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PRIVATE LONG TERM CARE INSURANCE: THEORETICAL APPROACH AND RESULTS APPLIED TO THE SPANISH CASE(**)

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Abstract

The passing of the Law 39/2006 has given to Spanish insurance companies the chance of offering products that cover the expenses associated to the risk of dependence. However, due to the lack of reliable statistic information about dependent population, it is extremely difficult to evaluate not only the frequency but also the cost. These two items make the pricing process with a big cloud of uncertainty. This paper proposes a methodology for premium calculation taking into account not only the availability of the data but also the current legal framework in Spain. Together to the theoretical approach, premium calculations for two possible versions are included. Finally, it is introduced a simulation model that pretends to evaluate the impact that a portfolio with these kind of contracts would have on the solvency of an insurance company.

Keywords: Long term care insurance, Pricing, Multi-state model, Simulation, Solvency.
JEL classification: G22, C39, C15, C63.

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1. Introduction: scientific literature background

The design and approach of insurance contracts associated to the disability and/or dependence is not a new topic in the actuarial literature. It can be said that their design was firstly proposed more than forty years ago by Starr (1965a). However, the design as a group insurance with the description of their characteristics, covers, technical specifications and other aspects, appear in another paper written by the same author in the same year – Starr (1965b). *Encyclopaedia of Actuarial Science* (2004) offers the definition, according to the Actuarial Standards Board (1999), of the *Long Term Care Insurance*, (*LTCI* from now on), as "a wide range of health and social services which may include adult day care, custodial care, home care, hospice care, intermediate nursing care, respite care, and skilled nursing care, but generally not care in hospital".

LTCI has been treated not only from an actuarial point of view. There is a broad literature in areas such as Demography, Medicine, Gerontology or Government publications, specially in the US. Amongst the latter we can point out the papers of Dawson, Hendershot y Fulton (1987), Feller (1983), Hing (1987) and Kovar (1988). Within the demographic area Manton and Soldo (1985) and Faber and Wilkin (1981) can be pointed out. The former one includes the projections of the inactive population up to the years 2000 and 2040 by age and gender based on the figures dated on 1982 from the *National Long Term Care Survey* (*NLTCS*). Estimated prevalence rates were applied and projected on the population recorded by the *Office of the Actuary* of the *Social Security Administration*. The papers that join the *LTCI* with medical topics are those by Katz et al. (1970), Katz and Akpom (1976), Katz et al. (1983) and Somers (1987). The treatment of the insurance from a gerontologic point of view can be found in Brody (1987) who used the index proposed by Katz et al. (1970) to identify potential users or petitioners of the *LTCI*. In the same area, they should be mentioned the advances published in *Developments in Aging*: 1987, Volume 1 and 3 (1988), where the necessity to design private insurance policies to cover the contingencies of home nursing aid and other home assistance is widely suggested. Both documents propose recommendations to take into account for the regulation of this product market. Finally, Rivlin and Wiener (1988) describe certain technical characteristics concerned to these people, such as their needs, assessment of their health state or their financial resources.

In order to design an *LTCI*, four main aspects should be considered: scope of the contract -individual or group policies-, design -theoretical framework in which it is based-, evaluation of the coverages and obviously, its financing. Concerned to the design of long term care insurance, the actuarial literature offers two clearly differentiated approaches: on one side it is the so-called *multi-state model*, proposed by Haberman and Pitacco (1999) and on the other side, the alternative versions, especially Beekman (1990) and Levikson and Mizraki (1994). The multi-state models are widely used to develop *LTCI* or disability coverage, as well as for the so-called *PHI – Permanent Health Insurance –* a very common health insurance in Great Britain and for the insurance of severe or terminal disease, known as *Dread Disease Insurance.* The first time the semi-Markov models for the disability coverage were used was in Jansen (1966). A thorough treatment of this approach appears in Pitacco (1995). This approach is based on previous papers that apply the same methodology to life contingencies, such as Amsler (1968), Amsler (1988), Gregorious (1993), Haberman (1983), Haberman

(1984), Hoem (1969), Hoem (1988), Jones (1993), Wilkie (1988) and Wolthuis (1993). Before Pitacco (1995), other treatments appeared in Haberman (1988), Waters (1984), Waters (1989), Renshaw and Haberman (1992). All of them were focussed on the application of these techniques to situations connected to disability and dependence. After Pitacco (1995), it can be mentioned CMIB (1991) -*Continuous Mortality Investigation Bureau*-. Haberman and Pitacco (1999) has become an actuarial reference for modelling coverages associated with disability and dependence, especially in a multi-state manner.

Levikson and Mizraki (1994) carefully showed how to calculate premiums for multiple coverages in *LTCI* insurance. Besides these authors and Beekman (1990), there are other papers with a view different from that of multi-state, such as Chuard (1993), Chuard and Chuard (1992), Courant (1984), Hännikäinen (1988), Litow (1990), Sanders and Silby (1986), Sanson and Waters (1988), Segerer (1993), Sverchup (1965), SwissRe Group (1982), Türler (1970) and Westwood (1972), amongst others.

