Increasing life expectancy – the impact on old-age pension benefits

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Abstract. The demographic changes currently observed in European markets have an important effect on the stability of pension systems and the amount of old-age pension benefits. One of the most important changes is increasing life expectancy, which will significantly affect the amount of old-age pension benefits. These old-age pension benefits come from both the statutory and the voluntary parts of the pension system and are the main source of income for most elderly households. The reduction of these benefits as a result of increasing life expectancy is a major threat to the financial situation of retiree households. The purpose of this paper is to identify the impact of increasing life expectancy on old-age pension benefits from both the statutory part and selected forms of the voluntary part of the pension system operating in Poland. To achieve this aim, life annuity calculations were used. The results obtained clearly indicate the impact of increasing life expectancy on the amount of benefits received by elderly people, in particular from the compulsory part of the pension system. In the case of selected voluntary forms of the optional part of the pension system, the possibility of differentiating benefits based on gender has a significant effect on the amount of these benefits.

Keywords: life expectancy, old-age pension benefits, life annuities.
JEL Codes: G22, J26, J11.

1. Introduction

   The population ageing[2] is a global and irreversible process, and the degree of advancement depends on the phase of development of a given society. The demographic trends observed in Poland that have a direct effect on the age structure of the population and simultaneously on the process of the ageing of the population are the consequence of many factors, among which the systemic and

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[2] The process of the population ageing as well as its effects have been discussed in the literature (*inter alia* [Lipczyńska, 2015; Dragan 2011; Kilian 2010; Szukalski 1998]).

structural changes that began in the 1990s should be mentioned. Noteworthy most of all are the trends in the development of average life expectancy, the level of fertility and migration abroad, which determine the changes in the age structure of the population as well as the intensity of the process of the population ageing.

In Poland, much as in other European countries, there is a visible positive trend toward the regular extension of average life expectancy, which is regarded as one of the greatest successes in the history of humanity [Bloom et al. 2015]. Available forecasts regarding the average life expectancy at birth in Poland indicate that the average life expectancy for men will increase from 72.8 years in 2013 to 82.6 years in 2060, whereas the average life expectancy for women will increase from 80.9 years in 2013 to 88.1 years in 2060 [European Commission (EC) 2015]. This situation may have a significant effect on the realisation of demographic risk (in particular the risk of longevity) in the Polish pension system [Kowalczyk-Rólczyńska 2016; Szczepański 2014], because increased longevity implies extension of the period during which old-age pension benefits are received. If together with the growth of the period of receiving old-age pension benefits there is no corresponding growth in capital[3] accumulated through the pension system during the period of professional activity, the amount of those benefits will become progressively lower. It should be emphasised that the realisation of demographic risk in the pension system is also influenced by the decreasing number of births which in the years to come imply a decreasing number of individuals of productive age [Góra 2003]. Significant is the fact that the growing number of individuals in retirement generate increased needs for the payment of old-age pension benefits, which in pay-as-you-go systems are financed by current old-age pension insurance contributions by working individuals. If there are fewer and fewer of these individuals, then the problem of maintaining financial liquidity appears and consequently payments of pensions from the statutory part of the pension system become not only a substantial burden on public finances, but also do not achieve their fundamental aim of ensuring material security for old-age [Szumlicz 2015]. It should be noted that the low amount of old-age pension benefits from both the statutory and the supplementary parts of the pension system (under the condition that a given person has any additional forms of old-age insurance at all) will have an effect on the growth in the risk of poverty among the elderly [Babiak 2012; Zaidi 2010]. Women are at a decidedly greater risk of poverty among the elderly. This is linked with the fact that they live longer than men and receive lower old-age pension benefits. Moreover, during their working lives, women receive lower compensation, which translates into lower old age pension insurance contributions, and consequently into a lower amount of accumulated capital, which is the basis for the calculation of old-age pension benefits [EC 2011].

