sciendo

Wroclaw Review
of Law, Administration & Economics
Vol 14:2, 2024
DOI: 10.2478/wrlae-2024-0005

The Influence of Demographic and Economic Factors on the Widow's Reverse Annuity Benefits in Coronavirus Pandemic

*Agnieszka Marciniuk**, *Beata Zmyślona***

Keywords

reverse annuity contract, Covid mortality rate, interest rate, widow, elderly population, benefits, inequalities in health and social care

JEL classification

C5, C6, G17, G22, I13, J1

Abstract

The COVID-19 pandemic has affected many areas of society and the economy. In the epidemiological field, it has significantly increased mortality, especially in the elderly population. It has greatly affected the real estate and financial market. The price of housing, inflation, and interest rates rose. Therefore, housing is currently unaffordable. The analysis of the Life Expectancy Tables jumped to a higher risk of death for men than for women. The pandemic has made women more likely to be widowed than men, and more often, while their economic and social status has worsened.

* Assistant Professor, Wroclaw University of Economics and Business Faculty of Economics and Finance, Wrocław, Poland. E-mail: agnieszka.marciniuk@ue.wroc.pl
** Assistant Professor, Wroclaw University of Economics and Business Faculty of Economics and Finance, Wrocław, Poland. E-mail: beata.zmyslona@ue.wroc.pl

© 2024 Agnieszka Marciniuk, Beata Zmyślona, published by Sciendo. This work is licensed under the Creative Commons Attribution 4.0 License.

Higher mortality rates have an impact on the cash flow associated with insurance and reverse annuity contracts. Reverse annuity benefits also depend on the value of property and the interest rate.

This article analyses the impact of higher mortality rates, property values, and interest rates on annuity benefits for widows. The actuarial value of the life annuity is used on the calculation of benefits. The interest rate is modelled using the Svensson model of spot interest and the 3m WIBOR. Financial mathematics for life insurance and demographic methods are used.

I. Introduction

The Covid-19 pandemic has affected many economic, business, and social areas. It has caused a significant increase in mortality, especially among the elderly. Analysis of Life Expectancy Tables reveals a jump to a higher risk of death in the male population in comparison to female. Mortality modelling has received a great deal of attention in the contemporary literature [1],[2]. The research has been focused on the impact of age groups and causes of death on life expectancy differences between men and women.[3] The risk of widowhood observed in the female population occurred much more frequently than in the male population, which has further been intensified by the COVID-19 pandemic. The increase in male mortality results in singularising and feminising old age and causes exacerbated loneliness among elderly women, as well as a decline in economic and social status. This unfavourable situation for widows may be seen, for example, in exposure to financial burdens after the loss of a spouse, or in inequalities in the health care system.[4] Therefore, it is important, especially for women, to obtain additional financial support from private social or health insurance plans, or from other financial resources. In Poland, people in older age groups own property the value of which depends largely on where they live. Thus, a reverse annuity can be a good tool to provide additional financial security.[5]

---

1 Basellini, U., Camarda, C.G. Modelling and forecasting adult age-at-death distributions. "Population Studies", 2019, 73(1), 119-138.

2 van Raalte, A.A. What have we learned about mortality patterns over the past 25 years? "Population Studies", 2021, 75, 105-132.

3 Zazueta-Borboa, J-D., Aburto J.M., Permanyer, I., Zarulli V., Janssen F. Contributions of age groups and causes of death to the sex gap in lifespan variation in Europe, "Population Studies", 2023, 77(3), 475–496

4 Dabergott, F. The gendered widowhood effect and social mortality gap. "Population Studies", 2022, 76(2), 295-307.

5 Buckner D., Dowd K. How profitable are Equity Release Mortgages? "Economics Letters", 2020, 197.

During the pandemic, some notable phenomena could be observed on the housing market. People were locked in their houses and social distance increased. This resulted in an increasing number of divorces.[6] Some people lost their jobs and others moved to remote work. Consequently, people began to need more space for family and work life with the freedom to enjoy the outdoors. Schwartz and Wachter suggest that it is highly probable this is a lasting effect, and that "some expansion of remote work will continue, even after the pandemic, leaving transformed housing markets and changed housing location decisions".[7] The increase in demand for larger apartments with gardens, while at the same time cheaper mortgages with falling interest rates and low returns on deposits, and a discouraging accumulation of money have increased consumerism and real estate prices.[8],[9] The result is housing costs that are currently unaffordable.[10] The effects of the COVID pandemic will stay with us for many years to come.

This article aims to research the impact of higher mortality rates, property values, and interest rates on annuity benefits for widows. The data analysis covers the period 2018-2022, using data on the three-month WIBOR interest rate in Poland, the long-term interest rate determined by the ECB, Polish Life Tables, and real estate prices from the Polish market. The presented numerical examples are based on the authors' own calculations in Matlab.

II. Data and Methods

Reverse annuity contract

A reverse annuity is a type of equity release contract. It is a sales model aimed at older people. The contract is based on the transfer of property to a company that is interested in acquiring it, in exchange for a lifelong monthly

6 Rossier, C. Family Demography in the Post-Covid Era. Population and Development Review, 2021, Special Issue, 59–63.

7 Schwartz A.E, Wachter S. COVID-19's Impacts on Housing Markets: Introduction. "Journal of Housing Economics", 2023, 59 (B), 101911, ISSN 1051-1377

8 Balemi, N., Füss, R., Weigand, A. COVID-19's impact on real estate markets: review and outlook. "Financial Markets and Portfolio Management", 2021, 35, 495–513.

9 Muellbauer J., Murphy A. Duca J. What drives house prices: Lessons from the literature. "VoxEU", 2021. [Retrived: 2023-07-24] https://cepr.org/voxeu/columns/what-drives-house-prices-lessons-literature.

10 Schwartz A.E, Wachter S. COVID-19's Impacts on Housing Markets: Introduction.

benefit.[11],[12] The transferral of property to the company takes place after signing the contract, but the senior person can live there until their death. This right is guaranteed in section four of the Mortgage Register.

The yearly benefit of the reverse annuity contract for a person aged x, who pays a financial sum at the beginning of each year, as long as they are alive, is calculated as follows,[13]

$$\ddot{b}_x = \frac{\alpha \cdot W}{\ddot{a}_x}, \tag{1}$$

where W is the real value of the property, $\alpha$is the percentage of W, $\alpha \in (0\%,100\%]$ and $\ddot{a_x}$ – represents the actuarial value of individual whole life annuity for a person at age x.

The actuarial value $\ddot{a_x}$ is calculated as follows,[14]

$$\ddot{a}_x = \sum_{k=0}^{\infty} v^k \cdot {}_k p_x, \tag{2}$$

where v denotes the discounting factor and ${}_k p_x$ is the probability that a person of age x will live at least k years.

The discounting factor v is determined by using the following formula,

$$v = \frac{1}{1+i}, \tag{4}$$

where i is the interest rate.

