A Simulation Study of the Delayed Effect of Covid-19 Pandemic on Pensions and Welfare of the Elderly: Evidence from Poland

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Abstract. Changes in the demographic structure of the population have imposed alterations in the pension systems. In many countries, including Poland, the amount of retirement benefits is highly dependent on life expectancy, which in the case of increases in longevity leads to a decrease in accrued benefits. A dynamic Monte Carlo simulation model was developed to investigate the financial implications of the aging problem in connection with the previously unexpected demographic changes caused by the Covid-19 pandemic on future pension payments. The model uses data from Polish statistical databases. The study distinguishes different life cycle profiles, i.e. women and men with average and minimum wage earnings. Simulation experiments are conducted in two variants. The first variant takes into account the currently registered shortening of life expectancy, while the second variant assumes that life expectancy is continuously lengthening, as it was observed until the outbreak of the Covid-19 epidemic. The simulation results show that the Covid-19 pandemic has a beneficial effect for future retirees, which is reflected in the expected higher replacement rates at retirement.

Keywords: Simulation, Modeling, Retirement, Ageing.

1 Introduction

Aging populations are an international problem that affects most countries in the world. We are currently observing major changes in the demographic structure of the population, the most characteristic of which are increasing life expectancy and decreasing fertility rates. Although it is true that in the last two years, as a result of the prevailing Covid 19 epidemic, life expectancy has shortened, but at the same time there has been a further decline in fertility. Slowly but unavoidably, the structure of the population is changing [1], expressed by an increasingly intense growth in the percentage of old age groups (older than 65 years) and an increasingly significant decline in the size of working age groups (20-64 years). According to [1] the number of people over 65 years of age per 100 people of working age has increased from 20 in 1980 to 31 in 2020.

Progressive demographic change is placing a significant strain on public finances. Therefore, many countries around the world are reforming their retirement policies in

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such a way as to maintain the stability of pension systems while covering the increased costs of ageing populations. In the past, pension systems were dominated by PAYGO DB (pay-as-you-go defined benefit) schemes, in which the amount of the pension depended on the number of years worked. However, recent years have witnessed a paradigm shift from PAYGO DB to PAYGO DC (pay-as-you-go defined contribution) schemes, in which the amount of pension benefit is closely related to the amount of earnings during the entire period of employment. The Polish pension system was also radically altered in 1999 with the establishment of a new legislative act, under which a DC system came into force.

In DC schemes, the amount of retirement benefits is highly dependent on life expectancy, which in the case of increases in longevity leads to a decrease in accrued benefits. The timing of retirement is also crucial, as the longer the pension contributions are accumulated, the higher the accumulated capital, and the shorter the estimated time of longevity. However, the impact of demographics on DC scheme benefits is even stronger, as the accumulated pension capital is annually indexed by the change of the sum of premiums accrued, which in turn depends on the level of employment and the average salary in the economy. This means that the more people in the working age group pay pension contributions and the higher the salaries, the higher the annual indexation of the accumulated capital. The currently observed changes in the demographic structure of the population, manifested by the decreasing number of people in the working-age group, add therefore another unfavorable factor, in addition to extended longevity and lowered retirement age, affecting the amount of pension benefits. The number of people in the working age group determines how intensely the accumulated capital, which defines the size of future pensions, will grow.

To calculate the financial implications of the aging problem in connection with the previously unexpected demographic changes caused by the Covid-19 pandemic, a dynamic Monte Carlo (MC) simulation model was developed. The model uses data taken from Polish statistical databases for the period 2000 to 2020, i.e., from the introduction of pension reform in Poland to the present. The simulation model is used to analyze the effects of the Covid-19 pandemic on the gross pension, depending on the decision made on the timing of retirement. One of the issues raised was how significant is the impact of changes in life expectancy on retirement. The study distinguished four different lifecycle profiles: women and men with average wage earnings and women and men with minimum wage earnings. An additional scenario was examined: a scenario in which a delayed retirement decision is made. To investigate the effect of SARS-Cov2-induced changes in life expectancy, we conducted a simulation study that accounts for the reduction in longevity observed as a result of the Covid-19 pandemic in the past year and a second study that hypothesizes that a gradual increase in life expectancy is occurring at all times.

