NOTES TO THE PRODUCTS OF THE SUPPLEMENTARY PENSION SAVING SCHEME

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Abstract

This paper discusses selected products of the payout phase of the third pillar pension scheme in the Slovak Republic which are stated by Act 650/2004 Coll. on the supplementary pension saving scheme and on amendments to some acts. By means of stochastic modeling of the force of mortality, it models and analyses the amounts of pension annuities in the designed products of the third pillar pension saving according to costs, technical interest rate in the Slovak Republic and requirements of the European Court of Justice.

Key words: *pension, product, force of mortality, technical interest rate.*

1. Introduction

Supplementary pension saving constitutes the third pillar of the pension system in Slovakia, which is based on an optional basis. Supplementary pension saving represents a voluntary pillar of the pension system in which funds are managed by private companies called doplnková dôchodková sporiteľňa – DDS (supplementary pension asset management company). A supplementary pension asset management company is a limited liability company established on the territory of the Slovak Republic which is run under the conditions stipulated by law on the basis of a license issued by the National Bank of Slovakia (NBS). Each DDS is required to create and manage a payout supplementary pension fund and at least one contributory supplementary pension fund. The area of supplementary pension saving is regulated by Act 650/2004 Coll. on supplementary pension saving and amendments to other related acts. The most significant latest changes to supplementary pension saving were enacted by amendments to Act 318/2013 Coll. and Act 301/2014 Coll.[1]. Supplementary pension saving is intended to give the savers a possibility to get a so-called

- supplementary income in retirement,
- supplementary pension income when they finish work in so-called health risk occupations, which include occupations classified in category 3 or 4 on the basis of a health protection authority decision, or employed work as a professional dancer or musician playing a wind instrument in a theatre or an ensemble.

[1]The current version of Act 650/2004 Coll. is accessible at https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2004/650/ (accessed March 11, 2016).

Supplementary pension saving is mandatory for employees performing so-called risk work and their employer is obliged to conclude an employer-occupational policy with the supplementary pension asset management company chosen by the employee. During the period of work in a high risk occupation, the employee can but also does not have to pay the contributions.

For other employees and persons over 18 years of age supplementary pension saving in the 3rd pillar is optional. If these persons decide to enter this pillar, they have to conclude a participant agreement with a supplementary pension asset management company. Their employer is not obliged to conclude an employer occupational policy. The contributions for these employees can be also paid by their employer if they have concluded an employer-occupational policy. In the saving phase, the savers or their employers pay contributions to the supplementary pension saving system, which the savers can invest in one or more contribution funds of the chosen pension asset management company. In the payout phase, after the saving in the supplementary pension system has been terminated, the participant is paid benefits. The amount of benefits depends also on the time of concluding the participant agreement and the fact if it includes a so-called benefit plan. For the participants who concluded an agreement before 31 December 2013 and have a benefit plan as part of their agreement the benefits are set in the benefit plan. Law amendments have no impact on the benefits. For the participants who concluded an agreement after 1 January 2014, or signed an annex to the agreement which cancelled the benefit plan, the benefits are regulated by Act 650/2004 Coll. on supplementary pension saving. The clients who conclude an agreement after 1 January 2014 or those who agree with the terms of the annex regain the possibility to subtract the contributions from the tax base up to 180 € a year. The new condition to get the supplementary pension benefits is approval of an early or proper retirement pension by the Social Insurance Company or attaining the age of 62. The amendment to the Act thus supports the purpose of supplementary pension saving, which is to enable the participant to gain a supplementary pension income in old age. The stricter rules will apply to new savers who perform work with a health risk. In this article, we deal with calculating the amount of pension set in the so-called benefit plan. This applies to the pensions paid out on the basis of agreements concluded before 31 December 2013, where the savers did not sign an annex under the amended Act (Ministry of Labour, Social Affairs and Family of the Slovak Republic, 2015).

