INSURANCE AND SOCIAL SECURITY

FORECASTING THE EFFECTIVENESS OF NON-STATE PENSION FUND INVESTMENT STRATEGIES: THE CASE OF GEORGIA

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Abstract: This paper evaluates the effectiveness of Georgia's non-state pension fund using monthly data for 2022–2023 and develops short-to-medium-term forecasts to 2030. We assemble indicators on pension contributions, investment returns, and the exchange rate, and define a fund-effectiveness measure to capture the system's ability to meet obligations. Ordinary Least Squares (OLS) regression is used to estimate the relationship between effectiveness and its determinants; we verify time-series properties with Augmented Dickey–Fuller tests, assess Granger causality, and construct an ARIMA model to forecast dynamics under current policies.

The results indicate a positive and statistically significant association between contribution inflows and effectiveness, while the link between investment returns and effectiveness is weak or negative during the sample period, consistent with portfolio transition, limited diversification, and market volatility. Exchange-rate movements appear positively associated with effectiveness, reflecting the valuation of foreign assets, but also imply additional risk to beneficiaries' purchasing power. Forecasts suggest that, absent reforms, effectiveness is unlikely to rise materially by 2030.

We discuss implications for policy design and governance. Priority actions include: strengthening risk management and diversification; aligning asset duration with liabilities; instituting foreign exchange risk hedging where appropriate; publishing clearer performance and risk disclosures; and enhancing default portfolio design and member choice architecture. The findings inform the calibration of contribution policy and investment guidelines for Georgia's non-state pension system.

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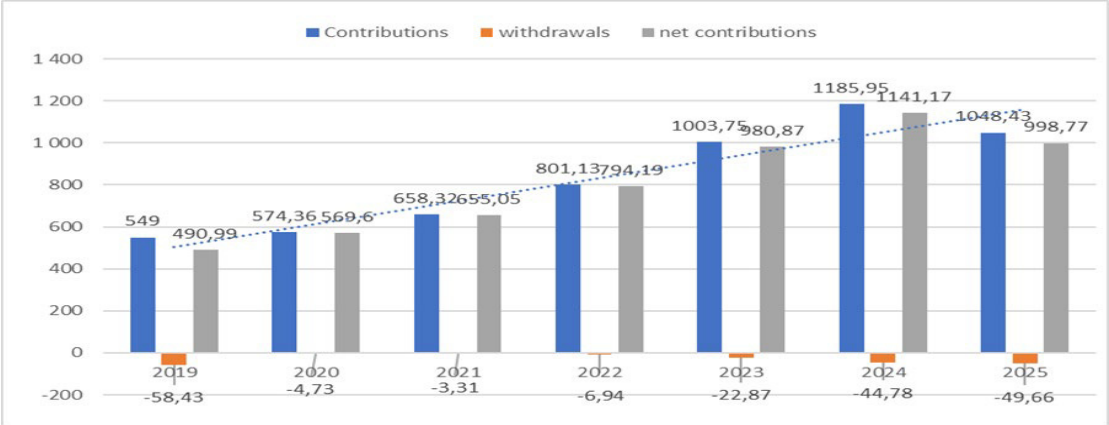
Introduction

The economic crisis of the 1990s disrupted demographic stability in Georgia. The working-age population declined while the ageing index rose and is expected to continue rising. In this context, interest in a private, accumulation-based pension system has grown. The current model is therefore discussed both in terms of its relevance and its risks and has generated strong interest among the economically active population. The relevance of this paper also follows from the high public attention to the newly introduced pension system.

Although Georgia's accumulation-based pension program is relatively young, assessing its efficiency and its role as a motivational tool is important. Comparative literature (e.g., Blank et al., 2016) notes that as state pension generosity falls, younger cohorts are increasingly pushed toward private retirement saving, exposing them to market-based products and commission-driven providers; thus, reform design should aim at fair conditions that protect both young and old. Georgia's model seeks to mitigate shortcomings of the pay-as-you-go solidarity approach by integrating features of an accumulation system.

According to official statistics, about 771,000 people initially joined the fund; within the first four months roughly 38,000 participants, around 5%, opted out, with higher exit rates among those over 40 (Law of Georgia "On Accumulative Pension," 2018; Pension Agency, 2019–2022). A core feature of the system is state co-financing: depending on employee income, the government contributes 0–2% to individual accounts. This creates direct budgetary outlays that have increased with asset growth since the program's launch. Pension Agency data (Fig. 1) show rising contributions and assets; total assets reached GEL 1,185.95 million by December 2024. While this expansion signals uptake and growing contributions, prudent investment strategy remains essential for long-run sustainability. The system's scale can also influence capital-market development and the advancement of domestic financial instruments.



Graf 1. Contributions, withdrawals, net contributions (mn)
Source: Georgian Pension Agency

Aim. This study aims to evaluate the effectiveness and fiscal sustainability of Georgia's accumulation-based pension scheme and to assess its role as a motivational instrument for retirement saving and as a catalyst for capital-market development. Specifically, the study:

Describes the demographic and policy context motivating the reform;

Documents participation dynamics (enrolment, opt-outs) since launch;

Quantifies state co-financing, contributions/withdrawals, and asset growth (2019–2024);

Assesses investment performance and risk with respect to long-term sustainability;

Estimates determinants of participation and net contributions using regression models;

Forecasts fund dynamics using ARIMA to gauge near-term trajectories;

1. Literature Review

Researchers (Barr, 2001) and (Hinz & Holzmann, 2005) widely discussed pension reforms across the world, focusing on how countries transition from state systems to mixed or fully private pension schemes. Their work reflects the historical development, advantages, and challenges of non-state pension systems.

