Mortality and life expectancy, especially concerning non-mandatory occupational pension plans

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I. Summary

Those people who would like to secure a life-long pension for their old age need an insurance institution which provides insurance for groups of people against these risks. Here the insurance institution relies on its experience in the past and uses a so-called *mortality table*. In this the likelihood of an insured person dying by a certain age is indicated.

Life expectancy up to the time of retirement in particular is an important indicator in judging longevity patterns.

Private life insurance companies, which enter into a commitment within the scope of occupational pension plans, have been using common mortality tables for decades in their group business. Due to the fact that the number of people insured in a single life insurance company is too small to satisfy the law of large numbers, the private life insurance companies integrate their figures into a single set of statistics and jointly use the resulting mortality table.

Since insurance supervision has been in operation, the supervisory authority requires that the prudence concept be adhered to whereby valued biometric principles must be applied cautiously. In particular this means that *mortality trends* have to be taken into account concerning retiree mortality. A procedure of this nature is based on actuarial principles and recognised international standards and has been in use since 1960 in Swiss private insurance.

Caution is necessary because on less cautious assumptions there is a danger of underfinancing, which could lead to later cuts in benefits and even insolvency of the life insurance company. On the other hand, an overcautious attitude does not work against the insured persons: in the case of premiums which are too high as a result of overcautious assumptions, these overwhelmingly flow back to those insured persons who paid a high premium.

Private life insurance companies have been using the GRM/F 95 mortality table since 1995. It is a mortality table for that generation of people who reached retirement age in 2003. It estimates the life expectancy of a 65-year-old at 20.5 years for men and 27.1 years for women. The GRM/F 95 mortality table takes into account possible improvements in life expectancy up to the death of the insured person. In addition private life insurance companies consider it necessary to have a slight safety margin, because of the difficulty of predicting what will happen in the future and because those insured especially in the non-mandatory sector are continually subject to an adverse selection.

The Federal Office of Private Insurance (FOPI) follows the developments relating to mortality of those insured by the private life insurance companies and examines mortality tables each time there are tariff revisions.

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II. Groups of people, mortality tables and life expectancy

Those people who would like to secure a lifelong pension for their old age need an insurance institution, which provides insurance for groups of people, so-called communities, against these risks. If this community is large enough, then this offsets the fluctuations according to the law of large numbers. This means that insured persons who die earlier can finance those insured persons who die later with the unused capital. For the insurer it is a question of calculating as accurately as possible how long the life of a pensioner is so that the accumulated capital is sufficient for the time between retirement and death. In order to determine this period of time in as reliable a fashion as possible, the insurance institution relies on experience in the past using a so-called mortality table. The table indicates the probability of an insured person dying by a certain age.

Mortality tables are drawn up based on a community under observation, where by means of observations carried out over a period of time the number of deaths are recorded. The observation period usually lasts approximately 1 – 5 [1] years. In a mortality table, along with the probability of dying at the age of x, q_x, the life expectancy e_x [2] of a person aged x is set out for the relevant age in tabular form. For pension insurance the probability of the retired person dying is one of two key values [3] in calculating the present value required to finance a lifetime pension. Life expectancy at the time of retirement is an important indicator in assessing the longevity of groups of people.

III. Different communities – different periods of observation – different mortality tables

Mortality tables depend not just on the group of people under observation but also on the period of observation. In Table 1, five mortality tables are shown which are of importance for occupational pension plans. The indication of the size of the group of people under observation as well as the period of observation gives further information on the significance of the mortality tables used in occupational pension plans.

Mortality table	Period of observation	No. of years under observation	Number of pensioners under observation			
			Men	Women [4]	Total M + W	Annually
SM/F 1988-93	1988-1993	6	2'366'000	4'201'000	6'567'000	1'094'500
EVK 2000	1993-1998	6	138'000	26'000	164'000	27'300
VZ 2000	1989-1998	10	49'000	32'000	81'000	8'100
BVG 2000	1999-2001	3	136'000	51'000	187'000	62'300
SVV 96-2000	1996-2000	5	126'000	62'000	188'000	37'600

Table 1

[1] The size of the group under observation is important. The larger the group is, the shorter the observation periods can be kept. Short periods of observation are advantageous. During a short assessment period, mortality rates do not change considerably and in this way the data recorded is not distorted.

