Pension Funds and Social Security
Lecture notes

Massimiliano Menzietti
a. y. 2020/2021
Week 12
Health Insurance (Pitacco, 2014)

Health Insurance Products

Introduction

In a broad sense, the expression health insurance denotes a large set of insurance products which provide benefits in the case of need arising from either accident or illness, and leading to loss of income (partial or total, permanent or non-permanent), and/or expenses (hospitalization, medical and surgery expenses, nursery, rehabilitation, etc.).

Health insurance, in its turn, belongs to the area of insurances of the person, where we find:

- life insurance (in a strict sense) and life annuities, which provide benefits depending on survival and death only, i.e. on the insured’s lifetime;
- health insurance, which provides benefits depending on the health status and related financial consequences (and depending on the lifetime as well);
- other insurances of the person, whose benefits are due depending on events such as marriage, birth of a child, education and professional training of children, etc.

Health insurance products are usually shared between “life” and “non-life” branches according to national legislation and regulation.
Main Health Insurance Products

**Accident insurance** covers a range of risks which may be caused by an accident (in particular, but not only, the risks of permanent disability and death). Various types of benefits can be included in the policy: usually, a lump sum is paid in the case of permanent disability.

**Sickness insurance** policies include medical expense reimbursement, and possibly hospitalization benefits, as well as fixed-amount benefits in the event of temporary or permanent disability.

The term **disability insurance** denotes various types of covers, providing benefits in case of temporary or permanent disability.
Long-term care insurance (LTCI) provides the insured with financial support, while he/she needs nursing and/or medical care because of chronic (or long-lasting) conditions or ailments.

Critical illness insurance (CII), or Dread disease insurance, has a very limited extension of the coverage, which is defined via listing. The benefit is a fixed lump sum.

Policy term
Health insurance may be provided by both one-year and multi-year covers, and, in particular, lifelong covers. For example, accident insurance is typically based on one year policies, whereas income protection is usually provided by multi-year policies. Durations shorter than one year apply, for instance, to policies providing coverage of health risks related to travels and sojourns.

One-year covers on the one hand and multi-year covers on the other require different actuarial structures, the latter also implying a life insurance-like approach and related biometric assumptions.

Remark. It is worth noting that a long-duration cover, and in particular a lifelong cover, can improve the “quality” of the insurance product from the policyholder’s point of view. As regards sickness insurance, for example, an arrangement based on one-year covers (or even on longer temporary covers) does not provide the individual with any guarantee that the insurer will extend the coverage over the whole lifespan, either because the individual has attained a very old age, or because a very high amount of health-related costs has been experienced by the individual and reimbursed by the insurer. Further, if specific underwriting requirements must be fulfilled at the time of renewal, a higher premium may be charged because of worsened health conditions.

Monetary Benefits and Service Benefits
As regards the amounts of monetary benefits provided by health insurance products, we can recognize the following types:
• Reimbursement benefits are designed to meet health costs, for example medical expenses. Hence, this category consists of expense-related benefits. Limitations such as deductibles and limit values are usually included in the policy conditions.

• The amount of a predefined benefit is stated at policy issue, for example to provide an income when the insured is prevented from working by sickness or injury. In this category, we find both annuity benefits and lump sum benefits as well. As regards the amount of the annuity or the lump sum, we have:
  o fixed-amount benefits, which are independent of the severity of the health-related event and the possible consequent costs;
  o degree-related benefits (or graded benefits), whose amount is linked to the severity of the health status expressed by some degree, e.g. the degree of disability.

In the case of service benefits, a care service is provided by the insurer, relying on an agreement between care providers (e.g. hospitals) and the insurer.

Policy Conditions
Several policy conditions are strictly related to the type of benefits provided by the health insurance products: underwriting requirements, amount of deductible, allocation of the policy reserve in the case of early termination of the contract, etc.

With regards to duration-related conditions, i.e. policy conditions which either define the coverage period or the benefit payment period following the claim, some important duration related conditions are represented in Figure below, where a generic disability claim in a multi-year cover is referred to.
The insured period (or coverage period) is the time interval during which the insurance cover operates, in the sense that a benefit is payable only if the claim time belongs to this interval. In principle, the insured period begins at policy issue, say at time $0$, and ends at policy termination, say at time $m$. However, some restrictions to the insured period may follow from specific policy conditions. In particular, the waiting period is the period following the policy issue during which the insurance cover is not yet operating for sickness-related claims. It aims at limiting the effects of adverse selection.

In many policies the benefit is not payable until the disability due to sickness or accident has lasted a certain minimum period called the deferred period. In sickness and accident covers the deferred period is usually rather short, mainly aiming at reducing the cost and hence the premium of the insurance products.

When a lump sum benefit is paid in case of permanent disability, a qualification period is commonly required by the insurer in order to ascertain the permanent character of the disability; the length of the qualification period would be chosen in such a way that recovery would be practically impossible after that period.
The **maximum benefit period** is the upper limit placed on the period for which benefits are payable (regardless of the actual duration of the sickness or the disability).

Another restriction to benefit payment may follow from the **stopping time** (from policy issue) of annuity payment. In disability annuities, the stopping time often coincides with the retirement age. Hence, denoting by $x$ the age of the insured at policy issue and by $\xi$ the retirement age, the stopping time $r$ (from policy issue) is given by $r = \xi - x$.

When conditions such as the deferred period or a maximum benefit period are included in the policy, in case of recurrent disabilities within a short time interval it is necessary to decide whether the recurrences have to be considered as a single disability claim or not. The term **continuous period** is used to denote a sequence of disability spells, due to the same or related causes, within a stated period. So, the claim administrator has to determine, according to all relevant conditions and facts, whether a disability is related to a previous claim and constitutes a recurrence or has to be considered as a new claim.