As can be seen from the above, the reverse annuity benefits depend on the value of property W, interest rate i, and the expected lifetime of a person of age x.

---

11 Marciniuk, A., Zimková, E., Farkašovský, V., Lawson, C.W. Valuation of Equity Release Contracts in Czech Republic, Republic of Poland and Slovak Republic. "Prague Economic Papers", 2020, 29(5), 505-521.

12 Dębicka, J., Heilpern, S., Marciniuk, A. Application of Copulas to Modelling of Marriage Reverse Annuity Contract. "Prague Economic Papers", 2020, 29(4), 445-468.

13 Marciniuk, A., Zimková, E., Farkašovský, V., Lawson, C.W. Valuation of Equity Release Contracts in Czech Republic, Republic of Poland and Slovak Republic. "Prague Economic Papers", 2020, 29(5), 505-521.

14 Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., Nesbit, C. J. Actuarial Mathematics. Itasca, Illinois: The Society of Actuaries, 1986.

Life expectancy at birth

Increase in the proportion of seniors observed in recent decades is a consequence of several demographic processes, the most important of which are the lengthening of human life expectancy and the simultaneous decline in fertility (drop in birth rates) below the level ensuring the continuation of generations. The elderly population, due to its constant growth, is characterised by an increasing internal diversity (e.g., in terms of age, gender, education, place of residence, health status), which will further intensify in the face of the so-called double ageing (i.e., a very dynamic increase in the proportion of people aged 80 and over in the population). In particular, a pronounced feminisation and singularisation of ageing can be observed.

An important measure taken into account when estimating actuarial values is life expectancy at birth. In Poland, since the 1960s, a systematic extension of the average life expectancy has been observed, both in the populations of men and women. Many factors influence this phenomenon, including improvement in nutrition, development of medicine, increased detection and treatment of diseases, advancement of the quality and access to medical services, and social changes related to improved living conditions and hygiene. The decrease in the value of life expectancy in 2020-2022 was the result of the pandemic from the SARS-CoV-2 virus, causing COVID-19. Life expectancy values in the years 1960-2022 in male and female population are presented in Figure 1.

Increase in average life expectancy causes a growing population of elderly people, with a particularly dynamic growth in the group aged 80 and over. Additionally, the phenomenon of feminisation and singularisation of ageing can be observed among seniors.

The feminisation of ageing is due to a higher population of women than men, which increases with age and is especially observable in older age groups. In Poland, in the entire population, the percentage of widows is almost five times higher (13.7%) compared to the percentage of widowers (2.9%), and increased male mortality rates occur in the group of people over 50 years of age.[15] The feminisation rate varies not only according to age but also to place of residence. It increases with age and is higher in cities, except for the group of people aged 85 and over. The coefficient values for 2021 are presented in Figure 2.

[15] Ziębińska B. Pomoc społeczna w starzejącym się społeczeństwie. „Zeszyty Naukowe KUL", 2022, 65, nr 4 (260).

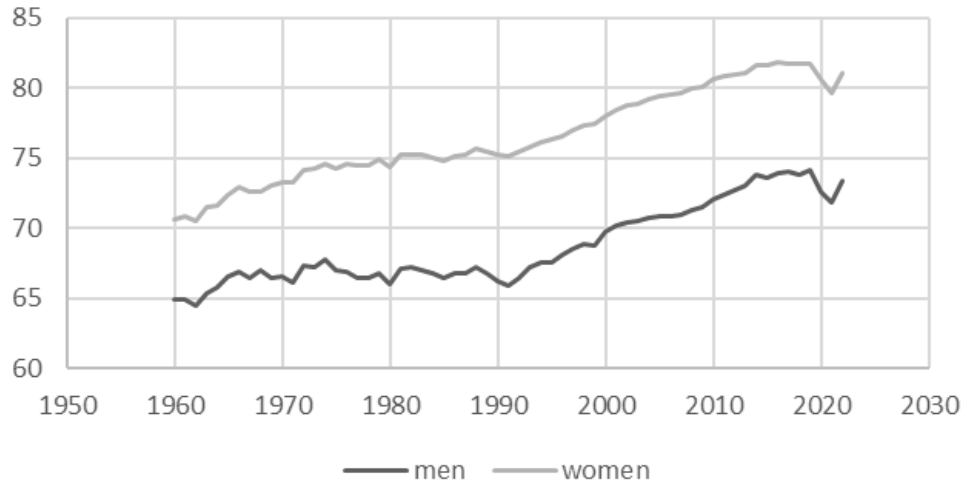


Figure 1: Life expectancy at birth in Poland in female and male populations (1960-2022)
Source: authors' elaboration based on GUS data

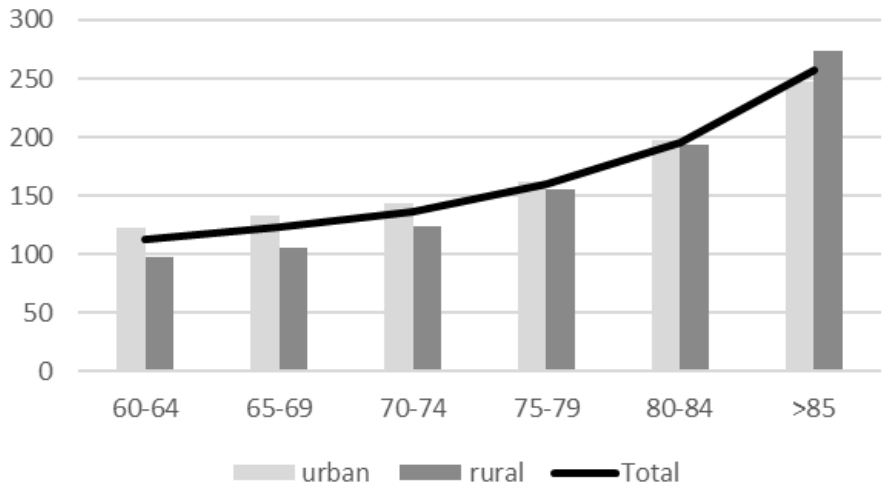


Figure 2: Feminisation rate in Poland in 2021
Source: authors' elaboration based on GUS data

However, the singularisation of ageing is characterized by a high percentage of older people living in single-person households. According to forecasts, in 2030, just over half (53.3%) of households in Poland will be run by people over 65 years of age, including 17.3% by people aged 80 and over, and due to the feminisation of old age, women are much more likely to stay in single-person

households.[16] The increase in the percentage of older people in society has not only economic but also health and social consequences.

Mortality rate

The Covid pandemic has deepened the phenomena of feminisation and secularisation. Figure 3 shows death rate (i.e., the number of deaths per 1,000 people) in the population of seniors aged 60 and over in 2010-2021, taking into account the division of the population by gender.

The analysis of the mortality structure shows that the high mortality of the male population, especially in older age groups in Poland, has increased.