[2] Life expectancy ex can be calculated from the given probability of dying ox using the following recurrence formula: $e_x = 0.5 + (1 - q_x) * (0.5 + e_{x+1})$

[3] The other key figure is the rate of interest used to calculate the interest on the present value of the pension available when the pension starts to be paid. In order to maintain the pension at the level promised from the time it starts to be received up until death, the interest on the sum invested should reach this rate of interest for the duration of the payment of the pension, the life insurer provides the insured person with an interest guarantee.

[4] As far as the women are concerned, the widows of those men who died and who were still working or in retirement are only included in the SM/F 1988-1993 mortality table, they are not included in the other four tables.

The larger the number of pensioners is, the more reliable and balanced are the mortality figures indicated in the mortality tables. Both the credibility and balance of a mortality table can even be improved by incorporating other, appropriate mortality tables and actuarially proven processes without suppressing the individual properties characterising a specific community in the process. Communities may exhibit individual structures, as shown in the five mortality tables mentioned above.

Population mortality tables cover the entire population. In Switzerland the population mortality tables are compiled and published by the Swiss Federal Statistical Office on the basis of the Federal population census carried out every decade. At the moment, the last one in this series is the SM/F 1988-1993 table. The total number covers, along with those in gainful employment, all those not in gainful employment, e.g. children, young people, students, pensioners, sick people, invalids, etc. The population mortality table valid at the time is also used for the Federal Old-Age and Survivors' insurance (1st pillar).

The big pension institutions such as the Federal Pension Fund Publica (formerly the Federal Insurance Fund) with the final version EVK 2000, and the Insurance Fund of the City and Canton of Zurich with its latest version VZ 2000, draw up their own mortality tables. Recently 12 big pension funds (ABB, COOP, Credit Suisse, PK Energie, Migros, Nestlé, SBB, Schindler, Sulzer, Swatch, Swiss Re und UBS) gathered data relating to the insured persons in a joint mortality table called BVG 2000 and which was drawn up by the pension fund experts PRASA Hewitt and ATAG Libera.

These mortality tables are based on communities within the scope of occupational pension plans (2nd pillar). Occupational pension plans are organised on a decentralised basis. This explains why the three entities (Confederation, city and canton of Zurich and 12 private sector pension institutions) differ in structural terms (concerning age, gender, profession, social background).

Private life insurance companies which enter into a commitment within the scope of occupational pension plans, have, for decades been using joint mortality tables for their group business. Due to the fact the number of insured persons in a single life insurance company is too small to satisfy the law of large numbers, private life insurance companies integrate their figures into one big set of statistics and as a result use the resulting biometric basis, i.e. the resulting mortality table jointly. This mortality table is based on the joint data collected each decade. The last investigation of this kind was carried out from observations in the period 1996–2000 and resulted in the Swiss Insurance Association mortality table 1996-2000.

Those policy holders affiliated to the private life insurance companies are mainly small and medium-sized enterprises, as well as self-employed people. The needs and behaviour of this category of insured person are to a certain degree different from the insured person in the insurance institution in the big companies and state institutions described above. In particular, worth noting is the fact that the pension insurance-covered firms or employers affiliated to the private life insurance companies on average comprise 13 insured persons. A group of insured persons of this size is very heterogeneous [5] and is exposed adverse selection [6].

[5] Those insured with private life insurance companies are heterogeneous insofar as a number of small companies, craftsmen and service providers either have minimum LOB coverage or due to a higher income take out a considerable amount of insurance in the non-mandatory sector. Not just the behaviour of this group of insured persons but also their life expectancy must be assessed differently.

