Health insurance pricing in Spain. Consequences and alternatives

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Index

1. Introduction
   - The PHI in Spain
   - Pricing of PHI in Spain
   - Alternative pricing of PHI. Consequences for the insured
2. Non-life and life pricing techniques for PHI
   - Non-life pricing techniques
   - Life pricing techniques
   - Insured's valuation of the pricing technique
3. Numerical examples
4. Conclusions

Introduction

The present work focuses on **private health insurance contracts** (PHI) in Spain.

As starting point we formulate the following questions:

- What type of PHI do we have in Spain? How long an insured can be in the private health system in Spain?
- How PHI are priced in Spain?
- Could it be reasonable to apply a different actuarial technique for pricing PHI? What are the consequences from the insured point of view?

The PHI in Spain

- In Spain we have a **voluntary PHI model** which operates in parallel with the public healthcare system offering a **private duplicate cover**.
- Structure of the market:
  - **Healthcare insurance contracts** ($>$ 75% market share). The insured has to choose within a concerted medical frame.
  - **Reimbursement benefit contracts** ($<$ 10% market share). To meet (totally or partially) health costs.
  - **Forfeiture allowance contracts** (approx 15% market share). This type of coverage can be included in both previous contracts.
- **Latest age**: For most of the companies **65 years** old.

Pricing of PHI in Spain

Non-life insurance technique:

- Their main variable is the average annual claim amount.
- Premiums are settled for different ranges of ages and contracts are yearly renewed until the insured reaches the age of 65.

Therefore, PHI in Spain are **risk contracts yearly renewed with natural premiums**.

Disadvantages from the insured point of view:

- Natural premiums increase with the age.
- The insurance company can decide to not renew the contract (specially dramatically in case of serious illness).
- No coverage over the age of 65 years.

Main **advantage** from the insured point of view:

- No reserves are generated (no losses in case of lapse).

Alternative pricing of PHI. Consequences for the insured

Life insurance technique:

- Term contract until the insured reaches the age of 65 (possibility of lifelong contract).
- The contract is priced with an annual level premium incorporating all future average annual claim amounts.

Advantages from the insured point of view:

- Constant (level) premiums.
- The insurance company can not stop the contract.
- Possibility of lifelong coverage (some companies).

Level premiums can become the **main disadvantage** of this pricing technique **in case of lapse** if non transferable reserves are included.

Alternative pricing of PHI. Consequences for the insured

Let us consider a market with both types of policies:

- Annual (renewable) contracts.
  We assume that it is mandatory for the company to renew the contract (at any age).
- Term (lifelong) contracts.

We consider a particular insured who aims to remain in the portfolio (he/she does not contemplate the possibility of lapsing).

In case the total amount paid is the decision variable for our agent: What policy is more suitable for him/her?

It will depend on his/her particular technical bases (probably different than the ones used by the company):

- Interest rate (no considered by some few agents).
- Life mortality table (no considered by some agents).

Non-life and life pricing techniques for PHI

For both techniques, as is usual in health insurance, the portfolio is divided in age groups.

Within each group, risks are homogeneous risks (in terms of frequency and severity).

For a specific age x, we denote by

- r : Number of insured risks in the portfolio,
- m : Number of annual claims in the portfolio,
- y_j : Insurer's payment for the j-th claim.

The annual average claim amount per claim is then given by

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

and the annual average number of claims per policy is

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

Non-life and life pricing techniques for PHI

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

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

Henceforth, we price a contract for a policyholder with:

- Age at policy issue: x_0
- Age at the beginning of his/her last year in the portfolio: x_u (for lifelong insurance $x_u = \omega - 1$)
- Average annual claim amount for the year t to $t+1$:

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

  - Known for all possible t when the policy is issued.
  - Paid at the beginning of each year.
- At a last stage, we incorporate the medical inflation in the premiums. A given rate δ_t is assumed to be known for all possible t when the policy is issued (δ_0=1) .

