Health insurance pricing in Spain: Consequences and alternatives

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Abstract

For health insurance contracts, the actuarial technical bases are different depending on the country where the contract is issued. In Spain, private health insurance contracts have a very simple pricing rule based on non-life insurance techniques. The premiums are settled for different ranges of ages and the contracts are yearly renewed (risk contracts) until the insured reaches the age of 65. From this age on, most of the companies do not renew the contract and the insured losses the private health coverage. In other European countries, where the public health system does not provide universal health coverage, the private health insurance contracts are regulated by law. Life insurance techniques have to be applied to price lifelong contracts with level premiums. The present paper aims to start a discussion, from a technical point of view, on the private health insurance sector in Spain. We analyse what are the consequences for the insured (in terms of the total amount of premiums paid) arising out of the fact of applying non-life or life actuarial techniques to price the contracts. Particular attention is paid on how to index the premiums in both techniques in order to incorporate the medical inflation.

Keywords: health insurance, actuarial techniques, lifelong contract, medical inflation index

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1 Introduction

In the health insurance industry, the actuarial techniques used to price the contract differ depending on the country where the contract is issued. In Spain, most of the health insurance contracts are priced with a very simple pricing rule based on non-life techniques, the main variable is the average annual claim amount. Premiums are settled for different ranges of ages and the contracts are yearly renewed (risk contracts) until the insured reaches the age of 65. From this age on, most of the companies do not renew the contract and the insured losses the private health insurance coverage. In contrast to most of the European countries, in Spain the pricing techniques for health insurance contracts are not regulated by law. In several EU member countries (for instance, in Belgium and in Germany), the regulator force the health insurance industry to apply life insurance techniques to price lifelong contracts with level premiums. The lack of regulation in Spain can be easily understood by analysing the public health system which provides universal health coverage to all the population. However, the current crisis endangers the future of the public health system in Spain. Right now, we do not know what will be the effect of the crisis on the Spanish health system but we cannot exclude a copay scenario as in most EU member countries. As we will show, from the insured point of view, it is much more profitable that the company applies life insurance techniques to price his health contract. The only requirement is that the insured aims to remain for years in the portfolio once his policy has been firstly issued. A copay scenario requires lifelong contracts and these contracts must be priced with life insurance techniques since the most part of the savings occur, as we will see, from the age of 65 onwards.

The remainder of this paper is organized as follows. In Section 2, we describe the different possibilities for pricing the health insurance contracts: non-life insurance techniques and life insurance techniques. A premium indexing mechanism to incorporate the medical inflation is also described for both techniques. For lifelong health insurance covers we follow the proposal of Vercruysse et al. (2012). The differences on the premiums computed with non-life and life insurance techniques are evaluated with numerical examples in Section 3. The final section briefly concludes.

2 Non-life and life pricing techniques for health insurance contracts

In this section, we analyse from a technical point of view, the different possibilities for pricing health insurance contracts: non-life and life insurance techniques. We consider health insurance contracts which can be offered as term (annual and renewal) or lifelong insurance covers.

For both possibilities (non-life and life techniques), the main variable for pricing is the average annual claim amount for the generic insured. Let N be the random number of claims for the generic insured ($N = 0, 1, ...$) in a specifically year and let Y_j be the insurer's payment for the j-th claim. The total annual payment to the generic insured: S is given by

$$S = \begin{cases} 0 & if \quad N = 0, \\ Y_1 + Y_2 + \cdots + Y_N & if \quad N > 0. \end{cases}$$

with

$$E(S) = E(N) \cdot E(Y).$$

As is usual in health insurance, we introduce the age as a risk factor, i.e., the probability distribution of the random variable S depends on the age of the generic insured. The total portfolio is divided in groups of ages and, within each group, risks can be considered as "analogous" risks, in terms of amounts (maximum amounts) and exposure time. For a specific age x, let us assume that the portfolio contains a number r of insured risks and let m be the number of annual claims in the portfolio for this specific age. Then, the annual average claim amount per claim is given by

$$\overline{y}_x = \frac{y_1 + y_2 + \cdots + y_m}{m}$$

and the annual average number of claims per policy ("claim frequency" index) is given by