**Accident Insurance**

Accident is usually meant as an “unintended, unforeseen, and/or violent event, which directly causes bodily injuries”. Accident insurance is also referred to as personal accident insurance.

Accident insurance policies usually provide a one-year cover. A qualification period is usually applied in the case of permanent disability benefit. Several exclusions can be stated in the policy conditions, which limit the range of covered accidents (war-related accidents as well accidents related to illegal activities are usually not covered).
Special insurance plans are designed to cover specific types of needs: for example, travel accident insurance, student accident insurance, etc...

**Types of Benefits**

Various benefits can be provided by accident insurance policies:

- **Death benefit** consists of a lump sum paid in the case the insured dies as a result of an accident.
- **Permanent disability benefit** consists of a lump sum paid in the case of disability. Usually this is a degree-related benefit. A benefit schedule first associates a disability degree to the severity of injury; then, the amount of the benefit is expressed as a percentage of the sum insured. The figure below shows some examples of benefit grading: (a) no deductible, (b) franchise deductible, (c), a deductible with “adjustment”.

![Diagram of benefit grading]

- **Reimbursement of medical expenses** can be provided by an accident insurance policy; in the case the expenses are related to a covered accident.
- **A daily benefit during disability spells** can be paid as a fixed-amount benefit in the case of temporary disability caused by a covered accident. Usually the maximum benefit period ranges, according to policy conditions, from some months to one year.
Sickness Insurance

Sickness insurance policies provide benefits in the event the insured becomes sick. The benefits provided by sickness insurance vary according to the type and the extension of the insurance policy.

Types of Benefits

Reimbursement of medical expenses is the most important benefit provided by a sickness insurance policy. The benefit package can include various items:

- hospital inpatient cover includes all the services provided while the insured is hospitalized, including surgery, lab tests, drugs, etc.;
- outpatient cover relates to services provided in a physician’s office and hospital outpatient setting, including minor surgery;
- further coverage includes the reimbursement of expenses related to lab tests, to physician-prescribed drugs, etc.

The hospitalization benefit consists of a fixed-amount daily benefit paid during hospital stays. This benefit is not expense-related.

A daily benefit during sickness spells can be provided as a fixed-amount benefit in the case of temporary disability caused by a covered sickness.

Permanent disability benefit consists of a lump sum paid in the event of permanent disability caused by sickness.

Policy Conditions

The deductible (also called flat deductible, or fixed-amount deductible) is a predefined amount that the insured has to pay out-of-pocket before the insurer will cover the remaining eligible expenses. Depending on the insurance product, the deductible can either refer to each single claim, or to the policy period (e.g. the policy year). The deductible works as a disincentive for the insured to incur unnecessary medical expenses. Of course, the higher the deductible the lower the premium.
The proportional deductible is the fraction of eligible medical expenses that the insured has to pay, after having met the flat deductible.

The stop-loss is the maximum amount the insured will pay out-of-pocket for medical expenses. It can be referred either to each single claim or to the policy period.

Once the above policy conditions have been stated, medical expenses are consequently shared between insured and insurer. The sharing can formally be described as follows. Assume that the policy conditions refer to each claim. We adopt the following notation:

\( x \) = generic expense amount;

\( D \) = flat deductible;

\( \alpha \) = proportional deductible;

\( SL \) = stop-loss;

\( M \) = amount which depends on \( D, \alpha, SL \);

\( u \) = out-of-pocket payment;

\( y \) = reimbursement benefit paid by the insurer.

Of course \( u + y = x \). We have, for \( 0 < \alpha \leq 1 \):

\[
\begin{align*}
u &= \begin{cases} 
  x & \text{if } x < D \\
  \alpha(x - D) + D & \text{if } D \leq x < M \\
  SL & \text{if } x \geq M 
\end{cases} \\
y &= \begin{cases} 
  0 & \text{if } x < D \\
  (1 - \alpha)(x - D) & \text{if } D \leq x < M \\
  x - SL & \text{if } x \geq M 
\end{cases}
\]

where

\[
M = \frac{1}{\alpha}(SL - (1 - \alpha)D)
\]
Fig. 3.5 The out-of-pocket payment

<table>
<thead>
<tr>
<th>Expense amount x</th>
<th>Out-of-pocket u</th>
<th>Reimbursement benefit y</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.00 €</td>
<td>50.00 €</td>
<td>- €</td>
</tr>
<tr>
<td>300.00 €</td>
<td>150.00 €</td>
<td>150.00 €</td>
</tr>
<tr>
<td>900.00 €</td>
<td>300.00 €</td>
<td>600.00 €</td>
</tr>
<tr>
<td>1,800.00 €</td>
<td>500.00 €</td>
<td>1,300.00 €</td>
</tr>
</tbody>
</table>

D 100.00 €
α 25%
SL 500.00 €
M 1,700.00 €

Fig. 3.6 The reimbursement benefit
Underwriting requirements are usually applied in order to assess the individual health status at policy issue. The underwriting process may result in higher premium rates for substandard risks, that is, when poor health conditions are ascertained.

Waiting periods are commonly applied to limit possible adverse selection.

A sickness insurance product can provide coverage to more individuals, in particular all the members of a family.

Disability Insurance

The term disability insurance denotes various types of covers, providing benefits in case of temporary or permanent disability. Income protection (briefly IP) policies in particular pay a periodic income to an individual if he/she is prevented by sickness or injury from working and hence from getting the usual income. In the event of permanent disability, the benefit can consist of a lump sum.