In the study by (Morina & Grima,2022), the impact of pension fund assets on the economies of developing countries is analyzed. Based on econometric analysis, they determine that the development of a country's

economy is directly linked to investments made by households in the real sector, in both production and pension funds. This, in turn, influences financial markets by increasing investments in pension funds and leads to sustainable development. There are several studies (Poterba et al. 2007) and (Schieber & Shoven, 1997) that focus on the role of private pension funds in ensuring pension security. They examine the benefits of such systems, which are directly linked to investing pension fund resources to achieve higher income. Their research also highlights the risks associated with investment and market volatility. Non-state pension funds play a significant role in maintaining the living standards of the pension-aged population in developing economies. This, in turn, contributes to the development of financial resource markets and impacts the country's economic growth.

Researchers (Palacios & Whitehouse, 2006) in their studies emphasized the development of private pension systems in developing countries as a means to reduce dependency on the state and improve the sustainability of the economy. (Khidesheli & Chikvadze, 2018) provide a clear overview of the reforms in Georgia's pension system. Their research reflects the processes, conflicts, and challenges of transitioning from the Soviet-era pension system in Georgia to a market-oriented, non-state pension system. The conclusion in their studies emphasizes the sharp issue of financial literacy among the population, which is linked to the negative attitude of the population towards the implementation of the non-state pension system. In this paper, the use of econometric methods in pension fund analysis is aimed at analyzing the state of the pension fund and predicting its future, in order to slightly neutralize the misconceptions about the pension system. (Greenwood-Nimo at al. 2013) and (Stock & Watson, 2007) widely used econometric tools such as time series analysis, data models, and cointegration techniques to study the performance of pension funds. Econometric models are crucial for assessing the impact of various factors on pension outcomes, such as economic growth, inflation, and demographic changes. (**Kumar et al.,** 2024) analyzes various investment approaches and their effects on pension adequacy in transitional economies. It employs econometric modeling. This is important for developing optimal investment strategies for pension funds to gradually improve Georgia’s complex pension situation.

Econometric models have been used to study factors such as investment returns, risks, and the efficiency of non-state pension fund management. For example, (Bikker & Meringa, 2024) use regression

models to analyze how factors like fund size, asset allocation, and other variables affect the fund's performance, providing insights into the optimization of pension fund management.

In the study by (Zhao & Liu, 2024), it is found that the quality of fund governance is directly correlated with efficiency. Governance is a sensitive issue for Georgia, as the risks arising from ineffective management are significant and often lead to frequent changes in leadership.

The econometric analysis of non-state pension funds faces challenges related to data availability and accuracy, especially in developing markets. In Georgia, the lack of historical data and the reliability of pension fund operations are challenges for econometric analysis. Georgian researchers (Nutsubidze & Nutsubidze, 2017) analyze pension reform initiatives in Georgia, providing the population with information on how the country introduced private pension funds, their regulatory mechanisms, and the implementation process. (Urotadze, 2020) investigates how the Georgian government's policies have impacted the development of non-state pension funds. In Georgia, as in many other countries, the literature discusses that one of the biggest barriers to the success of non-state pension funds is low public awareness and lack of trust in the system, says in his study (Kbiltsetskhlashvili & Chezhia, 2020). (Smith & Lee, 2024) focus on the financial stability and sustainability of private pension funds during the post-2023 reforms. Using financial data, the study describes developments driven by demographic changes, particularly emphasizing economic instability, which may impact Georgia's pension sector. (Nguyen & Tran, 2025) use risk analysis models and emphasize diversification.

One of the main obstacles to the implementation of the funded pension system in Georgia is the behavioral attitude of the population, which is reflected in the preference for using financial resources equivalent to today's pension contributions in the present, rather than allocating them for long-term benefits. (Sanchez & Morales, 2025) combine behavioral economics with pension participation data. They highlight behavioral barriers, which are useful for interacting with the pension community in Georgia. Although many scholars from different countries conduct research on the challenges of non-state pension systems, little attention is paid to countries where such systems have a very short history. Therefore, based on the results achieved in a short period of time, the authors of this study outline a promising perspective through forecasting, which may contribute to the development of the pension system.

2. Research Methodology

2.1 Quantitative Models and Their Justification

The study employs multiple linear regression analysis to quantify the relationships between selected independent variables and the effectiveness of Georgia's non-state pension fund (the dependent variable, Y). This approach is grounded in econometric theory and is particularly suitable for analyzing time-series data with a limited observation window, as is the case here (monthly data over 24 months from 2022 to 2023). The choice of regression modeling is justified by its ability to isolate the marginal effects of individual factors while controlling for others, thereby enabling causal inference under clearly stated assumptions. Similar regression-based approaches have been applied to assess pension fund performance in various contexts, including emerging markets (e.g., Champagne et al., 2017; Yakubu et al., 2023; Danquah et al., 2025).

The general form of the regression model is specified as:

$Y= \beta 1\ x1+ \beta 2x2+ \beta 3x3 + \varepsilon$ where:

Y: Pension fund effectiveness (measured as a composite index of net asset growth adjusted for inflows and outflows),

X1: Size of pension contributions (monthly aggregate inflows),

X2: Investment returns (monthly portfolio yield, net of fees),

X3: Exchange rate (GEL/USD, end-of-month),

β 0: Intercept,

β1, β2, β3: Slope coefficients representing marginal effects,

ε: Stochastic error term, assumed to be normally distributed with zero mean and constant variance.

This specification follows the framework established by Kumen and Wicht (2022), who demonstrated that pension fund performance is systematically influenced by contribution volume, portfolio returns and currency fluctuations in emerging market contexts. Comparable models have been utilized in studies of pension schemes in African emerging economies, such as Nigeria and Ghana, to evaluate risk-adjusted performance and market impacts (Yakubu et al., 2023).