The structure of this paper is as follows. Section 2 briefly describes the Polish pension system. Section 3 provides background information on the simulation methods used to model pension systems. Section 4 presents the MC simulation model and the data it uses. In Section 5 simulation results are presented and discussed. Finally, Section 6 contains conclusions with some remarks and perspectives.

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2 The Polish Pension System

The Polish pension system is based on three pillars, of which the first two pillars are mandatory and the third is voluntary. A pension contribution of 19,52% of earnings (split between employer and employee) is recorded for personal retirement accounts and is divided into two mandatory pillars. The first mandatory pillar is in the form of a notional (nonfinancial) account. The term ‘notional’ means that contributions (12.22% of an employee’s salary) are built into individual accounts and at retirement this capital is converted into a monthly pension using an algorithm based on life expectancy. Therefore, this capital may be treated as claims against the government [2]. The second mandatory pillar (fed by 7.3% of an employee’s salary) is administered by private open pension funds and/or the state company (Social Insurance Company, ZUS), where financial assets are gathered. Each insured person can decide whether to have the entire contribution transferred to a sub-account in the ZUS or to divide it between open funds and ZUS. However, even if the insured person decides to save in the second pillar in private open fund, 10 years before retirement, the accumulated funds are systematically transferred to the sub-account in ZUS. The third pillar offers additional savings methods that are facilitated by some tax benefits.

This paper focuses only on the first two obligatory pillars.

Capital accumulated in both mandatory ZUS accounts is indexed annually. Indexation of contributions in a pension account means multiplying the sum of contributions in the insured person's account by the index. The value of the first-pillar index depends on the so-called written premiums (i.e., the increase in salaries and the number of persons insured in ZUS) from the previous year, but cannot be lower than inflation or negative. The indexation of the second pillar account is derived from the gross domestic product (GDP) growth rate of the last 5 years.

However, the assessment base for pension contributions may be limited. This happens when a person's annual income exceeds the amount equal to thirty times the projected average monthly salary in the national economy for a given calendar year.

The state pension is calculated by dividing the capital accumulated in both pillars ($Capital1$ and $Capital2$) by the average life expectancy determined for persons of the same age as a person retiring (see Eq. 1).

$$Pension_k = \frac{Capital1 + Capital2}{Life\ expectancy_k} \tag{1}$$

where k is the retirement age.

Life expectancy is defined as the average number of months that people of a particular age could expect to live. It is determined jointly for men and women and is announced every year by the President of the Central Statistical Office. By 2045, life expectancy is expected to increase by approximately 12 months [1].

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3 Simulation Methods in Retirement Planning

The existing literature on pension systems in the context of longevity risk is relatively scarce [3]. Jimeno et al. [4] identified three methodological approaches to analyze the impact of demographic change on the sustainability of pension systems. These are aggregate accounting, general equilibrium, and individual life-cycle profile models.

The first approach is based on strong assumptions about demographic and economic variables and the determination of accounting identities. In this approach, the behavior of individuals is not taken into account. Analytical methods such as discrete choice models [5], dynamic optimization models, and forecasting models [3] are used. Another class of models is general equilibrium models with overlapping generation (OLG). These models study an artificial economy populated by rational agents who make their own decisions about consumption, savings, pension claims, and labor supply. The purpose of using these models is to study the impact of different government policy options, such as those involving an increase in retirement age [6] or changes in the structure of taxes and transfers [7], on the macroeconomic variables responsible for the behavioral responses of individuals. The advantage of OLG models is, in particular, that they allow one to model the behavior of individuals [8].

The approaches discussed above have made significant contributions to understanding the impact of demographic change on various pension systems and the economy, but their main weakness is that they model the dynamics of population change at the aggregate level and that the individuals modeled behave rationally.

The third group of models, that is, the individual life cycle profile models, uses simulation methods to follow the lives of many different individuals to calculate the distribution of retirement benefits under different alternative retirement rules. Two simulation approaches are noticed here [9], i.e. Monte Carlo (MC) and dynamic microsimulation (MSM). Microsimulation operates at the level of individuals. The model simulates the life paths of a virtual population by accessing detailed demographic data and pension payment records and applying mathematical formulas to model individual behavior. The MC simulation relies on one or more typical individuals to describe the experiences of some larger group. Several input assumptions are made that relate to a typical representative of the target occupational group, and the conclusions are valid only for predefined individuals.