After Haberman y Pitacco (1999), other papers based on the proposed models -multi-state methodology or any other alternative version- were published. They proposed several changes or included some question to improve the pricing of these insurance contracts. The most remarkable papers are Actuarial Standards Board (1999), Dullaway and Elliott (1998), Society of Actuaries (2002) and Werth (2001). Besides, there are other publications -Karlsson (2002), Riedel (2002), WHO (2000), WHO (2002a) y WHO (2002b) amongst them- that compare the implementation of these kind of insurance contracts in several countries from a theoretical and empirical point of view.

Beekman (1990) suggested an approach related to certain medical concepts, such as the lost of independence to carry out Instrumental Activities of Daily Living -from now on *IADL*- as it was proposed by Katz et al. (1970). He explicitly accepted the recovery hypothesis, that is, the possibility of complete reversion to normal health state -independence- every time an insured was declared as dependent. Therefore, he proposed an approach in which the two states of dependence and full activity alternate until the death. He proposed an approximate formula to get the actuarial value of the *LTCI* based on alternative methods different from that based on multiple states. To develop his approach, he basically used the concept of expected active life, introduced by Katz et al. (1983), as the interval of the person's lifetime in which it can carry out *IADL*. US empirical data for both men and women, which were used by Katz (1983), were available to the author. Based on these data, he proposed an insurance with reversion that can be subscribed by people over 65.

Related to the evaluation of the *LTCI* coverages, it is needed to point out Brown (1982) and Lew and Garfinkel ((1984) and (1987)). Both papers show a comparison by gender amongst the expected lifetime for non-disable people and for other groups over 65. In the *Long-Term Care Coverages* (Society of Actuaries, 1986) are described in detail questions related to the supplementary *LCTI* coverages of the nursing care provided at home of the insured. The definition of the so-called insurable event is specified. The authors criticise too the use of indicators for measuring the independence to carry out *IADL* (*Instrumental Activities of Daily Living*) if they lack of the sophistication or relevance to rightly assess these contingencies.

Another key aspect of this product, the financing, has also been treated in papers such as the *Long-Term Care Insurance* (Society of Actuaries, 1988) and Shapiro and Stuart (1988).

This paper presents an insurance contract from an actuarial point of view, focused on the necessities of the eligible dependent people in Spain. It is a non multi-state model and it is fully adjusted to the Spanish legal framework. Premium estimations are based on Spanish figures and they distinguish between men and women according their age. Finally, capital requirements are calculated according to Solvency II scheme.

2. A private LCTI: an approach

2.1. Theoretical and legal framework

The fundamentals of the proposed insurance are shown in this section. It is an individual non multi-state insurance contract. Aspects concerned to financing are not included in this paper. Comparing with cases included in Haberman y Pitacco (1999), this insurance is based on the *stand-alone* model, although it is a very simplified version because it only assumes three possible states: active, eligible dependent and dead. No recovery is allowed. The approach presented here has been elaborated taking into account current legal framework in Spain. That is, the beneficiaries of the product will be those people that, after becoming as dependent and being evaluated according to the regulatory scale established in RD 504/2007, they will achieve at least 25 points. As a first approach, it has not been made any distinction amongst different levels reflected in the Spanish legal framework. It can be said that is an all or nothing insurance. This means that once the person is evaluated and reaches the threshold of 25 points, it starts to receive the benefits associated to the insurance, no matter what the degree or level is reached. The development of this model is not based on transition matrices but on the prevalence rates estimated until 2059 instead, based on the projections for Spanish population prepared by INE until that year. Therefore, the approach presented here is in line with that of Beekman (1990) and Levikson and Mizraki (1994), because it diverges from the multi-state model. Moreover, it is similar to the model exposed in Manton y Soldo (1985), because the prevalence rates are projected for a large time interval, as it was done by these authors. The statistical information used in this study is that collected in Disabilities, Impairments and Health State Survey -known as EDDES, according to its Spanish acronym-. In spite of the distance in time, it is the only source that soundly treats disability to a national level. This macro-survey was prepared by INE together with IMSERSO and Fundación ONCE using data collected in 1999. They asked to more than 220,000 people who were living in their private households. So people living in residencies were excluded.

2.2. Initial Hypotheses

The formulation of the insurance needs to specify some hypotheses about aspects such as life tables used, expected lifetime of the dependent people, limit age for the subscription and the maximum lifetime and assessment of the dependence intensity.