$$\phi_x = \frac{m}{r}.$$

Under this assumptions, our main variable, the average annual claim amount, is defined by

$$C_x = \phi_x \cdot \overline{y}_x.$$

Henceforth, we consider a policyholder aged x_0 at policy issue, so that his age t years after policy issue is $x_0 + t$. The average annual claim amount for the year t to $t+1$ is denoted by

$$C_{x_0+t}(t), \quad t = 0, 1, \cdots, x_u - x_0,$$

where x_u is the age of the insured at the beginning of his last year in the portfolio (in case of lifelong insurance $x_u = w - 1$) . We assume that quantities $C_{x_0+t}(t)$ are known for all possible t when the policy is issued. Furthermore, we assume that the $C_{x_0+t}(t)$ are paid at the beginning of each year, i.e., at time t (observe that a more realistic assumption can be easily adopted but it will lead to more complicated calculations without significantly different results).

We incorporate to our calculations the possibility that the insured changes his health insurance company. Following Vercruysee et al. (2012), from the insurer point of view, the non-exit probability for our policyholder is then given by

$${}_tp^l_{x_0} = {}_t p_{x_0} \cdot \exp\left(-\int_0^t \lambda_{x_0+s} ds\right) = \exp\left(-\int_0^t \left(\mu_{x_0+s} + \lambda_{x+s}\right) ds\right),$$

where μ_{x_0+s} is the instantaneous death rate at age $x_0 + t$ and λ_{x_0+s} is the instantaneous lapse rate at the same age.

We next describe the two possibilities for pricing this health insurance contract.

2.1 Non-life insurance techniques

We consider a term contract issued today by a policyholder aged x_0 and yearly renewed until he reaches the age x_u. We assume that the premiums are paid yearly in advance as long as the policy is in force. The annual premiums paid at the beginning of each year are denoted by $P_{x_0}(t)\,,\ t = 0, 1, \cdots, x_u - x_0$.

For each year, we have a risk contract with one-year covers. Under the hypothesis established above, the equivalence principle gives rise to an annual premium

$$P_{x_0}(t) = C_{x_0+t}(t)\,, \quad t = 0, 1, \cdots, x_u - x_0 \tag{2.1}$$

and the total amount paid by the policyholder is

$$\sum_{t=0}^{x_u-x_0} P_{x_0}(t) = \sum_{t=0}^{x_u-x_0} C_{x_0+t}(t)\,. \tag{2.2}$$

The present value and the actuarial present value corresponding to all future premiums are, respectively, given by

$$PV = \sum_{t=0}^{x_u-x_0} P_{x_0}(t) \cdot (1+i)^{-t} \quad \text{and} \quad APV = \sum_{t=0}^{x_u-x_0} P_{x_0}(t) \cdot (1+i)^{-t} \cdot {}_tp_{x_0}. \tag{2.3}$$

where i denotes the interest rate. Observe that the lapse probabilities do not have to be considered here since the analysis is done from the policyholder point of view.

Finally, we deal on how to adapt the premium amounts in order to incorporate the medical inflation (measured through some predefined medical inflation index, *medical IPC* in Spain). We assume that, at policy issue, we have reliable information with respect to the evolution of future medical inflation. More precisely, a given constant rate δ measures the future annual medical inflation which is assumed to be constant. This simplifying assumption is not realistic but allows us to investigate the effect of medical inflation in our calculations. For a deeper analysis on premium indexation we refer the reader to Pitacco (1999) and Vercruysee et al. (2012).

We assume that only the annual claim amounts are subject to inflation whereas the other elements of the technical basis are in line with reality, i.e.,

$$C^*_{x_0+t}(t) = (1+\delta)^t \cdot C_{x_0+t}(t)\,, \quad t = 1, \cdots, x_u - x_0. \tag{2.4}$$

Substituting $C^*_{x_0+t}(t)$ in (2.1) we have all future indexed premiums $P^*_{x_0}(t)$. The total amount of premiums paid as well as the corresponding present value and actuarial present value are obtained by substituting $P^*_{x_0}(t)$ in (2.2) and (2.3).

