VALUATION OF EQUITY RELEASE CONTRACTS IN POLAND COMPARED TO THE CZECH REPUBLIC AND THE SLOVAK REPUBLIC*

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Considerable progress in the development of medicine, and the growing awareness within society of healthy nutrition and lifestyle have contributed to the increase of life expectancy. The elderly population in Europe is growing. This population group will probably not have enough income to cover their retirement needs. It appears that the pension funding gap will become one of the critical social issues facing Europe. However, many elderly people hold a large amount of wealth in the form of real estate, however many of them do not want to sell their properties and to move from their home. However, markets in different countries offer the so-called equity release contract for the retired, which could help them cover their financial needs.

People can surrender their real estate to a company interested in acquiring such a property, in exchange for monthly benefits. One such possibility is a reverse annuity contract (like a sales model) or a reverse mortgage (like a credit model), which have existed in Poland for several years. Due to the fact that the couples often own property, the marriage reverse annuity contract is considered here.

This study's main purpose is to apply the generalized reversionary annuity model to determine the benefit of marriage reverse annuity contracts and reverse mortgages (cf. Marciniuk, 2017). To determine the amount of two equity release contract the author considered a particular case of a marriage joint life and reversionary annuity (cf. Luciano,

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Spreeuw, and Vigna, 2016), which pays yearly one financial unit as long as both spouses are alive, and a fraction R of it (R means a reduction factor, $R \in [0,1]$) when only one of the couple is alive. These benefits are calculated based on the equivalent principal. The benefits depend on the age of spouses, their future lifetime, and the real value of their properties, which, in turn, is determined by the place where they live; the frequency of payments also affects the amount of the benefit.

Let W be the real value of the estate. Only percentage α of real estate W is paid to the owners. Usually $\alpha \in (0\%,\ 50\%]$. Moreover m means the number of sub-periods of year ($m > 0$) and (x, y) are ages of entry of x-year-old husband and y-year-old wife. The independent random variables $K_x^{(m)}$ and $K_y^{(m)}$ describe the future lifetimes of the x-year-old man and the y-year-old woman, which is determined in sub-periods of a year. The benefit of a reverse annuity contract $\ddot{b}_{(x,y)}^{(m)}$ is paid for the whole lifetime, and the reverse mortgage $\ddot{b}_{(x,y):\overline{n}|}^{(m)}$ is paid only for n-years. Both benefits are calculated on the basis of the following lemmas (cf. Marciniuk, 2017).

Lemma 1. The yearly benefit of marriage reverse annuity contract for spouses (x, y), which pays $\frac{1}{m}$ at the beginning of sub-period of a year as long as both spouses are alive, and $\frac{R}{m}$ $(m > 0)$ when only one spouse is alive, is calculated as follows

$$\ddot{b}_{(x,y)}^{(m)} = \frac{\alpha \cdot W}{R\ddot{a}_x^{(m)} + R\ddot{a}_y^{(m)} + \ddot{a}_{x:y}^{(m)}(1-2R)}. \tag{1}$$

The Last Surviving Status (LLS) is a special case when $R = 1$ and the Joint-Life Status (JLS) occurs when $R = 0$.

Value $\ddot{a}_x^{(m)}$ is the actuarial value of the whole life annuity for a person aged x and $\ddot{a}_{x:y}^{(m)}$ is the actuarial value of the whole life annuity for JLS, which pay $\frac{1}{m}$ at the beginning of a year (cf. Marciniuk, 2016).

The marriage reverse mortgage is determined on the basis of second lemma, which is as follows (cf. Marciniuk, 2017)

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Lemma 2. The term of yearly actuarial value of due life annuity for spouses (x, y), which pays $\frac{1}{m}$ $(m > 0)$ financial unit at the beginning of sub-period of a year as long as both spouses are alive, and a fraction R of it when only one spouse is alive, is calculated as follows

$$\ddot{a}^{(m)}_{(x,y):\overline{n}|} = \frac{1}{m}\sum_{k=0}^{n\cdot m-1} v^{\frac{k}{m}}\left[R\left({}_{k/m}p_x - {}_{k/m}p_{x:y}\right) + R\left({}_{k/m}p_y - {}_{k/m}p_{x:y}\right) + {}_{k/m}p_{x:y}\right] = R\ddot{a}^{(m)}_{x:\overline{n}|} + R\ddot{a}^{(m)}_{y:\overline{n}|} + \ddot{a}^{(m)}_{x:y:\overline{n}|}(1-2R). \quad (2)$$

Hence, the due benefit of a marriage reverse mortgage is determined by the following formula

$$\ddot{b}^{(m)}_{(x,y):\overline{n}|} = \frac{\alpha \cdot W}{R\ddot{a}^{(m)}_{x:\overline{n}|} + R\ddot{a}^{(m)}_{y:\overline{n}|} + \ddot{a}^{(m)}_{x:y:\overline{n}|}(1-2R)}. \quad (3)$$

The Last Surviving Status is a special case when $R = 1$ and the Joint-Life Status occurs when $R = 0$.