When pricing this kind of insurance contracts, It is necessary to consider two different types of probabilities. The first one is related to the possibility of becoming eligible dependent and it will be explained later. It will be obtained based on the estimated prevalence rates. The second type refers to the possibility of survival or not. In order to evaluate these probabilities PERM/F-2000[1] tables have been used, in particular, those related to new production. These tables distinguish between men and women and allow that the probability of death could change with time. In particular, that probability for a person of age *x* in year 2000 within *t* years

[1] Included in the Resolution of 3 October 2000 of the Dirección General de Seguros y Fondos de Pensiones that gives compliance to that foreseen in the number 5 of the second transitory disposition of the Regulation Control and Supervision of Private Insurance, passed in the Real Decree 2486/1998, of 20th November, related to the mortality and life tables to be used by the insurance entities.

time will be $q(x+t;A)=q(x+t;2000)\cdot e^{-\lambda_{x+t}\cdot t}$ where *A* = (2000 – *x*) is the year of birth of the individual in question and λ_{x+t} is the improvement factor for the cohort born in 2000 – (*x* + *t*).

The use of the tables indicated above solves the problem of assessing mortality and life expectancy for general population. However, the insurance proposed in this paper is related to a specific group of people, those that are dependent and also have right to receive public aid. Therefore, it must be asked if it is right to use these tables in this situation. In order to give an answer to this question we will use the hypothesis proposed by Haberman and Pitacco (1999), known as *Danish model* because it is used by the insurance companies in that country to calculate the transition rates among states. We are going to assume three possible situations -states-: active, disabled and dead, represented by *a*, *d* and *m* respectively. The Danish model assumes the following analytic expressions for the mortality rates:

$$\mu_x^{ad} = 0{,}0004 + 10^{0.06x-5{,}46}$$
$$\mu_x^{am} = \mu_x^{dm} = \mu_x = 0{,}0005 + 10^{0.038x-4{,}12}$$

Therefore, based on the second equation, it can be deduced that the mortality rates in non-eligible disabled people is the same as in active population. So that, as $\mu_x^{am} = \mu_x^{dm} = \mu_x$ it implies that active and disabled people have the same survival probabilities and, consequently as indicated by Haberman y Pitacco (1999), in all cases, the expression for this probability is ${}_tP_x^{aa} + {}_tP_x^{ad} = {}_tP_x^{dd} = {}_tP_x$. In other words, as their survival probabilities are the same as those of general population, the probabilities related to dependent people will be obtained from the table exposed in the previous section.

Hypothesis about limit age for the subscription and the maximum lifetime should be done. The maximum age to subscribe the policy will be that for the retirement, which is 65. Moreover, it is assumed that this age will remain constant in the future. Related to the maximum lifetime, it will use the same than in tables PERM/F-2000, that is, 115 years old.

Because of the incidence of legal framework, it is needed to measure the dependence intensity. In order to do that, it will be used the scale derived to the application of RD 504/2007. This scale will be used on EDDES data. Another hypothesis related to this that should to be done is that the average score obtained at a certain age will remain constant over time. That is, the average score at age *x* will be $\bar{s}_x(1999)$. This level will be the same for any considered year, that is $\bar{s}_x(1999) = \bar{s}_x(t) \quad \forall \mathrm{t} = 2006, \ldots, 2059$. Clearly, as time goes by, the score for a particular person will be sequentially changing. More specifically, it will follow the following sequence: $\bar{s}_x(t), \bar{s}_{x+1}(t+1), \bar{s}_{x+2}(t+2), \ldots, \bar{s}_{x+k}(t+k)$.

EDDES includes people with ages between 6 and 99. However, the tables that have been used consider ages up to 115, originating the same problem as in the prevalence rates case: how to assess the score for people between both age limits. To do that, it was estimated a trend for scores in people over 64. This age is considered as the origin because a continuous increasing score is registered in both men and women as it can be seen in the following figure:

[Insert Figure 1]

After that, the next step was to forecast values for the scale for people between 100 and 115. The estimated values are summarised in Table 1.

[Insert Table 1]

Once the basis hypothesis have been introduced, it is needed to do some previous estimations concerned to prevalence rates and costs. In order to assess the impact of dependence in each individual over time, it is needed to estimate the number of eligible people, what is made using the two sets of projections of population until 2059, prepared by INE - from now on P1 and P2-. It was assumed that the elevation factor associated to each data in EDDES evolves in the same manner as the weight of its age subgroup into the total population. In general terms, the prevalence rate for a certain age and year is the ratio of both concepts, that is, $w_x(t)=\frac{edp_x(t)}{P_x(t)}$ being $w_x(t)$ the prevalence rate at age *x* in year *t*, $edp_x(t)$, for eligible people, the number of dependent people with right to receive public aid with age *x* in year *t* and $P_x(t)$ the total population of age *x* in year *t*.

The use of this scheme produces estimations for the prevalence rate from 2006 to 2059 and for all the ages between 6 and 99. However, two problems are left to be addressed: the first one is related to the estimation of prevalence rate for ages above 99 and the second one is associated to assess the prevalence rate for those years that exceed the limit of 2059. To solve the first problem, it is needed to assume an ultimate value that the previous rate can get at the limit age -115-. This rate will be denoted as w_{115}^*. Values for intermediate ages have been evaluated through linear interpolation using the following expression:

$$w_x(t)=w_{x-1}(t)+\frac{w_{115}^*-w_{99}(t)}{16} \quad t=2006,\ldots,2059 \quad x=100,\ldots,115\,.$$

Obviously, it must be satisfied that $w_{115}^{*} > w_{99}(t)$.