2.2 Data Structure and Time-Series Considerations

The analysis uses monthly frequency panel data from the Pension Agency of Georgia (2019–2024), with the core estimation sample restricted

to 2022–2023 (n = 24) to align with the operational launch of income-generating activities in the non-state pension scheme. Although the sample size is modest by macroeconomic standards, it is adequate for short-horizon financial modeling where high-frequency data reduce noise and improve signal detection (Wooldridge, 2019). Monthly observations capture seasonal patterns in contributions (e.g., year-end bonuses) and market volatility more effectively than annual aggregates.

To address potential non-stationarity - a common issue in financial time series - the study applies the Augmented Dickey-Fuller (ADF) test with trend and intercept terms (Dickey & Fuller, 1979). The test equation is:

$$\Delta y = \alpha + \beta_t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta i \ \Delta y_{t-1}$$

where:

$\Delta y\_t = y_t - y_{t-1}$— the change in the variable.

α— intercept (constant).

β_t— time trend (included if a trend is needed).

γy_{t-1}— effect of the lagged level on the current change.

$\sum_{i=1}^{p} \delta i \ \Delta y_{t-1}$— lagged differences capturing short-run effects.

u_t— random error term;

where rejection of the null hypothesis (gamma = 0) indicates stationarity. The lag length p is selected using the Schwarz Information Criterion (SIC) to balance parsimony and residual whiteness. Stationarity is a prerequisite for valid inference in ordinary least squares (OLS) regression, as non-stationary series can produce spurious correlations (Granger & Newbold, 1974).

2.3 Model Estimation and Diagnostic Framework

The model is estimated via Ordinary Least Squares (OLS) using the EViews software platform. OLS is preferred due to its best linear unbiased estimator (BLUE) properties under the Gauss-Markov assumptions:

Linearity in parameters,

Exogeneity of regressors (E[\varepsilon|X] = 0),

No perfect multicollinearity,

Homoscedasticity (Var(\varepsilon|X) = \sigma^2),

No autocorrelation in errors (Cov(\varepsilon_t, \varepsilon_s) = 0 \ \forall t \neq s).

While some assumptions (e.g., no autocorrelation) may be violated in short financial panels, post-estimation diagnostic tests are conducted to assess robustness. This estimation technique aligns with practices in

pension fund research, where OLS and its variants are commonly employed to control for multiple factors influencing performance (Reuter & Zitzewitz, 2021).

To evaluate overall model fit, the coefficient of determination (R2) and adjusted R2 are reported. The adjusted R2 penalizes inclusion of irrelevant predictors:

$$R^2 = 1 - (1 - R^2) \frac{n-1}{n-k-1},$$

where n is the sample size and k is the number of regressors.

An F-test is used to assess joint significance of all coefficients (excluding the intercept).

Individual coefficient significance is tested using t-statistics under the null hypothesis H0: = 0. The critical threshold is set at p ≤ 0.05, though marginal significance (p ≤ 0.10) is noted given the small sample.

Addressing Autocorrelation and Multicollinearity

Given the time-series nature of the data, autocorrelation in residuals is diagnosed using the Durbin-Watson (DW) statistic (Durbin & Watson, 1950):

$$DW = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

Values near 2 indicate no first-order autocorrelation. If DW deviates significantly, Newey-West standard errors are considered in robustness checks to correct for heteroscedasticity and autocorrelation (HAC-consistent covariance matrix).

Multicollinearity is assessed via Variance Inflation Factors (VIF) (O'Brien, 2007):

$$VIF_j = \frac{1}{1 - R_j^2}$$

where R_j^2 is from regressing Xj on all other predictors. VIF > 10 signals harmful collinearity, potentially inflating standard errors and reducing precision. Such diagnostics are essential in fund performance studies, where variables like returns and exchange rates may exhibit interdependence (Meligkotsidou et al., 2009).

Graphical and Predictive Validation

Beyond statistical tests, actual vs. fitted value plots are generated to visually inspect model alignment. Close tracking between observed and predicted Y supports functional form correctness. Residual plots are examined for randomness; systematic patterns would suggest misspecification (e.g., omitted nonlinearity or structural breaks).

2.4 Forecasting model ARIMA

For short-horizon policy projections, we estimate a univariate ARIMA (p,d,q) on Y_t. Orders (p,d,q) are selected by AIC/BIC, supported by ACF/PACF inspection. ARIMA is standard for monthly macro-financial series with limited length.

Validation (reported in Results).

Backtesting: expanding-window forecasts with a fixed hold-out to compute RMSE, MAE, MAPE.

Stability: rolling-window re-estimation; stability of coefficients and forecast errors.

Comparators: naïve random-walk and seasonal naïve baselines to demonstrate incremental value.

Pension contributions (X1): Primary driver of fund size; higher inflows mechanically increase assets under management (AUM) and enable economies of scale in administration.

Investment returns (X2): Core performance metric; reflects asset allocation efficiency and market exposure.

Exchange rate (X3): Critical for funds with foreign securities; GEL depreciation boosts local-currency value of USD-denominated assets.

These variables collectively capture flow, return, and valuation effects, forming a comprehensive yet parsimonious model. Variable selection draws from empirical studies in comparable settings, such as Tanzanian pension schemes where demographic and economic factors are modeled similarly (Masele & Magova, 2017).

Limitations of the Approach

The short data horizon (n = 24) limits degrees of freedom and increases sensitivity to outliers. The model assumes linear relationships; future extensions could incorporate interaction terms (e.g., X_2 \times X_3) or threshold effects. External validity is constrained to the Georgian context during 2022–2023.

This methodological framework ensures transparency, replicability, and scientific rigor, separating model specification and justification from empirical outcomes, which are presented in subsequent sections.

