Construction of biometric actuarial bases for long-term care insurance

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Introduction

The issue of long-term care, for not only the elderly but also younger people, arises in most developed countries, inevitably accompanying the ageing of the population, increased life expectancy and the breakdown of the nuclear family. How can society deal with this new challenge? In different countries the State has set up programmes to provide assistance for dependent people, but generally these programmes do not cover all the needs of the people concerned.

In order to make up for some of the shortfall, private long-term care insurance has made an appearance in some of the countries confronted with this problem.

The development of long-term care insurance over the last few years could not have taken place without the creation of a pricing model, generally a Markov model combined with biometric databases.

In fact, the majority of long-term care insurance pricing models assume that a policy holder, healthy at the time of purchase, will be independent, dependent or deceased "t" years after taking out the policy.
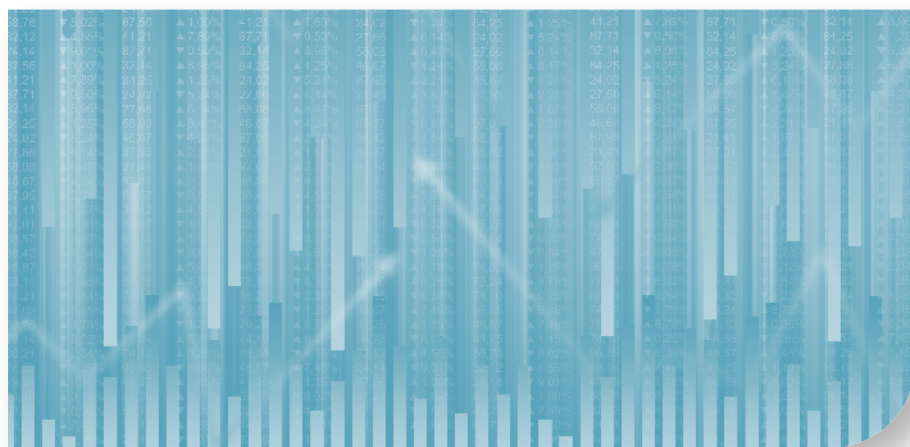
Several fundamental assumptions are therefore indispensable to the pricing and management of a long-term care insurance policy, whether the cover is expressed in terms of fixed payments (annuities) or on a reimbursement of expenses basis:

- **Survival of the autonomous insured,** or the assumption that the autonomous insured, which enables us to determine whether the insured person who is in a state of autonomy on date "t" will have died by date "t+1" without being in a state of dependence at some point.
- **Termination of policy (or policy lapse) assumptions,** which corresponds to the probability of the insured who is alive and non-dependent failing to continue paying the premium.
- **Incidence of dependence assumption,** which corresponds to the probability of the insured who is autonomous on date "t" being dependent on date "t+1".
- **Survival in a state of dependence assumption,** which enables us to determine whether the insured who is dependent on date "t" will still be dependent on date "t+1".
- If several degrees of dependence are envisaged, **additional assumptions governing the transitions** between the different states of dependence must also be established.

Depending on the specificities of long-term care insurance practice in each country, it is important to take account of the definition of dependence, both in terms determining severity – for example the inability to perform ADLs (Activities of Daily Living), paying attention to their number and the definition of each ADL – and the temporal dimension (elimination period, notions of temporary or permanent dependence): each assumption obviously depends on all these definitions.

It should be noted that age and sex are the most decisive factors in establishing these assumptions. However, it also can be useful to adapt some of these rules to the condition that causes dependence. For example, the incidence of dependence is different if it is due to cancer or to dementia; the same applies to length of survival in a state of dependence. It should also be noted that the probabilities of transition between the different states of dependence vary according to not only the age reached, but also the age of inception of dependence, where the influence of the condition causing the dependence can once again make itself felt.

Depending on the specific terms of a long-term care product, other segment distinctions can be made (smoker/non-smoker, type of medical underwriting, distribution network, etc.).

All the assumptions to be determined are therefore important, and a large amount of individual data is needed to be able to carry out an exhaustive study.

Furthermore, these rules must, in most cases, be established up to a great age (120 years for most developed countries), with this age generally being a function of life expectancy in the country concerned.

After over 25 years in the long-term care insurance market and with 50 reinsurance contracts in force, SCOR Global Life has built up considerable experience based on a large number of portfolios of policyholders.