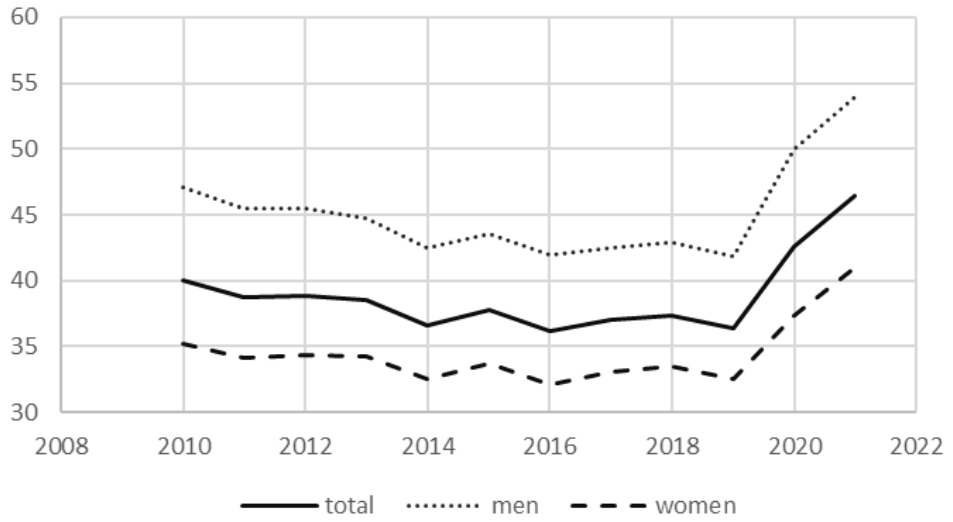


Figure 3: The death rate in Poland of senior populations (above 65 years old)
Source: authors' elaboration based on GUS data

The impact of the pandemic on mortality in the population can be seen while analysing the cause of deaths. In Figure 4, the structure of deaths in the Polish population in 2019-2021 is presented. The data allow a conclusion that the COVID mortality rate reached its highest value in 2021, causing almost one fifth of deaths. The pandemic has increased the so-called health debt, thus revealing weaknesses related to the accessibility of the health care system, and negligence in the prevention and treatment of serious and chronic diseases.

[16] Błędowski P., Szatur-Jaworska B., Szweda-Lewandowska Z., Kubicki P. Raport na temat sytuacji osób starszych w Polsce. „Instytut Pracy i Spraw Socjalnych", 2012, 28–29.

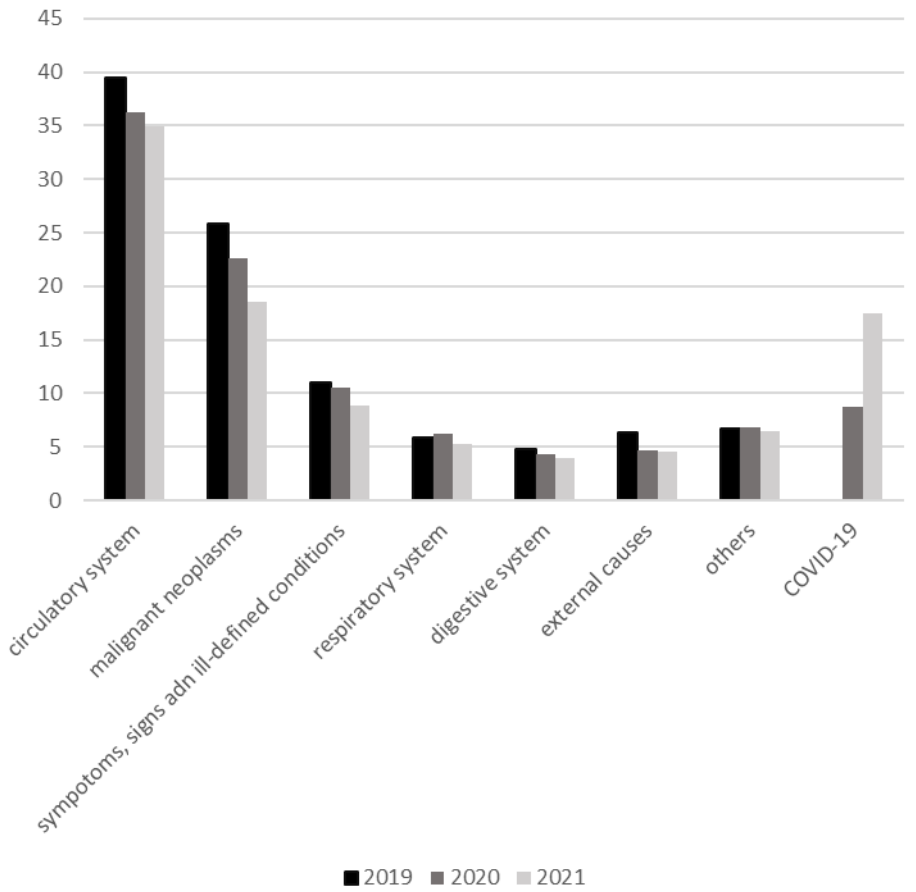


Figure 4: The causes of death of populations in Poland (in percentages)
Source: authors' elaboration on the basis of GUS data

Figure 5 shows the values of the COVID mortality rate measured by the number of deaths due to COVID per 100,000 inhabitants by age groups and gender. It can be seen that this rate increased with age and was at least one and a half or twice as high in the male population in almost all age groups. The disproportion in COVID mortality in the populations of men and women is caused by the so-called health inequalities in the male population. Men are generally in worse health, for a variety of reasons, from negligence in prevention to the burden of numerous, untreated chronic diseases.

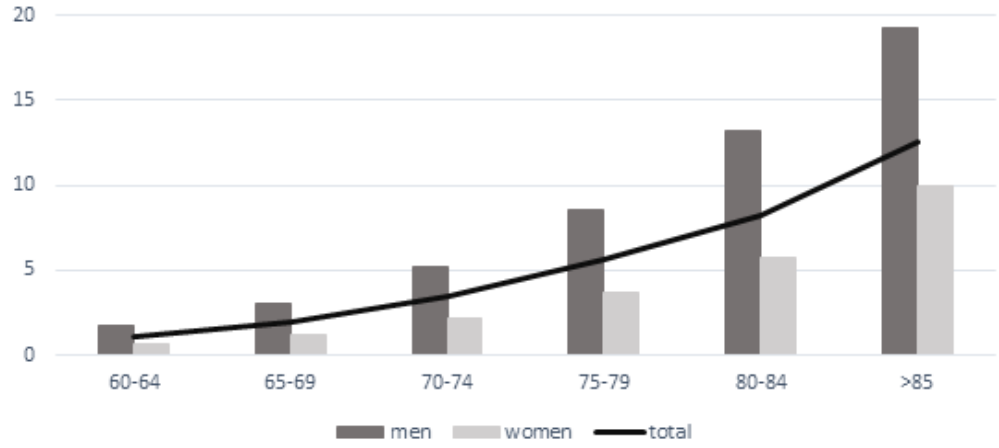


Figure 5: Covid mortality rate in the elderly population in 2020
Source: authors' elaboration based on GUS data

Health inequalities

It is necessary to point out that extending the life of the population does, however, have economic and social consequences, as well as a certain impact on the average health status of the population. Researchers note that living longer is not the same as living in good health (i.e., without disability and chronic diseases). Increasing rates of human diseases and accompanying disabilities, common in ageing societies, prompt the opening question of whether living longer means living with a disability.[17] A population with a relatively high life expectancy is not necessarily healthier.[18] From a societal point of view, a long life is a desirable value, but only if it is accompanied by health, and therefore also by a good quality of life and the absence of limitations in the performance of daily activities.