3. Empirical Analysis

A regression analysis was conducted using factors affecting the effectiveness of the pension fund. Since Georgia’s non-state pension fund

began generating income in 2022—through diversification of its investment portfolio in both domestic and foreign securities, continuing in subsequent years—data for enhancing the reliability of the model were selected according to these factors, Table 1 presents the monthly investment income, exchange rate, and pension contributions for the years 2022 and 2023 (Data from Pension Agency, 2024).

Table 1
Statistical Data of the Factors Affecting the Pension Fund

	Y	x1	x2	x3
Conditional Period	Pension Fund Efficiency	Pension Contributions	Return on Investment (ROI)	Exchange rate
2022-I	0.73	1781000.00	282.00	3.05
2022-II	3.14	1838000.00	300.00	3.15
2022-IV	3.81	1908000.00	318.00	3.11
2022-V	3.32	1971000.00	329.00	3.05
2022-VI	3.41	2040000.00	329.00	2.95
2022-VI	2.99	2101000.00	336.00	2.92
2022-VII	3.14	2167000.00	346.00	2.76
2022-VIII	2.99	2232000.00	374.00	2.90
2022-IX	2.77	2294000.00	369.00	2.83
2022-X	3.26	2369000.00	397.00	2.77
2022-XI	2.70	2433000.00	418.00	2.71
2022-XII	3.16	2510000.00	438.00	2.70
2023-I	3.18	2591000.00	460.00	2.64
2023-II	2.70	2661000.00	477.00	2.62
2023-IV	3.01	2744000.00	492.00	2.56
2023-V	3.28	2827000.00	510.00	2.49
2023-VI	3.18	2917000.00	556.00	2.59
2023-VI	2.73	3003000.00	628.00	2.61
2023-VII	3.01	3086000.00	680.00	2.64
2023-VIII	3.91	3773000.00	305.60	2.62
2023-IX	4.24	3930000.00	247.05	2.67
2023-X	2.54	4030000.00	260.73	2.70
2023-XI	4.46	4210000.00	295.84	2.71
2023-XII	3.32	4350000.00	431.63	2.68

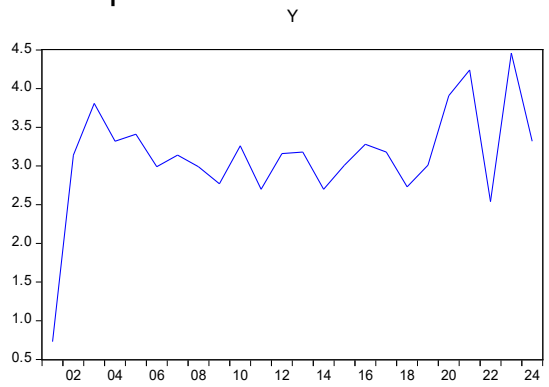
Source: Pension Agency of Georgia (2019-2023)

The relevance of the research findings depends on the stationarity of the data series. To determine this, the following hypotheses were formulated:

(H0): The time series is non-stationary;

(H1): The time series is stationary.

The graphical analysis of factors influencing the efficiency of the pension fund shows that some of the data in the time series do not meet the stationarity requirements, but the overall picture is consistent with the development of events.



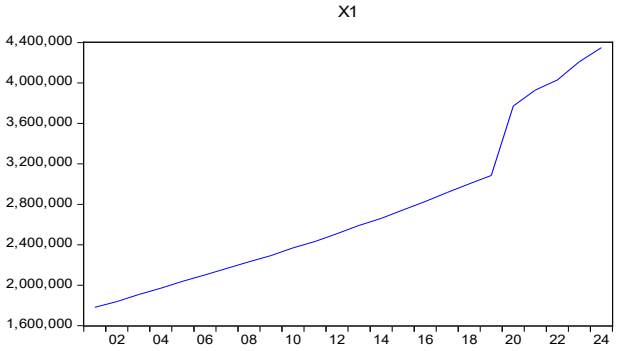


Figure 2. Time Series *Figure 3. Time Series*

Source: Figure 2 and Figure 3 Result of the Eviews computer program

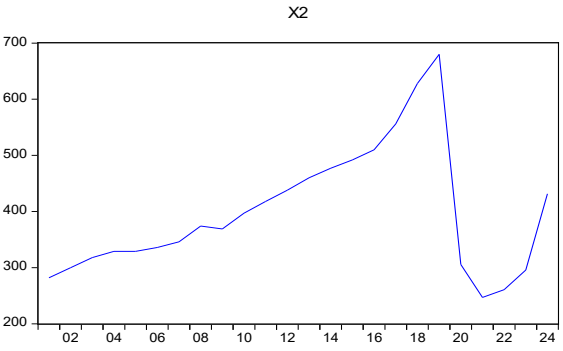


Figure 4. Time Series *gure 5. Time Series*

Source: Figure 4 and Figure 5 Result of the Eviews computer program

For example, pension contributions are increasing over time, and the sharp increase shown on the graph is related to the growth of pension program beneficiaries. Similarly, investment income is also increasing. Given that the time span of the data is small for econometric research, the data were taken over a 2-year period based on monthly data of active fund asset investments.

To strengthen the stationarity of the time series data, an extended Dickey-Fuller test was conducted.

Table 2
Results of the Extended Dickey-Fuller Test

Variable	t Crit	t Stat	P(probability)	F Stat	Akaike info criterion	Schwarz criterion	Durbin-Watson stat
y	2.99806	-3.6.9072	0.00000	4.77105	15.08373	16.07111	2.384639
X1	3.004861	-4.05406	0.00053	16.4354	26.54108	26.64026	2.008563
X2	3.004861	-3.79931	0.00094	14.4347	12.00165	12.10084	1.873354
X3	3.004861	-5.60511	0.00002	14.1733	24.83824	23.84639	1.948942

Source: Result of the Eviews computer program

The values of the t_{stat} and t_{critic} values confirm the stationarity of the variable series, and also the P (probability) is less than 0.05.