Moreover, we remind that the European Union Council Directive 2004/113/EC (Gender Directive) guarantees equal treatment between men and women in the access and supply of goods and services. The European Court of Justice ruled that the national governments of Member States of the European Union were obliged to change their laws accordingly by December, 21, 2012. That means, that insurance companies must calculate premiums of life insurance products, including life insurance and pension annuities, with respect to so-called unisex life tables (Oxera, 2012).

This paper is divided into four Sections. In Section 2, we mention modelling of selected products of the supplementary pension saving products, which should be paid out to clients who entered into a contract with a supplementary pension company before December 31, 2013 and did not sign an annex to the contract in compliance with the amended Act. Section 3 contains results of the force of mortality modelling and corresponding probability of survival and death obtained using IBM SPSS Statistics 19 system. Moreover, in this part are analysed the amounts of selected products with respect to the force of mortality of 2012 to 2014 and a 1.9 % old technical interest rate and 0.7 % current technical interest rate (National Bank of Slovakia, 2013, 2015). We mention also the impact of the rule of the European Court of Justice regarding to gender. That means that we analyse an increase or decrease in the amount of so-called unisex annuity according to annuities which would be calculated using gender. In Section 4, we mention other possible products and methods of payment of annuities from contracts with supplementary pension companies since January 1, 2014.

2. Preliminaries

2.1 Basic Concepts of Pension Annuity Modelling

Pension annuity contracts offer a regular series of payments. If the pension annuity continues until the death of the annuitant, it is called a whole life annuity. The buying of a whole life annuity guarantees that the income will not run out before the annuitant dies. In this part we show how probabilities of survival or death can be calculated under the framework of life insurance. Let (x) denote a life aged x, where $x \geq 0$. The death of (x) can occur at any age greater than x, and we can model so-called future lifetime of (x) by a continuous random variable T_x.

First, we will define basic quantity known as the force of mortality. A fundamental building block of our investigation are mortality tables from the year 2013 which are published on the web page of the Statistical Office of the Slovak Republic[2]. The force of mortality is a fundamental concept in modelling future lifetime. We denote the force of mortality at age x by μ_x and we define it as in Dickson et al. (2009), i.e. as

$$\mu_x = \lim_{dx \to 0^+} \frac{1}{dx} \Pr\left[T_x \leq dx\right]. \tag{1}$$

On the basis of the number of living and dying, we determine the force of mortality by the formula

$$m_x = \frac{D_x}{P_x}, \tag{2}$$

where D_x is the number of dying at age x and P_x is the number of living at age x.

Throughout this paper we illustrate our results on the Standard Survival Model using Gompertz' law, which models the force of mortality as follows:

$$\mu_x = A + B \cdot c^x, \tag{3}$$

where A, B and c are constants and x is entry age of individual.

We will summarize the relevant actuarial notation for survival and mortality probabilities:

- ${}_t p_x$ is the probability that individual (x) survives to at least age $x+t$,
- ${}_t q_x$ is the probability that individual (x) dies before age $x+t$,
- ${}_{r|t} q_x$ is the probability that individual (x) survives r years, and then dies in the subsequent t years, that is, between ages $x+r$ and $x+r+t$.

Following Dickson et al. (2009), we can derive ${}_t p_x$ as follows

$${}_t p_x = exp\left\{-\int_x^{x+t} \mu_r \, dr\right\}. \tag{4}$$

[2]Available at www.statistics.sk (accessed August 12, 2015).

Using expressions (3) and (4) we obtain ${}_tp_x$ in the shape

$$ {}_tp_x = exp\left\{-At - \frac{B \cdot c^x}{\log c}\left(c^t - 1\right)\right\}, \tag{5}$$

and subsequently, we can model the probability of survival and probability of death with $t = 1/12$. Constants A, B and c can be obtained by modeling of the force of mortality using IBM SPSS Statistics 19 system.