2.2 Life insurance techniques

We consider a term (lifelong) contract issued today by a policyholder aged x_0 with coverage until he reaches the age x_u. The contract is priced with level premiums. We assume that the premiums are paid yearly in advance as long as the policy is in force. The level annual premiums paid at the beginning of each year, $t = 0, 1, \cdots, x_u - x_0$, are denoted by $\pi(x_0)\,.$

The actuarial equivalence principle gives rise to level annual premiums

$$\pi\left(x_0\right)=\frac{\sum_{t=0}^{x_u-x_0} C_{x_0+t}\left(t\right)\cdot\left(1+i\right)^{-t}\cdot{}_t\,p_{x_0}^l}{\sum_{t=0}^{x_u-x_0}\left(1+i\right)^{-t}\cdot{}_t\,p_{x_0}^l} \tag{2.5}$$

and, then, the total amount paid by the policyholder is

$$\sum_{t=0}^{x_u-x_0}\pi\left(x_0\right)=\left(x_u-x_0+1\right)\cdot\pi\left(x_0\right) \tag{2.6}$$

while the present value and the actuarial present value corresponding to all future premiums are, respectively, given by

$$PV=\sum_{t=0}^{x_u-x_0}\pi\left(x_0\right)\cdot\left(1+i\right)^{-t}\quad\text{and}\quad APV=\sum_{t=0}^{x_u-x_0}\pi\left(x_0\right)\cdot\left(1+i\right)^{-t}\cdot{}_tp_{x_0}. \tag{2.7}$$

Substituting the natural premiums by a level premium (life insurance technique) leads to a positive mathematical reserve for years $t=1,\cdots,x_u-x_0-1$. We denote by $V_{x_0+t}\left(t\right)$ the reserve which can be computed (prospectively) as

$$V_{x_0+t}\left(t\right)=\sum_{s=t}^{x_u-x_0}\left(C_{x_0+t}\left(s\right)-\pi\left(x_0\right)\right)\cdot\left(1+i\right)^{-s}\cdot{}_s\,p_{x_0}^l. \tag{2.8}$$

Therefore, introducing medical inflation on the annual claims amount will influence, not only the premiums (since they are not natural premiums), but also the future required reserve. In order to keep the equivalence principle fulfilled indexation can be done over future premiums and/or over future reserve. Notice that premium increases are financed by the policyholder while reserve increases are financed by the insurer. Vercruysee et al. (2012), proposed a premium indexing mechanism for health insurance premiums ensuring fairness for both parties. We again assume the simplifying hypothesis of an annual constant inflation δ on the claim amounts.

In this case, following the proposal in Vercruysee et al. (2012) the premium is yearly impacted by $(1+\alpha)\cdot\delta$ for some $\alpha>0$. Choosing the value $\alpha=\alpha^*$ such that the expected present value of all future required reserves increases is equal to 0 the insurer has no actuarial gain due to the benefit increase. Indexed premiums are defined as

$$\pi_t^*\left(x_0\right)=\left(\left(1+\alpha^*\right)\cdot\delta\right)\cdot\pi_{t-1}^*\left(x_0\right),\quad t=1,\cdots,x_u-x_0. \tag{2.9}$$

Observe that we have to include a subscript to the yearly premium since indexation breaks the constant level premiums. The total amount paid by the policyholder is now given by

$$\sum_{t=0}^{x_u-x_0}\pi_t^*\left(x_0\right) \tag{2.10}$$

while the present value and the actuarial present value can be obtained by substituting π_t^* in (2.7).

3 Numerical example

In order to illustrate previous results we consider the technical bases described in Vercruysee et al. (2012). The yearly interest rate is assumed to be $i = 0.02$. The one-year lapse probability is

$$\lambda_{x_0+t} = \begin{cases} 0.1 - 0.002\,(x_0 + t - 20) & \text{if} \quad x_0 + t = 25, 26, \cdots, 70, \\ 0 & \text{otherwise.} \end{cases}$$

The one year death probability follows the first Heligman-Pollard law, that is,

$$\frac{q_{x_0+t}}{1 - q_{x_0+t}} = A^{(x_0+t+B)^C} + D\ e^{-E(\ln(x_0+t) - \ln F)^2} + G\ H^y$$

with $A = 0.00054$, $B = 0.017$, $C = 0.101$, $D = 0.00013$, $E = 10.72$, $F = 18.67$, $G = 1.464 \cdot 10^{-5}$ and $H = 1.11$.