[6] Adverse selection means that when insured persons choose their options, in the majority of cases, they opt for the one which is most expensive for the insurer. In occupational pension plans, most insured persons have the option of taking a pension or receiving a lump sum payment. The lump sum payment option is chosen by those insured persons who do not enjoy such good health or who, being better off, can afford to take a lump sum with a mainly non-mandatory proportion or who, as an unmarried person, does not have any surviving dependents. What the insurer is left with are insured persons with a higher than average life expectancy and in most cases a considerably younger spouse or a pension the present value of which is inferior to what it should be. In recent years, more than 50% of those insured with life insurance companies took the lump sum option.

IV. Communities observed and how, on the basis of these, a periodic table is drawn up

In spite of the fact that the insured persons observed in occupational pension plans are quite diverse, the life expectancy of pensioners is not so diverse, as seen in the Table below.

All five mortality tables are so-called periodic tables. Periodic tables stem from a group of insured persons under observation and those insured persons who die during the period of observation. The insured persons are categorised according to their age at the time of the observation and those who die are categorised according to their age when they die. The probability of dying q_x is calculated for all ages x and is the result of dividing the number of deaths by the number of insured persons. The probabilities of dying are adjusted using pertinent and recognised smoothing out procedures and extremes are eliminated. The five mortality tables for the ages between 80 and 110 are to be found in the appendix.

The latest mortality table is the BVG 2000, its focal point is the year 2000, as far as the other four are concerned, their focal points are before this.

Periodic tables can be improved by estimating, by means of a recognised actuarial method, the drop in mortality for a fixed period of time which many extend to 10 years from the focal point in time and in taking account of the probability of dying qx in the calculation. This was the case with the VZ 2000 mortality table, which was extrapolated by six years into the future. The result was a rise in the life expectancy indicated by this table.

Mortality table	Period of observation	Focal point	Extrapolation in years	Focal point after extrapolation	Remaining life expectancy at 65	
					Men	Women
SM/F 1988-93	1988-1993	1991	-	1991	15.5	19.7
EVK 2000	1993-1998	1996	-	1996	17.6	20.4
VZ 2000	1989-1998	1994	6	2000	17.3	21.8
BVG 2000	1999-2001	2000	-	2000	17.8	21.1
SVV 96-2000	1996-2000	1998	-	1998	16.9	21.1

Table 2

V. Why does the mortality trend have to be allowed for?

Since the beginning of insurance supervision, the supervisory office requires that the principle of prudence is followed whereby valued biometric principles must err on the side of caution. In particular this means that the mortality trend should be taken into account when calculating pensioner mortality. A procedure of this nature is justified actuarially and is a recognised international standard and has been in use in Swiss private insurance industry since 1960.

In contrast this does not occur, or only to a restricted degree, in pension funds and pension welfare institutions which in practice regularly take into account the drop in the mortality rate by means of periodic revisions to the mortality tables without prefinancing. The longevity surcharge mostly serves the sole purpose of continuously taking into account the expected conversion to new calculation bases. This means that pension funds either tolerate corresponding emerging underfunding or shift it to the generation in employment by means of pay-as-you-go financing.

With an analysis of trends, one takes account of the fact that medical progress as well as the increase in life expectancy which has been going on for decades, will not abruptly come to an end. Trend assessments actually show the following increases in life expectancy in the population mortality per decade:
– In the case of men: 1.0 year
– In the case of women: 1.6 years

This simple analysis of trends is described in detail and explained in the appendix. Pensioners, who, for example retire in 2004, are thus subject to a trend which from the mortality table's observation point in time (EVK2000: 1996) up to the estimated death, extends to almost three decades. This means that pensioners are getting older than those in the data recorded in the past and this in all pension funds and pension welfare institutions.

VI. How are mortality trends taken into account?

If mortality trends are taken into account in a mortality table, the result is a so-called generation table. Generation tables differ from periodic tables in particular in that the calculated life expectancy of a pensioner no longer depends solely on the age reached but also on the year in which the person was born. Thus a 65-year-old person has a higher life expectancy when the mortality trend is falling and if they reach this age not in the year 2000 but in 2004. Generation tables may be based on periodic tables in which the mortality trend is included.