Van Sonsbeek [10] developed an MSM model that simulated life paths for a sample of the Dutch population to analyse the effects of ageing budgetary, redistributive and labour participation. The author formulated conclusions for policy measures intended to reduce state pension costs. Schofield et al. [11] used MSM to estimate the costs of early retirement in Australia due to back problems. They found that early retirement not only limits the retiree's income, but also reduces their long-term financial capacity. Halvorsen and Pedersen [12] studied the gender gap and its influence on the general inequality in the distribution of pension income, using an advanced MSM model.

The MC approach to solving decision-related problems in the area of retirement planning is not the predominant choice, but it has been applied a number of times. McFarland and Warshawsky [13] studied the relationship between financial market fluctuations and the degree of retirement security for retirees at age 65. The authors used historical returns and interest rates taken over a long period (95 years) and tested

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two investment strategies. MC simulation methods can also be used to indicate the optimal retirement age. Bieker [14], using historical data, defined three input probability distributions (inflation rate, wage growth rate, and life expectancy) and ran MC simulations for different retirement age scenarios. Mielczarek [9] built an MC simulation model to compare two variants of the Polish pension system. Simulations enabled calculation of the economic implications of the new pension system strategy from the perspective of the individual worker and comparison of the results of the previous system, assuming the same macroeconomic circumstances.

4 Methodology

4.1 Method and Output Measures

The dynamic MC simulation method was used to simulate the pension to be received in 2042 or later by a hypothetical worker from two obligatory pillars. Simulation starts in the year 2008 when a hypothetical individual is 25 years old and he/she begins earning a living. From 2008 to 2019, the growth of capital accumulated in the first and second obligatory pillars is simulated on the basis of real values of capital indexation. From 2020 to the moment of reaching the retirement age (that is, at least until 2043) the growth of the accumulated capital is simulated according to different scenarios of indexation and according to different individual life-cycle professional profiles.

Two groups of workers by income level and gender are considered: minimum- and average-wage workers. Individual earnings are assumed to grow in line with the economy’s average. This means that the individual is assumed to remain at the same point of earning distribution: low-income workers are paid the minimum wage at all times, while average-income workers' wages are always at the average-wage level.

Calculations of annual changes in an individual’s first and second pillar accounts were made for different numbers of working years and were replicated 500 times.

Two indicators were chosen as baseline measures in the simulation. These ratios are calculated when the decision is made to retire. The most important indicator is the gross future replacement rate (GRR). The GRR represents the level of retirement benefits from mandatory public pension systems relative to earnings while working. Following [15], the probability of achieving the target gross replacement rate (TRR) was also analyzed. Three TRR values were investigated: 40%, 45%, and 50%.

We also examined to what extent, in the face of shortened life expectancy, delayed retirement can contribute to higher pensions.

4.2 Assumptions

Several assumptions were formulated in the simulation model.

- The simulation is run separately for a hypothetical female employee and a hypothetical male employee.

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- Hypothetical workers belong to two main income classes: those earning the minimum wage and those earning the average wage. The simulation is run separately for both earning classes and separately for both genders.
- The salary change occurs on the last day of the calendar year. Mid-year changes in an employee's salary are not considered.
- There are no unemployment intervals in the professional history of the individual.
- The capital accumulated in the pension account in the first pillar is increased monthly by an amount equivalent to 12.22% of the employee's gross salary.
- The capital accumulated in the pension account in the second pillar is increased monthly by an amount equivalent to 7.3% of the employee's gross salary.
- There are no delays in money transfer; therefore, no interest is added due to late payments.
- The simulation is run with a one-year step.
- There are no preretirement withdrawals.
- There is no fee contribution paid by individuals.
- Life expectancy is assumed to increase every year.

4.3 Input Distributions

The key variables in the model were described using random distributions that were fitted by analyzing historical data. All available and published values were considered (Table 1).

The indexation rates of the accumulated capital in the first pillar were forecasted based on the historical data from the period 2000-2020, published annually by the Minister of Family, Labour and Social Policy. These years cover the entire period that the current pension system has been in effect. Indexation means multiplying the sum of contributions by the index. The triangular distribution was fitted to the data.

The indexation rates of the accumulated capital in the second pillar were forecasted based on the historical data from the period 2008-2020, published annually by the Minister of Family, Labour and Social Policy. Indexation means multiplying the sum of contributions by the index. These years cover the entire period that the current pension system has been in effect. The triangular distribution was fitted to the data.