The Healthy Life Years (HLY) indicator (also known as Disability Free Life Expectancy (DFLE)) is nowadays one of the primary indicators used to assess the health status of a population.

[17] Gromulska L., Wysocki M.J. Goryński P. Lata przeżyte w zdrowiu (Healthy Life Years, HLY) – zalecany przez Unię Europejską syntetyczny wskaźnik sytuacji zdrowotnej ludności, „Przegląd Epidemiologiczny", 2008, no 62(4).

[18] Ojrzyńska A. Ocena trwania życia w zdrowiu populacji Polski z wykorzystaniem sumarycznych miar stanu zdrowia. „Śląski Przegląd Statystyczny", 2013, 17(11), 261-274.

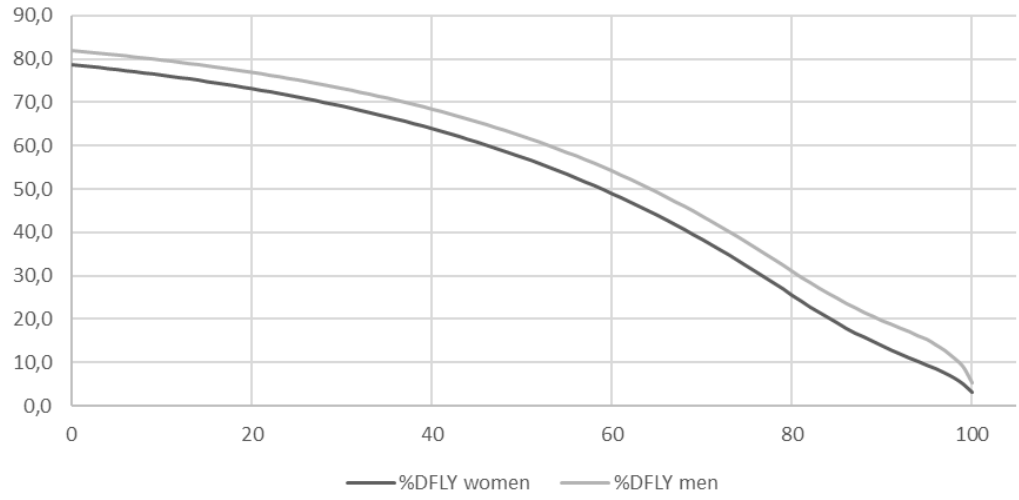


Figure 6: Percentage of life duration in good health [%HLY]
Source: authors' elaboration based on GUS data

In Poland, the HLY rate is lower in the female population than in the male population. This means that women live longer, but the consequence is that they are more likely to experience chronic diseases that worsen their health. An indicator defined as the percentage of life duration in good health [%HLY] illustrates this well. This indicator is defined as the percentage of life expectancy that a person of age x will live in good health and is calculated as the healthy life expectancy divided by the average life expectancy for a population. In Figure 6, the values of the indicator in female and male populations are shown. It is clear that, regardless of age, men live longer in better health and further implies that women experience more disabilities and chronic diseases, which often require expensive treatment.

Interest rate

The interest rate plays an important role in determining benefits. During the coronavirus pandemic, governments responded very quickly and comprehensively to economic policy by reducing interest rates.[19] As a result of the Covid-19 pandemic, interest rates practically declined to zero, before rising rapidly in July 2022. This paper considers the 3m WIBOR rate and the long-term interest rate,

[19] Muellbauer J., Murphy A. Duca J. What drives house prices: Lessons from the literature. "VoxEU", 2021. [Retrived: 2023-07-24] https://cepr.org/voxeu/columns/what-drives-house-prices-lessons-literature.

determined by the European Central Bank (ECB). Monthly data from January 2020 to July 2022 are considered.

The WIBOR is the interest rate on which mortgages are offered in Poland. It is determined based on the reference rate of the National Bank of Poland. The one-month, three-month and six-month WIBOR (1m WIBOR, 3m WIBOR, and 6m WIBOR, respectively) are distinguished. This article takes into consideration the 3m WIBOR. In 2018, the 3m WIBOR was equal to 1.72%. During the pandemic, the interest rate decreased to 0.22%, and it has increased to 7% since September 2021. The 3m WIBOR still remains at a similar level. It can be observed in Figure 7.

According to the EU Solvency II Directive, the actuarial values should be determined based on the European Central Bank's long-term interest rate,[20] which is designated by using the Svensson model of spot interest. This model has the following form,[21],[22]

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

where $\beta_0 \geq 0, \beta_0 + \beta_1 \geq 0, \tau_1, \tau_2 > 0$.

The parameter β_0 is the long-term interest rate. This interest rate had been decreasing for a long time to almost zero. However, in 2022, there was an increase to almost 2%, which can be observed in Figure 8.

The price per square meter of property

One of the effects of the pandemic was an increase in housing demand and, consequently, a rise in the price per square meter. This was influenced by a number of factors, as real estate and mortgage markets are a complex, interrelated set of parties that include households, developers, banks, and investors.[23] Lockdown, social distancing, and quarantine caused people fearing another home lock-in to look for larger apartments and houses with gardens in different

20 https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html

21 De Rezende, R. B., Ferreira, M. S. Modeling and Forecasting the Yield Curve by an Extended Nelson-Siegel Class of Models: a quantile autoregression approach. "Journal of Forecasting", 2013, 32 (2), 111-123.

22 Marciniuk, A., Zimková, E., Farkašovský, V., Lawson, C.W. Valuation of Equity Release Contracts in Czech Republic, Republic of Poland and Slovak Republic. "Prague Economic Papers", 2020, 29(5), 505-521.

23 Brodeur, A., Gray, D., Islam, A. Bhuiyan, S. A literature review of the economics of COVID-19. "Journal of Economic Surveys", 2021, 35 (4).