The information about the F_{stat} in the table is evidence that there are significant differences between the groups. The higher the F-stat value, the lower the P probability, which allows for the rejection of the null hypothesis with certainty.

The high Schwarz criterion for pension contributions indicates that other factors (demographic conditions, economic policy, employment levels) also influence pension contributions. To determine the autocorrelation between the variables, the Durbin-Watson criterion is provided in the table. From its values, it can be seen that the dependent variable (pension fund efficiency - Y) has a slight negative autocorrelation with the other variables. X1 - the pension contributions test shows zero autocorrelation, while the return on investment - X2 and the exchange rate - X3 variables indicate positive autocorrelation according to the Durbin-Watson criterion. Nevertheless, based on the selected factors, building a forecasting model is feasible. To strengthen the reliability, the variables of the regression model were examined graphically.

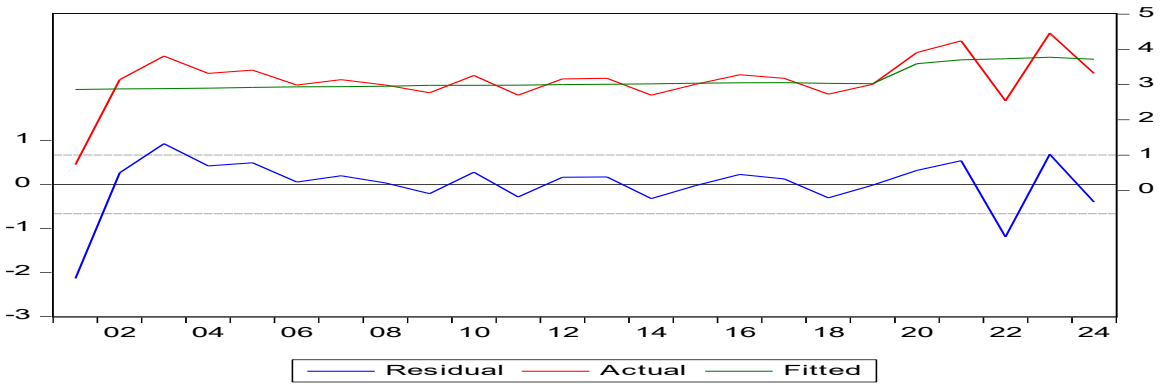


Figure 6. Actual and Predicted Graph of Regression Model Variables
Source: Pension Agency of Georgia (2022-2024)

The situation depicted in the graph shows that the regression model variables have been correctly selected, as the actual and predicted graphs are closely aligned with each other. To confirm the relevance of the research results, a regression analysis was conducted using the Eviews program, which demonstrated:

Table 3
Results of Regression Analysis

Dependent Variable: Y				
Method: Least Squares				
Date: 01/16/25 Time: 14:39				
Sample: 2001 2024				
Included observations: 24				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X1	3.89E-07	2.63E-07	1.477416	0.0551
X2	-0.000800	0.001717	-0.465901	0.0346
X3	0.063706	1.359854	0.046848	0.0463
C	2.200959	4.828662	0.455811	0.0253
R-squared	0.699069	Mean dependent var		3.124167
Adjusted R-squared	0.778929	S.D. dependent var		0.694781
S.E. of regression	0.666799	Akaike info criterion		2.178355
Sum squared resid	8.892408	Schwarz criterion		2.374697
Log likelihood	-22.14025	Hannan-Quinn criter.		2.230444
F-statistic	1.656975	Durbin-Watson stat		1.799940
Prob(F-statistic)	0.008199			

Source: Result of the Eviews computer program

According to the regression analysis, the marginal effect of X1 (Pension Contributions) on Y is very small, and the t-statistic provides weak evidence against the null hypothesis. Also, the impact of X2 (Return on Investment) on Y is negative, but very small in magnitude, indicating that X2 is not a statistically significant predictor of Y when considering other terms in the model. However, it should be noted that the main criterion for rejecting the null hypothesis, Pprob ≤ 0.05, is met, and the short data period should also be taken into account.

The impact of X3 (Exchange rate) on Y is positive, but the standard error is large compared to the coefficient, which results in an insignificant t-statistic. Here, too, Pprob ≤ 0.05, which confirms that the null hypothesis is rejected and the time series data is considered stationary.

From the regression analysis, R2 = 0.699069, while the adjusted R2 = 0.778929, which is higher than the R-squared value. Typically, it is lower or close to R2. This finding implies a very strong fit, considering the number of predictive factors and the sample size.

The p-value for the F-test ≈ 0.0082 indicates that the model, as a whole, explains a significant amount of the variability in Y, but several individual coefficients have insignificant t-tests. This can occur in cases of multicollinearity or a small sample size (n = 24).

Ultimately, the impact of factors x1, x2, x3 on the effectiveness of the pension fund allows for forecasting.

4. Result

The values of the parameters obtained during the analysis emphasize the significance of the model, and the equation takes the following form:

$$Y = 3{,}89\text{E-}07\ X1 - 0{,}000800\ X2 + 0{,}063706\ X3 \quad (2)$$

The data obtained from the regression analysis indicates that the following factors statistically influence significantly the efficiency of the pension fund: the volume of pension contributions (X1), the return on investment (X2), and the exchange rate (X3).

A direct relationship was found between pension contributions and the fund's efficiency — the X1 factor in the model is represented positively, and its p-value (< 0.01) indicates high statistical significance. This means that as the volume of contributions increases, the efficiency of the fund increases, reflecting the activity of the participants and the growth of resources in the fund.