In reference to the estimation of the prevalence rate for years after 2059, it has been assumed that the growth of this rate will be the same as it was during the last year for which the estimation is available, that is, 2059. As $w_x(t)$ has been calculated for each gender and based on both projections elaborated by INE, the expected growth rates from 2059 on -*g*- are those reflected in the Table 2.

[Insert Table 2]

Obviously, the expected rate must not be higher than the limit rate for 115 years old -the one that was denoted as w_{115}^{*}-. So, the general expression for $w_x(t)$ *k* years in advance since 2059 will be $w_x(t) = \min\left\{w_{115}^{*}; w_x(t-k)\cdot(1+g)^k\right\} \quad \forall t = 2060,...$ what completes the whole set of estimated prevalence rates necessary to evaluate the pure premium of the insurance[2].

As it was pointed out before, the probability of becoming eligible dependent is based on estimated prevalence rates and they are calculated for each age, $w_x(t)$. Then, if $w_x(t)$ and $w_{x+1}(t+1)$ are the proportions of eligible dependent people of age *x* in year *t* and age *x*+1 in year *t*+1, then the probability of becoming dependent, expressed as $d_x(t+1)$ will be $d_x(t+1) = w_{x+1}(t+1) - w_x(t)$. Therefore, the probability that a person that is active in *t* may follow in the same situation in *t*+1 will be the complementary probability, that is, $a_x(t+1) = 1 - d_x(t+1)$.

[2] For better understanding of the calculation, we present the following example: for a man that has 20 years old in 2006 and using P1. The person will have 73 years old in 2059. The estimated prevalence rate for 2060 will be that of 2059 for a 74 years old corrected with the last growth rate. That is, if $w_{74}(2059)$ = 3,393% and *g* = 0,19158%, then $w_{74}(2060)$

Consequently, the probability that an individual would be still active after n years is ${}_n a_x(t+n)=\prod_{i=1}^{n} a_{x+i}(t+i)$ and the probability that in these n years it became dependent, expressed as ${}_n d_x(t+n)$, is ${}_n d_x(t+n)=1-{}_n a_x(t+n)$. These estimations were calculated for each gender.

Finally, cost of benefits should be estimated. This task was made taking into account the restrictions imposed by the Spanish legal framework. The models proposed by Rodríguez and Montserrat (2002) and Monteverde (2004) were used to estimate total costs and with the results obtained, it was defined the so-called cost per scale point -from now on CSP- as a ratio between the total average cost and the average degree for dependent population with the right to aid. A complete description of the process can be found in Alonso and Albarrán (2008) and the results for 2009 are shown in Table 3.

[Insert Table 3]

2.3. Insurance proposal

In order to obtain the expression for the net premium it is necessary to establish how income –premiums– are obtained and how expenses –benefits– are paid. Focusing in premiums, it will be assumed that they are received in advance and when the policyholder meets the following conditions:

= 3,400%. For the next year it would be necessary to know $w_{75}(2059)$. If this were 3,698%, then $w_{75}(2061)$ = 3,698% $(1+0{,}19158\%)^2$ = 3,712% and so on.

— his/her age is under the limit for subscription, that is, 65 years old

— he/she is still alive

— he/she is not became dependent. When this situation arrives, the premium payment will stop

Therefore, the amount to be charged as premium, $I_x(t)$, expressed in present value, for a person of age *x* in *t* will be $I_x(t) = \sum_{k=0}^{65-x-1} P_k \cdot {}_k p_x \cdot {}_k a_x(t+k) \cdot v^k$ where P_k is the premium to be paid by the policyholder in year *k*, $v = (1+i)^{-1}$ and ${}_k p_x$, is the survival probability for *k* years of a person aged *x* at the moment of evaluation. This is obtained using a generational table as ${}_k p_x = \prod_{k=0}^{n-1} {}_k p_{x+k}(t+k)$.

The premiums to be charged can be constant or variable over time:

— if they are constant then the expression for them is $P_0(t) = P_0 \quad \forall t$ and the expression for income is $I_x(t) = P_0 \sum_{k=0}^{65-x-1} {}_k p_x \cdot {}_k a_x(t+k) \cdot v^k$

— if the premiums grow yearly at a constant rate g_I then their expression is $P_k(t+k) = P_0(t) \cdot (1+g_I)^k$. So, income is $I_x(t) = P_0(t) \sum_{k=0}^{65-x-1} (1+g_I)^{k-1} \cdot {}_k p_x \cdot {}_k a_x(t+k) \cdot v^k$

If the attention is focused in benefits associated to this contract, the reception of them by the beneficiaries will take place if the following conditions simultaneously happen:

— the policyholder is up to date with the insurer

— the beneficiary is still alive

— the beneficiary became dependent

It will be assumed that the expenses associated with the insurance will be received at the end of the year. They can be expressed by the following expression:

$$E_x(t) = \sum_{k=1}^{115-x} R_{x+k-1} \cdot {}_k p_x \cdot {}_k d_x(t+k) \cdot v^k$$

in which R_k is the amount of the benefit received. It is calculated as the product of the average score for a certain age and the CSP in year k, that is $R_{x+k}(t+k) = \bar{s}_x(t+k) \cdot CSP(t+k)$.

