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FORECASTING MORTALITY FOR KAZAKHSTAN AND ASSESSING IT'S IMPACT ON THE STATE PENSION SPENDING

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Abstract

This paper uses the mortality projection methods of Knykova A. and Sapin A., based on the original Lee-Carter model, in order to investigate mortality rates for Kazakhstan for the time period from 2018 to 2025 and assess their impact on the state pension spending in Kazakhstan. The results show that improvements in mortality rates have been increasing the number of years that people spend in retirement in Kazakhstan, which directly affects the public pension spending. The overall state pension spending is expected to increase in Kazakhstan from 2019 to 2025, reflecting the gradually increasing effect of mortality improvements, but the state pension spending's share of GDP is projected to decline from 2021 to 2024. However, extra expenditures of the government on pensions due to future mortality improvements will increase gradually as a share of GDP over time and reach 0,02% in 2024.

Keywords: forecasting mortality for Kazakhstan, Lee-Carter model, life expectancy, state pension spending.

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ҚАЗАҚСТАННЫҢ ӨЛІМ КӨРСЕТКІШТЕРІН БОЛЖАУ ЖӘНЕ ОЛАРДЫҢ МЕМЛЕКЕТТІК ЗЕЙНЕТАҚЫ ТӨЛЕМДЕРІНЕ ӘСЕРІН БАҒАЛАУ

Аңдатпа

Бұл мақалада 2018 жылдан бастап 2025 жылға дейінгі кезеңдегі Қазақстандағы өлім-жітімнің деңгейін зерттеу мақсатында Ли-Картердің бастапқы үлгісі негізінде Кныкова А. және Сапин А. дайындаған өлім көрсеткіштерін болжау әдістері қолданылады, және олардың мемлекеттік зейнетақы төлемдеріне жасалатын әсеріне баға беріледі. Алынған нәтижелер Қазақстанда өлім деңгейінің төмендеуін және осыған байланысты зейнетке шыққан адамдардың өмір сүру ұзақтығының ұлғаюын көрстеді. Ал бұл дегеніміз мемлекет тарапынан төленетін зейнетақы шығындарына тікелей әсер етеді. 2019 жылдан бастап 2025 жылға дейін Қазақстандағы зейнетақыға бөлінетін мемлекеттік шығындар біртіндеп артады, ал бұл өлім-жітімнің біртіндеп төмендеуінің әсерін көрсетеді. Алайда, болжам бойынша, мемлекет тарапынан төленетін зейнетақы шығындарының ЖІӨ-дегі үлесі 2021 жылдан бастап 2024 жылға дейін төмендейді. Өлім-жітімнің төмендеуіне байланысты мемлекеттік зейнетақы төлемдерінің қосымша шығындары біртіндеп ЖІӨ-ң үлесі ретінде ұлғаяды және 2024 жылы 0,02% жетеді.

Түйін сөздер: Қазақстанның өлім көрсеткіштерін болжау, Ли-Картер үлгісі, өмір сүру ұзақтығы, мемлекеттік зейнетақы төлемдері.

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ПРОГНОЗИРОВАНИЕ СМЕРТНОСТИ В КАЗАХСТАНЕ И ОЦЕНКА ЕЕ ВЛИЯНИЯ НА ВЫПЛАТЫ ГОСУДАРСТВЕННОЙ ПЕНСИИ

Аннотация

В данной статье используются методы прогнозирования смертности Кныковой А. и Сапина А., основанные на оригинальной модели Ли-Картера, с целью изучения показателей смертности в Казахстане за период с 2018 по 2025 гг. и оценки их влияния на государственные пенсионные расходы. Результаты показывают, что снижение темпов смертности увеличивает количество лет, которые люди проводят на пенсии в Казахстане, что напрямую влияет на государственные пенсионные расходы. Ожидается, что совокупные государственные пенсионные расходы в Казахстане будут постепенно увеличиваться с 2019 по 2025 год, отражая тем самым эффект от постепенного снижения смертности. Однако, согласно прогнозам, доля государственных пенсионных расходов в ВВП сократится с 2021 до 2024 года. Дополнительные расходы государства по выплате пенсии будут постепенно увеличиваться в процентах от ВВП ввиду снижения темпов смертности с течением времени и достигнут 0,02% в 2024 году.