Based on health insurance data collected by the Italian National Institute of Statistics (ISTAT) graduated by the Italian Association of Insurance Companies (ANIA), the average annual claim amounts are given by

$$C_{x_0+t}(t) = 20.4476472 \cdot e^{0.038637\, x_{0+t}} \quad \text{for} \quad x_0 + t \geq 20. \tag{3.11}$$

We consider two possible ages for entering in the portfolio: policyholder's age $x_0 = 25$ or $x_0 = 50$ at policy issue. We also consider two possible coverages :

- Health insurance contract until the policyholder reaches the age of 65 (maximum period of coverage in Spain in most private health insurance companies).
- Lifelong health insurance contract (the ultimate age reachable is assumed to be $w = 110$).

In both cases, we consider the two possibilities for pricing described above: non-life and life insurance techniques.

The premiums corresponding to the first case, *term contract until the age of 65*, are shown in Figure 1. When non-life insurance techniques are used to price, the annual premiums are simply obtained from (3.11) for $x_0 = 25$ $(t = 0, 1, \cdots, 40)$ or $x_0 = 50$ $(t = 0, 1, \cdots, 15)$. Level premiums with life insurance techniques are obtained from (2.5) with the corresponding values for the variables involved.

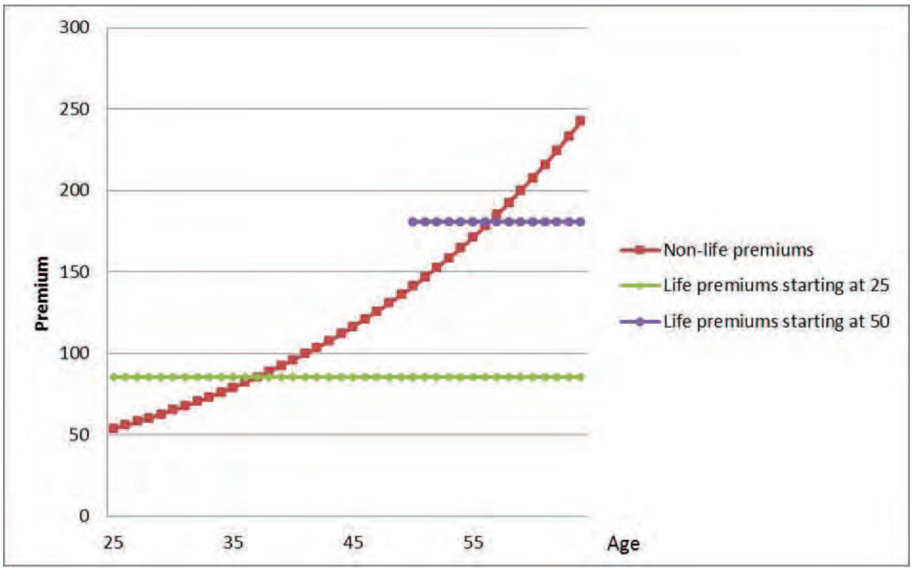

Figure 1: Premiums for term contract until the age of 65 ($x_0 = 25$ or $x_0 = 50$)

Table 1 compares the total amount paid by a policyholder aged 25 at policy issue depending on the techniques used to price. As we can see, in case the policyholder survives until the age of 65, the total amount paid is much lower in case the insurer applies life insurance techniques, i.e., a level premium for the total term. If we observe the present value (actuarial present value) of the total amount paid, the gaps are lower but still significantly. Values in Table 1 follow immediately from (2.2) and (2.3) for non-life techniques and from (2.6) and (2.7) for life techniques.

25 until age 65	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	5032.36€	3176.28€	3081.53€
Life	3416.80€	2383.44€	2337.97€
Percentage saved (life vs. non-life)	32%	25%	24%

Table 1: Total premiums (non-life and life) starting at 25 until age 65

We repeat the same analysis for a policyholder aged $x_0 = 50$ at policy issue. The obtained results are presented in Table 2. Observe that now the differences arising from the application of non-life or life pricing techniques are almost no significantly. This result is not surprising due to the short term of the contract.