Disability benefits can be paid by individual disability insurance, group insurance or pension plans.

Type of Benefits in Individual Policies

In individual disability insurance policies, permanent or not-necessarily permanent disability is considered according to the product design. Moreover, some disability policies only allow for total disability, whereas other policies also allow for partial disability.

The disability income benefit is a fixed-amount annuity benefit providing income protection in the case of total disability.

Various definitions of total disability are used. Some examples are as follows:

- the insured is unable to engage in his/her own occupation;
• the insured is unable to engage in his/her own occupation or carry out another activity consistent with his/her training and experience;
• the insured is unable to engage in any gainful occupation.

When one of the above definitions is met to a certain degree only, partial disability occurs.

Some policies provide a **lump sum benefit** in the case of permanent (and total) disability. The cover may be a stand-alone cover or it may be a rider to a basic life insurance policy, say an endowment insurance. A qualification period is commonly applied to limit the moral hazard.

**Types of Benefits in Group Insurance and Pension Plans**

Disability group insurance may represent an important part of an employee benefit package. There are two main types of benefits provided by disability group insurance:

• the short-term disability (STD) benefit protects against loss of income during short disability spells;
• the long-term disability (LTD) benefit protects against long-term (and possibly permanent or lasting to retirement age) disabilities.

The two fundamental types of disability benefits which can be included in a pension plan are as follows:

• a benefit consisting of an annuity to a disabled employee;
• a benefit consisting of a deferred annuity to a (permanently) disabled employee, beginning at retirement age.

The second type of benefit is usually found when a LTD group insurance operates (outside the pension scheme), providing disability benefits up to the retirement age.


**Benefit Amount and Policy Conditions**

Disability insurance should be distinguished from other products, within the area of health insurance. In particular, (short-term) sickness insurance usually provides reimbursement of medical expenses and hospitalization benefits. Long-term care insurance provides income support for the insured, who needs nursing and/or medical care because of chronic or long-lasting conditions. A Critical illness (or Dread disease) policy provides the policyholder with a lump sum in case of a dread disease, i.e. when he/she is diagnosed as having a serious illness included in a set of diseases specified by the policy conditions. Note that in all these products the payment of benefits is not directly related to a loss of income suffered by the insured, whereas a strict relation between benefit payment and working inability characterizes the disability annuity products providing income protection.

In individual disability insurance the size of the insured benefit needs to be carefully considered by the underwriter at the time of application, in order to limit the effects of moral hazard. In particular, the applicant’s current earnings and the amount of benefits expected from other sources (social security, pension plans, etc.) in the event of disablement must be considered.

In disability group insurance, benefits while paid are related to pre-disability earnings, typically being equal to a defined percentage (e.g. 70%) of the salary. In pension plans the benefit payable upon disability is commonly calculated using a given benefit formula, normally related to the formula for the basic benefit provided by the pension plan.

Benefits and premiums are often linked to some index, say an inflation rate, in the context of an indexation mechanism.
Long-Term Care Insurance

Long-term care insurance (LTCI) provides the insured with financial support, while he/she needs nursing and/or medical care because of chronic (or long-lasting) conditions or ailments.

Several types of benefits can be provided (fixed-amount annuities, care expense reimbursement, etc...).

The benefit trigger is usually given either by claiming for nursing and/or medical assistance (together with a sanitary ascertainment), or by assessment of individual disability, according to some predefined metrics (e.g. the ADL method, see below).

Remark LTCI products deserve an extensive presentation for various reasons. On the one hand, LTCI provides benefits of remarkable interest in the current demographic and social context. On the other hand, LTCI covers are “difficult” insurance products both from the insurer’s and the individual perspective. We note, in particular, the following aspects:

- In many countries, the elderly population is rapidly growing because of increasing life expectancy and low fertility rates.
- Household size is progressively reducing, with a consequent lack of assistance and care services provided to old members of the family inside the family itself.
- LTCI products are rather recent (especially if compared to other insurance products in the framework of health insurance, e.g. personal accident insurance and sickness insurance). As a consequence, senescent disability data are scanty, so that pricing difficulties arise.
- High premiums (for instance, because of a significant safety loading) can be an obstacle to the diffusion of these products. Further, it should be stressed that, in its stand-alone format, the LTCI product only provides “protection”, excluding other types of benefits (e.g. a straight life annuity or a death benefit).
Appropriate packaging of LTCI benefits together with lifetime-related benefits can enhance the clients’ propensity to purchase LTCI products.

Measuring the Severity of Disability

According to the ADL (Activities of Daily Living) method, the activities and functions considered are, for example, the following: 1) Eating, 2) Bathing, 3) Dressing, 4) moving around, 5) personal hygiene, 6) going to the toilet.

The simplest implementation of the ADL method is as follows. For each activity or function, the individual ability is tested. The total disability level (or LTC score) is given by the number of activities or functions the insured is not able to perform, and, finally, it is expressed in terms of LTC state. See the table below, where an example of graded LTCI benefit is also given.

<table>
<thead>
<tr>
<th>ADL score; unable to perform:</th>
<th>LTC state</th>
<th>Graded benefit (% of the insured benefit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Activities</td>
<td>I</td>
<td>40</td>
</tr>
<tr>
<td>4 or 5 Activities</td>
<td>II</td>
<td>70</td>
</tr>
<tr>
<td>6 Activities</td>
<td>III</td>
<td>100</td>
</tr>
</tbody>
</table>

More complex implementations of the ADL method rely on the degrees of ability to perform the various activities.