As in the case of the premiums, it can be assumed a constant or variable amount for the benefits:

— if they are constants, their expression for a given year is $R_{x+k}(t+k) = \bar{s}_x(t+k) \cdot CSP(t)$, and the expression for the expenses will be $E_x(t) = CSP(t) \sum_{k=1}^{115-x} \bar{s}_{x+k} \cdot {}_k p_x \cdot {}_k d_x(t+k) \cdot v^k$

— if the benefits are assumed to grow at a constant rate g_G, their expression for a given year will be $R_{x+k}(t+k) = \bar{s}_x(t+k) \cdot CSP(t) \cdot (1+g_G)^k$ and the expression for expenses will be $E_x(t) = CSP(t) \sum_{k=1}^{115-x} \bar{s}_{x+k} \cdot (1+g_G)^{k-1} \cdot {}_k p_x \cdot {}_k d_x(t+k) \cdot v^k$.

So, the general expression for premium will be written as the value of P_0 that satisfies the equality between income and costs, both in present value, that is

$$P_0(t)=\frac{CPB(t)\sum_{k=1}^{115-x}\bar{s}_{x+k}\cdot(1+g_G)^{k-1}\cdot{}_kp_x\cdot{}_kd_x(t+k)\cdot v^k}{\sum_{k=0}^{65-x-1}(1+g_I)^{k-1}\cdot{}_kp_x\cdot{}_ka_x(t+k)\cdot v^k}$$

where g_I and g_G can be equal or different from zero.

3. Numerical results

Premiums have been calculated for ages between 25 and 64 for men and women. As an example, let us assumed that a policyholder is 40 in 2009, the annual growth rate for premiums is 4.5%, the interest rate is 4.0%, the expected annual growth rate for CSP is 4.2% and the limit prevalence rate is 100%. The results for this set of assumptions are shown in Table 4, distinguishing between gender and INE projection. For the sake of comparison, results that would be obtained for constant premiums are also included.

[Insert Table 4]

As we can see the premiums for women are much higher than those for men and, for both genders, those calculated with P2 are higher than those estimated with P1. Appendix 1 reflects all the net premiums for all ages between 25 and 64, calculated with the set of hypothesis formerly indicated.

As the premiums are so expensive, benefits can be reduced in order to bring insurance costs down. For this reason, a new version of the insurance contract is proposed, in which benefits will only be received if the score is under 75 points. That is, benefits from private insurance will only be received if the individual is classified as dependent in degree I or II. Those dependents classified as degree III would receive care by the public system.

As in the previous case, premiums are calculated for each age and gender. However, it is necessary to estimate previously several items for each case, such as the average score and its projection up to the age of 115, the prevalence rate, and the CSP with its growth rate. The results for this new version are contained in Appendix 2.

4. Determination of the capital requirements according to Solvency II

Finally, it has been determined the amount of own funds required by the proposed contract. The estimation has been made according the Solvency II scheme, a future framework that will be applicable in the EU. It has been calculated the *Solvency Capital Requirement – SCR –*, one of the two key concepts included in this methodology. This means that it is needed to calculate the Value at Risk at a level of confidence of 99.5% over a one year horizon. To do that, it has been used a numerical simulation model that replicates the sequence of the cash flows associated to the insurance. This model has the following random elements:

– the survival probabilities, ${}_kp_x$, that are obtained from the expression

$$_k p_x = p_x(t) \cdot p_{x+1}(t+1) \cdot \cdots \cdot p_{x+k-1}(t+n-1) = \prod_{k=0}^{n-1} {}_k p_{x+k}(t+k)$$

where $_k p_x$ is distributed according a binomial distribution $B(1;b)$, in which $b = \frac{p_{x+k}(t+k)}{p_x(t)}$ are the probabilities obtained from generational tables. If at any moment a zero value is obtained – that is, the individual is dead – the inflows of the insurance end.

– the prevalence rates are also supposed to be distributed as a binomial distribution $B(1;b)$ where, in this case, b is obtained as $w_x(t+1)$ - $w_x(t)$. If at any moment b would be equal as one – that is, the individual becomes dependent – the premium collection would stop and the payment of dependence benefits would begin.

The cost for caring the beneficiary is assessed after calculating the average score and its evolution. The insurer can obtain one of the following yearly results:

– it could be equal to the premium received if the contingency did not happen. In this case, the company will have a surplus.