Non-life pricing techniques

Assumptions:

- Premiums are paid yearly in advance as long as the policy is in force.
- 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. The equivalence principle gives rise to annual premiums:

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

Annual premiums indexed by inflation, $P^*_{x_0}(t)$, are simply obtained by substituting in equation (1):

$$C^*_{x_0+t} = \prod_{s=0}^{t} (1 + \delta_s) \cdot C_{x_0+s}, \quad t = 1, \cdots, x_u - x_0.$$

Life pricing techniques

Assumptions:

- Premiums are paid yearly in advance as long as the policy is in force.
- Level annual premiums paid at the beginning of each year are denoted by $\pi(x_0)$, $t = 0, 1, \cdots, x_u - x_0$.

The actuarial equivalence principle gives:

$$\pi(x_0) = \frac{\sum_{t=0}^{x_u - x_0} C_{x_0+t} \cdot (1+i)^{-t} \; \cdot_t p_{x_0}}{\sum_{t=0}^{x_u - x_0} (1+i)^{-t} \; \cdot_t p_{x_0}}, \tag{2}$$

with

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

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

Life pricing techniques

Observe that substituting the natural premiums by a level premium leads to a positive mathematical reserve for $t = 1, \cdots, x_u - x_0 - 1$.

Denote by V_{x_0+t} the reserve which can be computed as

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

Medical inflation on the annual claims amount will influence, not only the premiums but also the future required reserve.

To keep the equivalence principle fulfilled indexation can be done over future premiums and/or over future reserve.

Following Vercruysse et al. (2012), we index yearly premiums by:

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

where α^* is the value that makes the expected present value of all future required reserve increases equal to zero.

Insured's valuation of the pricing technique

Insured's assumptions for discounting:

- Annual interest rate: i'.
- Survival probability: ${}_tp'_{x_0}$. Since no lapse probability is contemplated from the insured point of view, for some particular law of mortality:

$$ {}_tp'_{x_0} = \exp\left(-\int_0^t \mu'_{x_0+s} ds\right). $$

Valuation of non-life/life premiums:

- General valuation:
  - Actuarial Present Value (APV) of all future premiums.
- Particular valuation made by some economic agents:
  - No survival probabilities are considered: Present Value (PV) of all future premiums.
    - A particular agent in this group may even consider a zero interest rate for discounting (key variable: Value of premiums).

Numerical examples

Technical bases for pricing (insurer): Vercruysse et al. (2012)

- Annual interest rate: $i = 0.02$.
- One-year lapse probability:

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

- First Heligman-Pollard law for the one year death probability:

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

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

- Average annual claim amounts:

$$C_{x_0+t} = 20.4476472 \cdot e^{0.038637 \cdot x_0 + t} \quad \text{for} \quad x_0 + t \geq 20.$$

Numerical examples

Insured's assumptions for discounting:

- General valuation. APV of all future premiums with:
  - $i' = 0.02$
  - ${}_tp'_{x_0}$ given by first Heligman-Pollard law defined above.
- Particular valuation. PV of all future premiums with:
  - $i' = 0.02$

  or even
  - $i' = 0$

Remarks:

1. Insured's assumptions for interest rate and law of mortality are equal to the ones used to price only for simplicity reasons.
2. In case the technical bases are exactly the same, APV of non-life and life premiums are equal.

Numerical examples

Age at policy issue and period of coverage:

Two possible ages for entering in the portfolio:

- $x_0 = 25$,
- $x_0 = 50$.

For both cases, two possible coverages :

- Health insurance contract until the policyholder reaches age 65 (maximum period of coverage in Spain in most PHI).
- Lifelong health insurance contract ($\omega = 110$).