The IADL (Instrumental Activities of Daily Living) method, also known as the PADL (Performance Activities of Daily Living) method, is based on the individual ability to perform “relation” activities; for example: ability to use a telephone, shopping, food preparation, housekeeping, etc.

The Barthel index and the OPCS index constitute two important examples of methods for assessing the disability severity, that is, the level of functional dependence.

As regards the OPCS index, see the example below.
Example. The OPCS index is based on the degree of functional dependence in performing 13 activities. The index quantifying the overall disability of a generic individual is calculated according to the following procedure:

1. the degree $p_j$ is assessed for each activity $j, j = 1, 2, \ldots, 13$;

2. let $p^{(1)}, p^{(2)}, p^{(3)}$ denote the three highest values among the $p_j$’s ($p^{(1)} \geq p^{(2)} \geq p^{(3)}$);

3. the overall degree, $p$, is determined as follows, that is, via a weighting formula:

$$ p = p^{(1)} + 0.4 \, p^{(2)} + 0.3 \, p^{(3)} $$

4. the value of $p$ determines the “category” and the “level” of disability; see the table below.

<table>
<thead>
<tr>
<th>$p$</th>
<th>Category</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5–2.95</td>
<td>1</td>
<td>–</td>
</tr>
<tr>
<td>3.0–4.95</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>5.0–6.95</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>7.0–8.95</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>9.0–10.95</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>11.0–12.95</td>
<td>6</td>
<td>I</td>
</tr>
<tr>
<td>13.0–14.95</td>
<td>7</td>
<td>I</td>
</tr>
<tr>
<td>15.0–16.95</td>
<td>8</td>
<td>I</td>
</tr>
<tr>
<td>17.0–18.95</td>
<td>9</td>
<td>II</td>
</tr>
<tr>
<td>19.0–21.40</td>
<td>10</td>
<td>II</td>
</tr>
</tbody>
</table>

LTCI Products: A Classification

Long-term care insurance products can be classified as follows:

- products which pay out benefits with a predefined amount (usually, a lifelong annuity benefit); in particular
  - a fixed-amount benefit;
– a degree-related (or graded) benefit, i.e. a benefit whose amount is graded according to the degree of disability, that is, the severity of the disability itself

• products which provide reimbursement (usually partial) of nursery and medical expenses, i.e. expense-related benefits;

• care service benefits.

**Fixed-Amount and Degree-Related Benefits**

A classification of LTCI products which pay out benefits with a predefined amount is proposed in the figure below.

**Immediate care plans**, or care annuities, relate to individuals already affected by severe disability, and then consist of:

• the payment of a single premium;

• an immediate life annuity, whose annual benefit may be graded according to the disability severity.
The premium calculation is based on assumptions of short life expectancy.

**Pre-funded plans** consist of:

- the accumulation phase, during which periodic premiums are paid;
- the pay-out period, during which LTC benefits (usually consisting of a life annuity) are paid in the case of LTC need.

Several products belong to the class of pre-funded plans. A stand-alone LTC cover provides an annuity benefit, possibly graded according to an ADL or IADL score. This cover can be financed by a single premium, by temporary periodic premiums, or lifelong periodic premiums. Of course, premiums are waived in the case of an LTC claim. This insurance product only provides a “risk cover”, as there is, of course, no certainty in future LTC need and the consequent payment of benefits.

A number of **combined products** have been designed, mainly aiming at reducing the relative weight of the risk component by introducing a “saving” component, or by adding the LTC benefits to an insurance product with a significant saving component. Some examples follow:

- LTC benefits can be added as a rider to a whole-life assurance policy. For example, a monthly benefit of, say, 2% of the sum assured is paid in the case of an LTC claim, for 50 months at most. The death benefit is consequently reduced, and disappears if all the 50 monthly benefits are paid. Thus, the (temporary) LTC annuity benefit consists in an acceleration of the death benefit. The LTC cover can be complemented by an additional deferred LTC annuity (financed by an appropriate premium increase) which will start immediately after the possible exhaustion of the sum assured and will terminate at the insured’s death.
An insurance package can include LTC benefits combined with lifetime-related benefits, i.e. benefits only depending on insured’s survival and death; more precisely:

1. a lifelong LTC annuity (from the LTC claim on);
2. a deferred life annuity (e.g. from age 80), while the insured is not in LTC disability state;
3. a lump sum benefit on death, which can alternatively be given by:
   a. a fixed amount, stated in the policy;
   b. the difference (if positive) between a stated amount and the amount paid as benefit 1 and/or benefit 2.

Four possible individual stories and the consequent outcomes in terms of benefits are shown in the following figure.

![Diagram of insurance package options](image-url)
• **Life care pensions** (also called life care annuities) are life annuity products in which the LTC benefit is defined in terms of an uplift with respect to the basic pension. The basic pension $b$ is paid out from retirement onwards, and is replaced by the LTC annuity benefit $b^{[LTC]}$ ($b^{[LTC]} > b$) in the case of an LTC claim. The uplift can be financed during the whole accumulation period by premiums higher than those needed to purchase the basic pension $b$.

![Diagram of life care pensions](image)

• The **enhanced pension** is a particular life care pension in which the uplift is financed by a reduction (with respect to the basic pension $b$) of the benefit paid while the policyholder is healthy. Thus, the reduced benefit $b^{[healthy]}$ is paid out as long as the retiree is healthy, while the uplifted benefit $b^{[LTC]}$ will be paid in the case of an LTC claim (of course, $b^{[healthy]} < b < b^{[LTC]}$).
Finally, a **lifelong disability cover** can include:

- an income protection cover (briefly, IP) during the working period, that is, during the accumulation period related to LTC benefits;
- an LTC cover during the retirement period.