Ключевые слова: прогнозирование смертности в Казахстане, модель Ли-Картера, продолжительность жизни, выплаты государственной пенсии.

1. Introduction

Kazakhstan has had a tendency towards a decrease in mortality rates among the population, as well as a positive trend for life expectancy. According to the World Bank data for Kazakhstan there has been a steady increase in life expectancy at birth since 2005, which can be attributed to the increase in GDP per capita and socio-economic stabilization. This is what is known as a longevity risk, that is, the risk that can result in more payments than expected for pension funds and insurance companies due to the increase in life expectancy.

Forecasting and finding further trends in mortality rates are even more important issue for life insurance companies as their solvency or financial strength depends chiefly on whether they set up accurate long-term mortality assumptions in their life tables used to determine insurance premiums and reserves. In addition, knowing the future mortality profile of the population would provide a government with comprehensive statistical data that would enable a direction for social policies, the provision of services, and therefore, the size of public spending, with a direct effect on the areas of public health, medicine, and social security, among others. Therefore, it is important for the government and life insurance companies in Kazakhstan to take into account future developments in mortality rates in their decision making process.

As a scientific research approach to modeling and forecasting mortality rates in Kazakhstan, the author of this paper uses the Lee-Carter model. In that, this paper is based on the research by Knykova A. and Sapin A. [1], but extends it further by assessing the impact of future mortality changes on the state pension spending in Kazakhstan. The predicted model can be used to construct life tables for Kazakhstan, which in turn can be used in state pension planning.

2. Literature Review

There are many approaches for modeling mortality rates, which include the imposition of empirical tables obtained from other countries and historical settings, parametric model schedules, relational models, functional models and hierarchical Bayesian models. Of these approaches, the most successful and widely used for forecasting future mortality patterns have been the relational and functional models, and particularly, the model developed by Lee R.D. and Carter L. [2]. They proposed the two-factor model for describing the log of a time series of age-specific death rates as the sum of an age-specific parameter and the product of a time-varying parameter, and another age-specific parameter. In their paper, Lee and Carter applied the Singular Value Decomposition (SVD) to estimate the model's parameters for the US data so that the model was fitted to historical data. The time-varying parameter was then projected as a stochastic time series using standard Box–Jenkins methods and used to generate forecasted mortality rates.

The Lee-Carter model has been widely used in forecasting mortality in different countries: Belgium, Taiwan, Japan, Canada, Chile etc. There are some variations and extensions of this model which are intended to improve the predictive power of the Lee-Carter model [3]. Brouhns N., Denuit V. and Vermunt J.K. [4] aimed to investigate possible improvements of the powerful Lee-Carter method and specifically switched from a classical linear model to a Poisson regression model, which was perfectly suited for age-sex-specific mortality rates. Giacometti R., Ortobelli S. and Bertocchi M. [5] also experimented with variants of different distributional assumptions in forecasting age-specific mortality in Italy.

Haberman S. and Renshaw A. [6] presented an enhanced version of the Lee-Carter model that includes an age modulated cohort index in addition to the standard age modulated period index. As this paper is based on the research by Knykova A. and Sapin A. [1] that relies on the original Lee-Carter model there is still room left for improvements by experimenting with variations and extensions of the original Lee-Carter model.

It should be noted that the Lee-Carter model does not attempt to incorporate assumptions about advances in medical science or catastrophe mortality shocks [7]. It means that this model is unable to forecast sudden improvements in mortality rates due to the discovery of new medical treatments or severe future deteriorations caused by epidemics, so that no information other than previous history of mortality is taken into account. However, the complexity of social and biological factors that determine mortality levels suggests that the most reliable and compelling approach of predicting the future human mortality is merely to extrapolate past trends [8].