Appropriately, value $\ddot{a}^{(m)}_{x:\overline{n}|}$ is the actuarial value of term life annuity for a person aged x and $\ddot{a}^{(m)}_{x:y:\overline{n}|}$ is the actuarial value of the term life annuity for JLS, which pay $\frac{1}{m}$ at the beginning of a year (cf. Marciniuk, 2016).

The calculations of the benefits are based on fixed interest rate i and the interest rate function depending on time t for Polish real data. The discounting factor v^k for $k = 1,2,...,$ is given by the use of function $R_{0,k}$. The best fitted model is the Svensson model. In this case function $R_{0,k}$ has the following form (cf. Marciniuk, 2017)

$$R_{0,k} = \beta_0 + \beta_1\frac{\tau_1}{k}\left(1-e^{-\frac{k}{\tau_1}}\right) + \beta_2\left(\frac{\tau_1}{k}\left(1-e^{-\frac{k}{\tau_1}}\right) - e^{-\frac{k}{\tau_1}}\right) + \beta_3\left(\frac{\tau_2}{k}\left(1-e^{-\frac{k}{\tau_2}}\right) - e^{-\frac{k}{\tau_2}}\right), \quad (4)$$

where

$$\beta_0 = 0.02096,\ \ \beta_1 = -0.01684,\ \ \beta_2 = 0.05844,\ \ \beta_3 = -0.05069,$$
$$\tau_1 = 0.33388,\ \ \tau_2 = 0.57974.$$

Parameter β_0 is the long-term rate. To compare the results, the constant interest rate $i = \beta_0 = 2.096\%$ is also used to calculate the benefits.

The discounting factor $v^k = \exp(-k \cdot R_{0,k})$ for $k = 1, 2, \ldots$

For example, the yearly benefits of the marriage annuity contract (for $m = 1$) are presented in Table 1 for a married couple, when the husband is aged x and the wife is aged y, where $x, y \in \{60, 70\}$. It is assumed that they own a hundred square meter apartment. Its real value depends on the spouses' place of residence. Seven capitals of voivodeships were chosen to compare the results (cf. Marciniuk, 2017) based on data from 2015. The Life Tables data for the seven chosen voivodeships were used. Moreover, $R \in \left\{0, 0.25, \frac{1}{3}, 0.5, 0.75, 1\right\}$. The spot rate is denoted as *Sv* in Table 1. It is assumed that $\alpha = 50\%$.

Table 1. The benefit of marriage reverse annuity contract for different *R*

R	Wroclaw		Warsaw		Krakow		Lublin		Gdansk		Poznan	
	i	*Sv*	*i*	*Sv*	*i*	*Sv*	*I*	*Sv*	*i*	*Sv*	*i*	*Sv*
	x = 60, y = 60											
0	5122	5065	6866	6788	5564	5501	4166	4119	4967	4911	5228	5169
0.25	4453	4403	6003	5935	4893	4838	3640	3599	4343	4294	4563	4512
1/3	4268	4220	5762	5697	4704	4651	3493	3454	4168	4121	4378	4328
0.5	3939	3895	5333	5273	4367	4318	3232	3196	3858	3815	4049	4003
0.75	3531	3491	4797	4743	3943	3898	2907	2874	3470	3431	3638	3597
1	3200	3164	4359	4311	3594	3553	2641	2611	3154	3118	3304	3266
	x = 70, y = 60											
0	6584	6511	8742	8645	7227	7147	5427	5366	6438	6366	6787	6712
0.25	5337	5278	7160	7080	5913	5847	4394	4345	5241	5182	5510	5449
1/3	5021	4964	6753	6678	5575	5513	4131	4085	4935	4880	5185	5127
0.5	4488	4437	6063	5995	5003	4947	3691	3650	4419	4370	4638	4586
0.75	3872	3828	5258	5199	4336	4287	3182	3146	3820	3777	4004	3959
1	3404	3366	4641	4589	3826	3783	2796	2765	3364	3326	3522	3483
	x = 60, y = 70											
0	6185	6116	8264	8171	6730	6654	5007	4951	5975	5909	6339	6268
0.25	5300	5241	7112	7032	5819	5754	4326	4277	5145	5087	5442	5381
1/3	5059	5002	6796	6719	5568	5505	4138	4091	4917	4862	5197	5138
0.5	4637	4585	6242	6171	5126	5068	3807	3764	4517	4466	4768	4714
0.75	4121	4074	5561	5498	4580	4528	3400	3361	4026	3980	4242	4194
1	3709	3666	5015	4958	4139	4092	3071	3036	3631	3590	3820	3777

Source: (Marciniuk, 2017).

