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Assessment the Economic Impact of Raising the Retirement Age in Russia: Factor Analysis and ANCOVA Model

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ABSTRACT

Reforming pension systems amid demographic aging and rising fiscal pressure necessitates robust tools for the quantitative assessment of their socio-economic consequences. The **purpose** of the study is to develop and test a comprehensive methodology for the retrospective evaluation of pension reform, integrating coefficient, factor, variance, and regression analyses within an enhanced analysis of covariance (ANCOVA) framework, supplemented by graphical validation. The **methodology** is applied to the 2018 Russian pension reform, which introduced a gradual increase in the statutory retirement age. Official statistical data from Rosstat and the Social Fund of Russia for the period 2001–2023 are used as the empirical basis. The analysis reveals that, during the interim implementation phase of the reform (2019–2023), the financial sustainability of the pension system improved. This improvement is partially attributable to a demographic shock–namely, the reduction in the number of elderly citizens due to excess mortality in 2020–2021. At the same time, a decline in the earnings replacement rate was observed, indicating a deterioration in the relative level of pension provision. Crisis events, including forced medium-term shifts in budgetary policy priorities, further diminished the effectiveness of the reform. The **results** demonstrate a statistically significant association between the implementation of the reform and changes in key performance indicators of the pension system; however, they do not confirm the achievement of the stated objective–namely, an improvement in the level of pension adequacy. Under conditions of persistently high ruble-denominated inflation, the study **recommends** continuing to develop the non-state pension system.

Keywords: pension reform; pension; replacement rate; mandatory pension insurance; ANCOVA; long-term savings

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INTRODUCTION

Population ageing, declining birth rates, increasing life expectancy, and structural changes in the economy are putting significant pressure on state pension systems, making their reform inevitable and a continuous process [1]. Currently, there is extensive international experience in reforming social security systems in various countries [2, 3]. The ILO[1] report notes that the pace of reforms being implemented is still insufficient to bring the level of coverage of the world's population by at least one social protection program to 80%. This remark primarily concerns countries with low per capita income and underdeveloped social security systems. Social security system reforms are continuously ongoing [4], and their vectors are changing in accordance with political priorities and the specifics of global challenges, including low birth rates and ageing populations [5]. Pension reforms often spark a surge of public criticism and raise many questions, which often remain unanswered. After several years, public interest and increased attention to the reform that was carried out are fading, although real opportunities are emerging to give it an objective assessment based on relevant reporting statistical indicators [6].

To achieve the main goals of pension system reform, which typically include (1) ensuring long-term financial sustainability and (2) increasing pensioners' incomes, measures related to adding/excluding pension system levels [7] and adjustments to the financial parameters of the pension system [9] are used. A prime example of the latter is the change (increase) in the retirement age in many countries, linked to the rise in life expectancy [10, 11].

Despite active scientific and public discussion on pension system reform, there is a lack of empirical studies in domestic and foreign literature aimed at quantifying the economic consequences of already implemented pension reforms [12]. The absence of a comprehensive methodology that allows for the simultaneous assessment of the statistical significance and socio-economic effect of the reform, with the time point of its implementation fixed, determines the high relevance and theoretical significance of this study.

The purpose of this study is to develop a comprehensive methodology for assessing the socio-economic consequences of social policy reforms and to test it using the example of the pension reform implemented in the Russian Federation since 2019. To achieve the set goal, the following tasks were set and solved:

1. A systematic review of existing empirical studies was conducted and methodological approaches to evaluating the effectiveness of pension reforms were summarized.

2. A comprehensive methodology for quantifying the results of pension system reforms was developed, integrating coefficient, factor, dispersion, regression, and graphical analyses into a single system of interconnected analytical procedures that provides a statistically sound and unambiguous interpretation of the reform effect.

3. Recommendations was formulated for adjusting pension policy parameters and directions for the further development of the pension system of the Russian Federation.

RESEARCH HYPOTHESES

Hypothesis H1: The implementation of the 2018 pension reform in Russia is statistically associated with an increase in the long-term financial sustainability ratio of the pension system.

Hypothesis H2: The implementation of the 2018 pension reform in Russia is statistically linked to an increase in the level of pension provision, measured by the replacement rate of lost earnings with an old-age insurance pension.

[1] ILO (2024). World Social Protection Report 2024–26: Universal social protection for climate action and a just transition. URL: https://www.social-protection.org/gimi/Media.action?id=10982 (accessed on 20.11.2025).

LITERATIRE REVIEW

One common approach to assessing the economic effect of social security reforms is a comparative analysis of the dynamics of key indicators before and after their implementation [11, 12]. The advantage of this method lies in the ability to use several performance indicators simultaneously. However, its application requires careful preparation of time series and can lead to cumbersome analytical constructions when expanding the set of control variables [13, 14].

Evaluating the economic effect of social security reforms is associated with a number of methodological difficulties. These include the cyclical nature of economic dynamics [15], the presence of time lags between the implementation of a reform and the manifestation of its effect [16], as well as the simultaneous implementation of numerous interconnected transformations in the social sphere, which makes it difficult to isolate the contribution of individual measures to the overall result [17, 18].

An analysis of domestic scientific literature on pension system reform reveals a significant gap: most research focusses on assessing the current effectiveness of pension systems rather than quantitatively measuring the economic impact of reforms that have already been implemented. Typically, such works rely on simple methods of coefficient, horizontal, and vertical analysis of the descriptive characteristics of the pension system [19–21].

In foreign scientific literature, the issues of pension reforms have been studied more thoroughly [22, 23]. However, even there, the primary emphasis is on forecasting the potential effects of reforms using macroeconomic modelling, while empirical studies aimed at statistically verifying the impact of reforms that have already been implemented remain relatively rare.

Individual papers within the Russian scientific community are also dedicated to assessing the long-term consequences of hypothetical changes to the pension model. For example, K.V. Moiseev [24] applies the overlapping generations (OLG) model to analyze the macroeconomic transition from a solidarity-based to an accumulation-based pension system. The study highlights that distribution systems have a structural sustainability constraint due to demographic ageing and a shrinking proportion of the working-age population. The author notes: "...despite the advantages of such a (solidarity-based) system, it becomes impossible to maintain it in countries with a growing elderly population and a shrinking workforce...", which, in his opinion, "applies to the situation in Russia" [24]. Nevertheless, such works remain isolated and are predominantly theoretical, offering no tools for ex post evaluation[2] of social reforms that have already been implemented.