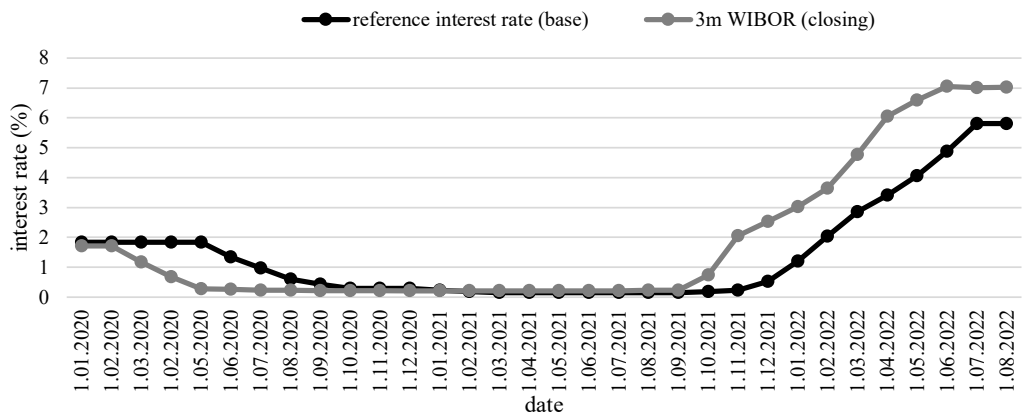


Figure 7: Reference interest rate and the 3m WIBOR in Poland
Source: authors' elaboration based on data received from https://uokik.gov.pl/stopa_referencyjna_i_archiwum.php and https://stooq.pl/q/d/?s=plopln3m

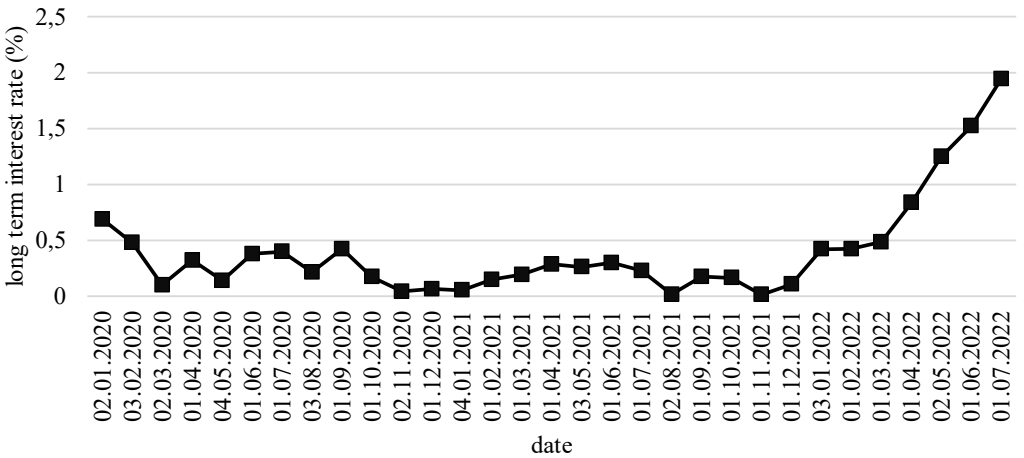


Figure 8: Long term interest rate from ECB.
Source: author's elaboration based on data received from https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html

locations.[24] Other factors were remote work and extremely cheap mortgages.[25] Low interest rates during the pandemic can be seen in the last subsection in Figures 7 and 8. Cheap credit means an increase in consumerism along with ease

24 Muellbauer J., Murphy A. Duca J. What drives house prices: Lessons from the literature. "VoxEU", 2021. [Retrived: 2023-07-24] https://cepr.org/voxeu/columns/what-drives-house-prices-lessons-literature.

25 Balemi, N., Füss, R., Weigand, A. COVID-19's impact on real estate markets: review and outlook. "Financial Markets and Portfolio Management", 2021, 35, 495–513.

of financial obligations.[26] The pandemic also resulted in low returns on deposits, stocks, etc., which did not encourage the accumulation of savings and building of financial security. On the contrary, it urged the purchase of housing. As a consequence of these elements, the rise in the price of a square meter of real estate can be observed. Fiscal and monetary policy interventions during the pandemic contributed to the decline in affordability.[27]

A significant increase in property prices is noted, among others, in the United States, the United Kingdom, France, Germany, and Poland.[28] Figure 9 shows average housing prices per square meter. The quarterly data is taken from Statistic Poland from the first quarter (Q1) of 2020 to Q1 of 2022 compared to Q1 of 2018.

Real estate prices are showing an upward trend. The average price of an apartment in Poland increased by more than 27% in the first quarter of 2022 compared to the first quarter of 2018 and by 15% compared to the first quarter of 2020. Between 2020 and 2022, the average price per square meter grew largely by 1.8% every quarter. However, in many cities prices doubled or tripled, which can be seen in Figure 10. These are offer prices for 2018-2022.

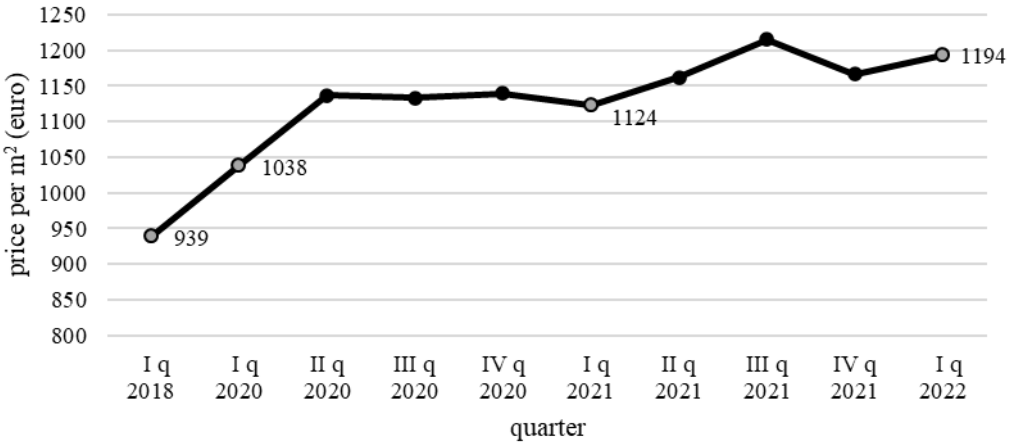


Figure 9: Average price per square meter of property
Source: authors' elaboration based on data received from https://stat.gov.pl/

26 Beck R.H., McGuire B. COVID's long impact on the housing market. "Bankrate. Real Estate." 2022, [Retrived: 2023-07-24] https://www.bankrate.com/real-estate/covid-impact-on-the-housing-market/.

27 Schwartz A.E, Wachter S. COVID-19's Impacts on Housing Markets: Introduction. "Journal of Housing Economics", 2023, 59 (B), 101911, ISSN 1051-1377.

28 Muellbauer J., Murphy A. Duca J. What drives house prices: Lessons from the literature. "VoxEU", 2021. [Retrived: 2023-07-24] https://cepr.org/voxeu/columns/what-drives-house-prices-lessons-literature.