In terms of trend inclusion, the mortality tables with a sufficiently large number of pensioners are most suitable such as the population mortality tables with their large statistical base, but less so the mortality tables of the Federal Insurance Fund (EVK) and the VZ 2000 with their somewhat smaller number of pensioners. Indeed the number of pensioners in the GRM/F tables is scarcely larger (cf. Table 1), but the private life insurance companies compensate for the relatively small number of pensioners by having more frequent and longer observation periods. This approach allows the private life insurance companies to detect trends more reliably from their own statistical data. In turn, these trends are, however, examined on the basis of population trends and with the aid of special statistical tests for strength and sustainability.

The trend assessment itself can, with the aid of a logarithmic regression procedure, be extracted from a series of mortality table generations from the community chosen for the trend assessment and then applied to the periodic table for which the future mortality trend has to be assessed. These periodic tables thereby become generation tables. An example of tables of this nature are the Cohort Mortality Tables for Switzerland [Kohortensterbetafeln für die Schweiz] (Swiss Federal Statistical Office, Bern, 1998). They are based on a somewhat more complicated trend inclusion model to take account of the special relationships in certain age groups. But for people of retirement age, an exponential extrapolation, as brought about by logarithmic regression, is particularly suitable.

Logarithmic regression is one of several possible procedures which have been used especially by private life insurance companies for decades. There are more refined and more reliable trend assessment procedures, especially if the mortality data has to be categorised additionally according to the causes of death.

Determining mortality trends by logarithmic regression will in future lead to an exponential reduction in mortality rates, i.e. the reduction at the start is stronger but then levels out. The opposite is true of life expectancy: after a distinct rise at the start of the trend, thereafter it grows but with the curve clearly flattening out. The diminishing medical marginal utility with the increase in life expectancy is thus taken into account in that the increase at the start of the trend as well as the levelled out rise in the following sector are clearly more pronounced at a lower level than at a higher one.

VII. How did the private life insurance companies proceed?

The mortality trend calculated by means of logarithmic regression based on the four most recent population mortality tables (1960–1993) was applied to the surveys of the private life insurance companies for the period 1986–1990 and 1996–2000. This resulted in the following life expectancy for 65-year-old people as shown in the Table below.

It shows that the improvement in life expectancy during the period 1988–1998 has not matched the trend of the last 30 years. However, this has nothing to do with trend slow downs and more to do with restructuring the insured persons under observation.

Mortality table	1988	1990	1995	1998	2000	2005	2010	2015	2020
Men									
SVV 1986-1990	16.5	17.9	18.4	18.7	19.0	19.5	20.0	20.5	21.0
SVV 1996-2000	-	-	-	16.9	18.2	18.7	19.2	19.7	20.2
Women									
SVV 1986-1990	20.7	23.1	23.8	24.3	24.5	25.2	25.8	26.5	27.0
SVV 1996-2000	-	-	-	21.1	23.5	24.2	24.9	25.5	26.1

Table 3

By moving from premandatory insurance benefits to LOB mandatory insurance benefits, the insured persons with the private life insurance companies were scarcely affected by the influx of the insured persons with a less than good state of health. This obviously had a restraining effect on the state of health of the pensioners. After 15 years of LOB mandatory insurance benefits the number of pensioners has once again stabilised. The inclusion of the trend, which causes an unvaried rise in the latest mortality measurements as well thus continues to anticipate the future evolution of mortality appropriately.

The private life insurance companies have used the GRM/F 95 mortality table since 1995. This is in actual fact not a generation table, it is a mortality table for the generation of people who reach pensionable age in 2003. The GRM/F 95 mortality table stems from the 1986 –1990 mortality measurements of the private life insurance companies including a sufficient longevity safety margin. It estimates the life expectancy of a 65-year-old man at 20.5 years and at 27.1 years for women. These life expectancy figures are approximately 10% higher than those obtained by including the mortality trend up to 2005 from the 1996–2000 mortality measurements. Why is this the case?