The results of the literature review indicate a significant lack of empirical studies that have applied a comprehensive methodology for evaluating the effectiveness of already implemented pension reforms based on economic-mathematical and econometric models. At the same time, as noted in works on global social policy analysis [25, 26], pension system reforms worldwide are sustainable and continuous, which objectively requires the development of ex post evaluation tools capable of providing reliable feedback for adjusting current policies and justifying a long-term socio-economic development strategy.

MATERIALS AND RESEARCH METHODS

The object of the study is the 2018 pension reform in the Russian Federation, which provides for a phased increase in the retirement age between 2019 and 2028. Given that the reform implementation process will only be completed in 2028, this study is limited to an interim assessment of its socio-economic consequences.

[2] Retrospective, meaning analysis and evaluation of the result after the reform has been implemented.

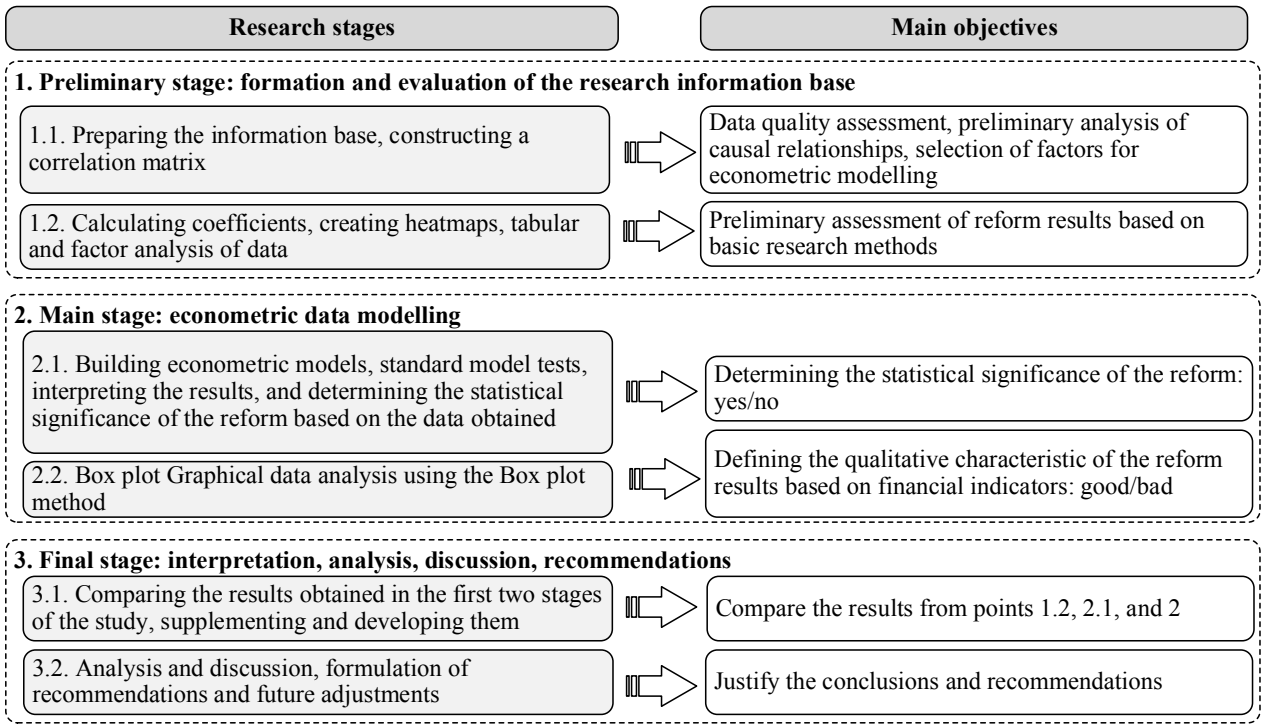

Fig. 1. **Schematic Description of the Research Methodology**

Source: Developed by the author based on research materials.

To assess the economic effect, it is proposed to use a combined three-stage approach based on coefficient, factor, dispersion, and regression data analysis, as well as methods for constructing heat maps for data presented in tabular form.

A schematic description of the research methodology is shown in *Fig. 1*.

To assess the economic effect of the pension reform in Russia as of 2023, open data from the Pension Fund of Russia[3] and Rosstat[4] for the period 2001–2023 were used.

The sample of dependent variables includes several indicators reflecting the effectiveness of pension reform, among which is the pension replacement rate for lost earnings, as well as other factors related to the pension system.

Descriptive statistics, full and abbreviated variable names are presented in *Appendix 1*.

The factor model is developed based on the theoretical framework described in E.D. Zabolotsky's study [27], which proposes evaluating the effectiveness of a pension system using financial sustainability ratios and financial efficiency (the ratio of expected insurance payments to insurance contributions) within cross-country comparisons.

This study proposes to supplement E.D. Zabolotsky's methodology with a lost earnings replacement rate and calculate an integral coefficient reflecting a comprehensive quantitative assessment of the effectiveness of Russia's pension system. The integral coefficient was used as the main dependent variable in subsequent econometric modelling, formulas (1)–(4).

$$K_{Eff_{PS}} = K_{FinUst} * K_{ZamP}, \quad (1)$$

[3] SFR. Key indicators of pension provision in the Russian Federation. URL: https://sfr.gov.ru/info/statistics/pension_provision_sfr (accessed on 11.10.2025).

[4] Rosstat. The older generation. URL: https://rosstat.gov.ru/folder/13877 (accessed on 11.10.2025).

$$K_{FinUst} = \frac{Employed\_Share * Insurance\_rate\_Tot * Average\_salary}{Insurance\_rate\_Tot * Average\_assigned\_pension}, \quad (2)$$

$$K_{Pokr} = \frac{(Life\_exp\_total - Retirement\_age\_avg) * Average\_assigned\_pension}{Average\_work\_duration * Insurance\_rate\_Tot * Average\_salary}. \quad (3)$$

Let's make a few clarifications regarding the third formula. Firstly, the average duration of working life ($Average\_work\_duration$) is calculated conditionally, as this data is not publicly available in the Rosstat database, and the idea itself was proposed as a calculated indicator in the work [28], which does not contain all the necessary information for the calculations. In this regard, the average retirement age was used, from which 18 years were subtracted to obtain the indicator of hypothetical working life expectancy. Secondly, when calculating K_{Pokr}, the general rate of insurance contributions for mandatory pension insurance for the corresponding year was used, without taking into account cash flows for non-state pension provision, as well as tax benefits (rates of 0% and 10%) for certain categories of insurance contribution payers [29, 30]. Finally, the actual life expectancy of pensioners does not match the "expected remaining life" figure from Rosstat, but it was chosen for the calculations to show the actual life expectancy as a factor in the efficiency of the pension system, rather than a target or calculated indicator.

$$K_{ZamP} = \frac{Average\_assigned\_pension}{Average\_salary} * 100\%. \quad (4)$$

According to the research methodology, higher $K_{Eff_{PS}}$ values correspond to a more efficient state of the pension system. The target replacement rate for pensions (K_{ZamP}) according to the Strategy for the Long-Term Development of the Russian Pension System until 2030 is 40%.