Next, we present the obtained results:

- Pricing: Non-life and life premiums (health insurance company).
- Valuation of non-life/life premiums (particular insured)

Numerical examples

Pricing: Non-life and life premiums (health insurance company)

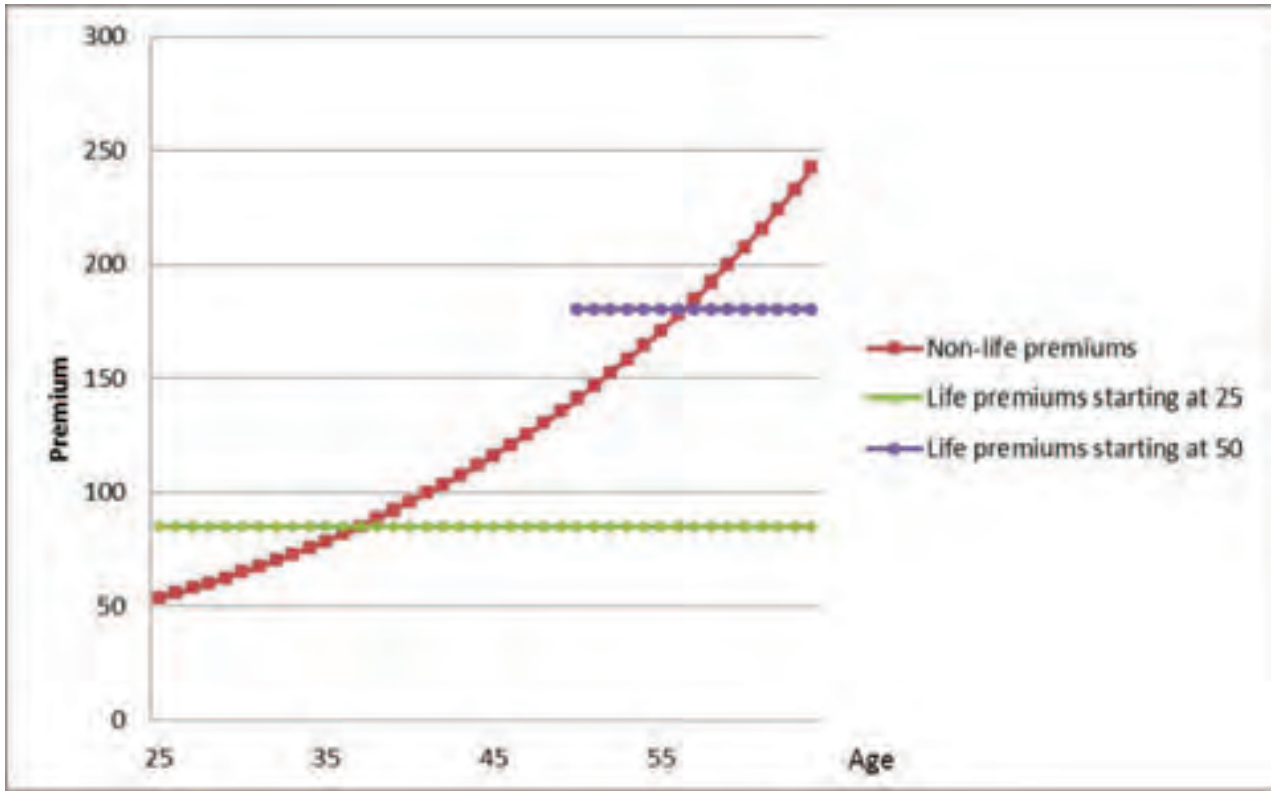

Figure 1: Premiums for term contract until age 65 ($x_0 = 25$, $x_0 = 50$)

Numerical examples

Valuation of non-life/life premiums (particular insured)

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: Term insurance contract starting at 25 until age 65

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: Term insurance contract starting at 50 until age 65

Numerical examples

Pricing: Non-life and life premiums (health insurance company)