– it could be equal to the difference between the premium received and benefit paid if the contingency happened during that year. In this case, the final result could be positive or negative, depending on the amount of each concept.

– it could be equal to the benefit paid if the contingency has happened in past years. For this reason there has not been premium reception and therefore, the result is negative

– it could be equal to zero if the policyholder is still alive, the limit for premium has been exceeded and the contingency has not still happened.

A reserve is created accumulating results obtained in previous years. The balance at any moment can be calculated as the one in the previous year capitalised at a rate i –it is supposed that this rate is the same as the one that is used for discounting flows – plus the result of this year, that is $R_t = R_{t-1} \cdot (1+i) + F_t = R_{t-1} \cdot (1+i) + I_t \cdot (1+i) - E_t$. On average, at the end of the lifetime, the expected value of the reserve should be zero because the expected present value of the benefits paid to the beneficiary has to be the same as the expected present value of the premiums received from the policyholder.

In order to get the impact on capital of this insurance, it has been calculated the VaR value of expenses at a level of 99.5% over a one year horizon. Distinction between gender and age has been done. The results suggest that the projection chosen -P1 or P2- does not have influence on VaR. The explanation may be that a year ahead is a so short period of time to modify the estimated prevalence rates. The results also suggest that VaR is always higher for women and is nearly zero for ages under a certain bound. Appendix 3 summarises the results for a full-coverage insurance whereas Appendix 4 shows the results for an insurance with no coverage for Degree III. Both of them have been obtained running 25,000 iterations using @RISK. Nevertheless, in typical situation the portfolio of an insurance company consists of a great number of contracts. In this case, following Jorion (2000), VaR is calculated using this expression:

$$VaR_C = \sqrt{\sum_{i=1}^{n} VaR_i^2 + \sum_{i=}^{n} \sum_{\substack{j=1 \\ j \neq i}}^{n} \rho Var_i VaR_j}$$

where VaR_C is the value at risk of the whole portfolio and ρ is the correlation coefficient between the contracts that compose it. If it is assumed that the contracts are all equal but independent, then VaR_C is obtained as $VaR_C = \sqrt{nVaR^2}$ where n is the number of contracts in the portfolio. In general, let be n_{ij} the number of contracts for policyholders with age *i* and gender *j* -*j* may be *f* for females and *m* for males-, and VaR_{ij} the respective *VaR* value. So VaR_C may be written as:

$$VaR_C = \left\{ \begin{bmatrix} n_{1m} & \cdots & n_{zm} & n_{1f} & \cdots & n_{zf} \end{bmatrix}' \begin{bmatrix} VaR_{1m}^2 \\ \cdots \\ VaR_{zm}^2 \\ VaR_{1f}^2 \\ \cdots \\ VaR_{zf}^2 \end{bmatrix} \right\}^{\frac{1}{2}} \qquad i = 1,2,\ldots,z$$

5. Conclusions

One of the main difficulties that can be found during the design and pricing of these kind of insurance contracts is its hybrid nature as they share characteristics of both life and general insurance. In fact, as in the life insurance case, the residual lifetime is a basic element to take into account. This is the rationale for using life tables. The optimal situation should be that in which tables for dependent population could be used. However, this tool is not available in Spain yet. So, hypothesis about dependents mortality are required. On the other hand, as it is common in general insurance, the value of the benefit depends on the cost associated with the contingency. As it happened with life tables, the optimal situation would be the one in which the information related to the cost of the assistance of eligible dependent people would be available. Nevertheless, this is not the present situation, so certain specific assumptions about the amount and the future evolution of the costs are needed.

For all these reasons the results obtained have to be taken carefully. In any case, the study has shown that there is a set of factors with a huge influence in premiums, such as age and gender of the policyholder or the discount rate. As a general rule, the higher the age the higher the premiums. Also, this kind of contracts is ceteris paribus, more expensive for women. Obviously, the higher the discount rate, the lower the premium. Another key element to be pointed out is the tremendous impact that the full coverage has on premiums. As it can be seen in Appendix 1 and 2, not protecting against degree III of dependence results in a premium reduction between 57 and 73 percent, depending on age and gender. Obviously, the required capital is also lower but in a smaller proportion. The amount of own resources is around 10% lower in the second kind of contract, because although the prevalence rates are lower in this case, the CSP is quite similar to that in the full coverage contract. In both cases, VaR at 99.5% is zero under a certain age because the probability to become eligible dependent is lower than 0.5%.