**Expense-Related Benefits**

This category includes LTCI products which provide expense reimbursement. Two basic types of products can be recognized:

- Stand-alone LTC cover, whose benefits consist in (partial) reimbursement of expenses related to LTC needs, in particular nursery, medical expenses, physiotherapy, etc.
- LTC benefits can also be provided by an LTC cover as a rider to sickness insurance. The resulting product is a lifelong sickness insurance. In order to cover LTC needs, eligible expenses are extended, so to include, for example, nursing home expenses. Further, a fixed-amount daily benefit can be provided for expenses without documentary evidence.
Service Benefits
The LTCI products providing care service benefits usually rely on an agreement between an insurance company and an institution which acts as the care provider. An interesting alternative is given by the Continuing Care Retirement Communities, briefly CCRCs, which have become established in the US. CCRCs offer housing and a range of other services, including long-term care. The cost is usually met by a combination of entrance charge plus periodic fees (that is, upfront premium plus monthly premiums).

Critical Illness Insurance
A Critical Illness Insurance (CII), or Dread Disease (DD), policy provides the policyholder with a lump sum in case of a severe illness, i.e. when he/she is diagnosed as having an illness included in a set of diseases specified by the policy conditions. The most commonly covered diseases are heart attack, coronary artery disease requiring surgery, cancer and stroke. However, CII products have a very limited extension of coverage, defined via listing (rather than via exclusions).

Types of Benefits
It is important to stress that the benefit is paid on diagnosis of a specified condition, rather than on disablement. Hence, a CII policy differs in its objectives from other policies previously discussed. In particular, the CII cover:

- does not indemnify the insured against any specific loss due to medical expenses (as in traditional sickness insurance);
- does not meet any specific income need, arising from loss of earnings (which is conversely met by an income protection policy).
Policies are usually for a fixed term (say, 5 or 10 years), and include a waiting period (starting at policy issue) so that the CII benefit will not be payed if the diagnosis falls in the waiting period itself; the waiting period aims at reducing possible adverse selection.

The following benefit arrangements can be recognized:

1. A stand-alone cover only includes a CII benefit; the insurance policy ceases immediately after the payment of the sum assured.

2. A CII benefit can constitute a rider benefit for a life insurance cover, in particular a term insurance providing a benefit in the case of death. A CII rider benefit takes either of the two following forms.
   a. Additional benefit: According to this arrangement, the insurance policy includes two separate covers (possibly with different sum assured), one paying the sum assured in the case of death, and the other paying the sum assured in the case of critical illness. After the payment of the CII benefit, only the term insurance providing the death benefit remains in force.
   b. Acceleration benefit: The arrangement is defined as follows. Let $S$ denote the sum assured in the life insurance cover; the amount $\lambda S$ (with $\lambda$ stated in the policy conditions, $0 < \lambda \leq 1$) is payable on critical illness diagnosis, while the remaining amount $(1 - \lambda)S$ is payable on death, if this occurs within the policy term. Note that, if $\lambda = 1$ the whole insurance cover ceases after the payment of the CII benefit.

It is reasonable to assume that the (periodic) premiums are payable while the insured is healthy.
Combining Health and Life Benefits

It is worth noting that, from the insurer’s perspective, a combined product can be profitable even if one of its components is not profitable. Further, from a specific risk management perspective, packaging several insurance covers into one policy leads to a total amount of policy reserve which can constitute a policy “cushion” for facing poor experience inherent in one of the package components, provided that some degree of flexibility in using available resources is allowed.

Conversely, from the client’s perspective, purchasing a combined product can be less expensive than purchasing each single component, in particular thanks to a reduction of the acquisition costs charged to the policyholder.

Health Covers as Riders to Life Insurance

The simplest and most traditional way to combine benefits, in the framework of the insurances of the person, is to define a health-related benefit (or a cause-of-death related benefit) as a rider to a life insurance policy (viz a term insurance, a whole-life insurance, an endowment insurance, etc.).

Several examples have already been mentioned in previous sections. Accident insurance benefits can constitute riders to a life insurance policy which includes a death benefit, e.g. a term insurance (see link 1 in the figure below). In particular, the sum insured as the death benefit can be paid in the event of permanent disability.

Another type of rider provides, in the case of accidental death, an amount higher than the sum insured as the (basic) death benefit.

Critical illness benefit can be provided as a rider to a term insurance (see link 2 in the figure below); in this case the CII benefit is an acceleration benefit.

Waiver of premiums is a frequent rider benefit in several life insurance policies: premiums are waived in the event of (total) disability, over the whole disability spell.
Health Covers in Insurance Packages

Combining LTCI benefits with lifetime-related benefits leads to complex insurance packages (rather than simple rider benefits).

Various products integrate LTC guarantees into the saving process (as is the case for whole-life insurance, see link 3), or in the pension pay-out phase (see link 5). Moreover, LTCI benefits can be packaged with other health-related benefits, for example with income protection (link 4), or with lifelong sickness insurance (link 6).

Universal Life (UL) policies are typical products in the US market, which can be designed either as participating or unit-linked policies. Their main features consist in
a high flexibility available to the policyholder in deciding year by year: the amount of premium, to make a partial withdrawal, the type of investment backing the reserve, and so on. Further, similarly to a bank account, the policyholder receives a periodic statement, showing the costs (acquisition costs, management fees, fees for rider benefits, etc.) that have been charged to his/her policy account. If the policy is designed on a unit-linked basis, the current value of the fund is reported in the statement; if a participating arrangement is designed, the statement reports the annual adjustment which has been credited to the fund. The structure of a UL policy is shown in figure below.