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It is obvious that the benefit is higher when the price per square metre of the apartment is higher, and fraction R is smaller. The benefits calculated by the assumption of a constant interest rate are higher than in the case of the Svensson model.

Equity release products are relatively new in Poland but they are not offered by commercial banks in the Czech and Slovak Republics. However, interest in these products is growing, especially as the minimum wage and pension in these countries are very low, therefore people have to look for an additional source of income. Consequently, the second result of the scientific research is the estimation the potential benefits of reverse marriage annuity and reverse mortgage contracts, using jointly the Svensson model function and empirical property data from the selected Czech, Slovak, and Polish cities (cf. Marciniuk and Zimková 2018, Marciniuk et al. 2020). The real data of interest rate are taken from the Central European Bank. Most of the numerical examples are the result of the scientific cooperation of A. Marciniuk, E. Zimková, V. Farkašovský and C. Lawson (cf. Marciniuk and Zimková, 2018; Marciniuk et al., 2020). Some results were compared to the average pension of inhabitants from the selected cities, which can be seen in Table 2.

Table 2. Annual marriage reverse mortgage payments as a percentage of average pensions in the selected cities.

R	0	1/4	1/3	½	2/3	3/4	1
České Budějovice	84.42%	81.86%	81.04%	79.45%	77.92%	77.18%	75.03%
Brno	170.16%	165.00%	163.34%	160.14%	157.05%	155.55%	151.22%
Karlovy Vary	90.81%	88.05%	87.17%	85.46%	83.81%	83.01%	80.70%
Praha	198.47%	192.45%	190.53%	186.78%	183.18%	181.43%	176.38%
Hradec Králové	125.09%	121.29%	120.08%	117.71%	115.45%	114.35%	111.16%
Liberec	100.00%	96.96%	95.99%	94.11%	92.29%	91.41%	88.87%
Ostrava	73.88%	71.64%	70.92%	69.53%	68.19%	67.54%	65.66%
Kladno	99.95%	96.91%	95.94%	94.06%	92.25%	91.37%	88.82%
R	0	1/4	1/3	½	2/3	3/4	1
Banská Bystrica	120.34%	116.00%	114.62%	111.96%	109.42%	108.19%	104.66%
Bratislava	167.05%	161.02%	159.10%	155.41%	151.88%	150.18%	145.28%
Košice	139.55%	134.51%	132.92%	129.83%	126.88%	125.46%	121.37%
Nitra	147.11%	141.80%	140.12%	136.86%	133.75%	132.25%	127.95%
Prešov	120.52%	116.17%	114.79%	112.12%	109.57%	108.35%	104.82%
Trenčín	116.68%	112.47%	111.13%	108.55%	106.09%	104.90%	101.48%
Trnava	134.46%	129.60%	128.06%	125.08%	122.24%	120.87%	116.94%
Žilina	123.45%	118.99%	117.58%	114.85%	112.24%	110.98%	107.37%

Table 2, cont.

R	0	1/4	1/3	½	2/3	3/4	1
Gdańsk	134.91%	130.10%	128.58%	125.63%	122.81%	121.45%	117.54%
Katowice	65.01%	62.69%	61.95%	60.53%	59.18%	58.52%	56.64%
Kraków	136.57%	131.71%	130.16%	127.18%	124.33%	122.95%	118.99%
Lublin	98.75%	95.23%	94.12%	91.96%	89.90%	88.90%	86.04%
Poznań	110.13%	106.21%	104.96%	102.55%	100.26%	99.14%	95.95%
Szczecin	80.88%	78.00%	77.08%	75.32%	73.63%	72.81%	70.47%
Warszawa	154.41%	148.91%	147.16%	143.79%	140.56%	139.01%	134.53%
Wrocław	108.00%	104.16%	102.94%	100.58%	98.32%	97.23%	94.10%

Source: (Marciniuk et al., 2020).

It is shown that there is substantial scope for boosting retirement income in all the cases considered, though the precise size of the increase depends on factors such as the age and life expectancy of the contract buyers, the value of their assets, the payment consequences of the death of a spouse, and the pricing policies of the contract suppliers (cf. Marciniuk et al., 2020).

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