To start with, this is due to the structure of the table itself. The GRM/F 95 mortality table takes account of possible improvements in life expectancy up to the death of the insured person, this is something that periodic mortality tables, even extrapolated ones, do not do. Furthermore, the private life insurance companies consider a certain safety margin as necessary because of the difficulty in forecasting the future and because the people insured with them are subject to a continuous antiselection process (cf. footnote 6). The antiselection effect, which can be a danger to the solvency of the insurers, exerts, in contrast to the mandatory sector even more pressure on the non-mandatory sector which represents approximately 40-50% of insured benefits in occupational pension plans.

Whether or not the latest mortality measurements from 1996 to 2000 will be converted to a new generation table is undecided for the time being. Nevertheless a revision in the foreseeable future is to be expected.

VIII. Conclusion

The Federal Office of Private Insurance (FOPI) considers the procedure followed by the private life insurance companies as reasonable and considers it to be an interim solution which is not abusive until new mortality basic principles are introduced which will then be based on the most recent figures. In particular we will have to initially wait for the new 2003 population mortality tables to be able to revise the assessments of future mortality trends. FOPI follows developments in mortality from year to year in the insured persons of the private insurance companies, not just on the basis of submitted reports but also by consulting the data relating to mortality investigations carried out individually or jointly. This data and its plausibility is analysed by comparison with numerous other mortality tables used in Switzerland and internationally.

The mortality tables used by private life insurance companies are examined additionally each time there are tariff revisions. However, it is always the submitted insurance product as a whole which is authorised (preformulated terms of a contract, tariffs and biometric bases, especially the mortality table used).

APPENDIX
Mortality table GRM/F 1995 of the Swiss Insurance Association

Private life insurance companies which enter into a commitment in accordance with occupational pension plans use a common mortality table for their group business. These mortality tables are based on joint data collected every 5 years.

The mortality table associated with the joint group insurance tariff KT95 is based on the data collected from the 5-year period 1986-1990. Since then two more recent investigations were carried out for the 5-year periods 1991-1995 and 1996-2000. Due to the fact that the latest data collected does not show a change in trend concerning the longevity of the pensioners, the private life insurance companies dispensed with a revision and decided to continue using the existing mortability table.

The group insurance tariff KT95 including the associated mortality tables GRM/F95 for calculating pension present values was, at that time, approved by the Swiss Federal Office of Private Insurance (FOPI) and pension fund experts have been familiar with it for some considerable time.

The GRM/F95 mortality table is mortality table of first order. This means that the base mortality is smoothed out as a first step in a recognised procedure (mortality of second order) and in a second step, is reduced by an age-dependent trend reduction (mortality of first order).

Although this reduction is kept low, it anticipates the expected increase in the future of pensioner life expectancy as indicated by an assessment of a series of preceding mortality table generations from comparable investigations.

An estimate anticipating quite reliably the expected trend can be simply determined on the basis of Swiss population mortality tables.

Table 4: Life expectancy for 65-year-old men and women in accordance with GRM/F95

	men	women
Aged reached	65	65
Future life expectancy	20.5	27.1
Expected death	85.5	92.1

Future life expectancy in accordance with Swiss population mortality tables

Table 5: Future life expectancy of men

	Generation of population mortality tables								
Age	1881-88	1921-30	1939-44	1948-53	1958-63	1968-73	1978-83	1988-93	
1	51.8	61.3	64.7	67.8	69.4	70.5	72.1	73.7	
20	39.6	45.2	47.9	50.2	51.5	52.4	53.8	55.3	
40	25.1	28.3	30.4	31.9	32.8	33.6	35.1	36.8	
60	12.4	13.8	14.7	15.7	16.2	16.7	17.9	19.2	*)
65	9.7	10.8	11.6	12.4	12.9	13.3	14.4	15.5	
75	5.5	6.2	6.5	7.1	7.5	7.8	8.5	9.2	

*) approximately + 1.03 years per decade interval (in the period 1958-93)