![UL Policy Structure Diagram](image)

The underlying contractual form is a whole-life assurance. This way, the contract has no specified maturity; the contract terminates either because of death or full withdrawal. The death benefit is defined so that the sum at risk (that is, the difference between the death benefit and the fund) is positive. Given the wide range of benefits which can be included, the UL policy can be regarded as an insurance package in the context of the insurances of the person. Beyond the death benefit, many health-related benefits can be included; for example:

- lump sum in the case of permanent disability;
• daily benefit in the case of temporary disability;
• medical expense reimbursement, etc.

All these benefits (and the death benefit as well) can be financed, withdrawing the related annual (or periodic) cost from the fund, i.e. according to a natural premium-based arrangement.

**Group Insurance in the Health Area**

Many health insurance products can be designed and sold on a group basis. The products are then referred to as health group plans, and provide coverage to a select group of people.

The group typically consists of the employees of a firm, possibly extended to their dependents.

The usual benefit package first includes medical expense reimbursement. Another component of the package may be income protection insurance.

Health group insurance provided to the employees of a firm may be either compulsory or voluntary. In the former case, all the employees are members of the health plan, whereas in the latter all eligible employees may decide to opt for the group cover. Adverse selection does not affect health plans with compulsory membership, and hence the underwriting requirements (if any) are very weak; conversely, underwriting requirements are appropriate in the case of voluntary membership.

Whatever the membership arrangement, moral hazard can be limited by adopting appropriate deductibles.

Premium calculation can be organized either on an individual basis or on a group basis. The latter arrangement is typically applied when the membership is compulsory.
and the health cover is sponsored by the employer. In this case, premiums are usually calculated on a one-year basis taking into account the current structure of the insured group.

Health group plans can be placed in the framework of employee benefit plans. An employer can provide its employees with benefits other than the salary, among which we can find the following insurance-related benefits:

- death benefits, paid to the employee’s dependents in the event of death during the working period;
- pensions, i.e. post-retirement benefits;
- health insurance covers.

In traditional health group plans, the benefit package and the related limitations (exclusions, deductibles, etc.) are defined in the group insurance policy.

An alternative structure, implemented in the US in particular, can be found in the Defined Contribution Health Plans (briefly, DCHPs). Following the shift from “defined benefit pension plans” to “defined contribution pension plans”, a DCHP relies on the same logic as regards the employer’s contributions. Instead of paying premiums which depend on a defined package of health-related benefits, the employer pays a defined amount (that is, a contribution) to each employee. The employees can then purchase individual health policies on the insurance market, according to his/her needs and preferences. A DCHP can be implemented in different ways. The structure described above implements the so-called “pure” DCHP, or “individual market model of DCHP”. An alternative model is the “decision support model”, according to which the employer’s defined contributions fund for each employee a health-savings account and a health insurance cover (usually with high deductibles) within a health group policy. This way, difficulties in the choice of individual policies are eliminated,
while the employees retain, to some extent, the possibility of choosing an appropriate health insurance cover.

Public and Private Health Insurance

A large variety of health insurance arrangements can be found in different countries. In particular, mixed systems of health care funding, which rely on both public health insurance and private health insurance, are rather common.

Public health insurance is mainly financed through income-related taxation or contributions, whereas private health insurance basically relies on insurance products financed through premiums whose amount depends on the value of the benefit package, e.g. the expected present value calculated according to actuarial principles.

Private insurance premiums can be calculated either on an individual basis or on a group basis (for example in health group insurance).

Various “interactions” between public and private health insurance can be observed in different countries, as a result of the local legislation. For instance, participation into the public health insurance scheme can be mandatory either for the whole population or for eligible groups only, while it may be voluntary for specific population groups. Private health insurance is voluntary in most countries, while a basic health coverage is mandatory in some countries.

It is interesting to focus on a classification of the main functions of health insurance products:

1. Primary private health insurance is the health insurance that represents the only available access to basic coverage for individuals who do not have public health insurance, either because there is no public health insurance, or because individuals are not eligible to coverage under public health insurance (see (a)
below), or they are entitled for public coverage but have chosen to opt-out of such coverage (see (b)); in particular:

(a) principal private insurance represents the only available access to health coverage for individuals where a public insurance scheme does not apply;

(b) substitute private insurance replaces health coverage which would otherwise be available from a public insurance scheme.

2. Private insurance can offer duplicate covers, i.e. coverage for health services which are already provided by public health insurance. Duplicate covers also offer access to different providers or levels of service; it does not exempt individuals from contributing to public health insurance.

3. Complementary covers complement coverage of publicly insured services or services within principal/substitute health insurance (which pays only a proportion of qualifying care costs) by covering all or part of the residual costs not otherwise reimbursed.

4. Supplementary covers provide coverage for additional health services not covered by the public insurance scheme. Its extension depends on the local public health legislation, and may then include luxury care, long-term care, dental care, rehabilitation, alternative medicine, etc.
Introduction to Actuarial Aspects

Actuarial aspects of health insurance modelling, for premium and reserve calculations, are strictly related to:

- types of benefits, in particular as regards their definition in quantitative terms: fixed-amount, degree-related amount, expense reimbursement;
- policy term: one-year covers versus multi-year covers, and possibly lifelong covers;
- premium arrangement: single premium, natural premiums, level premiums, etc...

Obviously, the premiums paid by the policyholders have to meet the benefits paid by the insurer, according to a stated criterion. We now assume that the premium is paid at policy issue (thus, no splitting into a sequence of periodic premiums is allowed for), and hence just one amount, namely a single premium, facing future benefits has to be determined.