50 until age 65	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	2813.32€	2423.38€	2343.62€
Life	2707.88€	2366.01€	2297.42€
Percentage saved (life vs. non-life)	4%	2%	2%

Table 2: Total premiums (non-life and life) starting at 50 until age 65

As outlined below, the main differences arise at policyholder's older ages. Let us now consider a policyholder contracting a *health insurance with lifelong coverage*. The corresponding premiums, non-life and life insurance techniques, are shown in Figure 2.

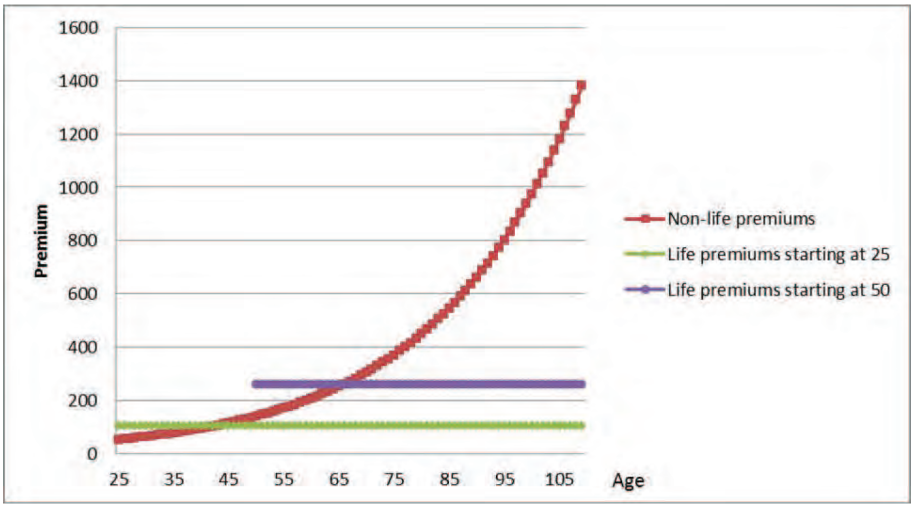

Figure 2: Premiums for lifelong contract ($x_0 = 25$ or $x_0 = 50$)

In Table 3, for the case $x_0 = 25$, we compare the different amounts paid (total value, PV and APV of the premiums) when the insurance is priced with non-life or life techniques. Observe that in case of lifelong insurance, from the insured point of view, it is much more cheaper that the company applies life techniques to price his health contract. By comparing results in Table 3 with results in Table 1, we can conclude that the most part of the saving due to the methodology of pricing (life techniques) occurs from the age of 65 on.

Age 25	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	35028.22€	11182.11€	5461, 21€
Life	8897.98€	4346.98€	3513.75€
Percentage saved (life vs. non-life)	75%	61%	36%

Table 3: Total premiums (non-life and life) for lifelong contract starting at 25

Similar conclusions can be derived from Table 4, which contains the comparison between the different amounts paid for a policyholder aged 50 at policy issue. In contrast to the term contract, Table 2, the differences between non-life and life premiums are now significantly.

Age 50	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	32809.18€	15557.79€	6340.38€
Life	15661.77€	9255.09€	6038.12€
Percentage saved (life vs. non-life)	52%	41%	5%

Table 4: Total premiums (non-life and life) for lifelong contract starting at 50

Finally, we index the premium amounts in order to incorporate the medical inflation on the average annual claim amounts. We restrict our analysis to the lifelong health insurance contract, where we have found larger differences in the total premiums.