A change in the minimum wage is made once a year, taking into account the percentage rate of increase/decrease. Between 2008 and 2022, there was an increase from 1126 PLN to 3010 PLN (167.32% increase). The gamma distribution was fitted to the data. A change in the average-wage is made once a year by taking into account the percentage rate of increase/decrease. Between 2004 and 2021, there was an increase from 2748.11 PLN to 6644.39 PLN (167.32% increase). The gamma distribution was fitted to the data.

In the Polish pension system, there is a limitation of the assessment basis for pension contributions. The limit is equal to 30 times the projected average monthly salary, which is announced annually by the Minister of Family, Labour, and Social Policy and is effective for the following calendar year. Between 2008 and 2022, there was an increase from 2843 PLN to 5922 PLN (108.3% increase). The triangular distribution was fitted to the data.

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Table 1. Input random distributions: fitted parameters and test statistics.

Input parameter	Random distribution	Statistic value
Indexation rates of the accumulated capital (%) – Pillar 1	Triangular: a = 101; b = 117; c = 105	Chi-square test *p-value* > 0.75 Kolmogorov-Smirnov test *p-value* > 0.15
Indexation rates of the accumulated capital (%) – Pillar 2	Triangular: a = 103; b = 105; c = 107	Kolmogorov-Smirnov test *p-value* > 0.15
Minimum wage – growth/decline in %	Gamma: alfa = 3.37; beta = 1.47; offset = 2	Kolmogorov-Smirnov test *p-value* > 0.15
Average wage – growth/decline in %	Gamma: alfa = 1.76; beta = 2.47; offset = 1	Kolmogorov-Smirnov test *p-value* > 0.15
Projected average monthly salary growth/decline in %	Triangular: a = -2; b = 5.4; c = 13	Kolmogorov-Smirnov test *p-value* > 0.15

4.4 Simulation Experiments

An overview of the MC model is presented in Fig. 1.

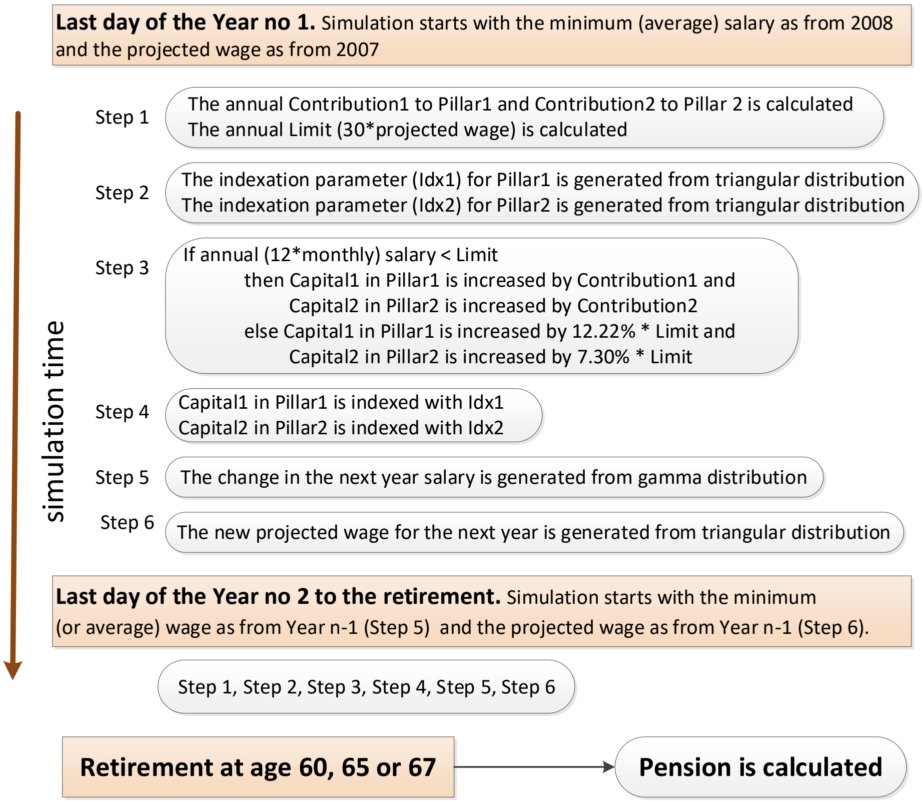

Fig. 1. An overview of the MC simulation model.