Experience data

Some insured lives portfolios provide enough credible information to establish the assumptions we need. Others, although more modest in size and length of experience, can nevertheless provide a non-negligible amount of information.

As in the handling of any data for statistical purposes, if several sources of information are aggregated, very close attention must be paid to the various parameters influencing the assessment of the risk, as these parameters may vary from one source to another.

These parameters are in particular:

- the definition used for the risk of dependence,
- parameters such as the deductible (whether there is one, whether or not it differs according to the cause of the dependence, relative or absolute deductible, duration…),
- any waiting periods,
- the risk selection at the start of cover in the case of insurance data,
- the management of claims,
- the characteristics of the population used,
- the insurance policy itself in the case of insurance data (for example: known anti-selection on this policy, distribution method)
- etc…

Certain data can sometimes be aggregated to build up experience-based probabilities once the parameters have been analysed in depth and the resulting statistical bias evaluated.

Assumptions based on experience

After gathering homogenous data, the death or incidence rate must be estimated.

To do so, the conventional methods used in the longevity/mortality field to estimate crude death rates are used: calculation of the exposure to the risk, whilst remaining attentive to incomplete data, then calculation of the crude rates.

If all the observations were complete and if there were no other outcomes than death for the estimation of the assumption of death of autonomous or dependent subjects, or inception of dependence for the estimation of the incidence of the risk, the estimation of the rate sought would use a classic binomial model. The corresponding estimator is not only the Maximum Likelihood estimator, but also that of the method of moments.

However, we are rarely in a situation with complete observations.

This is why this estimator is then extended to incomplete data by a Bernoulli-type approach (the only variable being the realisation or not of the event) or by taking account of age at the time of realisation of the event (Kaplan Meier estimator). The calculation of the confidence interval is useful to check the credibility of the results obtained.

The age-specific rates resulting from these estimates are then smoothed to obtain coherent results. To do this, Whittaker-Henderson smoothing – obviously one of several other possible methods – is easily programmed and can therefore be used.

Extension of the assumptions in individual insurance

Long-term care insurance experience data are, except in very rare cases, concentrated on a restricted age range: from 50 to 90, or sometimes 95, years.

This is inherent in the history of the risk itself: although the first policies were taken out in the 1980s (1970s for the very earliest ones in Israel, which did not sell very successfully) and we see an average purchase age of 60 to 65 years for individual policies in France for example, the maximum age reached by the insured will be 90 to 95 years.

Furthermore, the number of people taking out individual policies before the age of 50 is too low to obtain reliable estimates for relatively young ages.

It is therefore necessary to extend the assumptions, especially for higher ages, and it becomes indispensable if the payment of the benefit guaranteed in the policy applies for as long as the insured is in a state of dependence (alive therefore), which is the case of lifetime long-term care annuities.

Once again, the methods used are those used in longevity studies: the Kannisto method can therefore be used to extend the assumptions to great ages. Particular attention will of course be paid to the calibration of the calculations, as using a large age range (over 10 years for example) will lead to rates that are manifestly too low if we consider the data that can be obtained elsewhere (public surveys, policies that enable us to obtain certain estimations at great ages, general or insurance demographic data, etc.).

Checking the internal consistency of the assumptions obtained

Once each assumption has been estimated individually, it is indispensable to project an insurance portfolio applying these assumptions, then to compare the results obtained, in particular with prevalence data for the risk or with demographic trends specific to the country concerned.

Thus, projection of the portfolio must not lead to a prevalence of high dependence of 100% at the age of 100 years, as this would not be realistic.

Furthermore, the overall behaviour of the portfolio (insured who are dependent or autonomous within the definition set) must follow the commonly accepted demographic laws. For example, even if an insurer assumes that every insured person will have died by age 120, statistical outliers are certainly possible. Emerging experience may reveal a classic low-frequency, high-severity tail risk. Therefore it is important for the company actuary to constantly monitor and ensure that terminal assumptions resemble experience as closely as reasonably possible.

A case study: high dependence bases in individual insurance - France

SCOR Global Life's portfolio dates back to the 1980s. It contains 1.3 million people in France and 3 million around the world. In France, its exposure is over 15 million insured-years, with about 25,000 claims filed to date. The experience is significant and reliable up to over 90 years. It is growing year on year.