3. Selected Products of the Supplementary Pension saving

In this paper, we discuss three selected products of supplementary pension saving, on the basis of which pension annuities can be paid out. The mentioned products are as follows:

- Product 1 – includes a permanent monthly annuity and a programed withdrawal from an accumulated sum at the beginning of retirement time (does not include survivor's benefits),
- Product 2 – includes a temporary retirement pension paid out temporarily as a monthly annuity over a maximum period of n years, where n is a minimum of 10 years, unless the insured dies earlier; and a programed withdrawal from an accumulated sum at the beginning of retirement time (does not include survivor's benefits),
- Product 3 – includes a combination of permanent retirement pension and survivor's pension and is paid out to the entitled person in an amount of $k\,\%$ of the original monthly annuity with a certain payment period of l year.

First we will give basic notations which are used in the formulas of individual products:

- S - accumulated sum, gross single premium;
- p - programed withdrawal from an accumulated value at the beginning of retirement time (in %);
- i - technical interest rate;
- $v = \frac{1}{1+i}$ - discounting factor;
- m - number of paid, or paid out annuities within one year;
- x - retirement age;
- n - number of years of term pension;
- l - number of years of term pension;
- k - quotient of the m-thly paid out pensions within l years (in %);
- ω - maximum age to which a person can live to see (regarding used life tables is here $\omega = 130$;
- α - initial costs as a % from accumulated sum;
- β - administrative costs as a ‰ from yearly regular annuity;
- δ - collection costs as a ‰ from yearly regular annuity.

Remark 1: In actuarial notation, we use the notion gross monthly annuity in the case when we assume formulas with individual costs; and net monthly annuity when we assume a determination of monthly annuity only with respect to the force of mortality, with zero costs.

1. Product 1
   This product contains a permanent monthly annuity and a programed withdrawal $p\,\%$ from an accumulated sum at the beginning of retirement time.
   Gross monthly pension annuity (GMA_1) of Product 1 is given by formula

$$GMA_1 = \frac{S \cdot (1 - p - \alpha)}{12 \cdot \ddot{a}_x^{(12)} \cdot (1 + \beta + \delta)}, \tag{6}$$

where

$$\ddot{a}_x^{(12)} = \sum_{r=0}^{12(\omega - x - 1) + 11} \frac{1}{12} \, {}_{\frac{r}{12}}p_x \cdot v^{\frac{r}{12}}$$

is the expected present value of whole life benefits in advance of $1/12$ of monetary units (m.u.), 12 times per year, conditional upon the life client.

2. Product 2
   Product 2 contains a temporary monthly annuity and a programmed withdrawal $p\,\%$ from an accumulated value at the beginning of retirement time.
   Monthly pension annuity (GMA_2) of Product 2 is given by formula

$$GMA_2 = \frac{S \cdot (1 - p - \alpha)}{12 \cdot \ddot{a}_{x,\overline{n}|}^{(12)} \cdot (1 + \beta + \delta)}, \tag{7}$$

where

$$\ddot{a}_{x,\overline{n}|}^{(12)} = \sum_{r=0}^{12(n - x - 1) + 11} \frac{1}{12} \, {}_{\frac{r}{12}}p_x \cdot v^{\frac{r}{12}} \tag{8}$$

is the expected present value of term life benefits in advance of $1/12$ of monetary units (m.u.), 12 times per year, conditional upon the life client, over a maximum of n years.