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[3] Under the concept of capital one should understand here both accumulated pension entitlements (if the pension system is financed on a pay-as-you-go basis) (cf. [Ortyński 2010], indicated also by the abbreviation MKUE – Międzypokoleniowy Kapitał Uprawnień Emerytalnych [Intergenerational Pension Entitlement Capital] (cf. [Owczarek 2009]), as well as financial resources invested in financial assets (if the system is equity funded) (cf. [Szczepański 2015]).

The aim of this article is to evaluate the effect of the increase in longevity on the amount of old-age pension benefits paid to older persons living in Poland as part of the statutory pension system as well as selected supplementary retirement security. To this end, life annuity calculations were used.

2. Old-age pension benefits paid from the statutory part of the pension system and increasing longevity

People living in Poland receive old-age pension benefits from the Social Insurance Fund (FUS), which is administered by the Social Insurance Institution (ZUS). The benefit is paid as part of the statutory part of the pension system. The amount of old-age pension benefits in the reformed pension system (a reform of the pension system in Poland entered into force on 1 January 1999) is equal in value to the sum of old-age pension insurance contributions collected after 31 December 1998 plus the amount of valorised initial capital funds and the sum of funds credited to a subaccount, divided by average remaining life expectancy, expressed in months, for individuals of the same age as the person applying for the granting of old-age pension benefits [ZUS 2016]. Because of a legal settlement, the first old-age pension payments according to the new rules were made in 2009. The amount of such old-age pension benefits can be written as:

$$b = \frac{K}{e_x}$$

where: b – the amount of old-age pension benefits, K – the sum of accumulated capital, e_x – average life expectancy of a person aged x (expressed in months) who is applying for granting of an old-age pension.

In 2009, the amount of the average old-age pension benefit paid by the ZUS was PLN 1602.34 [Statistics Poland (GUS) 2010]. In that same year, the average life expectancy for 60-year-olds (that was the retirement age for women at that time) was 247.3 months [GUS 2010]. On the basis of these two statistics the amount of capital K was calculated, which simultaneously constituted the basis for further calculations. The amount of this capital was estimated as PLN 396,258.68. Calculations for the following years were made only for the first pillar of the pension system; capital accumulated within the second pillar was not taken into consideration. As mentioned above, in 2009 began the payment of old-age pension benefits from combined first and second pillars, however, the amount of money paid from the second pillar was insignificant[4]. Table 1 presents the amount of old-age pension benefits from the first pillar in the years 2009-2015, calculated according to the algorithm used by the ZUS. Moreover, it was assumed that the amount of accumulated capital was the same

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[4] According to estimates by *Gazeta Podatkowa* [2007], the monthly old-age pension benefit from the second pillar paid in 2009 should be between PLN 40 and PLN 70.

for each year[5] and the table of average life expectancy for both sexes published each year[6] was used. The assumption made that in each successive year, a person deciding to retire would hold exactly the same amount of accumulated capital that is the basis for granting old-age pension benefits, means that the results presented in Table 1 are an approximate representation of the actual average amount of monthly old-age pension benefits from the first pillar of the retirement system. Table 1 also presents for each of the analysed years the ratio between the average monthly old-age pension benefit paid from the first pillar of the pension system to the average monthly gross wages and salaries [GUS, undat.].

Table 1. Results of the calculation of old-age pension benefits paid by ZUS

Year	Average life expectancy for 60-year-olds [months]	Average monthly amount of old-age pension benefit from the first pillar for persons aged 60 [PLN]	Average monthly gross wages and salaries [PLN]	Ratio between the average monthly amount of old-age pension benefit paid from the 1st pillar of the pension system to average monthly gross wages and salaries
2009	247.3	1602.34	3 315.38	0.4833
2010	247.5	1601.05	3 435.00	0.4661
2011	251.5	1575.58	3 625.21	0.4346
2012	254.8	1555.18	3 744.38	0.4153
2013	255.2	1552.74	3 877.43	0.4005
2014	256.4	1545.47	4 003.99	0.3860
2015	261.4	1515.91	4 150.88	0.3652
2016	259.6	1526.42	4 118.63	0.3706

Source: Author's own calculations based on GUS data.