In addition to predicting mortality trends, assessing their socio-economic impact is another important issue as changes in mortality trends have dramatic societal implications for households as well as those firms, insurers and governments that are either expected to provide financial protection in case of premature death or meet the demands of retired populations for longer [9]. Particularly, for insurers they have a significant impact on pricing and reserving. Khalaf-Allah M., Haberman S. and Verrall R. [10] used the mortality projection model of Sithole T.Z., Haberman S. and Verrall, R.J. [11] in order to investigate the effect of mortality improvements on the cost of annuities of insurance companies. Another research [12] proposed several methods for comparing alternative mortality tables and illustrated their impact on annuity valuation for men and women in the US, the UK and Australia. The present paper attempts to contribute to the literature through investigating the impact of future mortality changes on the state pension spending in Kazakhstan.

3. Materials and research methods

3.1. Data

This study uses available official data, which include the population sizes of Kazakhstan by sex and selected age groups, as well as age-specific and sex-specific number of deaths for the period of 1999-2017.

Actual mortality rates for the period of 1999-2017 are estimated as the ratio of number of deaths to the midyear population size for 5-year (0, 1-4, 5-9, ... 95-99, 100+) age groups. Mortality at high ages (85 and above) are smoothed by using the Coale and Guo method [13] because otherwise small sample sizes yield implausible rates at high ages where the populations are really small.

3.2. Methodology of mortality forecasting

Mortality projection methods of Knykova A. and Sapin A. [1] are based on the original Lee-Carter model [2], which is a bilinear model in the variables x (age) and t (calendar year). The Lee-Carter model is defined as:

$$ln\, ln\left(m_{x,t}\right) = a_x + b_x k_t + \varepsilon_{x,t} \tag{1}$$

Where

$m_{x,t}$ – actual central death rate at age x in year t;

a_x – average age-specific parameter of mortality;

b_x – parameter that represents how much, at each age, the mortality rate responds to a change in k_t;

k_t – the time series for the general level of mortality that measures the tendency in mortality over time;

$\varepsilon_{x,t}$ – the error term.

In order to obtain a unique solution for the system of equations of the given model a_x is set equal to the average values of the $ln\, ln\left(m_{x,t}\right)$ over time, the sum of squares of b_x to unity, and sum of k_t to zero:

$$\hat{a}_x = \frac{1}{T}\sum_t \; ln\, ln\left(m_{x,t}\right), \qquad \sum_x \; b_x^2 = 1, \qquad \sum_t \; k_t = 0 \tag{2}$$

The parameter a_x can be easily calculated from equation (2) as the average over time of the log of the central death rate. Then the Singular Value Decomposition is applied to matrix $Z_{x,t} = ln\, ln\left(m_{x,t}\right) - \hat{a}_x$ in order to compute the parameters b_x and k_t:

$$\begin{pmatrix} ln\, ln\left(m_{x_1,t_1}\right) - \hat{a}_{x_1} & ln\, ln\left(m_{x_1,t_2}\right) - \hat{a}_{x_1} & \cdots & ln\, ln\left(m_{x_1,t_n}\right) - \hat{a}_{x_1} \\ ln\, ln\left(m_{x_2,t_1}\right) - \hat{a}_{x_2} & ln\, ln\left(m_{x_2,t_2}\right) - \hat{a}_{x_2} & \cdots & ln\, ln\left(m_{x_2,t_n}\right) - \hat{a}_{x_2} \\ \vdots & \vdots & \ddots & \vdots \\ ln\, ln\left(m_{x_m,t_1}\right) - \hat{a}_{x_m} & ln\, ln\left(m_{x_m,t_2}\right) - \hat{a}_{x_m} & \cdots & ln\, ln\left(m_{x_m,t_n}\right) - \hat{a}_{x_m} \end{pmatrix} \tag{3}$$

When applying the Singular Value Decomposition, the following expression is obtained:

$$Z_{x,t} = \sum_{i=1}^{r} \; \rho_i U_{x,i} V_{t,i}\,, \tag{4}$$

where r is the rank of the matrix Z, ρ_i $(i = 1,2,\dots,r)$ are the singular values with $U_{x,i}$ and $V_{t,i}$ as the corresponding left and right singular vectors. The first singular value and the first singular vectors give approximations of b_x and k_t:

$$\hat{b}_x = U_{x,1}\,, \hat{k}_t = \rho_1 V_{t,1} \tag{5}$$

Once the values of the parameters $\hat{a}_x$, $\hat{b}_x$ and $\hat{k}_t$ have been found only the mortality index needs to be forecasted by the appropriate ARIMA time series model, which is generated by the standard Box-Jenkins methodology. In particular, the model selection strategy involves the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC).