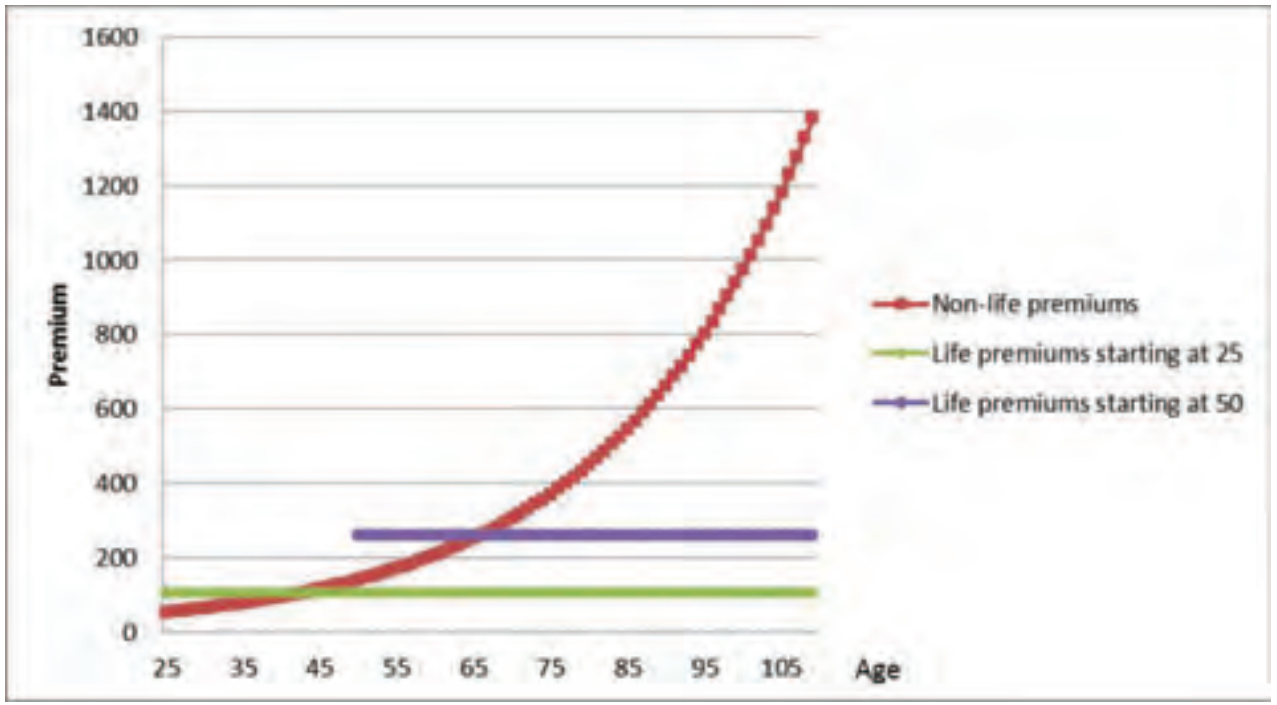

Figure 2: Premiums for lifelong contract ($x_0 = 25$ or $x_0 = 50$)

Numerical examples

Valuation of non-life/life premiums (particular insured)

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: Lifelong insurance contract starting at 25

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: Lifelong insurance contract starting at 50

Numerical examples

Incorporating inflation in lifelong insurance contracts

For simplicity reasons, we assume a constant annual rate of medical inflation:

$$\delta_t = \delta = 0.025.$$

Non-life premiums:

- $x_0 = 25$:

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

- $x_0 = 50$:

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

Numerical examples

Incorporating inflation in lifelong insurance contracts

Life premiums: $\delta_t = \delta = 0.025$.

- $x_0 = 25$:

$$\sum_{t=0}^{84} \left(V^*_{25+t}(t) - V_{25+t}(t)\right) = 0 \Rightarrow \alpha^* = 0.625.$$

$$\pi^*_t = (1 + 1.625 \cdot 0.025) \cdot \pi^*_{t-1} = 1.0406 \cdot \pi^*_{t-1}, \quad t = 1, \cdots, 84.$$

- $x_0 = 50$:

$$\sum_{t=0}^{59} \left(V^*_{50+t}(t) - V_{50+t}(t)\right) = 0 \Rightarrow \alpha^* = 0.325.$$

$$\pi^*_t = (1 + 1.325 \cdot 0.025) \cdot \pi^*_{t-1} = 1.0331 \cdot \pi^*_{t-1}, \quad t = 1, \cdots, 59.$$