The obtained results unambiguously indicate that in each successive year, a person aged 60 entering retirement would receive progressively lower benefits from the first pillar of the old-age pension system (assuming that each of these persons at the moment of retirement held exactly the same amount of capital, which constituted the basis for granting old-age pension benefits). Unsettling is also the fact that from year to year the ratio of the old-age pension benefit received from the first pillar to average monthly gross wages and salaries grew progressively worse. The cause of this situation was not only the increase in life expectancy for individuals aged 60, but also the increase in wages and salaries. These results, although they are only an approximation of real conditions, unambiguously indicate the need to accumulate additional retirement savings.

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[5] Changes in the value of capital (e.g. indexing capital to the level of inflation) could interfere with the reading of the effect of increasing life expectancy on the amount of old-age pension benefits .
[6] These tables are published as attachments to the Announcements of the President of GUS regarding the table of the average life expectancy of women and men in March of every year (since 2009).

It should be emphasised that the clear fall in the standard of living of people entering retirement with each successive year may have a significant effect on the realisation of the previously mentioned risk of poverty among older people. The EC has indicated that in many countries in Central and Eastern Europe the poverty rate among the elderly population will increase. The problem of poverty will in particular affect women over the age of 65 who live alone [EC 2011]. In the Polish market, this problem may affect people who receive minimal old-age pension benefits. In 2009, this was PLN 675.1 [GUS 2010], which constituted a mere 42.13% of the average old-age pension benefit paid by ZUS in 2009. In March 2017, the amount of the minimum old-age pension benefit in Poland was raised to PLN 1000[7]. Considering that the amount of the average old-age pension benefit paid by ZUS in March 2017 was PLN 2,085.60 [ZUS 2017], the ratio of the minimum old-age pension benefit to the average old-age pension benefit rose insubstantially to 47.95%. It should be emphasised that in the Polish market, women receive substantially lower old-age pension benefits than men. Moreover, as many as nearly 70% of women receive old-age pension benefits lower than the average old-age pension benefit paid by ZUS[8].

3. The effect of the increase in life expectancy on the benefits paid as part of equity release products

One source of additional retirement income may be equity release products, which are offered in many countries either on the loan model, the sales model, or both models combined [Salter 2014; Reifner et al. 2009; Tse 1994]. This article focuses on the sales model (*home reversion*). On the Polish market, this model is offered by mortgage funds (the best known are Fundusz Hipoteczny DOM, Fundusz Hipoteczny Familia), which as a rule pay a monthly life annuity benefit (although there is the possibility for a lump sum benefit or payment in several instalments [Fundusz Hipoteczny 2017]). Thus, the actuarial life annuity served here as well [Skałba 2003; Gerber 1990; Milevsky 2013]. According to Matłoka [1997] a life annuity is paid periodically, but only as long as the beneficiary is alive. The amount of the periodic (e.g. monthly) life annuity benefit paid to a person aged x at the beginning of every m of this payment period by the mortgage fund, if that person is still living can be written as:

$$b = \frac{RW_0 \cdot \alpha}{m \cdot \ddot{a}_x^{(m)}}$$

where:
b – the amount of the monthly life annuity benefit, $RW_0 \cdot \alpha$ – the value of home reversion, defined as a percentage of the market value of the property at the moment

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[7] According to the Act of 2 December 2016 regarding changes to old-age and other pensions from FUS, as well as several other acts [Journal of Laws 2017 item 2].
[8] Calculated on the basis of data from March 2017 [ZUS 2017].

the contract is concluded between an older person and a mortgage fund (also defined as Loan-to-Value, LtV), $\ddot{a}_x^{(m)}$ – the actuarial present value of a whole life annuity of 1 per year, payable in instalments of $1/m$ m-times per year at the beginning of every $1/m$ part of a year as long as the person aged x is alive. It is defined using the formula [Błaszczyszyn, Rolski 2004; Bowers et al., 1997]:

$$\ddot{a}_x^{(m)} = \frac{1}{m} \sum_{k=0}^{\infty} v^{\frac{k}{m}} \cdot {}_{\frac{k}{m}} p_x$$

where: $v^{\frac{k}{m}} {}_{\frac{k}{m}} p_{\overline{x}}$ the actuarial current value of payments in the amount 1 at the moment $\frac{k}{m}$, $v^{\frac{k}{m}}$ – discount factor, ${}_{\frac{k}{m}} p_x$ – probability of survival by the person aged x for further $\frac{k}{m}$ periods.