In general, an ARIMA(0,1,0) process is an appropriate time series model:

$$\hat{k}_t = \hat{k}_{t-1} + \theta + \varepsilon_t \tag{6}$$

Where θ – the drift parameter;

$\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$ – the error term.

Based on the data available for the period up to T it is possible to forecast $\hat{k}_t$ at time $T + h$ by iteration:

$$\hat{k}_{T+h} = \hat{k}_T + \hat{\theta} \cdot h + \sum_{i=T+1}^{T+h} \varepsilon_i \tag{7}$$

where an estimate of the drift parameter $\hat{\theta} = \frac{\hat{k}_T - \hat{k}_1}{T-1}$ only depends on the first and last of the $\hat{k}_t$ estimates.

If the error term is ignored, then the following expression is obtained for a point forecast for the time-varying mortality index at time $T + h$:

$$\hat{k}_{T+h} = \hat{k}_T + \hat{\theta} \cdot h = \hat{k}_T + \left(\frac{\hat{k}_T - \hat{k}_1}{T-1}\right) \cdot h \tag{8}$$

It should be taken into account that because of uncertainty the variance of forecasted $\hat{k}_{T+h}$ tends to increase as the forecast horizon h increases. Therefore, these deviations will be taken into account within the range of 95% confidence interval:

$$\hat{k}_{T+h} \pm 1{,}96 \cdot \sqrt{h} \cdot \sigma_\varepsilon \tag{9}$$

Plugging the forecasted values of $\hat{k}_t$ into the equation (1) one can easily obtain forecasts of log mortality rates. Further, corresponding abridged life tables can obtained by using the data on forecasted mortality rates.

3.3. Assessing the impact of future mortality changes on the state pension spending

Derived abridged life tables for population of Kazakhstan can be used further to forecast state pension spending in Kazakhstan for the period of 2019-2025, and at the same time investigate the effect of mortality improvements on the additional cost of that spending. Before we proceed further, let us give a brief overview of the state pension provisions in Kazakhstan.

There are two types of pension which are paid from the national budget: basic pension and solidarity pension. Both of them represent lifelong monthly pension payments and carry no legal rights for potential beneficiaries to any dependent's pension upon death of the dependent.

The basic pension is granted to all individuals upon reaching the normal retirement age (59,5 for females (increased annually by 6 months until reaching 63) and 63 for males as of 01.01.2020) and is carried out regardless of the prior labor experience. Starting from July 1, 2018, its level depends on years of service, ranging from 54% of cost of living allowance (COLA) to 100% of COLA. The basic pension is paid on a monthly basis and once it has commenced for any individual, is then annually indexed to CPI. This means that the basic pension payments for any individual will be stable for future years in real prices.

The solidarity pension is based on a defined-benefit pay-as-you-go pension system and has its origin in Soviet times. It was initially continued when Kazakhstan became independent, but was closed at the end of 1997 as the mandatory defined contribution system was introduced. This pension is appointed to certain categories of individuals, including individuals with pension entitlements upon reaching the retirement age, who have at least 6 months of work experience prior to January 1, 1998. The solidarity pension is also paid on a monthly basis and once it has commenced for any individual, is then annually indexed at a rate of inflation plus 2%, so that in real prices it will grow at an annual rate close to 2%.

Currently all the people at the retirement age or higher are potentially provided with the state pension payments in Kazakhstan. Indeed, the number of recipients of the basic pension and solidarity pension payments in 2019 amounted to 2,1 million people, which is slightly more than the total number of people at the retirement age or higher at the beginning of 2019. Although there are certain categories of recipients who haven't reached yet the normal retirement age, we will disregard them when forecasting the state pension spending as their share is relatively small and concentrate solely on recipients at the retirement age or higher.