The ratio of pension payments covered by insurance contributions within the framework of mandatory pension insurance (K_{Pokr}) reflects the potential of the pension system's financial model to generate cash flow for pensioners. The economic meaning of the coefficient lies in comparing the expected pension income with the necessary insurance contributions made throughout a working life.

Studies [22] and [27] show that the value of this coefficient varies significantly across countries. In Russia, it is noticeably lower than in a number of European countries. These differences are due to the age structure of the population, as well as differences in the ratio of pensioners to employed individuals, which determines the varying levels of balance in pension systems. However, a low coefficient value does not automatically indicate an imbalance in the pension system.

The long-term financial sustainability coefficient of the pension system (K_{FinUst}) reflects the ratio of revenues and expenditures of the pension system under mandatory pension insurance. A value of this coefficient at or above one indicates that the system is balanced due to its own sources of financing. A value exceeding one indicates the presence of a reserve to increase the level of pension provision by increasing the size of payments. Factor analysis of the coefficient dynamics allows us to identify the key reasons for changes in the pension system's effectiveness before and after the 2018 reform.

In study [27], the lost earnings replacement rate and the social insurance contribution rate are present in both the numerator and the denominator of the pension system's integrated effectiveness indicator formula. Based on this structure, it is possible to algebraically transform formula 1 by introducing an additional factor K_{ZamP}. As a result, the substitution coefficient is not duplicated in the final factor model, which is reflected in formula (5).

$$K_{Eff_{PS}} = \frac{Employed\_Share * Insurance\_(rate\_Tot) * Average\_salary}{Insurance\_(rate\_Tot) * Average\_(assigned\_pension)} *$$
$$* \frac{(Life\_\exp\_total - Retirement\_age\_avg) * Average\_assigned\_pension}{Average_{work_{duration}} * Insurance_{rate_{Tot}} * Average_{salary}} * K_{ZamP} =$$
$$= \frac{Employed_{Share}}{Insurance_{rate_{Tot}}} * \frac{(Life\_\exp\_total - Retirement\_age\_avg)}{Average_{work_{duration}}} *$$
$$* K_{ZamP} = WPR * RLWR * K_{ZamP}. \quad (5)$$

In the second stage of this study, the covariance analysis (ANCOVA) method, which combines elements of variance and regression analysis, is used to assess the statistical effect of the 2018 pension reform. The choice of this method is due to a number of considerations, primarily the fact that ANCOVA allows us to assess the presence of statistically significant differences in the mean values of the dependent variables before and after a fixed intervention point — in this case, and the adoption of pension reform in 2018. This aligns with the research objective, which aims to capture the statistical effect of the reform rather than identify a purely causal impact in a strict econometric sense.

It should be emphasized that ANCOVA does not solve the problem of endogeneity, as the intervention point is not an exogenous shock in the full sense, since it itself can be a response to previous macroeconomic and demographic trends. In this study, the ANCOVA method is used to establish the statistical effect of the reform and to form a basis for further, deeper causal assessments as data accumulates and the reform's transition period is completed.

In its general form, the theoretical model for ANCOVA is represented by formula (6).

$$Y_{ij} = \mu + \alpha_i + \beta * \left(X_{ij} - \bar{X}\right) + \varepsilon_{ij}, \quad (6)$$

where Y_{ij} — the value of the dependent variable for an object; μ — the overall mean (global mean) of the dependent variable for all groups; α_i — the effect of the independent variable, marking the period before and after the pension reform; β — the regression coefficient for the covariate, showing how the covariate affects the dependent variable; X_{ij} — the values of the covariate for the research object at each point in time (before and after the reform), i.e., the set of independent variables characterizing the state and effectiveness of the pension system during the analyzed period; $\bar{X}$ — the overall average of the covariate for all observations; ε_{ij} — the random error or residual component, reflecting the unexplained variations in the dependent variable.

Given that the ANCOVA method does not allow us to judge the direction of the pension reform's influence on the dependent variable $K_{Eff_{PS}}$, supplementing it with graphical analysis becomes methodologically necessary. The visualization tool used is a box plot, which provides a clear comparison of the distributions of key pension system performance indicators before and after the reform was implemented. This approach allows not only to confirm the statistical significance of the changes but also to assess their qualitative direction.

The following indicators were selected as independent variables in the ANCOVA models: real economic growth rates, the share of labor income in GDP, average wage and average pension levels, life expectancy for men and women, the amount of spending on financing the pension system, and the average retirement age.

Table 1

Coefficient Analysis of the Socio-Economic Impact of the 2018 Russian Pension Reform, Formula (1)

Year	Integrated indicator of pension system efficiency, %	Pension system financial sustainability ratio, units	Financial efficiency ratio of the pension system (average insurance payments to average insurance contributions), units	Pension replacement rate for lost earnings, %	Rank			
	K_Eff_PS	K_FinUst	K_Pokr	K_ZamP	**K_Eff_PS**	K_FinUst	K_Pokr	K_ZamP
1	2	3	4	5	6	7	8	9
2002	10.05	1.0130	0.3184	33.54	19	20	18	6
2003	9.41	1.0703	0.2977	31.78	22	16	20	10
2004	9.87	1.1899	0.2968	30.06	21	8	21	13
2005	9.89	1.2087	0.2967	29.67	20	6	22	14
2006	10.43	1.3499	0.3112	26.72	18	2	19	20
2007	11.63	1.3339	0.3463	27.09	16	3	17	19
2008	11.34	1.3272	0.3495	26.29	17	4	16	21
2009	14.30	1.0850	0.4504	31.49	12	15	11	11
2010	15.49	1.0005	0.4903	33.98	10	21	10	3
2011	17.27	0.9654	0.5483	35.10	7	22	4	2
2012	17.17	1.0942	0.4974	33.95	8	14	9	4
2013	17.30	1.1014	0.5076	33.29	6	12	8	7
2014	17.31	1.0944	0.5126	33.19	5	13	7	8
2015	19.00	1.0315	0.5626	35.22	1	19	2	1
2016	18.29	1.0443	0.5582	33.75	3	18	3	5
2017	18.71	1.0631	0.5755	32.90	2	17	1	9
2018	17.55	1.1402	0.5418	30.56	4	11	5	12
2019	16.44	1.1580	0.5158	29.59	9	10	6	15
2020	14.19	1.1603	0.4504	29.19	13	9	12	16
2021	11.67	1.1989	0.3594	29.07	15	7	15	17
2022	13.84	1.3111	0.4153	27.28	14	5	14	18
2023	15.03	1.4894	0.4160	26.04	11	1	13	22
Max	19.00	1.4894	0.5755	35.22	-			
Mean	14.37	1.1559	0.4372	30.90				
Median	14.67	1.1208	0.4504	31.02				
Min	9.41	0.9654	0.2967	26.04				
Max/Min	2.02	1.5428	1.9398	1.35				
STD	3.30	0.1346	0.0996	2.98				