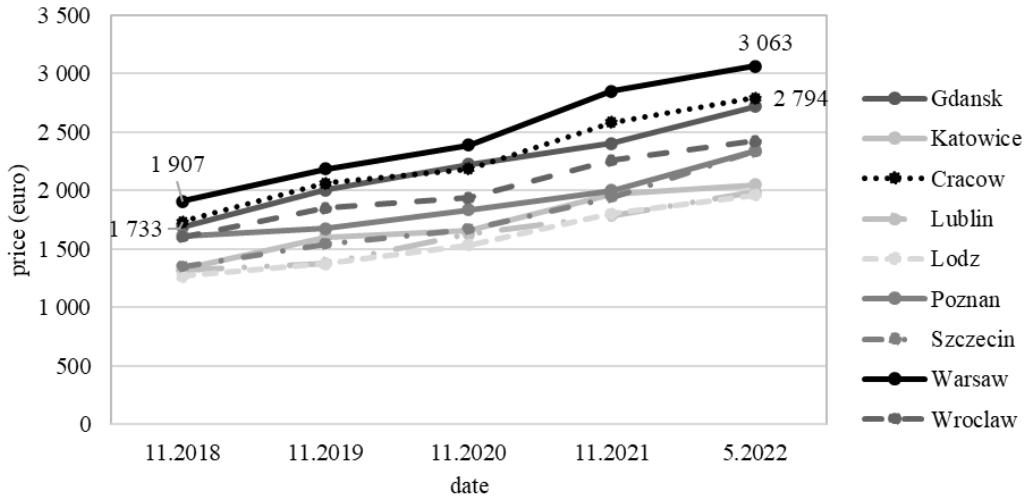


Figure 10: Price per square meter of property in some Polish cities
Source: authors' elaboration based on offer price reports https://www.bankier.pl

In Gdansk, the price was more than 156% higher than the average price in Poland. The largest increase in the price per square meter of an apartment in the selected cities was noted in Szczecin in May 2022 compared to November 2018. It meant an increase of more than 73.4%. In other cities, the growth was between 45% and 61%.

All the described factors significantly affect the benefit of reverse annuities, particularly for widows.

III. Reverse Annuity Contract's Benefit – Numerical Examples

At the beginning, a benefit is determined for a woman of age x, where $x \in \{60,61,\ldots,100\}$. A property with a value of €100,000 is considered. The reduction factor α is equal to 50%. Life Tables for women in Poland from 2018, 2020, and 2021 are taken into account. Benefits are calculated assuming a long-term interest rate of 1.817% (as of 1st January 2018). The example will show how the benefits fluctuate when a woman's life expectancy changes, with all other parameters staying the same. Figure 11 presents yearly benefits.

The lowest benefits are for Life Tables from 2018. In order to better compare, the relative differences in benefits have been calculated for 2020 and 2021 in comparison to 2018, as shown in Figure 12.

As a result of the decline in the future life expectancy of women, benefits have increased. The largest reverse annuity can be obtained by calculating benefits using Life Tables from 2021. In 2021, the differences are almost twice as in 2020.

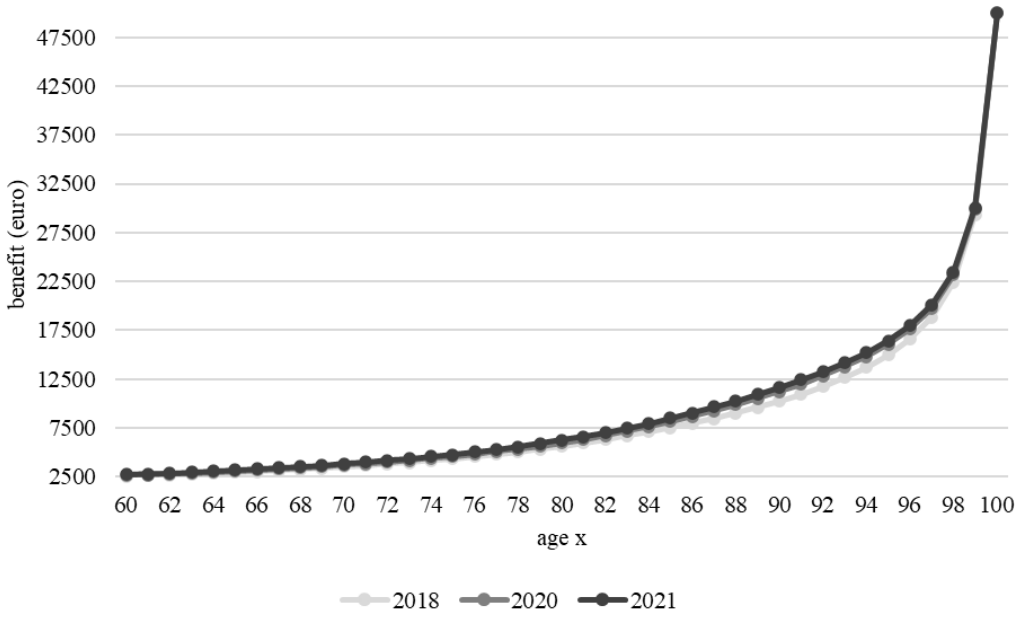


Figure 11: Yearly benefits for women with changing Life Tables while other parameters stay the same
Source: authors' elaboration made using authors' programs written in Matlab

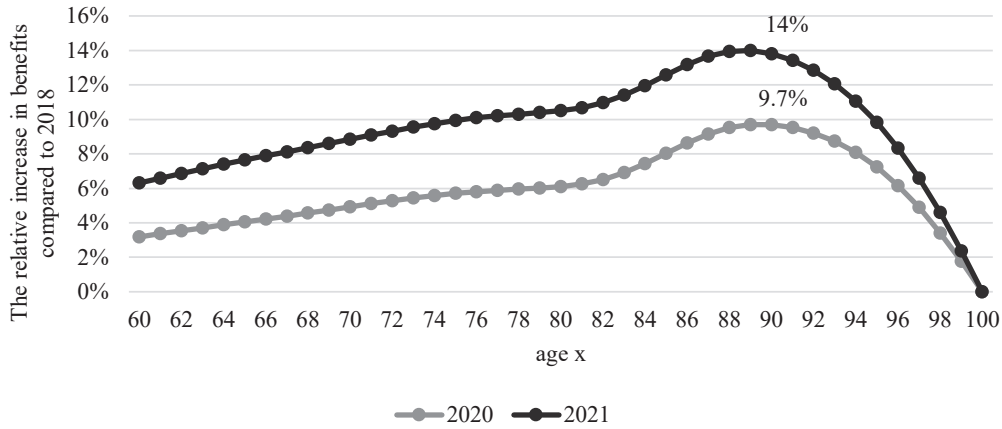


Figure 12: The relative differences in benefits compared to 2018
Source: authors' elaboration

The relative increases rise for a woman of up to 89 years, then decline sharply to zero for 100-year-old women. At their highest point, they reach 14% and 9.7%, as indicated on the graph.