In making our calculations, we assume that all current (at the normal retirement age or higher) and new retirees are provided with the basic pension and solidarity pension payments, and that all movements are uniformly distributed over the year.

In order to forecast the state pension spending, sex-specific probabilities of dying (nq_x) from derived abridged life tables need to be graduated into single year values (q_x). For these purposes, parametric modeling is widely used in demography since it provides results with the highest degree of smoothness. Among the parametric methods, the most successful attempt to describe the mortality pattern through a parametric model might be the one proposed by Heligman and Pollard [14]. We applied this method to obtain probabilities of death within one year of males and females aged only 55 and higher since our projection period is until 2025.

In addition, we need to interpolate the population structure of Kazakhstan by 5-year age groups at the beginning of 2019 into single ages for each gender using the Beers six-term modified formula as it combines interpolation with some smoothing of the given values [15].

For the sake of simplicity, we will neglect migration and treat mortality as the only factor that affects the expected number of pension payments over the years. We will calculate the state pension spending in any year by multiplying the estimated number of pension payments per year by the average amount of the monthly pension benefit in the corresponding year. According to available official statistics, in 2019 the average monthly amounts of the basic pension benefit and solidarity pension benefit were around 27,0 thousand KZT and 57,6 thousand KZT respectively (in local currency). We determine 2019 as the base year and assume that the real average values of the monthly basic pension in subsequent years will remain constant, while the real average values of the monthly solidarity pension will grow at an annual rate of 2%.

4. Results and discussion

Below there are comparisons of the fitted values of log mortality rates for 2001, 2005, 2009, 2013, 2017 and the forecasted values of log mortality rates for 2021 and 2025 for males and females in Kazakhstan (Fig. 1- 2).

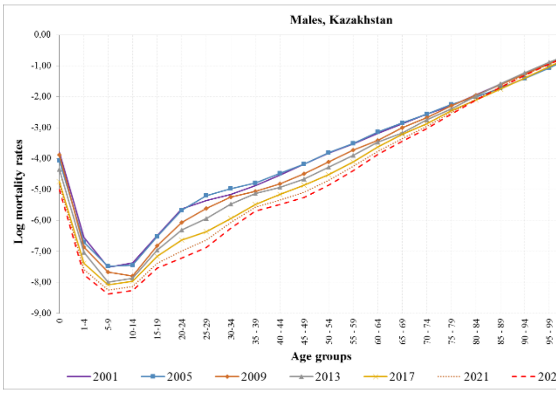

Figure 1. Comparison of the fitted values of log mortality rates for 2001, 2005, 2009, 2013, 2017 and the forecasted values of log mortality rates for 2021 and 2025 for the respective age groups, males.

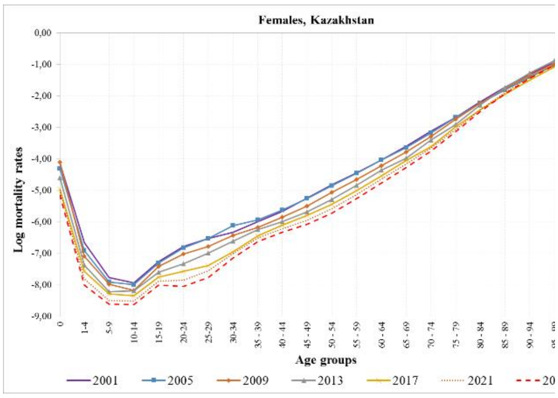

Figure 2. Comparison of the fitted values of log mortality rates for 2001, 2005, 2009, 2013, 2017 and the forecasted values of log mortality rates for 2021 and 2025 for the respective age groups, females.

From the Figures 1-2 we can observe a general trend towards a decrease in mortality rates over the years. If we consider younger age groups, then the rate of the decline in mortality rates increases over time as the age groups get older, reaching its peak at age groups 20-24 and 25-29. Further, there is a gradual decrease in the rate of the decline in mortality rates with little deviation.

The overall decline in forecasted mortality rates could not but affect the forecasted values of life expectancy in Kazakhstan. In particular, life expectancy at birth is expected to increase over the forecast period of 2018-2025 from age 69,25 to age 71,68 for males, and for females from age 77,16 to age 78,96.