3. Product 3
   Product 3 contains a permanent monthly annuity and a programed withdrawal $p\,\%$ from an accumulated sum at the beginning of retirement time and includes survivors' benefits in an amount $k\,\%$ of the original monthly annuity with a certain payment period of l year.
   Monthly pension annuity (GMA_3) of Product 3 is given by formula

$$GMA_3 = \frac{S \cdot (1 - p - \alpha)}{12 \cdot \left(\ddot{a}_x^{(12)} + k \cdot A_x^{(12)} \cdot \ddot{a}_{\overline{l}|}^{(12)} \right) \cdot (1 + \beta + \delta)}, \tag{9}$$

where

$$A_x^{(12)} = \sum_{r=0}^{12(\omega - x - 1) + 11} {}_{\frac{r}{12}|\frac{1}{12}}q_x \cdot v^{\frac{r+1}{12}}$$

is the expected present value of whole life benefits in the case of death of the pensioner, and

$$\ddot{a}_{\overline{l}|}^{(12)} = \frac{1}{12} \cdot v^{-\frac{1}{12}} \cdot \frac{1 - v^l}{v^{-\frac{1}{12}} - 1}$$

is the present value of an annuity-certain payable monthly in an amount of $1/12$ of one m.u. during l years. For more information, see for example Urbaníková and Maroš (2014).

4. Products with Respect to the Force of Mortality and Technical Interest Rate

Constants A, B and c for modelling of survival probability, with respect to expression (3), can be obtained by modelling of the force of mortality using IBM SPSS Statistics 19 system. On modelling of the curve of the force of mortality, we used unisex life tables which are published on the web site of the Statistical Office of the Slovak Republic. These constants for the years 2012 – 2014 are stated in Table 1.

Table 1: Constants of the survival model using unisex life tables

	A	B	c
2012	0.001362	0.00001374	1.113503
2013	0.000352	0.00001861	1.109063
2014	0.001433	0.00001293	1.113202

Source: the authors.

Table 2: Constants of the survival model using gender life tables 2014

	A	B	c
Male	0.000000	0.0000689	1.094054
Female	0.000000	0.00000434	1.126396

Source: the authors.

Corresponding probabilities of survival and death using unisex life tables of the year 2014 and formula (5) are listed in Table 3.

Table 3: Spreadsheet results for the calculation of actuarial functions using the Survival Model using unisex life tables of 2014

x	${}_{1/12}p_x$	${}_{1/12}q_x$
62	0.999029013	0.000970987
$62\frac{1}{12}$	0.999021562	0.000978438
$62\frac{2}{12}$	0.999014043	0.000985957
$62\frac{3}{12}$	0.999006457	0.000993543
$62\frac{4}{12}$	0.998998803	0.001001197
$62\frac{5}{12}$	0.99899108	0.00100892
$62\frac{6}{12}$	0.998983288	0.001016712
.	.	.
.	.	.
.	.	.
$129\frac{11}{12}$	0.294324474	0.705675526
130	0.291105525	0.708894475

Source: the authors.

In Tables 4 and 5, we offer monthly paid annuities with respect to our individual products on the basis of life tables of the years 2012 – 2014. All monthly paid out annuities are calculated with a basic accumulated sum of 10,000 €. In all products, we used initial costs in an amount of 3 % from the accumulated sum, administrative costs in an amount of 3 ‰ from yearly annuity and collection costs in an amount of 1 ‰ from the yearly annuity. In the last part, we assume initial costs 6 % and 10 % to compare the impact of initial costs on the amount of pension annuity. Moreover, we assume temporary pension annuities during $n = 15$ years, certain annuities during $l = 5$ years and in an amount 30 % from the original monthly annuity.

From these numbers, we can see that the impact of the force of mortality and the regress of the interest rate from 1.9 % to 0.7 % causes an average 14 % regress of monthly annuity in 2012; and 10 % in 2013 and 2014. What is very important, in comparison of the years 2012 with an interest rate 1.9 % and 2014 with an interest rate 0.7 %, the regress of monthly annuity is even 17 %. These data include also different forces of mortality with respect to individual monitored years.

Table 4: The amount of gross monthly pension annuities (€) according to retirement age with an accumulated sum 10,000 € and technical interest rate 1.9 % p. a.

