors were applied to produce the a(90) standard tables (see CMI Report No.2 [8]). The 1979 – 82 experiences are represented by the "Base" tables.

Apart from male immediate annuitants between 1947 and 1967 – 70, the greatest improvements have been at the lower ages. However, legislation enacted in 1956 introduced a new class of retirement annuity, and this is suspected of having changed the characteristics of the class of immediate annuitants. Male pensioners apart, the improvements since 1967 – 70 have proceeded at a rather slower pace than those before that period.

Table 18.7 shows the changes in mortality up to the 1983 – 86 experience (see CMI Report No.13 [12]). The ratios of actual to expected deaths (expressed as percentages) are shown for males and females, the expected deaths

$100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths (all ages combined)**		
Investigation	Males	Females
Permanent assurances	90%	81%
Temporary assurances	87%	82%
Linked assurances	76%	90%
Joint life 1st death assurances	76%	67%
Guaranteed acceptance assurances	121%	96%
Minimum evidence assurances	101%	104%*
Permanent assurances (Republic of Ireland)	107%	109%
Linked assurances (Republic of Ireland)	112%	99%
Immediate annuitants	117%	118%
Retirement annuities (in deferment)	81%	84%
Retirement annuities (in payment)	130%	126%
Life Office Pensioners, not retired early	121%	127%
Life Office pensioners, retired early	163%	193%
Widow(er)s of Life Office Pensioners	146%	123%
* Based on 2 deaths		

Table 18.7: $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths (all ages combined) for the 1983 – 86 experiences. Expected deaths based on the "80" series of mortality tables.**

being based on the appropriate "80" series table, using the ultimate experience only where the table is on a select basis. The "Amounts" experience has been shown where both "Lives" and "Amounts" data were collected, and the projected tables for the year 2010 have been used to calculate the expected deaths for pensioners and annuitants.

Table 18.7 includes some of the newer investigations being conducted by the CMIB, and not described before because no standard tables have yet been produced. "Guaranteed acceptance" assurances refers to endowment assurances under which acceptance was guaranteed in advance of underwriting. This class of business was entered into briefly under conditions of intense competition to sell mortgage-related endowments. The "actual/expected" percentages at durations 0 years and 1 year were 124% and 129% respectively for males, and 123% and 134% respectively for females. "Joint life 1st death" assurances refers to assurances written on one male life and one female life. "Minimum evidence" assurances refers to endowment assurances sold on the basis of a short proposal form, again in connection with house mortgages. The AM80 and AF80 tables were used as standards in these cases, and also for "Linked assurances" and the Irish experiences.

Tables 18.5 and 18.6, compared with Table 18.7, suggest that the projections incorporated in the new Annuitants' and Pensioners' tables will make broadly adequate allowance for future improvements if the past rates of improvement continue.

18.4.2 English Life Tables

Trends in mortality can be studied by comparison of the series of English Life Tables. Changes in methods of construction may lead to some distortion, especially at older ages, but the longer term trends are so pronounced that such effects are likely to be minor. Table 18.8, given in [6], expresses the mortality rates at selected ages and epochs as a percentage of the those of the English Life Tables No.8 (1910 – 12).

Particularly striking is the improvement in infant mortality. The mortality of females has improved by more than that of males, in proportionate terms. At most ages, mortality improved by more between 1971 and 1981 than during 1961-1971,

18.5 Further topics

18.5.1 Smoker/non-smoker mortality

The practice of charging different assurance premium rates for smokers and non-smokers is now widespread in the U.K.. Since 1988 the CMIB has collected data separately in respect of each group, where that is possible. The definition of a "smoker" is not uniform, but a common underwriting rule is that non-smoker will not have smoked cigarettes during the previous year; thus "non-smokers" may include ex-smokers, and pipe or cigar smokers.

The CMIB analysed the data for 1988 and 1989 in CMI Report No.13 [12]. Table 18.9 shows shows the ratios of actual deaths (all ages combined) to those expected on the basis of the AM80 table (males) or the AF80 table (females).

Age	ELT 8 1910 – 12	ELT 9 1920 – 22	ELT 10 1930 – 32	ELT 11 1950 – 52	ELT 12 1960 – 62	ELT 13 1970 – 72	ELT 14 1980 – 82
Males							
0	100	75	60	27	20	16	11
10	100	94	76	27	20	18	12
20	100	100	91	37	34	30	27
30	100	91	71	33	24	20	18
40	100	85	69	36	29	28	23
50	100	80	76	57	49	50	41
60	100	84	79	78	75	68	61
70	100	93	93	87	86	86	73
80	100	98	101	95	89	84	79
90	100	98	104	107	93	88	83
Females							
0	100	71	56	26	19	16	10
10	100	92	68	18	12	12	9
20	100	104	91	28	15	15	12
30	100	95	78	31	18	15	13
40	100	81	67	34	27	24	19
50	100	80	72	46	39	39	33
60	100	82	77	55	47	44	43
70	100	88	85	67	59	53	46
80	100	95	95	84	73	65	56
90	100	100	105	101	93	83	78