The yearly rate of medical inflation is assumed to be $\delta = 0.025$. Therefore, if non-life techniques are used to price, we obtain from (2.4) and (3.11) annual premiums given by

$$P^*_{25+t}(t) = 1.025^t \cdot 20.4476472 \cdot e^{0.038637\cdot(25+t)}, \quad t = 0, 1, \cdots, 84,$$

$$P^*_{50+t}(t) = 1.025^t \cdot 20.4476472 \cdot e^{0.038637\cdot(50+t)}, \quad t = 0, 1, \cdots, 59.$$

When life insurance techniques are used to price, following Vercruysee et al. (2012) premiums are yearly indexed following (2.9). We first find the values of α^* such that

$$\sum_{t=0}^{84} \left(V^*_{25+t}(t) - V_{25+t}(t)\right) = 0 \quad \text{and} \quad \sum_{t=0}^{59} \left(V^*_{50+t}(t) - V_{50+t}(t)\right) = 0,$$

where * indicates that the reserves in (2.8) have been computed with inflation in benefits and premiums. We obtain the values $\alpha^* = 0.625$ for $x_0 = 25$ and $\alpha^* = 0.325$ for $x_0 = 25$. Therefore, the yearly increment in premiums when age at policy issue is 25 is 4.06% while for an age at policy issue of 50 is 3.31%

The obtained annual premiums are shown in Figure 3.

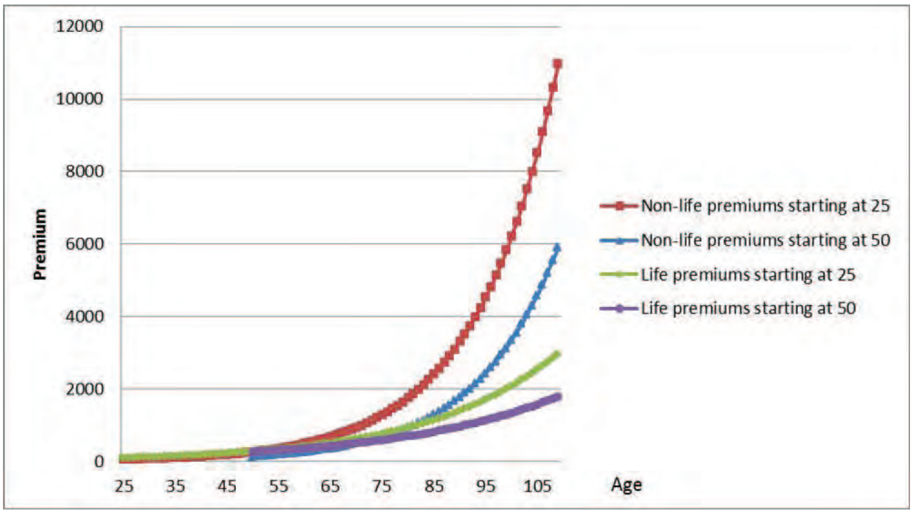

Figure 3: Indexed premiums for lifelong contract ($x_0 = 25$ or $x_0 = 50$)

The total amounts paid by the policyholder aged $x_0 = 25$ and $x_0 = 50$ at policy issue are, respectively, given in Table 5 and Table 6.

Age 25	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	178042.17€	47623.37€	14281.04€
Life	73471.71€	23207.13€	11094.45€
Percentage saved (life vs. non-life)	59%	51%	22%

Table 5: Total indexed premiums (non-life and life) for lifelong contract starting at 25

Again since we are considering a lifelong contract, the amount of total premiums computed with life insurance techniques are significantly smaller than the obtained with non-life techniques. Remark that the relative savings (percentage saved life versus non-life) are quite similar to the ones obtained when no inflation was incorporated, Table 3 and Table 4, specially when age at policy issue is 50. This result seems to indicate that for long periods of coverage and for an older age at policy issue, the relative saving does not depend much on the total amount of claim covered. However, more calculations need to be done in order to prove this result.

Age 50	Value of the premiums	Present value of the premiums	Actuarial present value of the premiums
Non-life	94318.72€	40159.89€	10802.58€
Life	47800.71€	23401.29€	10430.13€
Percentage saved (life vs. non-life)	49%	42%	3%

Table 6: Total indexed premiums (non-life and life) for lifelong contract starting at 50

4 Conclusion

Our aim in this paper has been contributing to start a discussion, from a technical point of view, on the consequences for the insured derived from the actuarial technical used to price. The technique used not only affects the price but also the duration of the contract (annual and renewal or lifelong). Observe that a more complete comparison of both techniques requires an analysis on the effect that each product has on the health insurance company. This involves analysis of the technical provisions and of the solvency capital required for each case. This approach is a topic for future research.

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