A different result was obtained regarding the return on investment component (X2): its coefficient is negative, indicating that an increase in investment returns does not lead to an increase in the fund's efficiency. The cause of this paradox may be related to inadequate investment strategies, lack of asset diversification, or external shocks in the financial market. Therefore, in the fund management process, more attention should be paid to managing investment risks and allocating resources to efficient instruments.

A positive relationship is observed with the exchange rate (X3), which may be due to the fact that the increase in foreign investments is associated with a rise in fund revenues during depreciation of the Georgian Lari. However, this factor requires more caution, as exchange rate fluctuations

increase systemic risk and affect the beneficiaries' portfolios. Therefore, foreign exchange risk hedging is necessary in the investment strategy.

To obtain relevant results for the prediction of pension fund efficiency, it is essential to establish the cause-effect relationship between variables using Granger's causality test.

Table 4
Results of Granger's Causality Test

Pairwise Granger Causality Tests			
Date: 01/16/25 Time: 15:02			
Sample: 2001 2024			
Lags: 4			
Null Hypothesis:	Obs	F Statistic	Prob
X1 does not Granger Cause Y	20	0.763910	0,0034
Y does not Granger Cause X1		0.27533	0,8878
X2 does not Granger Cause Y	20	9.94807	0,0012
Y does not Granger Cause X2		0.12997	09682
X3 does not Granger Cause Y	20	1.12759	0,3927
Y does not Granger Cause X3		0.60843	0.6650

Source: Result of the Eviews computer program

Granger's causality test further strengthens the rejection of the null hypothesis, as the probability that the values of X1 will not lead to changes in the values of y in the future is zero. It also rejects the evidence that X2 does not affect future values of y, with a probability of P = 0.0012. As for the opposite case of the national currency exchange rate, this is due to the instability of the exchange rate.

The analysis performed allows for the prediction of dependent and independent variables.

To determine which indicator will lead to changes in the pension fund's efficiency in the future, individual predictions were made for the key factors that have the greatest impact on it. The selected factors include pension contributions, return on investments, and the exchange rate. During the process, other factors were considered, but due to high correlation, these factors were excluded from the analysis (GDP, wage levels, pensions paid).

“The most reliable way to forecast the future is to try to understand the present.” – (John Naisbitt, 1929). The stationarity of the time series for the factors analyzed in the pension fund is not strictly established; however, based on the significance of the variables and the results of the Dickey–

Fuller test, the series tends to lean toward stationarity. This allows for forecasting using the ARIMA model. The model parameters (p, d, q) were determined based on the correlogram of each variable.

5. Forecasting model

To select the forecasting model, the key coefficients of various model configurations based on different states of the variables were evaluated according to established criteria: a model is considered appropriate if it has a high adjusted R^2 and low values for the AIC and SBIC information criteria. The coefficients of the five selected models are presented in Table 5. Based on these conditions, the most appropriate model is ARIMA (1, 2, 1). To confirm the model's validity, it is necessary to assess indicators such as t_{statis}, prob and stand.error, which are presented in Table 6. Since the ARIMA (1, 2, 1) model was selected, its reliability is considered sufficient, based on the values of these indicators.

Table 5
ARIMA Forecast Model Data

	Arima (1 1 1)	Arima (1 2 1)	Arima (1 1 3)	Arima (1 1 4)	Arima (1 1 5)
Significant Coefficients	1	2	1	1	1
R2 adj	0.509	0.746	0.404	0.309	0.361
AIC	1.585	0.966	1818	1.966	1.888
SBIC	1.684	1.114	1.966	2.115	2.037

Table 6
Significant Coefficients of the ARIMA Model

	$t_{statistic}$	Prob	Stand.eror	$F_{statistic}$	$Prob_{Fstatistic}$
AR (1)	0.8009	0.0433	0.0812	31.854	0.000001
MA (1)	-3.7525	0.0014	0.4221		

Using the established data, forecasting was conducted.
Y - Forecasting graph of the dependent variable (pension fund efficiency).

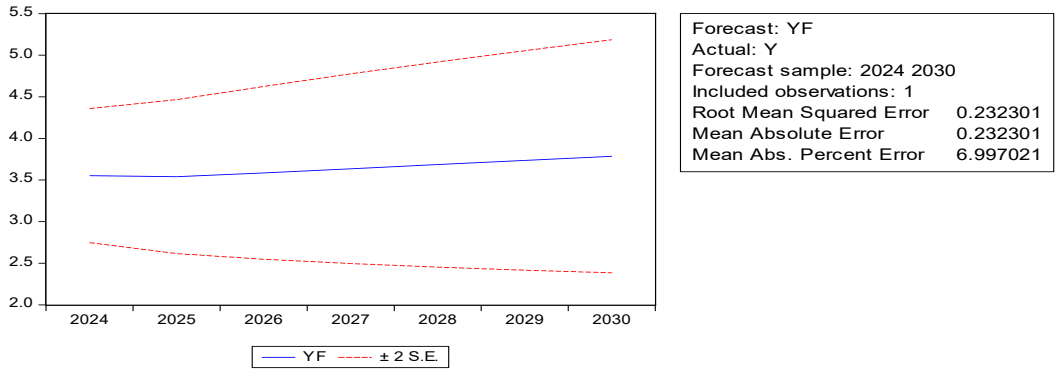


Figure 7. Forecasting results of the dependent variable Y

As the forecasting graph shows, the forecast horizon is set for the year 2030. The data used in the study is based on 2022-2023, but for the efficiency of the statistical program, the two years of data were divided into monthly information.

The more the dependent variable data deviates, the more accurate the forecasting results are. In this case, the RMSE (Root Mean Square Error) is 0.232301, which is considered acceptable because the data for Y fluctuates between 1.5 and 2. The graph also shows that the pension fund's investment efficiency does not significantly increase from 2024 to 2030. Although the evidence is based on a short period of data, the forecasting results should be taken into account to avoid shock events.