These homogeneous data have enabled us to build up non-parametric estimates, in particular for individual total dependence cover, which is defined as the inability to perform at least 3 activities of daily living out of 4, which must be consolidated and recognised by the insurer's medical department.

To extend the assumptions beyond the available data, the Kannisto method has been used, whilst comparing the data to other available data, including observations of compulsory insurance portfolios, which give a vision of the behaviour of the assumptions at ages greater than 90 years.

The estimates determined then enabled us to:

- determine the resulting mortality of the population and compare it with the reality of the portfolios.

- check the prevalence obtained: thus observations in the field and the different surveys available, in particular the PAQUID (Personnes Agées Quid), conducted in a partnership with the SCOR group, and HID (INSEE disability, incapacity and dependence survey), provide good indications of the prevalence of the risk, which can be compared to those obtained by combining the assumptions.

These checks led to the assumptions obtained being adjusted by a simple calculation process, questioning certain parameters to obtain a global model corresponding to the reality observed "in the field".

1. The incidence of total dependence

Incidence increases with age and is not the same for men and women. Incidence is seen to be higher for men at younger ages and the situation is then reversed before being reversed again at great ages.

Contrary to what was previously believed, the incidence of dependence is not exponential, but after a certain age, its growth rate slows.

Incidence of total dependence

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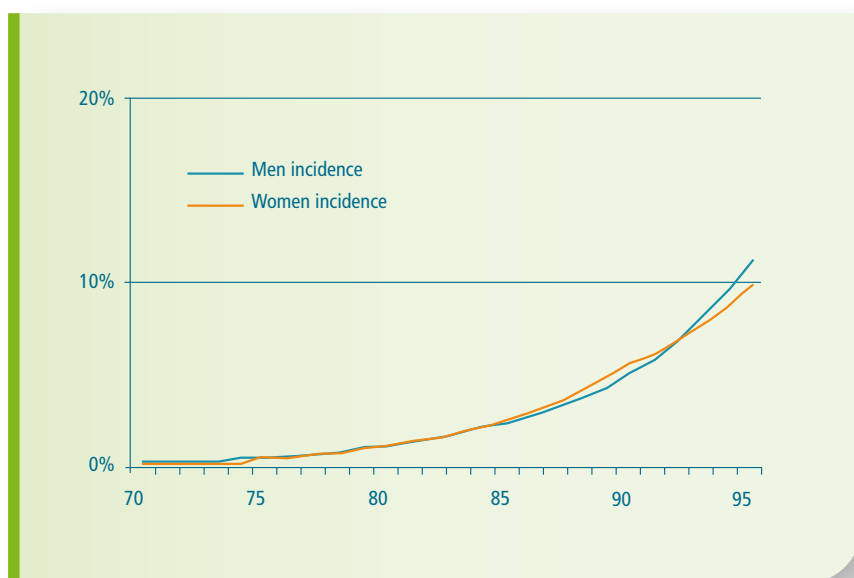
2. Mortality of the dependent insured

This assumption is a complex one. A classic mortality table depends on age and gender. The mortality assumption for a dependent person requires that we take account of the age of inception of the state of dependence, as life expectancy in this case varies according to the cause of the dependence, which is itself correlated with the age of becoming dependent.

The main causes of dependence have quite variable durations: relatively short (cancer…), average (rheumatism, cardiovascular disease…) or much longer, up to ten years (neurological problems, senile dementia). Within this framework, the theory of maintained dependence differs according to the number of years that the person is dependent.

The mortality rates for the first year of dependence do not increase strictly with age, but decrease until an age of about 75 years.

In fact, until age 75, there is a preponderance of illnesses such as cancer, which play out over relatively short periods, whereas after this age, the illnesses follow longer courses.

This is reflected in the intensity of the monthly mortality rates, which is higher for young ages in the first few months of dependence:

Mortality during 1st year of dependence

Men

65-69 years
75-79 years
85-90 years

Woman

65-69 years
75-79 years
85-90 years

During the course of the second year, it is interesting to observe that the mortality curves for men and women take on a more classic form and come to resemble the curves in the regulatory mortality tables more closely, demonstrating that the "Age" factor takes over once again.

As the years of dependence pass:

- the mortality curve flattens out;
- the influence of the state of dependence diminishes in favour of that of age;
- long-term diseases become predominant;
- mortality comes closer to general mortality.