The second example shows how benefits fluctuate when the interest rate and Life Tables change. The interest rate 3m WIBOR is considered (see Figure 7). However, only significant changes in the interest rate are included in the

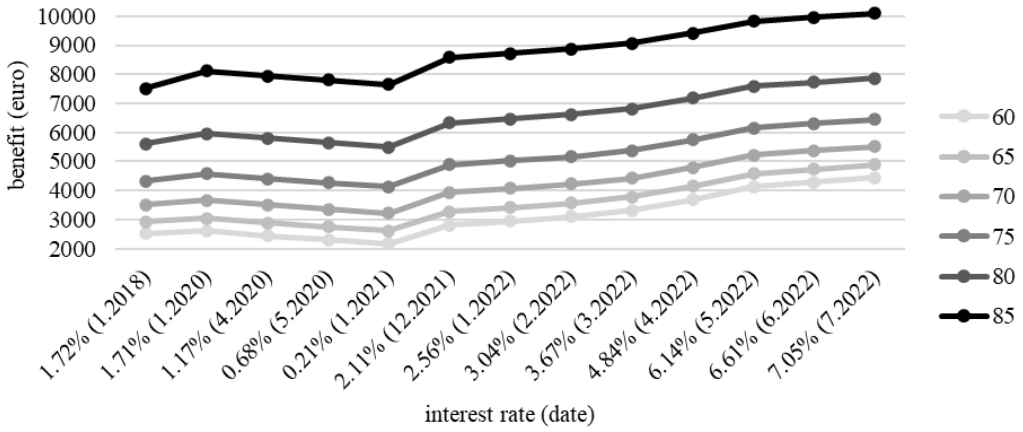


Figure 13: Yearly benefits for women with changing Life Tables, 3m WIBOR, while other parameters stay the same
Source: authors' elaboration made using authors' programs written in Matlab

calculation. Life Tables are taken into account for the same year as the interest rate, the exception being 2022, as more recent tables were not yet available at the time the calculations were made. Like before, the value of the property is equal to €100,000 and the reduction factor α is 50%. Yearly benefits are determined for women at age x, where $x \in \{60,65,70,75,80,85\}$, which can be seen in Figure 13.

It can be seen that when the interest rate in 2018 and 2020 was almost the same, and the expected lifetime decreased, the benefit increased. Then, when the interest rate and life expectancy decreased (until January 2021), the benefit also followed the same trend. From December 2021 there was an observable increase in the 3m WIBOR, and thus an upward trend in the reverse annuity. The interest rate had a greater impact than changes in life expectancy.

In the next example, the same benefits are determined but assume a variation in the long-term interest rate shown in Figure 8. The other parameters are not modified. The annual benefits are presented in Figure 14.

The long-term interest rate is more stable than the 3m WIBOR. In January 2020, a larger decrease in the 2018 benefit was observed (for women younger than 85). In 2018 benefits were lower only for women aged 85. Thereafter, benefits showed stabilisation and remained on a similar level, before rising rapidly in January 2021 as the long-term rate increased. In 2021, they remained on similar levels again (one higher, one lower). From the beginning of 2022, benefits rose.

The last example shows the changes that occur in women's benefits when variations in the interest rate (the 3m WIBOR), life expectancy, and property prices are taken into account. A woman is assumed to have a flat of 60 m^2 and the price per square meter changes quarterly, as shown in Figure 9 (average price in

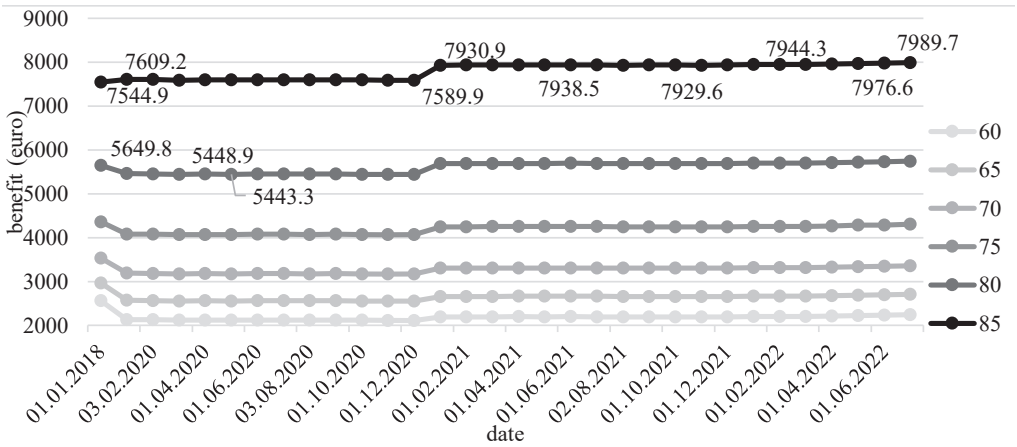


Figure 14: Yearly benefits for women with changing Life Tables, long term rate while other parameters stay the same.
Source: authors' elaboration made using authors' programs written in Matlab

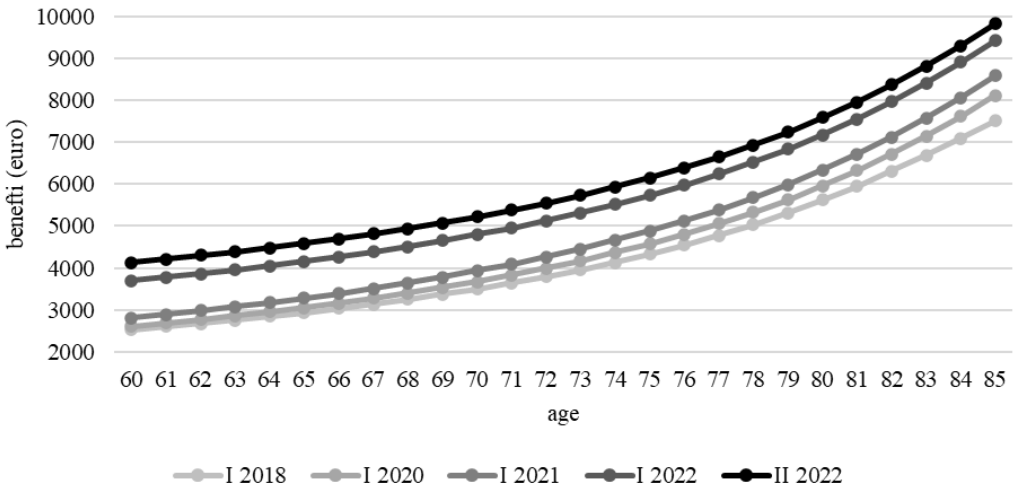


Figure 15: Yearly benefits for women with all parameters changing
Source: authors' elaboration made using authors' programs written in Matlab

Poland). A reduction factor of 50% has been assumed. Yearly benefits are determined for a woman of age x, where $x \in \{60,61,\ldots,100\}$, as shown in Figure 15.