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Simulation studies were conducted in two main scenarios (Table 2). Scenario 1 (Sc1) is a simulation of a retirement benefit for a person whose salary is kept at the minimum wage. Scenario 2 (Sc2) is a simulation of the retirement benefit for a person from an average-wage working group. Within each main scenario, simulations were performed for three different retirement ages: 60 (women), 65 (men), and 67 years. The study included an analysis for a retirement age of 67, because for a short period (from January 2013 to October 2017) this was the retirement age for both women and men in Poland.

Each of the six experiments (Sc1_60, Sc1_65, Sc1_67 and Sc2_60, Sc2_65, Sc2_67) was conducted in two variants: for shortened future life expectancy caused by the Covid 19 pandemic and for life expectancy projected before the SARS-Cov2 virus affected population longevity.

Table 2. Simulation scenarios.

Main scenario	Sub-scenario	Sub-sub scenario	Description
Sc1	Minimum-age working group		
	Sc1_60	Sc1_60Cov, Sc1_60NCov	retirement age = 60 (women)
	Sc1_65	Sc1_65Cov, Sc1_65NCov	retirement age = 65 (men)
	Sc1_67	Sc1_67Cov, Sc1_67NCov	retirement age = 67 for men and women
Sc2	Average-age working group		
	Sc2_60	Sc2_60Cov, Sc2_60NCov	retirement age = 60 (women)
	Sc2_65	Sc2_65Cov, Sc2_65NCov	retirement age = 65 (men)
	Sc2_67	Sc2_67Cov, Sc2_67NCov	retirement age = 67for men and women

5 Simulation Results

5.1 Gross Replacement Rate (GRR)

The Covid 19 epidemic caused significant changes in the life expectancy tables. The long-observed trend of increased longevity was reversed between 2020 and 2021, and life expectancy shortened by approximately 13 months for all age groups studied (Table 3). Therefore, two variants were simulated: a variant in which life tables are significantly modified as a result of the Covid 19 outbreak and a variant in which life expectancy increases steadily, as predicted before the outbreak. Figs.2 and 3 present distributions of the GRR values for persons who earn minimum wage and retire at the age of 60 (women) and 65 (men). Figs.4 and 5 present the GRR values for people who earn an average wage and retire at the age of 60 (women) and 65 (men).

Table 3. Life expectancy values in 2020 and 2021 according to [16].

Age	Life expectancy in 2020 [months]	Life expectancy in 2021 [months]
60	201,1	188,1
65	217,6	204,3
67	261,5	247,7

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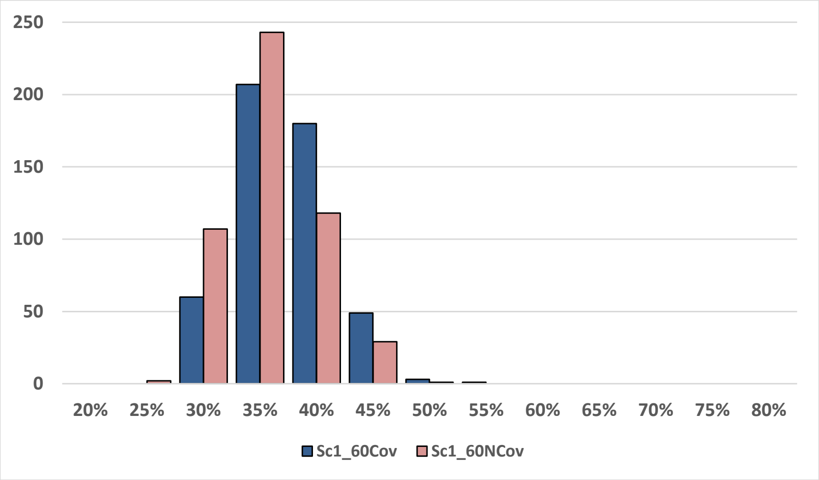

Fig. 2. Distribution of the GRR values for a person who retires at age 60 (woman) and who earns minimum wage during her professional career. Two scenarios are visualized: Life expectancy is reduced (Sc1_60Cov), or a pandemic does not affect life expectancy (Sc1_60NCov).