Mortality during 2nd year of dependence according to age

Mortality men
Mortality women
General mortality of insured men
General mortality of insured women
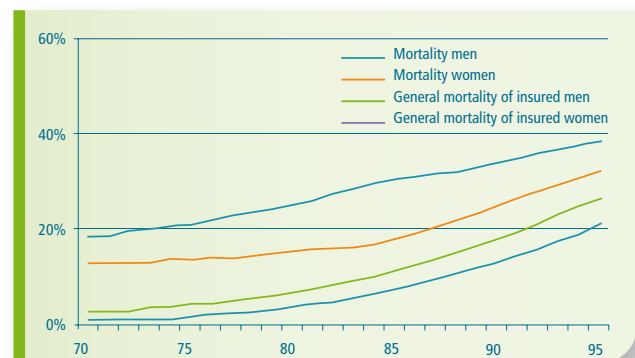
3. Mortality of the autonomous insured within the meaning of total dependence

This theory applies to the non-dependent, non-deceased insured. Longevity in a state of autonomy is therefore similar to life expectancy without disability, although the latter extends to the person's whole life whereas in this case, the definition of disability concerns only the loss of autonomy considered as permanent on the date of recognition.

Mortality in a state of autonomy is lower than general mortality. It seems that insured people live longer in a state of autonomy and that adjustments can reach 50% compared to the regulatory tables. It can also be seen that the populations concerned can withstand comparison with annuitants and have a longer life expectancy than annuitants.

At the same time, based on the regulatory mortality tables for the insured, in our portfolios it appears that the life expectancy of an autonomous person is considerably higher than the life expectancy of the general population at the same age. This phenomenon is intuitive: of course, the general population is made up not only of autonomous insured people, but also of dependent insured people whose mortality is higher than that of the autonomous insured.

## 4. The general behaviour of the portfolio

It was possible to model the portfolio in terms of mortality and prevalence of the risk using the assumptions defined in this way.

Its general behaviour must be confronted with the external data available and in particular the data for compulsory insurance portfolios, which provide information on a wider spectrum of ages, and the general population data available.

This allows the different parameters constituting the assumptions to be adjusted as they are not independent of each other: the overall portfolio mortality and risk prevalence constraints must be met.

For women, prevalence reaches almost 100% at the age of 120 years. The overall portfolio mortality is considerably lower than general mortality, and we systematically see lower mortality in insurance portfolios whatever the risk covered. Up to the age of 105, prevalence is higher for women than for men. The trend is then reversed, as a percentage though not in numbers (the cohort of women reaching great ages being much larger than for men). Men become dependent more quickly.

Prevalence of total dependence
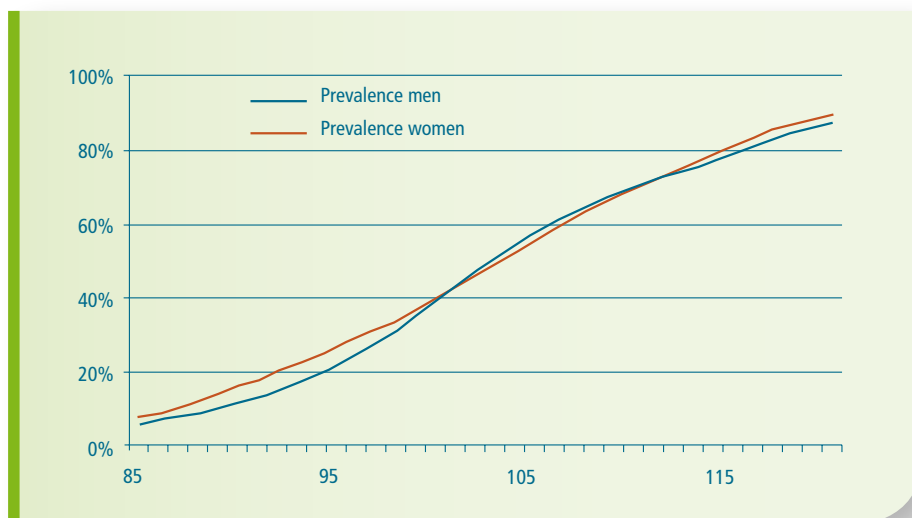
Mortality of a portfolio of general insured *vs.* portfolio of autonomous + dependent insured

Legend:
- Mortality of autonomous + dependent men
- General mortality of insured men