The formula above can be written, assuming uniform distribution of deaths over the year, as:

$$\ddot{a}_x^{(m)} = \ddot{a}_x - \frac{m-1}{2m}$$

where: $\ddot{a}_x$ – is the actuarial present value of a whole life annuity paid in the amount 1 per year at the beginning of each year as long as the person aged x is alive, m – number of payment periods in 1 year.

With the aim of showing the influence of increasing life expectancy on the amount of monthly life annuity benefit paid by an equity release product on the sales model, the following assumptions were made:

- the monthly life annuity benefit was determined for a 60-year-old woman and a 65-year-old man for the years 2009-2016;
- for each year the life expectancy table for women and for men issued by GUS was used,
- for the price per square meter for residential property, the average price per square meter of residential property on the secondary market was adopted, calculated as the average price for the largest cities in Poland in 2010[9] (since 2010, a stabilisation of residential real estate prices on the Polish market can be observed);
- the area of the residential unit adopted for the calculations was 60 m²;
- the average interest rate for mortgages issued in Polish currency, i.e. 4.5%[10] (as the average of all analysed years) was adopted as the discount rate;
- α was set at the level of 0.5[11].

The results of the calculations are shown in Table 2.

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[9] The data for the calculations come from [National Bank of Poland (NBP) 2011]. The average value for 1 m² of residential property in 2010 for the largest Polish cities was 2688.25 PLN.

[10] Calculated based on data from the report on residential loans and sales prices for real estate published by Sarfin-Amron [undat.].

[11] In developed markets the value of α as a rule depends on the age of the individual wishing to take out an equity release product. For example, on the Australian market, where the loan model is offered,

Table 2. Amount of monthly life annuity benefits paid through equity release on the sales model (PLN)

Year	2009	2010	2011	2012	2013	2014	2015	2016
for a man aged 65	1293.95	1273.77	1256.62	1252.81	1245.88	1222.91	1233.63	1217.53
for a woman aged 60	917.57	909.96	903.75	904.06	902.41	892.74	895.83	888.53

Source: Author's own calculations based on GUS data.

The presented results show the amount of monthly life annuity benefit a 60-year-old woman or a 65-year-old man would receive if they were to conclude contract for equity release on the sales model with a mortgage fund. It can be seen that in each successive year (from 2009-2014), the amount of the life annuity benefit paid to a man who turned 65 in that year was lower. Only in 2015 was it slightly higher. This is a consequence of the change in the number of people surviving in the subsequent years. In the end, the difference in the amount of monthly life annuity benefit paid to a man who turned 65 in 2009 and a man who turned 65 in 2016 was PLN 76.42. Bearing in mind the fact that equity release products are directed toward individuals (known as *asset-rich, cash-poor* [Li et al. 2010]), who have low income and simultaneously own property of moderate or high value, this difference may be significant. In the case of payments for women, they fall in the years 2009-2011, 2012-2014, as well as 2015-2016. However, these differences are minor.

When determining the amount of monthly life annuity benefit paid from equity release products, a certain pattern should be kept in mind that the older a beneficiary is, the higher the amount of the benefit received from this product will be, assuming price stability on the residential real estate market. Thus, also from the point of view of potential beneficiaries, the time the decision is made to use equity release services is very important. To illustrate this phenomenon, the amount of monthly benefits received for whole life were calculated for women aged 60 to 85, living in a city[12] and owning a residential unit 60 m² in size. For the calculations, the life expectancy table from 2015 was used.

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the LtV value rises with the age of the beneficiary and for a 60-year-old woman, the value of this indicator is between 25-30% [MoneySmart, undat.]. In contrast, Fundusz Hipoteczny Familia, operating on the Polish market, provides the information that through their sale model between 60% and 80% of the value of the property is paid [Familia SA, undat.]. The value for LtV adopted in this paper is a value located in the middle of these two solutions.