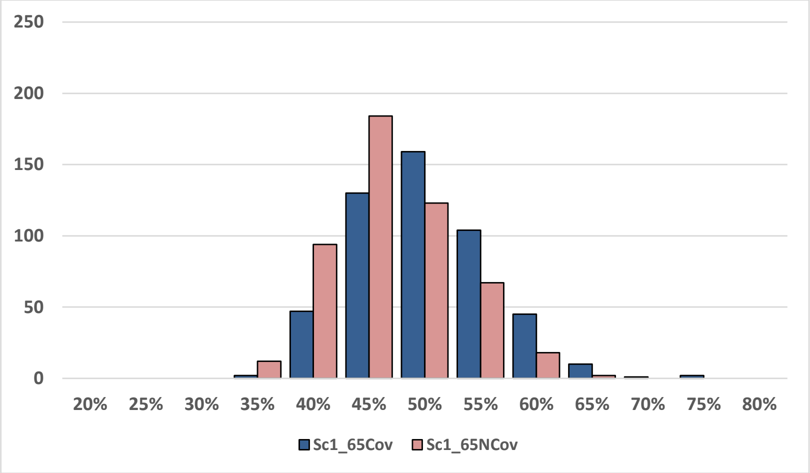

Fig. 3. Distribution of the GRR values for a person who retires at age 65 (man) and who earns minimum wage during his professional career. Two scenarios are visualized: Life expectancy is shortened (Sc1_65Cov) or a pandemic does not affect life expectancy (Sc1_65NCov).

The Figs.2 and 3 capture the essential differences between these two variants in minimum wage scenario. The Covid-19 epidemic caused the GRR values to shift to the right in the graphs, which means that the pension has increased relative to the last salary, and we observe more instances of higher GRRs in the simulation. The average GRR for retirement age 60 in the Sc1_60NCov variant is 32.89%, while in the Sc1_60Cov variant it is 34.18%. For retirement age 65, it is 44.64% and 47.28%, respectively. In Scenario 2, in which the retirement of a person from the average-wage

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working group was simulated, a similar trend can be observed (Fig.4 and Fig.5), but the differences for both variants are much smaller. This is caused by the limitation of the contribution base for retirement benefits, which means that the capital deposited in the mandatory pension funds is constrained from above.

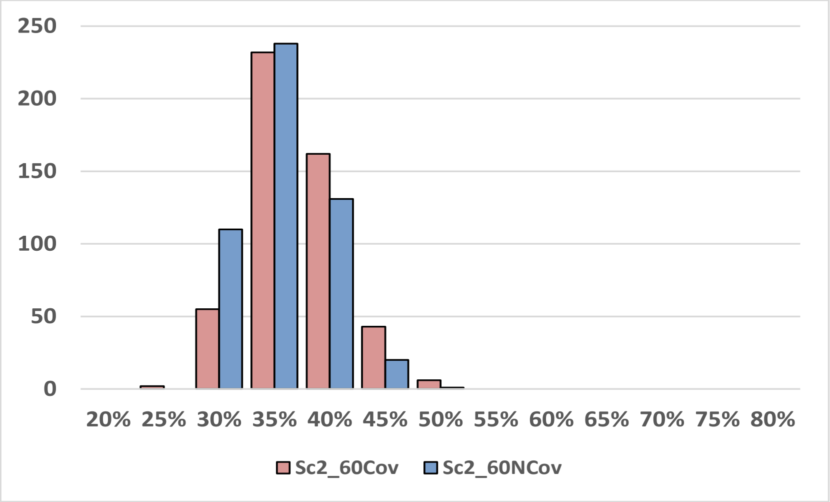

Fig. 4. Distribution of GRR values for a person who retires at age 60 (woman) and who earns an average wage during her professional career. Two scenarios are visualized: Life expectancy is shortened (Sc2_60Cov), or a pandemic does not affect life expectancy (Sc2_60NCov).