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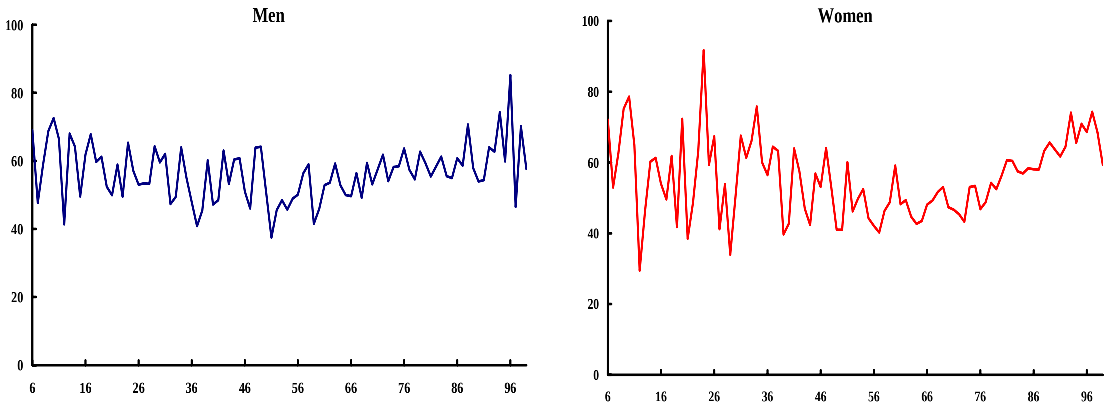
Figure 1: Average score by age and gender



Source: Own elaboration based on the RD 504/2007 and EDDES

Table 1: Estimation of the average score by gender for ages 100 through 115

Age	Men	Women
100	64.96	70.67
101	65.28	71.41
102	65.61	72.16
103	65.94	72.90
104	66.27	73.65
105	66.59	74.40
106	66.92	75.14
107	67.25	75.89
108	67.57	76.63
109	67.90	77.38
110	68.23	78.13
111	68.56	78.87
112	68.88	79.62
113	69.21	80.36
114	69.54	81.11
115	69.86	81.85

Source: own elaboration based on EDDES

Table 2: Forecast rates of growth of $w_x(t)$ starting in 2059

	Men	Women
based on P1	0.19518%	0.19276%
based on P2	0.72585%	0.73334%

Source: own elaboration

Table 3: CSP in 2009 (in euros)

	Men		Women	
Coverage	P1	P2	P1	P2
All degrees	256.67	256.69	260.19	260.44
Degrees I + II	243.24	243.25	249.58	249.76

Source: own elaboration

Table 4: Initial net premium at age 40 (in euros)

	Men		Women	
	P1	P2	P1	P2
Variable Premium	1,019.12	1,251.26	1,982.11	2,402.24
Constant Premium	1,678.06	2,059.95	3,280.64	3,975.07

Source: own elaboration

APPENDIX 1:
FULL COVERAGE: NET PREMIUM BY GENDER AND PROJECTION
(figures in euros of 2009)

	Men		Women	
Age	P1	P2	P1	P2
25	749.33	942.00	1,409.33	1,739.88
26	761.63	956.64	1,435.67	1,771.43
27	774.46	971.88	1,463.15	1,804.24
28	787.87	987.73	1,491.91	1,838.47
29	801.93	1,004.26	1,521.98	1,874.15
30	816.72	1,021.58	1,553.52	1,911.39
31	832.25	1,039.70	1,586.58	1,950.25
32	848.54	1,058.59	1,621.34	1,990.91
33	865.74	1,078.42	1,657.93	2,033.51
34	883.92	1,099.30	1,696.47	2,078.15
35	903.15	1,121.26	1,737.14	2,125.02
36	923.58	1,144.50	1,780.30	2,174.51
37	945.24	1,168.91	1,826.10	2,226.73
38	968.24	1,194.66	1,874.78	2,281.84
39	992.79	1,222.01	1,926.69	2,340.25
40	1,019.12	1,251.26	1,982.11	2,402.24
41	1,047.40	1,282.49	2,041.67	2,468.59
42	1,077.89	1,316.03	2,105.49	2,539.09
43	1,110.84	1,352.00	2,174.48	2,614.98
44	1,146.66	1,391.06	2,249.23	2,696.76
45	1,185.60	1,433.14	2,330.48	2,785.36
46	1,228.29	1,479.35	2,419.36	2,881.93
47	1,275.43	1,530.28	2,516.89	2,987.66
48	1,327.67	1,586.75	2,624.76	3,104.62
49	1,385.48	1,649.30	2,744.42	3,234.37
50	1,450.46	1,719.77	2,878.43	3,379.86
51	1,523.98	1,799.71	3,029.44	3,544.13
52	1,607.89	1,891.23	3,201.26	3,731.51
53	1,703.68	1,995.99	3,398.09	3,946.63
54	1,815.80	2,119.06	3,626.88	4,197.33
55	1,947.66	2,264.21	3,895.67	4,492.57
56	2,105.28	2,438.18	4,216.78	4,846.06
57	2,296.92	2,650.21	4,606.43	5,275.86
58	2,535.41	2,914.68	5,090.84	5,811.18
59	2,841.34	3,254.63	5,710.26	6,496.89
60	3,246.78	3,705.83	6,531.35	7,407.20
61	3,812.64	4,336.52	7,676.07	8,677.95
62	4,658.80	5,280.83	9,386.66	10,578.79
63	6,065.15	6,851.86	12,229.24	13,740.26
64	8,869.56	9,987.00	17,897.71	20,048.61