Numerical examples

Pricing: Non-life and life premiums (health insurance company)

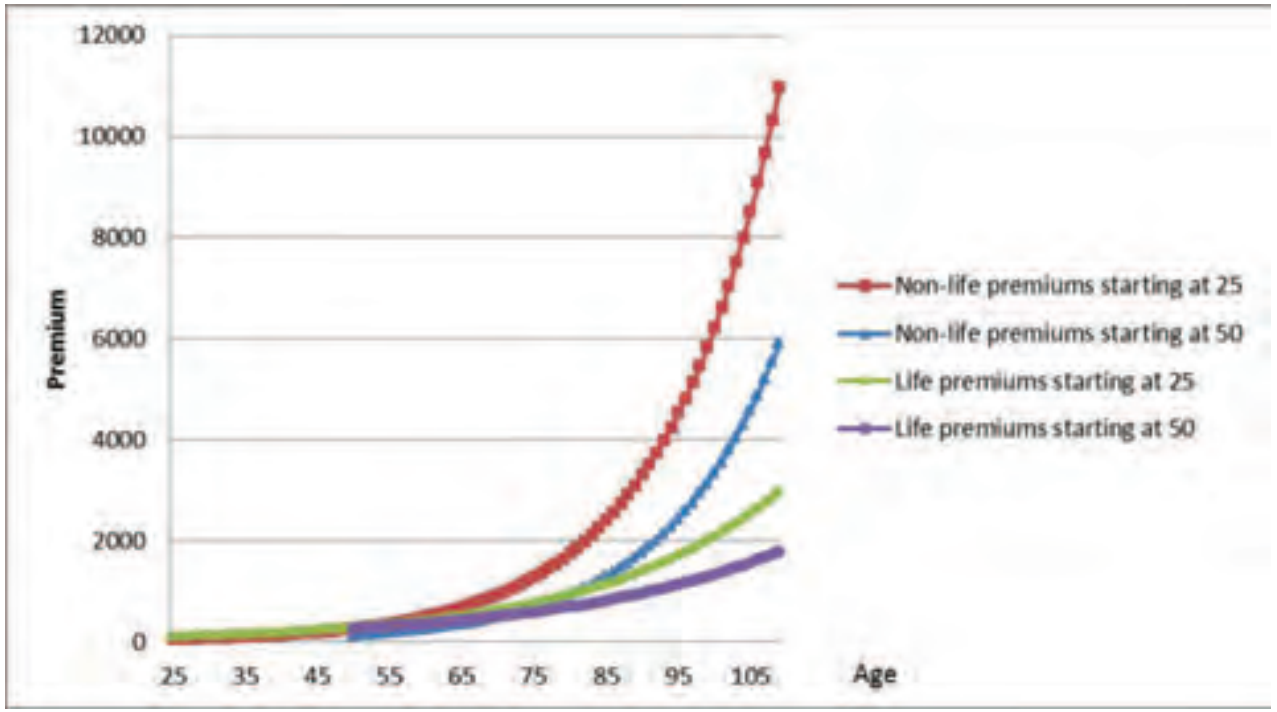

Figure 3: Indexed premiums for lifelong contract ($x_0 = 25$ or $x_0 = 50$)

Numerical examples

Valuation of non-life/life premiums (particular insured)

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: Indexed premiums for lifelong contract starting at 25

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: Indexed premiums for lifelong contract starting at 50

Conclusions

1. Relevant variables for comparing PHI (insured point of view):
   - How long is desired coverage period?
     - Short term coverage: Annual (renewable) contract.
     - Long term coverage: Term (lifelong) contract.

     Although the valuation of the total amount paid depends on his/her particular technical bases.
   - In Spain it is not mandatory for the companies to renew annual contracts.
   - For term (lifelong) contracts with non-transferable reserves, there is no freedom for changing the insurance company.
2. The current crisis endangers the future of the public health system in Spain.
   We cannot exclude a copay scenario which requires lifelong contracts priced with life insurance techniques.

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