Источник / Source: составлено автором по материалам исследования и данным Росстата и СФР / Compiled by the author based on research materials and data from Rosstat and SFR. URL: https://rosstat.gov.ru/folder/13877; https://sfr.gov.ru/info/statistics/pension_provision_sfr (дата обращения: 11.09.2025) / (accessed on 11.09.2025).

Table 2

Coefficient Analysis of the Socio-Economic Impact of the 2018 Russian Pension Reform, Formula (5)

Year	Integrated indicator of pension system efficiency, %	The ratio of employed people to pensioners (the inverse of the pension burden ratio)	The ratio of the duration of the retirement period to the working life (life period replacement ratio)	Pension replacement rate for lost earnings, %	Rank			
	K_Eff_PS	WPR	RLWR	K_ZamP	**K_Eff_PS**	WPR	RLWR	K_ZamP
1	2	3	4	5	6	7	8	9
2002	10.82	1.699	0.1899	33.54	19	10	21	6
2003	10.12	1.701	0.1873	31.78	22	8	22	10
2004	10.62	1.789	0.1975	30.06	21	4	20	13
2005	10.64	1.793	0.2000	29.67	20	3	19	14
2006	11.23	1.804	0.2329	26.72	18	2	18	20
2007	12.52	1.807	0.2557	27.09	16	1	17	19
2008	12.20	1.745	0.2658	26.29	17	6	16	21
2009	15.39	1.708	0.2861	31.49	12	7	14	11
2010	16.67	1.700	0.2886	33.98	10	9	13	3
2011	18.58	1.694	0.3124	35.10	7	11	12	2
2012	18.48	1.689	0.3223	33.95	8	12	11	4
2013	18.61	1.667	0.3354	33.29	6	13	9	7
2014	18.62	1.651	0.3397	33.19	5	15	7	8
2015	20.44	1.651	0.3514	35.22	1	14	6	1
2016	19.68	1.602	0.3638	33.75	3	17	4	5
2017	20.13	1.590	0.3848	32.90	2	18	2	9
2018	18.88	1.584	0.3901	30.56	4	20	1	12
2019	17.67	1.557	0.3835	29.59	9	21	3	15
2020	15.25	1.539	0.3395	29.19	13	22	8	16
2021	12.52	1.584	0.2720	29.07	15	19	15	17
2022	14.85	1.626	0.3349	27.28	14	16	10	18
2023	16.13	1.763	0.3515	26.04	11	5	5	22
Max	15.46	1.679	0.2993	30.90				
Mean	15.76	1.692	0.3173	31.02				
Median	10.12	1.539	0.1873	26.04				
Min	2.02	1.174	2.0824	1.35				
Max/Min	3.55	0.0821	0.0662	2.98				
STD	0.00	0.0000	0.0000	0.00				

Source: Compiled by the author based on research materials and data from Rosstat and SFR. URL: https://rosstat.gov.ru/folder/13877; https://sfr.gov.ru/info/statistics/pension_provision_sfr (accessed on 11.09.2025).

In the third stage of the study, the obtained results are analyzed and recommendations are justified.

RESULTS AND DISCUSSION

Tables 1 and *2* present the results of the coefficient analysis of the dependent variables, based on which the socio-economic effectiveness of the 2018 pension reform in Russia is assessed. An analysis of the data in *Table 1* shows that the maximum efficiency of the Russian Federation's pension system was observed during the period 2013–2017, with a peak value in 2015. Since 2019, there has been a steady decline in the overall efficiency indicator, most pronounced in 2020–2021, which coincides with the COVID-19 pandemic and the associated socio-economic shocks.

The greatest contribution to the overall effectiveness indicator came from the pension replacement rate for lost earnings, which was above the average for the study period between 2010 and 2017. Then it began to shrink primarily due to the faster growth rate of labor income compared to pensions. The issue and causes of the decline in the replacement rate in Russia are widely discussed in scientific literature [10, 24, 28, 31].

On the one hand, the observed dynamics reflect the expected consequences of the 2018 pension reform, including raising the retirement age, freezing the indexation of pensions for working pensioners, as well as anti-crisis financial policy measures aimed at mitigating the effects of the demographic trough (*Table 2*, column 8). On the other hand, the decrease in the number of recipients of old-age insurance pensions in 2020–2021, caused by excess mortality during the COVID-19 pandemic [32, 33], temporarily reduced the volume of interbudgetary transfers from the federal budget to the budget of the Social Insurance Fund of Russia. The data in *Table 2* (column 7) indicate a statistical correlation between the decrease in the number of pensioners and the growth of the long-term financial sustainability ratio of the pension system.

The approximately 20% change in the long-term financial sustainability coefficient of the pension system in 2020–2021 can be explained by a decrease in the number of pensioners due to excess mortality during the COVID-19 pandemic.[5] The remaining 80% are related to the demographic consequences of the phased increase in the retirement age.

During the econometric modelling, several ANCOVA model variants were constructed with different dependent variables (*Appendix 2)*. It should be noted that including a broader range of factors listed in *Appendix 1* is difficult. This limitation is because the period covered includes only 21 years (the average length of a time series).

The modelling resulted in four ACNOVA model variants that passed standard statistical tests and demonstrated a sufficient level of reliability. In each of the models, the categorical variable PensReform was statistically significant, indicating that the pension reform had a statistically significant economic effect on the performance indicators of the Russian pension system.

The ACNOVA model variants constructed in *Appendix 2* within the framework of this research methodology are only used to identify the statistical significance/insignificance of the pension reform; therefore, the results obtained can be considered acceptable [34].