Mortality of a portfolio of general insured *vs.* portfolio of autonomous + dependent insured

Legend:
- Mortality of autonomous + dependent women
- General mortality of insured women
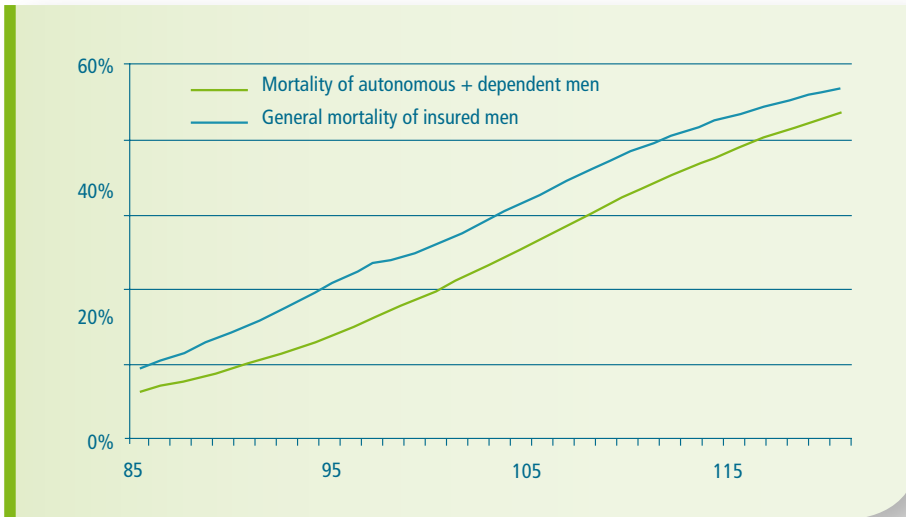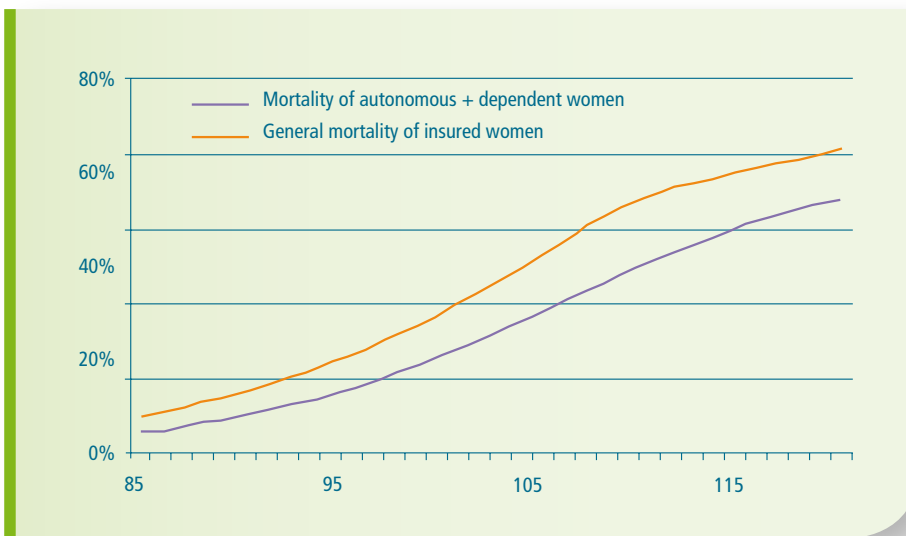
In conclusion

This document contains caveats about a certain number of factors that must be taken into account concerning both methodologies and the coherence of the results obtained.

Nevertheless, no mention has yet been made of the need to adapt assumptions obtained, no matter how consistent they are, to the model used: accordingly, there is no point in using conditional estimates in a model that only uses simple probabilities, and it is essential to point out the conditional nature of the assumptions obtained.

Particular care must therefore be taken when studying the links between the modelling of the risk and the results obtained from experience, including checking the coherence of the assumptions. There is no point in drawing up estimates that do not match the use made of them.

The SCOR Global Risk Center (www.scorglobalriskcenter.com) provides a number of articles on the subject of long-term care around the world, in particular SCOR Paper no.15 on long-term care insurance policies, which we advise you to read.

The SCOR Global Risk Center collects and analyses information from the most relevant sources on risk and insurance and reinsurance-related issues. It contains both internal documents and external resources selected by SCOR.

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