NOTE: premiums have been calculated using the following assumptions:

- premiums grow at 4.5% year-over-year rate
- discount rate is 4%
- CSP rises 4.2% on a year-over-year rate
- ultimate prevalence rate is 100%
- there is no free assistance period

Source: own elaboration

APPENDIX 2:
COVERING DEGREES I AND II: NET PREMIUM BY GENDER AND PROJECTION
(figures in euros of 2009)

	Men		Women	
Age	P1	P2	P1	P2
25	213.88	270.73	380.00	473.26
26	219.86	278.03	391.73	487.46
27	226.10	285.61	403.99	502.25
28	232.61	293.51	416.81	517.69
29	239.41	301.74	430.23	533.80
30	246.55	310.34	444.30	550.65
31	254.03	319.33	459.06	568.27
32	261.87	328.71	474.57	586.71
33	270.12	338.54	490.88	606.04
34	278.81	348.84	508.06	626.31
35	287.98	359.69	526.19	647.64
36	297.68	371.10	545.37	670.09
37	307.96	383.14	565.71	693.79
38	318.84	395.81	587.26	718.80
39	330.40	409.19	610.16	745.23
40	342.75	423.42	634.56	773.26
41	355.97	438.58	660.68	803.10
42	370.16	454.82	688.62	834.91
43	385.45	472.21	718.66	868.90
44	401.98	490.91	751.05	905.43
45	419.93	511.15	786.11	944.82
46	439.48	533.05	824.27	987.51
47	460.94	557.03	865.94	1,033.98
48	484.58	583.35	911.75	1,084.94
49	510.67	612.41	962.30	1,141.15
50	539.86	644.91	1,018.54	1,203.64
51	572.74	681.50	1,081.56	1,273.65
52	610.14	723.14	1,152.78	1,352.83
53	652.71	770.56	1,234.04	1,443.20
54	702.32	825.92	1,327.88	1,547.68
55	760.54	890.94	1,437.49	1,669.86
56	829.92	968.53	1,567.75	1,815.21
57	914.03	1,062.71	1,725.04	1,990.94
58	1,018.48	1,179.80	1,919.72	2,208.69
59	1,152.17	1,329.84	2,167.68	2,486.35
60	1,329.06	1,528.52	2,495.25	2,853.51
61	1,575.50	1,805.55	2,950.42	3,364.18
62	1,943.20	2,219.26	3,628.76	4,125.77
63	2,553.56	2,906.44	4,753.25	5,389.11
64	3,769.85	4,276.45	6,991.88	7,905.42

NOTE: premiums have been calculated using the following assumptions:

- premiums grow at 4.5% year-on-year rate
- discount rate is 4%
- CSP rises 4.2% on a year-over-year rate
- ultimate prevalence rate is 100%
- there is no free assistance period

Source: own elaboration

APPENDIX 3.:
FULL COVERAGE: CAPITAL REQUIREMENTS BASED ON VAR AT 99,5%
(figures in €)

Men

Age	Individual *VaR*	Policies in portfolio		
		100	1.000	5.000
50	0	0	0	0
60	0	0	0	0
70	0	0	0	0
75	0	0	0	0
80	14,646	146,457	463,136	1,035,604
85	13,567	135,671	429,030	959,340
90	13,322	133,218	421,272	941,992
95	14,776	147,763	467,267	1,044,841
100	16,033	160,325	506,993	1,133,671

Women

Age	Individual *VaR*	Policies in portfolio		
		100	1,000	5,000
50	0	0	0	0
60	0	0	0	0
70	0	0	0	0
75	13,372	133,718	422,855	945,532
80	14,100	141,001	445,884	997,027
85	14,615	146,146	462,154	1,033,407
90	15,947	159,467	504,279	1,127,601
95	17,764	177,638	561,740	1,256,089
100	17,697	176,969	559,624	1,251,358

Source: own elaboration

APPENDIX 4:
COVERAGE FOR DEGREES I AND II: CAPITAL REQUIREMENTS BASED ON VAR AT 99,5%
(figures in €)

Men

		Policies in portfolio		
Age	Individual *VaR*	100	1,000	5,000
50	0	0	0	0
60	0	0	0	0
70	0	0	0	0
75	0	0	0	0
80	0	0	0	0
85	10,442	104,419	330,201	738,351
90	10,695	106,948	338,198	756,234
95	11,895	118,952	376,161	841,121
100	11,973	119,733	378,630	846,643

Women

		Policies in portfolio		
Age	Individual *VaR*	100	1,000	5,000
50	0	0	0	0
60	0	0	0	0
70	0	0	0	0
75	0	0	0	0
80	11,049	110,486	349,387	781,252
85	10,739	107,394	339,610	759,391
90	12,107	121,073	382,867	856,116
95	13,265	132,651	419,479	937,983
100	12,779	127,795	404,122	903,645

Source: own elaboration

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