[12] For calculation of these values the life expectancy table for women aged *x* living in a city was used. It should be pointed out that mortgage funds are mainly interested in properties in large cities [Fundusz Hipoteczny, undat.]. It should be added that GUS publishes life expectancy tables both for the population as a whole as well as for urban residents and for those living in the country (by gender).

Table 3. The amount of monthly life annuity benefits paid to women aged 60-85 living in cities

Age	Average life expectancy [months]	Amount of the monthly life annuity benefit [PLN]	Age	Average life expectancy [months]	Amount of the monthly life annuity benefit [PLN]
60	289.8	793.74	73	168.60	1122.83
61	279.84	809.44	74	159.96	1166.41
62	270.00	826.19	75	151.56	1213.70
63	260.28	844.09	76	143.28	1265.89
64	250.68	863.24	77	135.24	1322.84
65	241.08	884.03	78	127.44	1385.11
66	231.72	906.08	79	119.88	1453.35
67	222.36	930.10	80	112.56	1528.32
68	213.12	956.01	81	105.60	1609.39
69	204.00	984.00	82	99.00	1696.94
70	195.00	1014.33	83	92.64	1793.26
71	186.12	1047.26	84	86.64	1897.23
72	177.24	1083.63	85	80.88	2011.68

Source: Author's own calculations based on GUS data.

The significantly increasing amount of monthly life annuity benefits, shown in the table above may constitute an important criterion in deciding to take out an equity release product. An individual wishing to use these services may postpone their decision for later, being aware that the older they are when they sign the contract with the entity offering the product, the higher the benefits they will receive[13]. It should still be emphasised that the appropriate time to decide to take advantage of the capital accumulated in real estate will be affected by factors regarding the potential beneficiaries themselves, including their financial situation, their financial needs in the coming years, and the state of their health.

4. Benefits paid by unit-linked insurance products and increasing life expectancy

Older individuals, seeking to raise their standard of living in retirement, may also take advantage of funds that they accumulate during their working lives, including through available forms of voluntary retirement insurance. One of these forms are

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[13] Assuming that life expectancy for persons aged x does not rapidly increase in subsequent years.

unit-linked insurance products, offered by life insurance companies. The accumulated funds in this form of voluntary retirement insurance may be paid out in a lump sum, for life, or with a fixed time horizon. Taking into consideration the third option, calculation of the benefit can be made on the basis of an actuarial *n*-year temporary life annuity. The amount of the periodic (e.g. monthly) benefit paid to a person aged *x* at the beginning of every *m* of this payment period by the life insurance company, if that person is still living can be written as:

$$b = \frac{K}{m \cdot \ddot{a}_{x:n\rceil}^{(m)}}$$

where: *K* – the amount of capital accumulated in the unit-linked insurance product, $\ddot{a}_{x:n\rceil}^{(m)}$ – the actuarial present value of a temporary (*n*-year) life annuity of 1 per year, payable in instalments in the amount $1/m$ *m*-times a year at the beginning of every $1/m$ part of a year over *n* years as long as a person aged *x* is alive. This can be determined using the formula [Gerber 1990]:

$$\ddot{a}_{x:n\rceil}^{(m)} = \alpha(m)\ddot{a}_{x:n\rceil} - \beta(m)(1 - {}_np_x v^n)$$

where:
$\alpha(m) \approx 1$, $\beta(m) \approx \frac{m-1}{2m}$ assuming the uniform distribution of deaths over the year, $\ddot{a}_{x:n\rceil}$ – the actuarial present value of temporary (*n*-year) life annuity paid in the amount 1 per year at the beginning of each year for a maximum of *n* years as long as the person aged *x* is alive, ${}_np_x$ – the probability that a person aged *x* will survive at least *n* years.