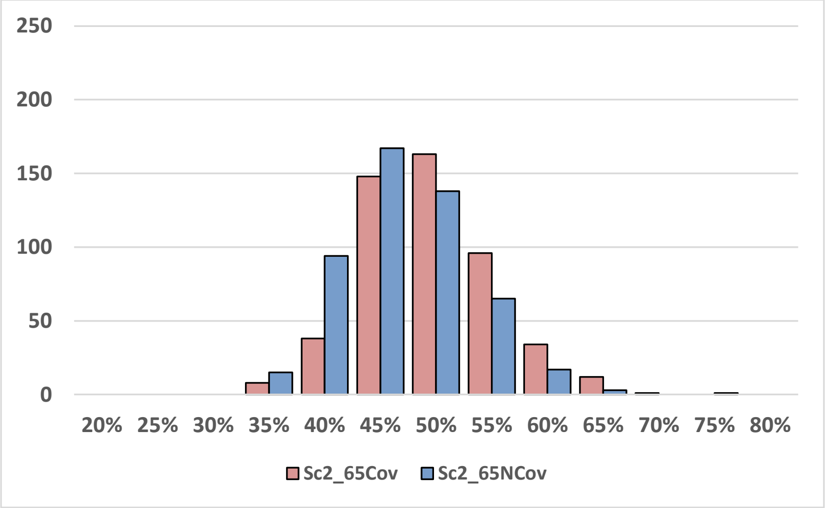

Fig. 5. Distribution of the GRR values for a person who retires at age 65 (man) and who earns an average wage during his professional career. wo scenarios are visualized: life expectancy is shortened (Sc2_65Cov) or when a pandemic does not affect life expectancy (Sc2_65NCov).

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5.2 Probability of Target Replacement Rates (TRR)

The second output measure taken into account was the probability of achieving the target replacement rate (TRR). Following [15], three values were tested: 40%, 45%, and 50%. Tables 4 and 5 summarize the simulation findings. There is a large difference between the retirement ages of 60 and 65 and 67. The higher the retirement age, the higher the probability of achieving the TRR in both variants (Cov and NCov). This is a clear indication in favor of extending the period of paid work and confirms the large pension gap between men and women.

Another conclusion comes from comparing the Cov and NCov variants. The probabilities of obtaining TRR are slightly lower for the variant not affected by the pandemic. The lower the retirement age, the more pronounced these differences are. For people who retire later than it results from the acquisition of pension rights, this is a clear prerequisite to use earlier life expectancy tables to determine the amount of the pension. These refer to the tables valid on the day when the insured person reached the retirement age of 60 years for women and 65 years for men, and not to the tables valid in the year of the actual retirement.

A somewhat surprising conclusion appears when comparing Table 4 and Table 5. Table 4 presents the probability of reaching the TRR in the case of a person earning minimum wage, while Table 5 refers to people in the average-wage group. It turns out that in some variants, minimum wage earners obtain a higher probability of reaching a given TRR threshold compared to average wage earners. This is the case, for instance, for a the NCov variant for retirement age equal to 60 years. The reason is the limitation of the contribution base for retirement benefits.

Table 4. Probability of three target replacement rates (TRR) for a scenario with shortened life expectancy (Cov) and with life expectancy unaffected by the Covid 19 outbreak (NCov). Applies to the minimum wage group of workers.

variant	Cov	NCov	Cov	NCov	Cov	NCov
Retirement age	60	60	65	65	67	67
P(TRR > 0.4)	0.094	0.050	0.880	0.800	0.986	0.950
P(TRR > 0.45)	0.012	0.008	0.616	0.424	0.890	0.776
P(TRR > 0.5)	0.000	0.002	0.308	0.174	0.674	0.490

Table 5. Probability of three target replacement rates (TRR) for a scenario with shortened life expectancy (Cov) and with life expectancy unaffected by the Covid 19 outbreak (NCov). Applies to the average-wage group of workers.

variant	Cov	NCov	Cov	NCov	Cov	NCov
Retirement age	60	60	65	65	67	67
P(TRR > 0.4)	0,098	0,042	0,908	0,782	0,982	0,976
P(TRR > 0.45)	0,012	0,002	0,610	0,448	0,898	0,794
P(TRR > 0.5)	0,000	0,000	0,284	0,170	0,642	0,512

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5.3 Delayed Retirement

Fig. 6 compares the GRRs for delayed treatment and with different life tables. The delayed retirement in the DC scheme allows for a higher pension due to a longer period of capital accumulation in retirement accounts and a shorter life expectancy. In the Polish pension system there is an additional possibility of increasing the pension benefits, as the insured who retires after reaching the age of retirement can choose the life table from the one currently in force and the one which was in force when he/she reached the retirement age. Therefore, the shortening of longevity due to the pandemic further contributes to the increase in retirement benefits. The differences in pension when selecting Covid nad Non-Covid tables are about 4 percentage points.