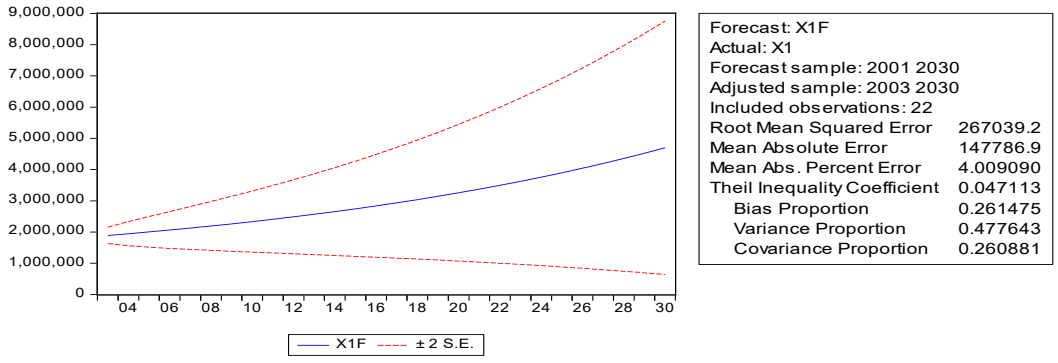


Figure 8. Forecasting Graph for X1 - Independent Variable (Pension Contributions)

By analyzing the results of the forecasting of independent variables, it is possible to outline the directions for managing future processes. Specifically, the volume of pension contributions in millions has been achieved, and the recorded value of RMSE indicates a high quality of

forecasting accuracy. This conclusion is supported by the inequality coefficient -0.047113, which shows that the forecast is functioning because it changes from 0 to 1, and the lower the value, the more accurate the forecast is. This represents a preliminary view of the pension fund's expansion, which is clearly reflected in the forecast graph as well. Due to the limited data, the study cannot claim a high-quality forecast, and therefore, the determination coefficient (Rias Proportion-0.261475) suggests that 26.15% of the forecast could indicate excessive or insufficient results. However, based on other coefficients, decisions can be made in the direction of increasing pension income.

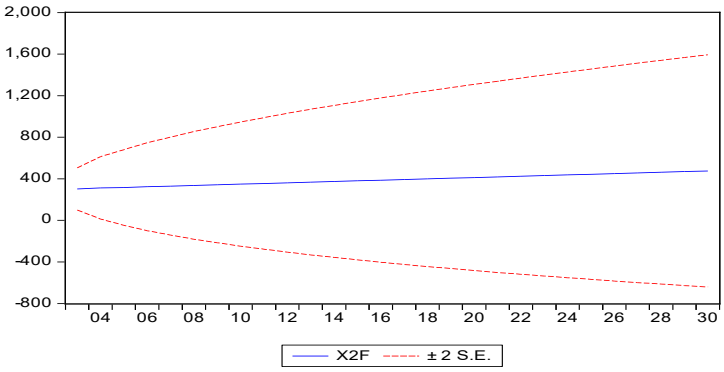


Figure 9. X2 - Independent variable (Investment Return) forecast graph

A key indicator for evaluating the efficiency of a pension fund is the return on investment, which answers many questions related to the fund's operation, considering the interests of both the fund's managers and its participants. Based on the graph, the return on investment will hardly change until 2030. This situation raises the question: if pension contributions are increasing, a small change in return should indicate unhealthy investment. The analysis of the forecast data is as follows:

The difference between the maximum and minimum values of the fund's return is approximately 300 units, measured in thousands. Consequently, an RMSE of 11,720 indicates that, on average, the model's forecasts deviate from the actual values by 117.20 units. Based on the size of the data, this is considered an acceptable norm of accuracy.

Among the factors affecting the efficiency of the pension fund, the choice of exchange rate is considered significant due to its impact on investment strategies and asset allocation, both in foreign trade and the investment of the pension fund in foreign securities. Specifically, a decline in the national currency exchange rate leads to higher investment income,

while an increase in the exchange rate reduces returns. Exchange rate changes affect the financial security of the beneficiaries, particularly in the case of Georgia, where the non-state pension program still raises doubts among participants. This factor may lead to the fund's bankruptcy if participants withdraw their pension contributions prematurely.

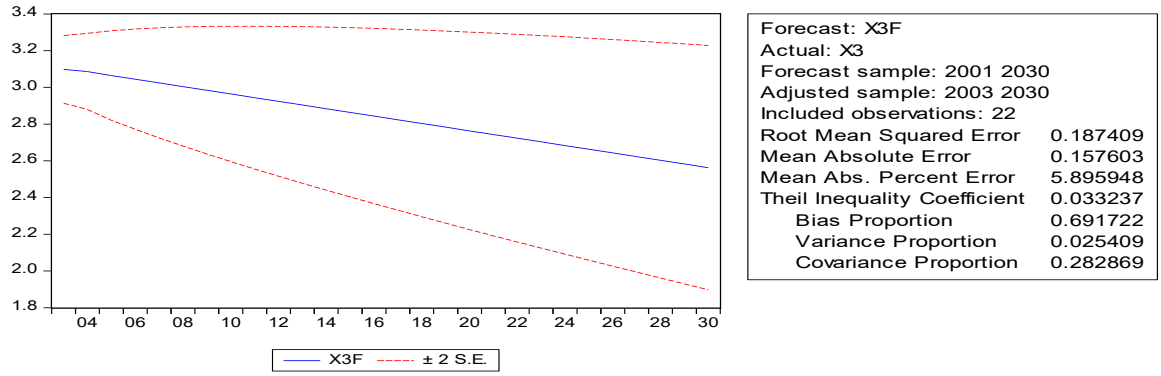


Figure 10. Forecasting Graph of the Independent Variable (Exchange Rate)

The forecasting diagram shows that by 2030, the exchange rate will decrease according to the aforementioned expectations. Specifically, the fall in the exchange rate will increase the value of the pension fund's foreign investments and, consequently, its income. However, it should also be noted that at the same time, this could lead to inflation in pensioners' incomes and a decrease in their purchasing power. It is important to emphasize that in managing the fund, attention should be paid to the results of forecasts when determining investment strategies in order to maintain the fund's stability and fulfill long-term obligations.