Table 18.8: **Rates of mortality of ELT No.8 – No.14, expressed as a percentage of those of ELT No.8.**

$100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths (all ages combined)**					
		Males (E = AM80)		Females (E = AF80)	
Type of assurance	Duration	Smokers	Non-smokers	Smokers	Non-smokers
Permanent	0	160	73	158	56
Permanent	1	160	70	140	73
Permanent	2+	91	53	120	64
Temporary	0	169	48	155	38
Temporary	1	69	42	69*	69
Temporary	2+	79	39	90	76
* Based on fewer than 5 actual deaths					

Table 18.9: $100\frac{\textbf{Actual}}{\textbf{Expected}}$ **deaths (all ages combined) of smokers and non-smokers, 1988 – 89, expected deaths based on the AM80 and AF80 tables.**

18.5.2 AIDS

In 1987 the Institute of Actuaries set up an AIDS Working Party to consider the actuarial implications of AIDS. At that time very little data was available, most of it relating to homosexual men in the U.S.A.. The Working Party used a multiple-state model for mortality among homosexual males in the U.K. proposed by Prof. A. D. Wilkie, which was described in their Report No.2 [14] and in Wilkie [21]. The model allowed for transfers between an "at-risk" state and a "clear" state, representing safer sexual behaviour, from "at-risk" to "infected" and from "infected" to "sick with AIDS". An "immune" state was also allowed for. There was great uncertainty about the transition intensities, and also the proportion of the male population "at-risk". Double-entry tables of additional mortality due to AIDS at each age and in each future year were produced, under a variety of assumptions. These showed deaths from AIDS rising to a peak close to the year 2000, then gradually declining. The most pessimistic projection showed a maximum of 56,780 additional deaths in 1999, while the most optimistic projection showed a maximum of 14,689 additional deaths in 1998.

The projections were compared with reported numbers of HIV-positive lives and AIDS deaths as these emerged, and were found to be too high. In 1989 Report No.4 [16] amended the projections to reproduce more closely the reported pattern; the modifications of the pessimistic and optimistic projections referred to above now showed peak deaths of 44,011 in 2000 and 11,091 in 1999, respectively. The Working Party suggested that an *ad hoc* allowance for future heterosexual spread of the epidemic could be made by assuming that the projected additional mortality rates should not reduce from their peak levels.

By 1991 it appeared that the optimistic projection — referred to as "Basis R" — was still too high, and further modifications were made in Report No.5 [17]. One of these, "Basis R6A" is particularly relevant as it currently forms the basis of the Government Actuary's guidelines to Appointed Actuaries on reserving for AIDS (see Section 18.5.3). For illustration, Figures 18.8 and 18.9 show the projected additional mortality in respect of males born in 1970 and 1950 respectively, under Bases R and R6A. The modifications referred to are *ad hoc* adjustments intended to strengthen reserving and pricing bases (see Section 18.5.3). For comparison, the AM80 Ultimate mortality rates are also shown where the scale allows.

The AIDS Working Party of the Institute of Actuaries has now been set

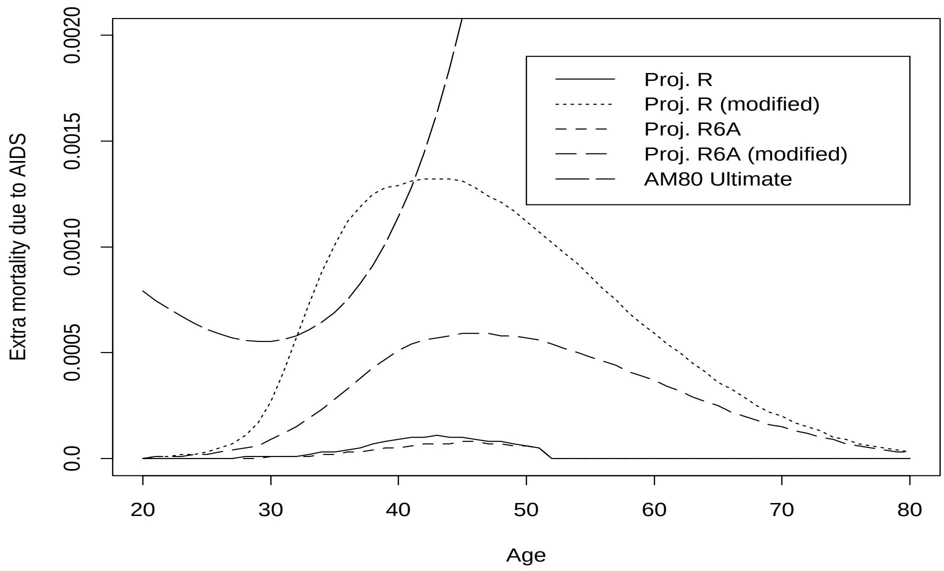

Figure 18.8: **Projected additional AIDS mortality, male born in 1970 (AIDS Working Party Reports Nos.4 & 5).**