For the sake of clarity, comparisons of the actual values of life expectancy at birth for the period 1999-2017 and the forecasted values of life expectancy at birth for the period 2018-2025 with associated 95% confidence intervals are presented below (Fig. 3-4):

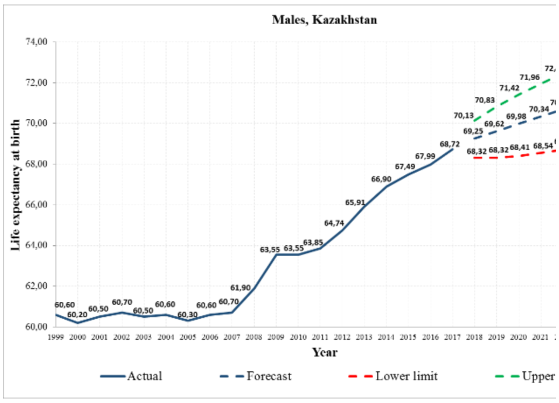

Figure 3. Comparison of the actual values of life expectancy at birth for the period 1999-2017 and the forecasted values of life expectancy at birth for the period 2018-2025 with associated 95% confidence intervals (males, Kazakhstan).

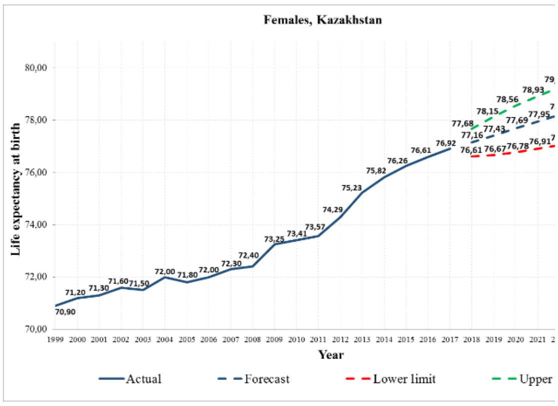

Figure 4. Comparison of the actual values of life expectancy at birth for the period 1999-2017 and the forecasted values of life expectancy at birth for the period 2018-2025 with associated 95% confidence intervals (females, Kazakhstan).

Improvements in mortality rates and life expectancy have been increasing the number of years that people spend in retirement, which have a direct effect on the size of public pension spending in Kazakhstan. Below there is a comparison of expected amounts of state pension recipients after allowing for mortality improvements since 2019 with the corresponding amounts of state pension recipients when we do not allow for mortality improvements (Tab. 1 – Comparison of expected amounts of state pension recipients after allowing for mortality improvements since 2019 and the corresponding amounts of state pension recipients when mortality improvements are not considered, for the period of 2019-2025).

Table 1. Comparison of expected amounts of state pension recipients after allowing for mortality improvements since 2019 and the corresponding amounts of state pension recipients when mortality improvements are not considered, for the period of 2019-2025.

Year	***Expected state pension recipients***						***Relative difference due to the allowance for future mortality improvements***		
	after allowing for future mortality improvements			*without allowing for any improvement in mortality in the future*					
	males	*females*	***total***	*males*	*females*	***total***	*males*	*females*	***total***
2019	*658 694*	*1 508 243*	*2 166 937*	*658 694*	*1 508 243*	*2 166 937*	*0,00%*	*0,00%*	*0,00%*
2020	*691 282*	*1 513 430*	*2 204 711*	*690 999*	*1 512 996*	*2 203 995*	*0,04%*	*0,03%*	*0,03%*
2021	*726 861*	*1 517 767*	*2 244 628*	*725 678*	*1 516 034*	*2 241 712*	*0,16%*	*0,11%*	*0,13%*
2022	*764 706*	*1 521 727*	*2 286 433*	*761 946*	*1 517 845*	*2 279 791*	*0,36%*	*0,26%*	*0,29%*
2023	*804 125*	*1 524 600*	*2 328 725*	*799 050*	*1 517 735*	*2 316 785*	*0,64%*	*0,45%*	*0,52%*
2024	*844 290*	*1 526 739*	*2 371 029*	*836 107*	*1 516 082*	*2 352 189*	*0,98%*	*0,70%*	*0,80%*
2025	*884 369*	*1 527 788*	*2 412 158*	*872 240*	*1 512 541*	*2 384 781*	*1,39%*	*1,01%*	*1,15%*