For almost all ACNOVA models, the group of indicators related to gross pension system financing (Log_PFR_expenses and Gov_exp_PF_GDP) showed not very high statistical significance. This could be due to the relatively stable dynamics of this indicator during the study period. For example, in 2000–2008, the funding for the pension system averaged around 6% of GDP, which indicated its chronic underfunding. In subsequent years (2009–2018), this figure increased to 8.6% of GDP. However, after the implementation of the 2018 pension reform, which was accompanied by a phased increase in the retirement age, the share of pension spending in GDP decreased, averaging 7.95% between 2019 and 2023.

The current assessment of the effectiveness of the 2018 pension reform is largely determined by the amount of funding allocated for the functioning of the pension system. However, in the constructed ANCOVA models, this factor did not demonstrate statistical significance. This is likely due to the fact that funding levels remained relatively stable (with a slight negative trend) between 2009 and 2023, while the average pension level continued to decline in relative terms under the influence of a number of objective socio-economic factors.

[5] RBC. The head of the Pension Fund of Russia assessed the reduction in the number of pensioners due to excess mortality. URL: https://www.rbc.ru/economics/30/06/2022/62bd7ec09a794781dc681c03 (accessed on 28.10.2025).

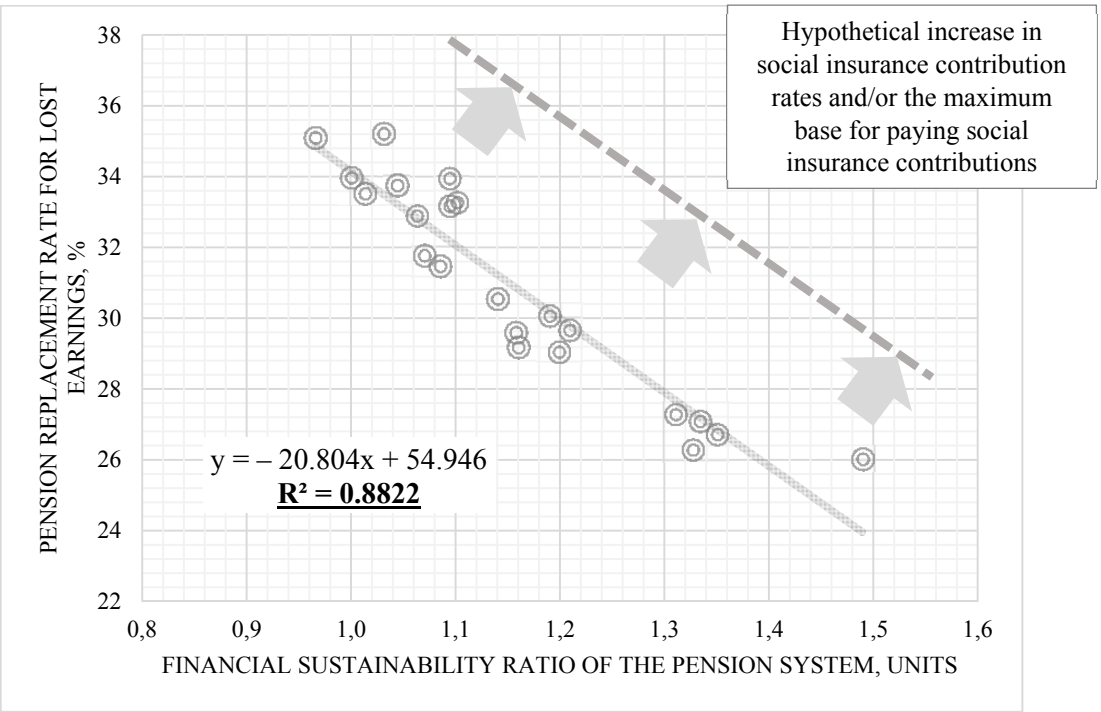

Fig. 2. **Relationship Between the Financial Sustainability of the Pension System and the Level of Pension Provision in the Case of Russia**

Source: Compiled by the author according to Rosstat data for the period 2002–2023. URL: https://rosstat.gov.ru/folder/13877 (accessed on 11.09.2025).

Note: The dotted line indicates the potential shift in the relationship under an increase in mandatory pension insurance contribution rates.

Among the key factors that influenced the dynamics of pension provision indicators, the sharp changes in budget policy priorities, driven by the crisis events of recent years, should be highlighted. In 2020, the budget system of the Russian Federation faced challenges posed by the COVID-19 pandemic. Alongside the negative consequences, this period was accompanied by a number of structural transformations, including in the field of social security. Specifically, processes of digitalization and modernization of social infrastructure were initiated [35], including the development of the concept of the Social Treasury. These measures contributed to improving the system's operational efficiency and expanding access to social services for the population.

After February 2022, there was a significant redistribution of budget priorities, which led to long-term socio-economic consequences that directly and indirectly affected Russia's social security system. The increase in government spending on the defense sector, accompanied by the withdrawal of a significant number of able-bodied citizens from the civilian economy and their transfer to sectors that do not produce consumer goods and services, led to a reduction in labor supply. Amid a developing labor shortage, nominal wage growth accelerated, which, combined with monetary and fiscal factors, contributed to sustained ruble inflation [36].

Analysis of the diagrams (*Appendix 3*) reveals statistically significant shifts in all four dependent variables and clarifies the direction of the reform's effect. The most pronounced negative shift was recorded in the lost earnings replacement rate (K_{ZamP}), as its median in the post-reform period is significantly lower, which confirms the degradation of the relative level of pension provision. At the same time, the financial stability ratio (K_{FinUst}) shows the opposite trend. For this factor, an increase in the median and a narrowing of the dispersion

indicate an improvement in the stability of the pension system's financial base. The overall effectiveness indicator ($K_{Eff_{PS}}$) and the contribution coverage ratio (K_{Pokr}) show a moderate decrease, highlighting the multifaceted nature of the reform: increased pension system sustainability is achieved at the cost of reduced social effectiveness (a decrease in the replacement rate).

CONCLUSIONS AND RECOMMENDATIONS

The pension reform implemented in the Russian Federation since 2019 and concluding in 2028 has had a statistically significant impact on key indicators of the pension system's functioning, which is confirmed by the results of factor, regression, and graphical analyses.

The positive effect of the reform was manifested solely in increasing the financial stability of the system (*Hypothesis H1*). Simultaneously, a decrease was recorded in the other components of effectiveness, including the level of pension provision (*Hypothesis H2*).

The current results of the 2018 pension reform in the Russian Federation indicate a potential contradiction between two stated goals: increasing the financial stability of the pension system and raising the level of pension provision. While maintaining the current model parameters, these goals may prove to be mutually exclusive [37], even though they were not initially intended to be in conflict (*Fig. 2*).