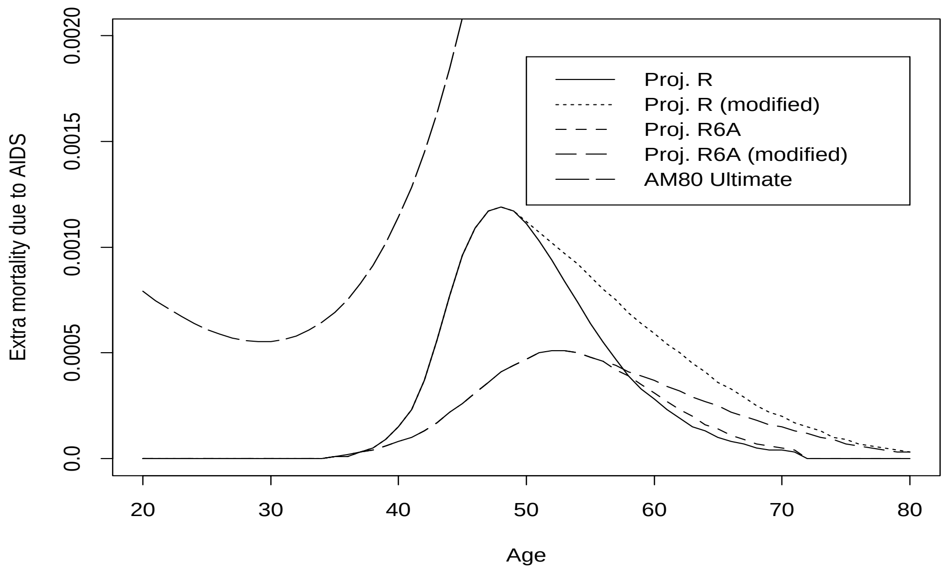

Figure 18.9: **Projected additional AIDS mortality, male born in 1950 (AIDS Working Party Reports Nos.4 & 5).**

up on a permanent basis as the AIDS sub-committee of the CMIB.

18.5.3 Regulation of life assurance business

U.K. regulations do not mandate any rates of mortality for pricing or valuation purposes. Regulation 60 ("Rates of mortality and disability") of the Insurance Companies Regulations 1981 [4] stated

> "The amount of the liability in respect of any category of contract shall, where relevant, be determined on the basis of appropriate rates of mortality and disability that take into account —
>
> **(a)** relevant published tables of rates of mortality and disability, and
>
> **(b)** the rates of mortality and disability experienced in connection with any similar contracts issued by the company in the past."

New regulations were introduced in 1994 to comply with the E.C. Third Life Directive. Regulation 70 of the Insurance Companies Regulations 1994 [5] states

> "The amount of the liability in respect of any category of contract shall, where appropriate, be determined on the basis of prudent rates of mortality and disability that have regard to the State of the commitment."

The Government Actuary has from time to time indicated to Appointed Actuaries the levels of additional mortality caused by AIDS, including possible future spread in the general population, which he considers might be consistent with the requirements of the Regulations. His most recent advice (letter dated 30 September 1993 [1]) is

> "... GAD believes that a sufficiently prudent assumption ... is that future mortality from AIDS in the general UK population will follow Projection R6A until it reaches its peak (around the beginning of the next century) and will then remain at that peak level."

Age	q_x	Age	q_x
100	0.399	105	0.537
101	0.418	106	0.458
102	0.402	107	0.465
103	0.451	108	0.474
104	0.442		

Table 18.10: **Crude mortality rates at ages 100 – 108 of the birth cohorts in England and Wales of 1859 – 69.**

Some examples of the effects are shown in Figures 18.8 and 18.9. Alternatively, 50% of the older (more pessimistic) Projection R might be used. It is open to Appointed Actuaries to justify different assumptions, for example where the use of an older mortality table provides margins at least as great.

18.5.4 Centenarians

The mortality of persons aged 100 or over (centenarians) in England and Wales was investigated by the Registrar General in 1981 [20], following an increase in the numbers recorded in censuses, from 271 in 1951 to 2,320 in 1971. Projection of lives aged 90 – 99 in 1961, on the basis of the ELT No.12 or ELT No.13 tables suggested that the latter total was about twice that expected. The results of (i) a 10% sample of National Insurance pensioners, and (ii) an enumeration of deaths over age 100 in 1970 – 79, and (iii) a similar investigation following the 1981 census [19], were similar. These results provide justification for the practice of excluding the data at the highest ages from the graduation of the English Life Tables.

In [20] the ungraduated estimates of the rates of mortality of the birth cohorts of 1859 – 69 shown in Table 18.10 were given.

18.6 Acknowledgement

I am grateful to Mr. Colin Kirkwood, chairman of the Executive Committee of the CMIB, for permission to use material which has appeared in various CMI Reports.

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