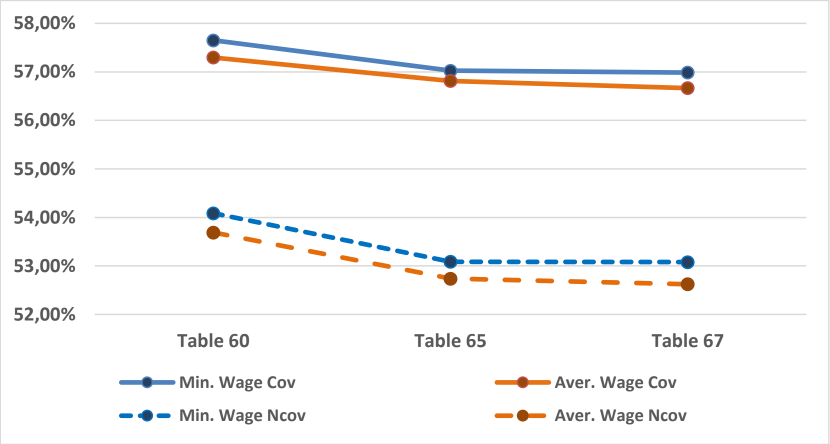

Fig. 6. GRRs when retiring at 67 (delayed treatment) and choosing different life expectancy tables. The graph shows the simulation results for minimum and average wage workers. Table 67: Life expectancy table applicable to retirement at age 67; Table 65: the life expectancy table applicable when the insured (male) has reached retirement age of 65; Table 60: the life expectancy table applicable when the insured (female) has reached retirement age of 60.

5.4 The Comparative Analysis of Simulation Techniques

Among the simulation methods used to study the impact of population aging on the sustainability of pension systems, in addition to the previously mentioned MC and MSM, agent-based simulation (ABS) is also used. Each approach has its advantages and disadvantages, and the purpose of simulation studies is usually somewhat different. Table 6 compares these three approaches in relation to the study of pension systems. The comparative analysis was carried out on the basis of selected items of the literature. All methods enable dynamic simulations useful for long-term analyses, allow for randomness and uncertainty, and are based on dynamic simulation analyses. The main differences between them concern such aspects as consideration of the full range of lifetime trajectories (MSM and ABS) versus selection of typical life trajectories (MC), and microlevel analysis (MSM and ABS) versus aggregated analysis (MC). If the goal is to study the impact of pension systems on individuals, then microsimulation and agent

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models allow you to explore in detail the different variants of characteristics and behaviour of employees. However, if the aim of the study is to formulate some universal relationships for typical characteristic groups of individuals, then MC simulation may be the choice. MC models do not require such detailed data about individual characteristics.

Table 6. Simulation techniques used for retirement studies: comparative analysis.

Feature	MC [9], [17]	MSM [12], [10]	ABS [18], [19]
Dynamics of lifetime trajectories	√	√	√
Unlimited number of uncertain elements	√	√	√
Micro-level analysis		√	√
Unlimited individual characteristics		√	√
Unlimited heterogeneity of lifetime trajectories		√	√
Changing preferences towards employment positions	√		√
Risks in the labour market	√		√
Typical lifetime trajectories	√		
Aggregated analysis	√		

6 Conclusions

The objective of the studies was to focus on the impact of the Covid-19 pandemic on projected retirement benefits. An MC simulation was successfully applied to compare two scenarios to test the impact of the Covid-19 pandemic on future pensions in two income groups and for different retirement ages. Although the presented model does not reflect all the factors that influence projected retirement benefits, it clearly shows that a shortening of life expectancy can affect future pension in various ways. Generally, this effect is beneficial for future retirees. The GRR ratios, obtained during the simulations, clearly move towards higher values, which means a higher replacement rate at retirement. An interesting conclusion can also be drawn by comparing the probabilities of obtaining TRR in the two study groups: the minimum wage and the average wage. In most cases, across retirement age classes, these probabilities, i.e. P(TRR > 0.45) and P(TRR > 0.50) are close to each other. This indicates a certain resilience of the pension system, unfavorable from the point of view of the retiree, to changes in the life tables.

Our study has some limitations. The most important limitation is the lack of correlation between demographic changes and capital indexation rates. The indexation parameters depend on the level of employment and the average salary in the economy. The volume of people in the working age group and the amount of contributions paid influence the annual indexation of the accumulated capital. Future research will focus on expanding the model by incorporating such dependencies.

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