Throughout, we can see that the number of people at the normal retirement age and higher is projected to increase regardless of whether or not we allow for future mortality improvements. The relative differences in the number of recipients due to the allowance for mortality improvements are higher for males. This is because males as the higher mortality group have more scope for mortality improvements, and with relatively lower mortality rates for females, further decreases in these rates will have smaller effect.

As the number of people at the normal retirement age and higher rises annually, so does the size of public pension spending in Kazakhstan as shown below (Tab. 2 - Comparison of expected state pension spending after allowing for mortality improvements since 2019 and the corresponding state pension spending when mortality improvements are not considered, for the period of 2019-2025).

Table 2. Comparison of expected state pension spending after allowing for mortality improvements since 2019 and the corresponding state pension spending when mortality improvements are not considered, for the period of 2019-2025.

Year	***Expected state pension spending in KZT thousand after allowing for future mortality improvements, 2019 constant prices***								
	Basic pension			*Solidarity pension*			*Total state pension*		
	males	*females*	***total***	*males*	*females*	***total***	*males*	*females*	***total***
2019	*202 710 050*	*475 954 971*	***678 665 021***	*432 613 278*	*1 015 758 421*	***1 448 371 699***	*635 323 328*	*1 491 713 392*	***2 127 036 720***
2020	*212 682 806*	*477 431 495*	***690 114 302***	*462 974 550*	*1 039 287 732*	***1 502 262 282***	*675 657 356*	*1 516 719 227*	***2 192 376 584***
2021	*223 625 772*	*478 925 310*	***702 551 082***	*496 531 449*	*1 063 390 305*	***1 559 921 754***	*720 157 221*	*1 542 315 615*	***2 262 472 836***
2022	*235 362 664*	*480 117 575*	***715 480 239***	*533 043 498*	*1 087 358 324*	***1 620 401 821***	*768 406 161*	*1 567 475 899*	***2 335 882 060***
2023	*247 708 620*	*481 141 114*	***728 849 734***	*572 224 397*	*1 111 469 937*	***1 683 694 334***	*819 933 017*	*1 592 611 051*	***2 412 544 068***
2024	*260 417 349*	*481 841 038*	***742 258 387***	*613 614 107*	*1 135 348 548*	***1 748 962 655***	*874 031 456*	*1 617 189 586*	***2 491 221 042***
2025	*273 221 953*	*482 277 769*	***755 499 722***	*656 660 942*	*1 159 105 156*	***1 815 766 098***	*929 882 895*	*1 641 382 925*	***2 571 265 819***

(cont'd)

Year	***Expected state pension spending in KZT thousand without allowing for future mortality improvements, 2019 constant prices***								
	Basic pension			*Solidarity pension*			*Total state pension*		
	males	*females*	***total***	*males*	*females*	***total***	*males*	*females*	***total***
2019	*202 710 050*	*475 954 971*	*678 665 021*	*432 613 278*	*1 015 758 421*	*1 448 371 699*	*635 323 328*	*1 491 713 392*	*2 127 036 720*
2020	*212 594 829*	*477 292 413*	*689 887 242*	*462 783 037*	*1 038 984 975*	*1 501 768 012*	*675 377 866*	*1 516 277 388*	*2 191 655 254*
2021	*223 257 478*	*478 369 570*	*701 627 048*	*495 713 701*	*1 062 156 358*	*1 557 870 059*	*718 971 179*	*1 540 525 929*	*2 259 497 108*
2022	*234 502 445*	*478 872 583*	*713 375 028*	*531 095 296*	*1 084 538 696*	*1 615 633 992*	*765 597 742*	*1 563 411 278*	*2 329 009 020*
2023	*246 125 132*	*478 940 510*	*725 065 642*	*568 566 428*	*1 106 386 387*	*1 674 952 816*	*814 691 560*	*1 585 326 898*	*2 400 018 458*
2024	*257 860 724*	*478 423 682*	*736 284 406*	*607 590 004*	*1 127 296 326*	*1 734 886 330*	*865 450 728*	*1 605 720 008*	*2 471 170 736*
2025	*269 426 661*	*477 390 622*	*746 817 282*	*647 539 347*	*1 147 359 399*	*1 794 898 746*	*916 966 008*	*1 624 750 021*	*2 541 716 028*