The decline in the efficiency of Russia's pension system can be smoothed out in the medium term by adjusting the key parameters of the financial model for pension provision — primarily the mechanism for indexing old-age insurance pensions [10, 38]. In these circumstances, the development of non-state pension institutions, which are capable of supplementing the solidarity system and mitigating the negative consequences of demographic asymmetry, becomes particularly important, while traditional budgetary policy tools are showing limited effectiveness in the current conditions.

CONCLUSION

This study proposes and tests a comprehensive methodology for evaluating the economic effect of pension reforms, combining coefficient, factor, dispersion, regression, and graphical analysis based on an improved ANCOVA model. The methodology was applied to evaluate the 2018 pension reform aimed at gradually increasing the retirement age in the Russian Federation.

Empirical analysis conducted on data from Rosstat and the Pension Fund of the Russian Federation for 2001–2023 confirmed the statistical significance of the reform's impact on key indicators of the pension system's functioning. It has been established that raising the retirement age contributed to an increase in the long-term financial sustainability ratio by reducing the number of insurance pension recipients. At the same time, there was a decrease in the lost earnings replacement rate, which indicates a degradation in the relative level of pension provision. Thus, the initial hypothesis about the positive effect of the reform is only partially confirmed, as the goal of strengthening the financial sustainability of the pension system has been achieved, but at the same time, an adequate increase in the level of pension provision has not been realized.

The analysis showed that a significant portion of the improvement in financial stability indicators in 2020–2021 was due to exogenous demographic shocks related to excess mortality during the COVID-19 pandemic. Additionally, the effectiveness of the reform was influenced by the crisis events of recent years, including structural changes in the labor market, the reallocation of budget priorities, and high inflation, which led to pension growth lagging behind wage dynamics.

The results indicate a potential conflict between the goals of increasing the financial sustainability of the pension system and ensuring a decent level of pension replacement while maintaining the current parametric model of the solidarity pension system. Under

these conditions, it seems appropriate to consider a set of measures aimed at adjusting the pension indexation mechanism to reflect the real dynamics of wages and consumer prices, a moderate increase in compulsory pension insurance contribution rates with the exclusion of productive assets from the tax base, as well as the active development of non-state pension provision and long-term savings institutions while preserving the solidarity component as a guarantor of a minimum level of pension protection.

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Appendix 1

Assessment of the Economic Effect of Pension Reform in Russia Using the ACNOVA Method: Characteristics of the Research Information Base

No.	Full name of indicator	Short name of indicator	Min.	Median	Average	Max.	Max./ Min.
1	Year	Year	2001	–	–	2023	–
Dependent variables							
2	Integrated performance of the pension system, %	**K_Eff_PS**	9.41	14.67	14.37	19.00	2.02
3	Pension system sustainability ratio	**K_FinUst**	0.97	1.12	1.16	1.49	1.54
4	Cost-effectiveness ratio of pension system (coverage by pension insurance contributions)	**K_Pokr**	0.30	0.45	0.44	0.58	1.94
5	Ratio of employed to retired (inverse pension burden)	**WPR**	1.539	1.692	1.679	1.807	1.1737
6	Ratio of length of retirement period to working life (replacement of life periods)	**RLWR**	0.1873	0.3173	0.2993	0.3901	2.0824
7	Rate of compensation for lost earnings	**K_ZamP**	26.04	31.02	30.90	35.22	1.35
Categorical independent variable							
8	Reform to raise retirement age	PensReform	NO	–	–	YES	–
Other independent variables							
9	Total population, million people	Population_total	143	145	145	148	1.04
10	GDP (current prices, billion rubles)	GDP_current	10 831	71 557	70 545	172 148	15.89
11	GDP (constant prices, billion rubles)	GDP_constant	9 368	65 487	65 916	160 852	17.17
12	Logarithm of GDP (in constant prices, billion rubles)	Log_GDP_constant	4	5	5	5	1.31
13	Elements of GDP (calculated as GDP by income):						
13.1.	Wage of employees (including wages and mixed income not observed by direct statistical methods), % of total GDP	GDP_wages_share	39	46	46	53	1.34
13.2.	Net taxes on production and imports, % of total GDP	GDP_ ProdAndImportTax_ share	8	14	14	20	2.58
13.3.	Gross profit of economy and gross mixed income, % of total GDP	GDP_TotEconInc_ share	31	40	40	53	1.72
14	Employment rate of the population aged 15-72 years, % of total population	Employment_rate	59	63	63	66	1.11
15	Number of workers, thous. persons	Labor_force	72 273	75 258	75 654	76 659	1.06
16	Number of workers, thous. persons, logarithm	Log_Labor_force	5	5	5	5	1.01

Appendix 1 (continued)

No.	Full name of indicator	Short name of indicator	Min.	Median	Average	Max.	Max./ Min.
17	Labour force older than working age	Labor_force1	5940	7230	7493	8142	1.37
18	Employed, thous. persons	Employed	64900	70613	71253	73636	1.13
19	Employed, thous. persons, logarithm	Log_Employed	5	5	5	5	1.01
20	Employment as % of total population	**Employed_Share**	45	49	49	50	1.12
21	Unemployed, thous. persons	Unemployed	2401	4304	4137	6294	2.62
22	Unemployment rate, % of labour force	Unemployment_rate	3	6	5	8	2.63
23	Total number of pensioners, thous. persons	Pensioners_total	38164	42181	42093	46480	1.22
24	Pensioners as % of total population	**Pensioners_total_ Share**	26	29	29	31	1.19
25	Number of old-age pensioners, thous. persons	Old_age_pensioners	29192	33427	33859	36710	1.26
26	Number of old-age pensioners as % of total population	Old_age_ pensioners_Share	20	23	23	25	1.22
27	Number of persons employed per pensioner (annual average), person	Workers_per_ pensioner	2	2	2	2	1.17
28	Life expectancy at birth. Males (years)	Life_exp_men	59	64	65	68	1.17
29	Life expectancy growth rate. Males, %	Life_growth_men	98	101	101	103	1.05
30	Longevity period. Males (years)	Retirement_period_ men	–1	4	4	8	–5.59
31	Life expectancy at birth. Females (years)	Life_exp_women	72	75	76	79	1.10
32	Life expectancy growth rate. Females, %	Life_growth_women	98	100	100	104	1.07
33	Period of longevity. Females (years)	Retirement_period_ women	17	20	21	23	1.35
34	Life expectancy at birth. Total population (years)	**Life_exp_total**	65	70	70	73	1.13
35	Average longevity (not weighted)	**Median_life_period**	8	12	13	15	1.97
36	Conditional average life expectancy (retirement age minus 18 years)	**Average_work_ duration**	40	40	40	41	1.04
37	Average salary, thous. rub.	**Average_salary**	4360	30401	28211	74854	17.17
38	Average salary, thous. rub., log.	Log_Average_salary	4	4	4	5	1.34
39	Average old-age pension (not all types of pension)	**Average_pension_ oldage**	1589	10142	10010	22353	14.07
40	Average old-age pension (not all types of pension), log	Log_Average_ pension_oldage	3	4	4	4	1.36