When changes in life expectancy, interest rates, and property prices are taken into account, all benefits are higher, which is particularly noticeable in 2022. The largest impact on the variation in benefits is the increase in property prices.

IV. Discussion and Conclusions

This paper presents the effects of mortality, the square-meter prices of housing, and the interest rate on the amount of reverse annuities for women. As a result of the Covid-19 pandemic, each of these factors changed. The analysis of the data covered the years 2018-2022, when a significant increase in mortality rates was observed in the population. Two interest rates, 3m WIBOR and the long-term interest rate, determined by the ECB, were taken into account. Interest rates fell practically to zero, then increased sharply to 7% (3m WIBOR) and 2% (long-term interest rate from the ECB). At the same time, the lockdown, keeping social distance, and the fiscal policy caused the demand on the housing market to rise, which triggered an increase in prices and a decrease in affordability.

Each of the listed economic and demographic factors affects the amount of the reverse annuity benefit, which is of great importance to all beneficiaries, especially women, who are more likely to become widows. The article considers several numerical examples where women of the same age enter into a reverse annuity contract but at a different point of time. It was assumed that the value of the property is fixed at 100,000 euros. When the interest rate remained on a similar level, but with a decrease in life expectancy, an increase in benefits was observed. If the rate of interest decreased and mortality went up, the annuity also declined. These examples show that the interest rate has a higher impact on benefits than the mortality rate. However, it turns out that if the growth in the value of the property was also included in the calculation, it is this factor that plays the largest role in determining the amount of the reverse annuity and affects its variation.

The conclusion is clear and in accordance with what was presented in the paper.[29] Namely, recent economic and demographic changes seem to enforce valorisation of reverse annuity contract benefits.

References

Balemi, N., Füss, R., Weigand, A. *COVID-19's impact on real estate markets: review and outlook.* "Financial Markets and Portfolio Management", 2021, 35, 495–513. https://doi.org/10.1007/s11408-021-00384-6

Basellini, U., Camarda, C.G. *Modelling and forecasting adult age-at-death distributions*. "Population Studies", 2019, 73(1), 119-138. DOI: 10.1080/00324728.2018.1545918

Beck R.H., McGuire B. *COVID's long impact on the housing market.* "Bankrate. Real Estate." 2022, [Retrived: 2023-07-24] https://www.bankrate.com/real-estate/covid-impact-on-the-housing-market/.

[29] Marciniuk, A. Equity Release Contracts with Varying Payments. "Prague Economic Papers", 2021, 30(5), 552-574.

Błędowski P., Szatur-Jaworska B., Szweda-Lewandowska Z., Kubicki P. *Raport na temat sytuacji osób starszych w Polsce*. „Instytut Pracy i Spraw Socjalnych", 2012, 28–29.

Bowers, N. L., Gerber, H. U., Hickman, J. C., Jones, D. A., Nesbit, C. J. *Actuarial Mathematics.* Itasca, Illinois: The Society of Actuaries, 1986. ISBN 978-09-3895-946-5.

Brodeur, A., Gray, D., Islam, A. Bhuiyan, S. *A literature review of the economics of COVID-19*. "Journal of Economic Surveys", 2021, 35 (4). 1007-1044. https://doi.org/10.1111/joes.12423

Buckner D., Dowd K. *How profitable are Equity Release Mortgages?* "Economics Letters", 2020, 197.

Dębicka, J., Heilpern, S., Marciniuk, A. *Application of Copulas to Modelling of Marriage Reverse Annuity Contract.* "Prague Economic Papers", 2020, 29(4), 445-468. doi: 10.18267/j.pep.745

Dabergott, F. *The gendered widowhood effect and social mortality gap.* "Population Studies", 2022, 76(2), 295-307. DOI: 10.1080/00324728.2021.1892809

De Rezende, R. B., Ferreira, M. S. *Modeling and Forecasting the Yield Curve by an Extended Nelson-Siegel Class of Models: a quantile autoregression approach.* "Journal of Forecasting", 2013, 32 (2), 111-123. http://dx.doi.org/10.2139/ssrn.1290741.

Gromulska L., Wysocki M.J. Goryński P. *Lata przeżyte w zdrowiu (Healthy Life Years, HLY) – zalecany przez Unię Europejską syntetyczny wskaźnik sytuacji zdrowotnej ludności*, „Przegląd Epidemiologiczny", 2008, no 62(4).

European Central Bank. *Yield curve index*. [Retrieved 2022-08-01] https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html.

Marciniuk, A., Zimková, E., Farkašovský, V., Lawson, C.W. *Valuation of Equity Release Contracts in Czech Republic, Republic of Poland and Slovak Republic.* "Prague Economic Papers", 2020, 29(5), 505-521. doi: 10.18267/j.pep.743

Marciniuk, A. *Equity Release Contracts with Varying Payments.* "Prague Economic Papers", 2021, 30(5), 552-574. doi: 10.18267/j.pep.784

Muellbauer J., Murphy A. Duca J. *What drives house prices: Lessons from the literature.* "VoxEU", 2021. [Retrived: 2023-07-24] https://cepr.org/voxeu/columns/what-drives-house-prices-lessons-literature.

Ojrzyńska A. *Ocena trwania życia w zdrowiu populacji Polski z wykorzystaniem sumarycznych miar stanu zdrowia*. „Śląski Przegląd Statystyczny", 2013, 17(11), 261-274.

Rossier, C. *Family Demography in the Post-Covid Era*. *Population and Development Review*, 2021, Special Issue, 59–63.

Schwartz A.E, Wachter S. *COVID-19's Impacts on Housing Markets: Introduction.*

"Journal of Housing Economics", 2023, 59 (B), 101911, ISSN 1051-1377. https://doi.org/10.1016/j.jhe.2022.101911

van Raalte, A.A. *What have we learned about mortality patterns over the past 25 years?* "Population Studies", 2021, 75, 105-132. DOI: 10.1080/00324728.2021.1967430

Zazueta-Borboa, J-D., Aburto J.M., Permanyer, I., Zarulli V., Janssen F. *Contributions of age groups and causes of death to the sex gap in lifespan variation in Europe*, "Population Studies", 2023, 77(3), 475–496. DOI: 10.1080/00324728.2023.2222723

Ziębińska B. *Pomoc społeczna w starzejącym się społeczeństwie.* „Zeszyty Naukowe KUL", 2022, 65, nr 4 (260).

Report

Report 1. Sytuacja osób starszych w Polsce w 2020 roku. Analiza statystyczna Głównego Urzędu Statystycznego, online: https://stat.gov.pl/files/gfx/portalinformacyjny/pl/defaultaktualnosci/6002/2/3/1/sytuacja_osob_starszych_w_polsce_w_2020_r.pdf