Although the insurance business is based on the management of pools of risks, we approach premium calculation on an individual basis, namely referring to a single insured and the related insurance cover.

The (individual) premium must rely on some “summary” of the random benefits which will be paid by the insurer. Therefore, we have to summarize:

1. with respect to time, determining the random present value of the benefits, referred at the time of policy issue;
2. with respect to randomness, calculating some typical values of the probability distribution of the random present value of the benefits, namely the expected value, the standard deviation, and so on.
Step 1 requires the choice of the annual interest rate (or, more generally, the term structure of interest rates) for discounting benefits. It should be noted, however, that, when the policy duration is short (say, one year or even less), we can skip this step as the time does not have a significant impact on the value of benefits.

Step 2 first requires appropriate statistical bases in order to construct the probability distribution of the random present value of the benefits, and then the choice of typical values summarizing the distribution itself. The complexity of the statistical bases also depends on the set of individual risk factors accounted for in assessing the benefits (e.g. age, gender, health status, etc.), and the set of rating factors, among the risk factors, which are taken into account in the premium calculation.

Moreover, the insurer also has to pay expenses which are not directly connected with the amounts of benefits, for example general expenses. It is common practice to charge a share of these expenses to each insurance policy via an expense loading.

Finally, a further increase in the premium amount provides the insurer with a profit margin. The following figure summarizes the process leading to the price of an insurance product.
Technical Features of Premium Calculation

Pricing health insurance products relies, to a large extent, on a mixture of non-life insurance (or general insurance) and life insurance actuarial methods. This section points out some basic technical ingredients of both the non-life and the life actuarial fields.

Non-life and life technical features are summarized in following figure, according to the type of benefit, the policy term and the premium arrangement.
Non-life Insurance Aspects

We refer to the calculation structure described above and focus on statistical bases and expense issues.

The premium calculation for all the types of health insurance covers relies on the claim frequency, whereas the claim size only concerns insurance covers providing expense reimbursement, and covers in which the benefit is graded, i.e. it depends on some degree, for instance the degree of disability.

The expected claim frequency enters into the premium (and reserve) calculations according to the actuarial structure adopted. Sickness insurance products significantly differ from disability insurance covers as regards the expression of the expected claim frequency.

Sickness insurance models mainly rely on an expected claim frequency expressed as the expected number of claims per insured in a given coverage period (typically a year), while disability insurance covers providing annuity benefits require more complex models, allowing for the evolution of the individual health status throughout time. It follows that expected claim frequencies should be expressed in terms of the probability of entering into the disability state (or into one of the possible disability states). Nevertheless, in the context of practical approaches to disability annuity modelling, we also find a large variety of approximate calculation methods, most of which have been defined to comply with scanty or inappropriate statistical data.

Experience monitoring can help in improving the reliability of statistical data used in premiums (and reserves) calculations. For this purpose, experience rating procedures, typically relying on credibility theory results, should be adopted.

The claim size constitutes the other component of the statistical basis which underpins the premium calculation. A typical example of claim size is given by the amount of health-related expenses. While rigorous actuarial models should rely on
the probability distribution of the claim size (as well as on the probability distribution of the claim number per policy), practical actuarial approaches usually account for the expected claim size only. Of course, the expected claim size is strictly related to policy conditions as the deductible and the limit value. Estimation of claim sizes is also required for claim reserving purposes. However, it should be noted that, in health insurance, claim reserving has a lower importance than in other non-life insurance areas. Nevertheless, specific claim reserving problems may arise from the presence of a deferred period in disability annuity benefits.

As regards insurer’s expenses, we note that, beyond shares of general expenses which are charged to the premium as is usual for all the insurance products, specific expenses related to the claim management must be accounted for in health insurance products. These expenses relate to the claim settlement (ascertainment and assessment of claims), as well as to the ascertainment of the claim prosecution throughout time, e.g. in insurance covers providing an annuity benefit in the case of not necessarily permanent disability.

Life Insurance Aspects
Life insurance actuarial aspects mainly refer to medium-term and long-term (possibly lifelong) products, in particular: disability insurance, long-term care insurance (LTCI) covers, and multi-year sickness insurance covers.

Again, refer to the calculation structure described above. Among the statistical bases, mortality assumptions are required for assessing the benefits (in particular in terms of the relevant expected present value) in all the multi-year health insurance covers, but in those financed with natural premiums. Further, mortality assumptions are needed for determining level premiums. Mortality assumptions are usually expressed in terms of a life table or a mortality law.
When disability annuities are concerned, more complex biometric models and assumptions are needed, in particular allowing for different age-patterns of mortality related to active people and disabled people respectively. Of course, disablement and recovery assumptions are also required.

As regards the choice of the life tables, or the parameters of the mortality law, it is worth stressing that health-related benefits are due in case of life. Hence, survival probabilities should not be underestimated (for both active and disabled people) in order to obtain a prudential assessment of the age-patterns of mortality. Long-term (and, in particular, lifelong) health insurance covers should allow for future mortality trend. Hence, projected life tables or mortality laws should be adopted for pricing and reserving. Nonetheless, future mortality trend is unknown, and this implies the presence of the aggregate longevity risk. Further, more complex longevity issues affect LTCI products. As these products pay benefits to people in senescent disability condition, trends in both the total life expectancy and the disability-free life expectancy should be considered.