Table 6: Future life expectancy of women

	Generation of population mortality tables								
Age	1881-88	1921-30	1939-44	1948-53	1958-63	1968-73	1978-83	1988-93	
1	52.8	63.8	68.5	71.9	74.5	76.2	78.6	80.5	
20	40.9	47.6	51.3	53.9	56.2	57.8	60.1	61.8	
40	26.7	30.9	33.3	35.0	37.0	38.4	40.7	42.5	
60	12.7	15.1	16.6	17.8	19.2	20.4	22.4	24.0	**)
65	9.9	11.8	13.1	14.0	15.2	16.3	18.2	19.7	
75	5.6	6.7	7.4	7.9	8.6	9.3	10.7	11.9	

**) approximately + 1.60 years per decade interval (in the period 1958-93)

From these figures the approximate life expectancy can also be calculated:

Table 7: Approximate life expectancy at the age of 65 (SM/F 1988-93)

	men	wom.	
a. age reached	65	65	
b. future life expectancy SM/SF 1988-93	15.5	19.7	
c. increase within the same trend	2.8	5.2	***)
d. life expectancy in 2003 (= b + c)	18.3	24.9	
e. expected age at death (= a + d)	83.3	89.9	

***) 13 years from 1990 to 2003, i.e. + 15.5 years or 19.7 years up to death

At this point it is important to point out that life expectancy of the entire population is less than that of the working population due to the fact that when a person is in employment and is insured in the “second pillar”, this has a strong selection effect.

Future life expectancy of people insured in the “second pillar”

The following figures are based on the 1996-2000 mortality investigations of the private life insurance companies (without projection into the future).

Table 8: Approximate life expectancy at the age of 65 (SVV 1996-2000)

	men	wom.	
a. age reached	65	65	
b. future life expectancy measurement 96 - 2000	17.8	22.0	
c. increase within the same trend	2.3	4.3	****)
d. expected future life expectancy (= b + c)	20.1	26.3	
e. expected age at death (= a + d)	85.1	91.3	

****) 5 years from 1998 to 2003 i.e. + 17.8 or 22.0 years up to death

Summary of expected age at death for retired persons

Tabelle 9: Summary

Type of table	men	wom.	
GRM/F 1995 with the life insurance company extrapolation	85.5	92.1	*****)
SM/F 1988/93 at the time of observation	80.5	84.7	******)
SM/F 1988-93 with SM/F extrapolation	83.3	89.9	
1996-2000 investigation with SM/F extrapolation	85.1	91.3	

*****) in the case of retirement in 2003, trend taken into account up until the death of the insured person

******) in the case of retirement at the time of observation, trend not taken into account

Conclusion

As table 5 shows, the improvement in life expectancy varies over the course of time. For example, for 65-year-old men in the period 1948-1993, there was a middling improvement of 0.78 years per decade. If one selects the period 1968-1993, then the result is 1.10 years per decade. On the basis of the tables from the period 1948-1973, one could have underestimated the future with a middling improvement of 0.45 years per decade. A temporary reduction in the trend or a temporary increase do not signify that the long-term trend has actually changed. A more reliable assessment of future life expectancy is permitted using trend assessments which are carried out using the *partial cause elimination methods*.

Methods of this nature allow deviations from the prognosis to be identified early enough and to make changes in the mortality tables. Partial cause elimination methods are based on the assumption that most people die prematurely, i.e. before they reach the genetically possible maximum age, of a disease or because of an accident. Should a disease fully (*complete-cause-elimination*) or partly (partial-cause-elimination) be healed or delayed (cause delay) or even avoided by using the appropriate prophylaxis (e.g. not smoking as the best protection against lung cancer), in this way the people concerned live longer. If one subdivides the probability of dying into the most important causes of death, it can be evaluated over the period of a decade to what extent medicinal and prophylactic progress reduce mortality due to potentially life-threatening illnesses. The calculations concerning future developments in mortality rates will thereby be more reliable and more stable than trying to forecast trends on the basis of experiences concerning mortality in the past.