Appendix 1 (continued)

No.	Full name of indicator	Short name of indicator	Min.	Median	Average	Max.	Max./ Min.
41	Average amount of pensions awarded	**Average_assigned_ pension**	1462	9250	9479	19490	13.33
42	Average size of pensions awarded, log	Log_Average_ assigned_pension	3	4	4	4	1.36
43	Minimum living wage of pensioner	Pension_minimum	1313	6097	5614	12363	9.42
44	Minimum living wage of pensioner, log	Log_Pension_ minimum	3	4	4	4	1.31
45	Replacement ratio of old-age pensions	Replacement_rate_ oldage	28	34	34	38	1.33
46	Income of RFP, billion ruble	PFR_income	700	5801	6025	13265	18.95
47	Income of RFP, billion ruble, log	Log_PFR_income	3	4	4	4	1.45
48	Expenses of RFP, billion ruble	PFR_expenses	790	5730	5821	13858	17.55
49	Expenses of RFP, billion ruble, log	Log_PFR_expenses	3	4	4	4	1.43
50	State expenditure on pensions in % of GDP	Gov_exp_PF_GDP	5	8	8	10	1.86
51	Retirement age of male	Retirement_age_ men	60	60	60	62	1.03
52	Retirement age of female	Retirement_age_ women	55	55	55	57	1.03
53	Retirement age (average)	**Retirement_age_avg**	58	58	58	59	1.03
54	Difference in retirement age between men and women	Retirement_age_gap	5	5	5	5	1.00
55	Assets of pension in % of GDP	Pension_funds_ assets_GDP	1	3	3	4	3.35
56	Rate of contributions for compulsory pension insurance (insurance part)	Insurance_rate_basic	14	15	16	16	1.14
57	Rate of insurance contributions for compulsory pension insurance (solidarity part)	Insurance_rate_ solider	6	6	6	6	1.00
58	Tariff for exceeding the base limit	Insurance_rate_extra	10	10	10	10	1.00
59	Rate of contributions for compulsory pension insurance (cumulative part)	Insurance_rate_ accum	6	6	6	6	1.00
60	Mandatory pension insurance contribution rate (total)	**Insurance_rate_Tot**	20	21	22	22	1.10

Source: Compiled by the author based on research materials and data from Rosstat and SFR. URL: https://sfr.gov.ru/info/statistics/pension_provision_sfr; https://rosstat.gov.ru/folder/13877 (accessed on 11.09.2025).

Appendix 2

ANCOVA Modeling Results: Assessment of the Current Socio-Economic Effect of the Pension Reform

Options of ANCOVA models and statistical significance of independent variables	Standard Model Tests	
	Shapiro-Vilka test (normal distribution of model residues)	Brescia-Pagan test (homophobicity of model remains)
Model 1. Dependent variable — integral measure of pension system efficiency (*K_Eff_PS*), % Df Sum Sq Mean Sq F value Pr(>F) PensReform 1 14.75 14.75 772.419 1.13e-06 *** Log_GDP_constant 1 56.99 56.99 2983.981 3.89e-08 *** GDP_wages_share 1 4.12 4.12 215.727 2.64e-05 *** Workers_per_pensioner 1 0.55 0.55 28.720 0.003042 ** Life_exp_men 1 5.03 5.03 263.280 1.62e-05 *** Life_exp_women 1 1.92 1.92 100.404 0.000169 *** Log_Average_salary 1 4.15 4.15 217.243 2.60e-05 *** Log_Average_assigned_pension 1 12.36 12.36 647.451 1.75e-06 *** Log_PFR_expenses 1 0.14 0.14 7.528 0.040611 * Gov_exp_PF_GDP 1 0.04 0.04 1.868 0.229915 Retirement_age_avg 1 0.20 0.20 10.467 0.023072 * Residuals 5 0.10 0.02 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1	completed (W = 0.9479, *p-value* = 0.4241)	completed (BP = 7.967, *df* = 11, *p-value* = 0.7163)
Model 2. Dependent variable — financial sustainability ratio of pension system (*K_FinUst),* un. Df Sum Sq Mean Sq F value Pr(>F) PensReform 1 0.08676 0.08676 263.082 1.62e-05 *** Log_GDP_constant 1 0.01277 0.01277 38.714 0.00157 ** GDP_wages_share 1 0.02859 0.02859 86.707 0.00024 *** Workers_per_pensioner 1 0.08419 0.08419 255.298 1.75e-05 *** Life_exp_men 1 0.00282 0.00282 8.558 0.03281 * Life_exp_women 1 0.00069 0.00069 2.085 0.20835 Log_Average_salary 1 0.00216 0.00216 6.541 0.05080 . Log_Average_assigned_pension 1 0.09096 0.09096 275.821 1.45e-05 *** Log_PFR_expenses 1 0.00022 0.00022 0.663 0.45260 Gov_exp_PF_GDP 1 0.00003 0.00003 0.082 0.78603 Retirement_age_avg 1 0.00005 0.00005 0.141 0.72282 Residuals 5 0.00165 0.00033 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1	completed (W = 0.94671, *p-value* = 0.4067)	completed (BP = 14.39, *df* = 11, *p-value* = 0.2121)
Model 3. Dependent variable — the financial efficiency ratio of the pension system (average insurance payments to average insurance contributions) (*K_Pokr*), un. Df Sum Sq Mean Sq F value Pr(>F) PensReform 1 0.01206 0.01206 86.876 0.000239 *** Log_GDP_constant 1 0.03588 0.03588 258.429 1.7e-05 *** GDP_wages_share 1 0.00614 0.00614 44.249 0.001158 ** Workers_per_pensioner 1 0.00433 0.00433 31.216 0.002534 ** Life_exp_men 1 0.00565 0.00565 40.661 0.001404 ** Life_exp_women 1 0.00146 0.00146 10.518 0.022871 * Log_Average_salary 1 0.00128 0.00128 9.251 0.028698 * Log_Average_assigned_pension 1 0.01236 0.01236 89.019 0.000226 *** Log_PFR_expenses 1 0.00005 0.00005 0.373 0.568165 Gov_exp_PF_GDP 1 0.00000 0.00000 0.020 0.893181 Retirement_age_avg 1 0.00029 0.00029 2.125 0.204741 Residuals 5 0.00069 0.00014 --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1	completed (W = 0.97423, *p-value* = 0.8873)	completed (BP = 13.031, *df* = 11, *p-value* = 0.2913)