In order to examine how increasing life expectancy affects the amount of benefits received from savings accumulated in unit-linked insurance, the amount of monthly benefits paid out over the subsequent 20 years for a 60-year-old beneficiary has been outlined. The monthly amount of the benefits has been calculated for the years 2009-2016 (Table 4), using the life expectancy table for both genders[14] for each of the analysed years. Moreover, the following assumptions were made:
  – the amount of accumulated capital is PLN 200 000;
  – an annual interest rate of 2.5%[15];
  – provisions and additional fees charged by the insurance company have been omitted.

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[14] The Act of 14 December 2012 regarding the change in the act on the insurance business introduced the provision, which remains in effect and states that *the use by an insurance company of the criterion of gender in the calculation of insurance premiums and benefits may not lead to differentiation of insurance premiums of benefits for specific individuals*. In the legal act in force, i.e. the Insurance and Reinsurance Business Act of 11 September 2015, this provision is found in Art. 34.1 [Journal of Laws 2013 item 53].

[15] The value adopted for the percentage rate is close to the interest rate for 10-year Polish Treasury obligations. Moreover, the value of 2.5% adopted for the calculations is lower than the average maximum technical rates in force during the period 1 May 2009-30 April 2016. According to § 46.3. of the Ordinance of the Minister of Finance of 12 April 2016 regarding detailed accounting rules for insurance

Table 4. The amount of monthly benefits paid to a person aged 60 over the following 20 years from capital accumulated in unit-linked insurance

Year	2009	2010	2011	2012	2013	2014	2015	2016
Amount [PLN]	1041.72	1035.74	1031.45	1031.16	1029.67	1021.43	1025.19	1020.67

Source: Author's own calculations based on GUS data.

The above results point to two relevant questions. First, over the course of the eight analysed years, the amount of the monthly benefits paid over twenty years to individuals who have turned 60 in the given year showed a declining trend, although these changes were not particularly large (from year to year the amount of the benefits differs by only a few zlotys). Secondly, if insurance companies were able to differentiate benefits based on gender, women would receive lower benefits than men. The inability to differentiate benefits by gender causes that women can receive higher benefits than they would if gender differentiation was applied. It should be mentioned that if insurance companies operating on the Polish market offered equity release services, the benefits women shall receive would be higher than in the case of those benefits paid by entities for which differentiation of benefits by gender does not apply.

It should be indicated that the above calculations of the impact of increasing life expectancy on the amount of benefits received from unit-linked insurance is not significant.

5. Conclusion

The calculations presented in this paper of the payment of old-age pension benefits from the statutory part of the pension system as well as the benefits paid by selected forms of supplementary retirement security are lower from year to year. A clearly greater decline is noted by using the life expectancy tables for women and men. The decline in these values is greater for benefits paid to men, and lower in the case of benefits paid to women. It can thus be concluded that increasing life expectancy has a greater impact on the amount of benefits paid to men as a group than to women as a group. It should be pointed out that in the above calculations many different assumptions were made, which means that the results obtained are an approximation of reality. Reduction of the number of assumptions and consideration of other factors affecting the amount of benefits could be the next stage in research in this area. Nevertheless, the annually declining amount of old-age pension benefits paid

and reinsurance companies, *the maximum technical rate is set and announced by the supervisory body on 31 January of each year*. Analysis of the General Terms and Conditions of Insurance (GTC) regarding unit-linked insurance clearly shows that life insurance companies use for proper calculations a technical interest rate lower than the maximum technical rate announced for a given year [Journal of Laws 2016 item 562].

from the first pillar of the pensions system together with the simultaneous increase in average wages and salaries in the national economy cause the ratio of these two values to decline significantly from year to year. The lack of additional retirement security could thus lead to an increase in the number of elderly people in danger of poverty. It is therefore also essential to accumulate additional savings during the period of professional activity.

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Abbreviations

EC – European Commission; FUS – Social Insurance Fund (*Fundusz Ubezpieczenia Społecznego*); GTC – General Terms and Conditions of Insurance; GUS – Statistics Poland (*Główny Urząd Statystyczny*); LtV – Loan-to-Value; MKUE – Intergenerational Pension Entitlement Capital (*Międzypokoleniowy Kapitał Uprawnień Emerytalnych*); ZUS – Social Insurance Institution (*Zakład Ubezpieczeń Społecznych*).