Retirement age	2012			2013		
x	GMA_1	GMA_2	GMA_3	GMA_1	GMA_2	GMA_3
62	38.78	51.62	36.31	36.66	49.13	34.36
63	40.21	52.38	78.52	38.00	49.84	35.49
64	41.73	53.22	38.81	39.43	50.64	36.70
65	43.37	54.17	40.18	40.96	51.53	37.99
66	45.13	55.23	41.65	42.61	52.52	39.36
67	47.03	56.41	43.22	44.37	53.62	40.83
68	49.07	57.74	44.89	46.28	54.85	42.38
69	51.28	59.23	46.67	48.32	56.23	44.05
70	53.66	60.89	48.58	50.53	57.76	45.82
71	56.23	62.76	50.63	52.91	59.47	47.71
72	59.02	64.85	52.81	55.48	61.39	49.74

Source: the authors.

Individual costs also have a significant impact on the amount of monthly annuities. The increase of only initial costs from the original 3 % from the accumulated sum to 6 % causes of decrease of monthly annuity of 4.5 % and to 10 % a decrease of 10 %. For more information, see Table 5, three last columns and Table 6. Table 6 and also the last three columns of Table 5 show that monthly annuity with original costs decreases by 5 % against net monthly annuity, by 9 % with changed initial costs on 6 % and even by 14.5 % with changed initial costs on 10 %.

Table 5: The amount of gross monthly pension annuities (€) according to retirement age with an accumulated sum $10,000$ €

Retirement age	Gross monthly annuity 2014, $i = 1.9\,\%$			Gross monthly annuity 2014, $i = 0.7\,\%$		
x	GMA_1	GMA_2	GMA_3	GMA_1	GMA_2	GMA_3
62	38.78	51.62	36.31	31.80	45.05	29.62
63	40.21	52.38	78.52	33.07	45.69	30.70
64	41.73	53.22	38.81	34.43	46.40	31.85
65	43.37	54.17	40.18	35.88	47.19	33.08
66	45.13	55.23	41.65	37.45	48.08	34.39
67	47.03	56.41	43.22	39.13	49.08	35.79
68	49.07	57.74	44.89	40.94	50.20	37.29
69	51.28	59.23	46.67	42.89	51.45	38.88
70	53.66	60.89	48.58	45.00	52.85	40.59
71	56.23	62.76	50.63	47.28	54.43	42.41
72	59.02	64.85	52.81	49.74	56.19	44.36

Source: the authors.

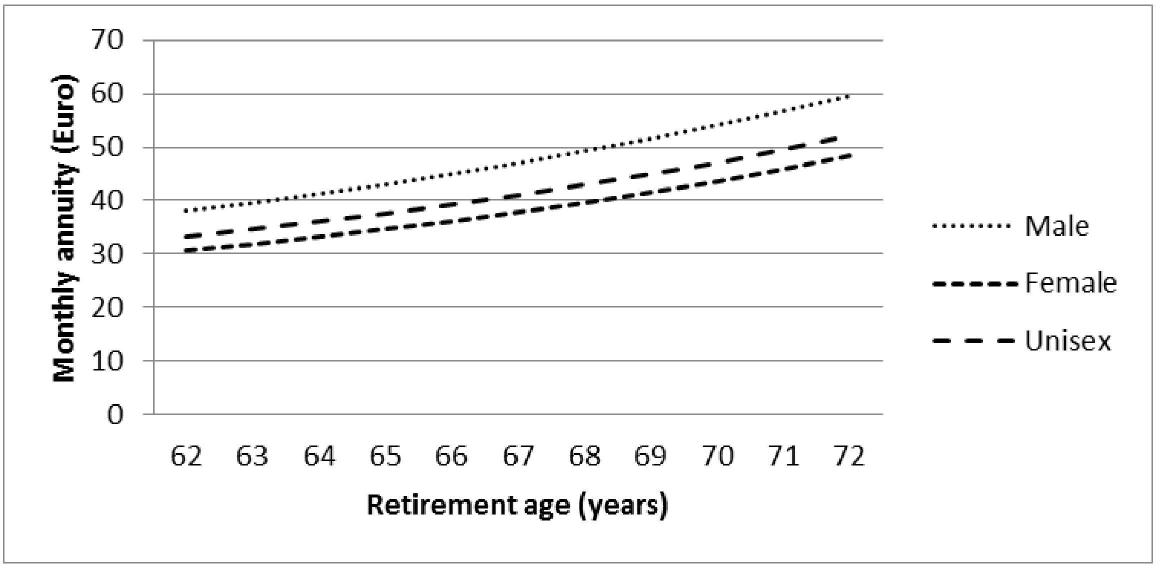
Table 6: The amount of gross (*GMA*) and net (*NMA*), monthly pension annuities (€) according to retirement age with the accumulated sum $10,000$ €, 2014, $i = 0.7\,\%$