Appendix 2 (continued)

Options of ANCOVA models and statistical significance of independent variables	Standard Model Tests	
	Shapiro-Vilka test (normal distribution of model residues)	Brescia-Pagan test (homophobicity of model remains)
Model 4. Dependent variable — pension replacement rate of lost earnings (*K_ZamP*), %	completed (W = 0.97976, *p-value* = 0.9548)	completed (BP = 10.183, df = 11, *p-value* = 0.514)

```
                           Df Sum Sq Mean Sq  F value   Pr(>F)
PensReform                  1  56.54   56.54 4625.448 1.30e-08 ***
Log_GDP_constant            1  20.69   20.69 1693.165 1.60e-07 ***
GDP_wages_share             1   5.37    5.37  439.445 4.58e-06 ***
Workers_per_pensioner       1  10.74   10.74  878.950 8.19e-07 ***
Life_exp_men                1   3.24    3.24  264.864 1.60e-05 ***
Life_exp_women              1   0.69    0.69   56.777 0.000652 ***
Log_Average_salary          1   6.03    6.03  493.430 3.43e-06 ***
Log_Average_assigned_pension 1  55.38   55.38 4530.616 1.37e-08 ***
Log_PFR_expenses            1   0.01    0.01    0.604 0.472184
Gov_exp_PF_GDP              1   0.01    0.01    1.165 0.329654
Retirement_age_avg          1   0.00    0.00    0.048 0.836049
Residuals                   5   0.06    0.01
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Source: Compiled by the author based on research materials and data from Rosstat and SFR. URL: https://sfr.gov.ru/info/statistics/pension_provision_sfr; https://rosstat.gov.ru/folder/13877 (accessed on 11.09.2025).

Note: Marks on the statistical significance levels of independent variables * p < 0.1; * * p < 0.05; * * * p < 0.01. Six missed observations deleted in each model.

Appendix 3

Economic Effect of Pension Reform: Graphic Analysis

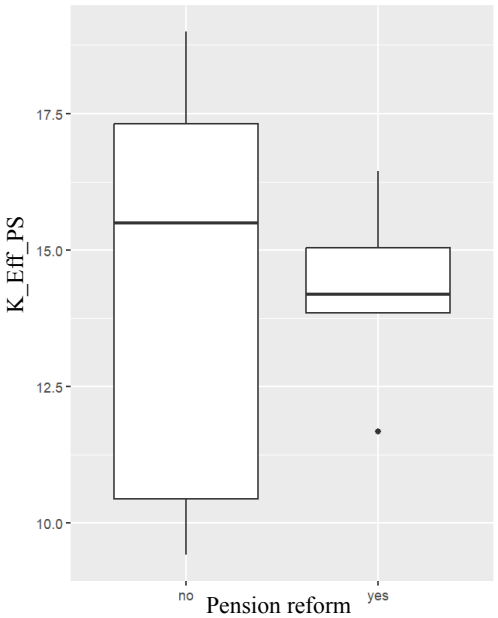

Fig. 3(a). **Economic Effect of Pension Reform in Terms of “Integral Indicator of Pension System Efficiency”, %**

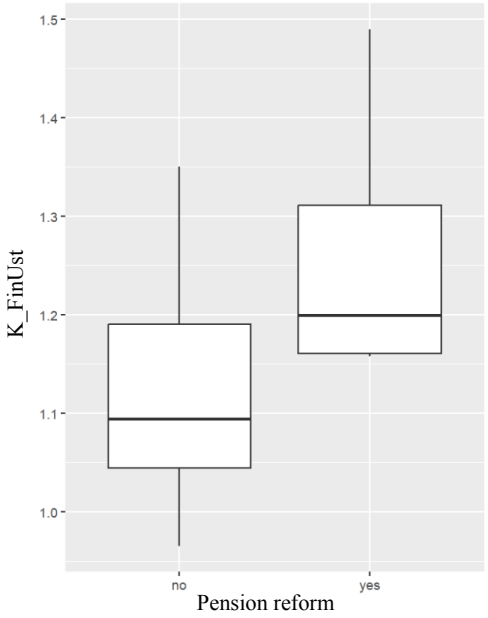

Fig. 3(b). **Economic Effect of the Pension Reform in Terms of “Financial Stability Ratio of the Pension System”, Units**

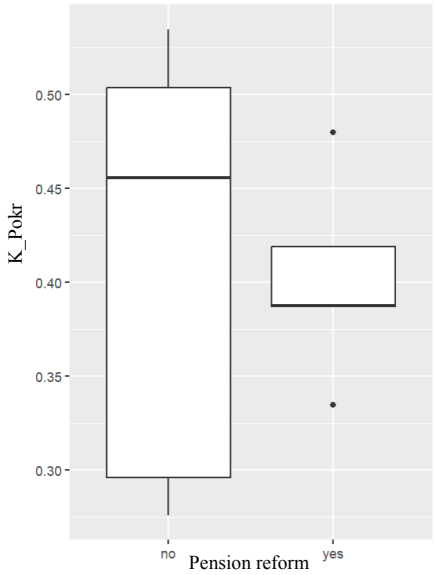

Fig. 3(c). **Economic Effect of the Pension Reform in Terms of "Financial Efficiency Ratio of the Pension Ssystem (Average Insurance Payments to Average Insurance Premiums)", Units**

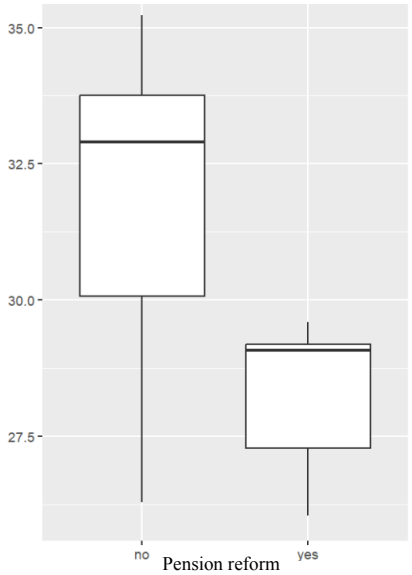

Fig. 3(d). **Economic Effect of the Pension Reform in Terms of "Pension Replacement Rate of Lost Earnings", %**

Source: Compiled by the author based on the materials of the study.