(cont'd)

Year	***Relative difference in pension spending due to mortality improvements***			***Share of expected state pension spending in GDP***					
				after allowing for future mortality improvements			***without allowing for any improvement in mortality in the future***		
	Total state pension			*Total state pension*			*Total state pension*		
	males	*females*	***total***	*males*	*females*	***total***	*males*	*females*	***total***
2019	*0,00%*	*0,00%*	***0,00%***	*0,93%*	*2,17%*	***3,10%***	*0,93%*	*2,17%*	***3,10%***
2020	*0,04%*	*0,03%*	***0,03%***	*1,05%*	*2,37%*	***3,42%***	*1,05%*	*2,37%*	***3,42%***
2021	*0,16%*	*0,12%*	***0,13%***	*0,97%*	*2,08%*	***3,05%***	*0,97%*	*2,08%*	***3,04%***
2022	*0,37%*	*0,26%*	***0,30%***	*0,99%*	*2,02%*	***3,01%***	*0,99%*	*2,01%*	***3,00%***
2023	*0,64%*	*0,46%*	***0,52%***	*1,01%*	*1,96%*	***2,97%***	*1,00%*	*1,95%*	***2,95%***
2024	*0,99%*	*0,71%*	***0,81%***	*1,02%*	*1,90%*	***2,92%***	*1,01%*	*1,88%*	***2,90%***
2025	*1,41%*	*1,02%*	***1,16%***						

It can be seen that, with the passage of time, the relative differences in total state pension spending increase and reach 1,16% in 2025, reflecting the gradually increasing effect of mortality improvements on extra expenditures of the government on pensions as time passes. Again, these relative differences are higher for males than for females due to the aforementioned reason. It can also be seen from the Table 2 that, even though the absolute values of total state pension spending increase steadily over time, we can observe that the state pension spending's share of GDP (latest GDP official forecasts are available up to 2024) is projected to decline from 2021 to 2024 regardless of whether or not we allow for future mortality improvements. So that the GDP growth is expected to outperform the growth in the state pension spending during that period. However, forecasts show that extra expenditures of the government on pensions, resulting from future mortality improvements under consideration, will increase gradually as a share of GDP over time and reach 0,02% in 2024.

5. Conclusion. This paper uses the mortality projection methods of Knykova A. and Sapin A. [1], based on the original Lee-Carter model [2], in order to investigate sex-specific mortality rates for Kazakhstan for the time period from 2018 to 2025 and assess their impact on the state pension spending in Kazakhstan.

Based on the forecasts, it can be concluded that there is a general trend towards a further decrease in forecasted mortality rates over time for males and females. This overall decline in forecasted mortality rates could not but affect the forecasted values of life expectancy in Kazakhstan. Thus, in particular, life expectancy at birth for the forecast period between 2018 and 2025 is expected to increase from age 69,25 to age 71,68 for males, from age 77,16 to age 78,96 for females.

Improvements in mortality rates and life expectancy have been increasing the number of years that people spend in retirement, which have a direct effect on the size of public pension spending in Kazakhstan. The overall state pension spending is expected to increase from 2019 to 2025, reflecting the gradually increasing effect of mortality improvements on extra expenditures of the government on pensions. This effect is higher for males than females because males with relatively higher mortality rates have more scope for mortality improvements. Although the absolute values of the overall state pension spending increase steadily over time, the state pension spending's share of GDP (latest GDP official forecasts are available up to 2024) is projected to decline from 2021 to 2024. However, forecasts show that extra expenditures of the government on pensions, resulting from future mortality improvements, will increase gradually as a share of GDP over time and reach 0,02% in 2024.

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