Retirement age	Net monthly annuity			Gross monthly annuity costs $\alpha = 6\,\%$			Gross monthly annuity costs $\alpha = 10\,\%$		
x	NMA_1	NMA_2	NMA_3	GMA_1	GMA_2	GMA_3	GMA_1	GMA_2	GMA_3
62	33.28	47.16	31.00	30.34	42.99	28.25	28.44	40.30	26.46
63	34.61	47.82	32.13	31.55	43.59	29.29	29.58	40.87	27.49
64	36.04	48.57	33.35	32.85	44.28	30.40	30.80	41.51	28.50
65	37.57	49.41	34.64	34.24	45.04	31.57	32.10	42.22	29.60
66	39.21	50.34	36.01	35.74	45.89	32.83	33.51	43.02	30.78
67	40.97	51.39	37.48	37.35	46.85	34.17	35.02	43.92	32.03
68	42.88	52.57	39.05	39.08	47.92	35.60	36.64	44.92	33.37
69	44.92	53.88	40.72	40.95	49.12	37.12	38.39	46.05	34.80
70	47.14	55.36	42.53	42.97	50.46	38.75	40.28	47.31	36.33
71	49.53	57.01	44.43	45.15	51.97	40.50	42.32	48.72	37.97
72	52.11	58.87	46.47	47.50	53.66	42.36	44.53	50.31	39.72

Source: the authors.

Based on the life tables of male, female and unisex, with technical interest rate 0.7 % p. a. men could see a reduction in monthly pension income from pension annuities of around 15 % on average; women could see a pension income rise of around 7 % on average. See Figure 1.

Figure 1: Net monthly premium of Product 1 with respect to gender using life tables 2014



Source: the authors.

5. Conclusion

In this paper, we have discussed selected products of the third pillar pension scheme stated by Act 650/2004 Coll., related to the payout phase. In particular, we focused on products which are defined for contracts with supplementary pension companies before January 1, 2014 unless the clients signed an annex to the contract by the amended Act. These mentioned contracts offer annuities calculated with respect to actuarial procedures.

Individual products have been modeled using the expected present values of the corresponding benefits. These products are influenced by a lot of factors and we have focused on the impact of administrative costs, technical interest rate and the force of mortality.

We have considered the latest constant technical interest rates in an amount 1.9 % p.a. and 0.7 % p.a. In our further research, we plan to study the impact of the force of mortality from the statistical point of view, which we would like to model by the so-called generalized Gompertz-Makeham's formula, in a shape (3) where the constants will be replaced by polynomials of higher degrees (Forfar et al., 1988; Macdonald, 1996).

In our work, we plan to deal with the Consultation paper on the creation of a standardised pan-European personal pension product[3]. Moreover, we plan to deal with very inspirative papers by Mihalechová and Bilíková (2014), Konicz and Mulvey (2015) and Konicz, et al. (2015, 2016).

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[3]The consultation paper is available at https://eiopa.europa.eu/Publications/Consultations/EIOPA-CP-15-006-Consultation-paper-Standardised-Pan-European-Personal-Pension-product.pdf. (accessed at September 15, 2015)

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