In multi-year covers the time-value of the money should be accounted for. An interest rate assumption is then required to assess the benefits, as in life insurance products. As already noted, a reserving process and a consequent asset accumulation works (but in the case of natural premiums). Assets backing the reserves can provide an extra-return (with respect to the guaranteed interest rate), which can partly be credited to the policyholders. However, it is worth noting that, unlike in life insurance products with a significant saving component, in many health insurance products the reserving process implies rather modest amounts.

The effectiveness of a health insurance cover can be reduced because of inflation, e.g. because of a decreasing purchase power of a disability annuity. The quality of a multi-year cover can then be improved by adopting an indexing mechanism; this way,
inflation-linked benefits can be obtained. In the case of a level premium arrangement and consequent reserving process, the benefit indexing must rely on a specific adjustment model, whose basic features are shared by life insurance and health insurance actuarial models.
Pricing and reserving for a LTC insurance

We consider a LTC insurance contract that pays an annuity benefit if the policyholder is disabled as long as he remains disabled.

First of all, we need a probabilistic model to represent the evolution of the risk over time. In the literature, a multi-state model is generally applied to LTC insurance to reproduce the states of a policyholder. The disabled state may be split in more than one state according to different disability degrees, but requires a wide range of statistical data, often not available.

Let \( \{S(\tau); \tau = 0,1,2, \ldots, T\} \) be a Markovian process describing the development of a single policy in discrete time, where the random variable \( S(\tau) \) represents the state of the process at time \( \tau \) and \([0; T]\) be a fixed finite time horizon. The LTC insurance is modeled by a multiple state model with a finite state space \( S \) and a set of transitions according to the following figures.

We assume that at initial time the policyholder is healthy and we disregard the possibility of recovery from the disabled state due to the usually chronic character of disability for elderly.

**Graph of an LTC multi-state model with 2 disable states**

States \((S)\): \( a = \) active; \( i' = \) LTC invalid (level I); \( i'' = \) LTC invalid (level II); \( d = \) dead
Graph of an LTC multi-state model with 1 disable state

States $(S)$: $a = $ active; $i = $ LTC invalid; $d = $ dead

In the following a three-state-model is adopted.

The probabilistic structure

Let $x$, with $x > 0$, be the entry age at time $t$; the transition probabilities of a policyholder being in state $j$ at age $x + \tau$, given that the policyholder is in state $i$ at age $x$ are defined as follows:

$$\tau p_{x,t}^{ij} = \mathbb{P}\{S(t + \tau) = j | S(t) = i\} \quad i, j \in S, i \neq j$$

while the probability of a policyholder being in state $i$ at age $x$ to remain in the same state up to age $x + \tau$ is:

$$\tau p_{x,t}^{ii} = \mathbb{P}\{S(t + z) = i \quad \text{for all } z \in [0,T], S(t) = i\}$$

For an active insured aged $x$ we have:

$p_{x}^{aa}$ Probability for $(x)$ to remain alive and active at age $x + 1$

$q_{x}^{aa}$ Probability for $(x)$ to die, starting from the active state, in one year

$p_{x}^{ai}$ Probability for $(x)$ to survive but to become disable at age $x + 1$

$q_{x}^{ai}$ Probability for $(x)$ to become disable and then to die in one year
\( p_x^a \) Probability for \( x \) to be alive at age \( x + 1 \) (active or disable)

\( w_x \) Probability for \( x \) to become disable in one year (alive or dead at age \( x + 1 \))

\( q_x^a \) Probability for \( x \) to die in one year

For a disabled insured aged \( x \) we have:

\( p_x^i \) Probability for \( x \) to be alive at age \( x + 1 \)

\( q_x^i \) Probability for \( x \) to die in one year

The following relations hold:

\[
\begin{align*}
p_x^a &= p_x^{aa} + p_x^{ai} \\
q_x^a &= q_x^{aa} + q_x^{ai} \\
w_x &= p_x^{ai} + q_x^{ai} \\
p_x^a + q_x^a &= 1 \\
p_x^i + q_x^i &= 1 \\
p_x^{aa} + q_x^{aa} + w_x &= 1
\end{align*}
\]

**Premium calculation**

We denote with \( R_h \) the random annuity paid at time \( h \) (we assume \( R \) constant).

The single premium for a LTC annuity is given by:

\[
U_x^{[LTC]} = \sum_{h=1}^{+\infty} E(R_h) v^h = R \sum_{h=1}^{+\infty} h p_x^{ai} v^h
\]
\[ U_x^{[LTC]} = R \sum_{h=1}^{+\infty} h^{-1} p_x^{aa} p_{x+h-1} v^h \bar{a}_{x+h}^i \]

where

\[ \bar{a}_x^i = \sum_{h=0}^{+\infty} h p_x^i v^h \]

and

\[ h p_x^i = \prod_{k=0}^{h-1} p_{x+k} \]

The level annual premium is equal to:

\[ p_{x,m}^{[LTC]} = \frac{U_x^{[LTC]}}{\bar{a}_{x:m}^{aa}} \]

where

\[ \bar{a}_{x:m}^{aa} = \sum_{h=0}^{m-1} h p_x^{aa} v^h \]

and

\[ h p_x^{aa} = \prod_{k=0}^{h-1} p_{x+k}^{aa} \]

**Technical reserves**

The technical reserve for an active insured is given by:

\[ t V_x^{(a)} = U_{x+t}^{[LTC]} - p_{x,m}^{[LTC]} \bar{a}_{x+t:m-t}^{aa} (0 \leq t < m) \]

\[ t V_x^{(a)} = U_{x+t}^{[LTC]} (t \geq m) \]
The technical reserve for an invalid insured is given by:

\[ tV_x^{(i)} = R\dot{a}_{x+t} \quad (t > 0) \]