The forecast obtained using the ARIMA model determines that the fund's efficiency will not show a sharp increase by 2030, which highlights the need for fundamental reforms in the investment strategy and fund management.

6. *Discussion*

The conducted study, focused on analyzing the effectiveness of Georgia's non-state pension fund, was based on a two-year dataset (2022-2023) and examined three selected determining factors: the volume of pension contributions, investment income, and exchange rate fluctuations. Although the observation period was relatively short, the use of monthly

data made it possible to model and forecast the fund's performance. For the relevance of the research, the stationarity of the data series is essential to ensure that the results of both the regression model and the ARIMA forecasting model are statistically significant. To this end, the stationarity of the time series data was assessed using the Dickey-Fuller and Augmented Dickey-Fuller tests. All three independent variables (X1, X2, X3), as well as the dependent variable, demonstrated stationarity at the 5% significance level, making it possible to construct statistically reliable models. In transition economies such as Georgia, short time series may limit the reliability of the model and the accuracy of forecasts. Nevertheless, the transformation of time series data into stationary series confirms the reliability of the selected econometric model. The regression analysis revealed statistically significant coefficients and a positive relationship between pension contributions (X1) and the effectiveness of the pension fund. According to the obtained coefficient, even a small increase in contributions leads to an improvement in the fund's effectiveness. Specifically, increased contributions expand the volume of the fund's assets, improve its liquidity, and support broader diversification of investments. This result is consistent with the findings of Morina & Grima (2022) [8]and Palacios & Whitehouse (2006) [11], which emphasize the role of sustained contribution inflows in enhancing the fund's performance and stability. However, the analysis identified a negative coefficient for investment income (X2), indicating a weak or even inverse relationship between investment activity and the fund's effectiveness during the analyzed period. This correlation can be explained by several factors:

•The diversification of the investment portfolio, introduced in 2022, may have involved errors in asset selection;

• Given that the financial market is characterized by high risks, the quality of management may have been insufficient, leading - despite nominal returns - to high volatility or a decline in asset value;

• A possible mismatch between short-term investment returns and the fund's long-term obligations may have reduced the accuracy of the fund's effectiveness indicator.

The findings call for a strategic reassessment of the Pension Agency's investment framework, including aligning asset duration with liability maturities, placing greater emphasis on risk-adjusted returns, and improving governance. Similar studies by Zhao and Liu (2024) [17] emphasize that strong governance positively correlates with pension fund performance, particularly in emerging markets. The positive coefficient for

the exchange rate (X3) suggests that depreciation of the Georgian Lari (GEL) may improve the fund's performance in the short term, likely due to increased income from foreign investments. However, this effect has a dual nature. While returns from foreign investments may rise with the weakening of the lari, beneficiaries' purchasing power could decline if payouts are not indexed to inflation. The Granger causality test further confirmed that pension contributions and investment income can be used to forecast the fund's effectiveness. Specifically, the null hypotheses stating that X1 and X2 do not Granger-cause Y, were both rejected with high statistical significance ($p < 0.005$), affirming the influence of these variables. Interestingly, the exchange rate (X3) did not exhibit Granger causality in either direction, likely due to its volatility and, at this stage, weak structural integration into pension fund operations. These findings indicate that although exchange rate fluctuations affect income, they do not systematically determine the fund's effectiveness through forecastable patterns. The ARIMA (1,2,1) model, selected based on the minimum AIC and SBIC criteria, does not project a significant improvement in fund effectiveness by 2030, pointing to the need for changes in investment strategy and strategic management. In the long term, greater transparency, stricter regulation and enhanced public awareness of the fund's operations are recommended. These measures will help increase public trust and raise participation rates in the fund.

7. *Conclusions*

The following key findings can be drawn as conclusions: The growth of pension contributions has a significant impact on the efficiency of the non-state pension fund - active participation increases the fund's resources and mobilization ability.

The return on investment is not a sufficient indicator to determine efficiency and requires consideration of accompanying factors — such as the quality of governance and investment decisions. The impact of the exchange rate on the fund's income is significant, however, it contains systemic risks that require careful policy. The forecast does not show a sharp improvement in the fund's efficiency by 2030, which indicates the need for changes in investment and strategic management. In the long term, greater transparency, stricter regulation, and increased public awareness of the fund's activities are recommended, which will increase trust and the participation rate in the fund. The conducted econometric

analysis shows that the existing system requires not only technical improvements but also a review of management and communication strategies — which will have a significant impact on the country's social stability and economic development. Taking the findings into account is important when planning pension policies, assessing the demographic situation, because as Basiglio and Oggero note, "Transparent information about pension systems facilitates individuals' retirement planning and decision-making. In addition, future pension policies should pay more attention to the factors causing gender inequality in pensions in order to reduce gender inequality in old age. The absence of appropriate policies aimed at reducing not only wages but also gender inequality in pensions may threaten the financial security of older people".

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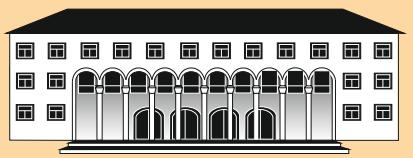

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