

ORIGINAL ARTICLE

Study on the Dynamics and Management of the Pillar III Private Pension System in Romania and Perspectives

Ștefan Virgil Iacob^{1,2*}, Ana Maria Popescu³ and Alina Eliza Dabija⁴

¹ Petroleum-Gas University of Ploiesti, 39 Bucharest Avenue, 100680 Ploiesti, Romania

² Romanian Academy, Institute of National Economy, 13 Septembrie Avenue, Bucharest, Romania

 <https://orcid.org/0000-0001-5831-203X>
e-mail: stefaniacob79@yahoo.com

³ Bucharest University of Economic Studies, 6 Piața Romană, 1st District, Bucharest, Romania

 <https://orcid.org/0000-0002-9119-3009>
e-mail: notariat.deiure@gmail.com

⁴ Ovidius University of Constanța, 1 Universității Alley, Building A, 1st Floor, 900470 Constanța, Romania

 <https://orcid.org/0009-0008-1438-6297>
e-mail: dabija_eliza@yahoo.com

* Corresponding author



Copyright: © 2025 by the authors

Citation (APA Style):

Iacob, S.V., Popescu, A.M., & Dabija, A.E. (2025). Study on the dynamics and management of the Pillar III private pension system in Romania and perspectives. *Economic Insights – Trends and Challenges*, 14(4), 25–45. <https://doi.org/10.51865/EITC.2025.04.02>

Abstract: In the context of recent economic transformations, characterized by macroeconomic volatility, persistent inflation and demographic changes, the sustainability of savings and social protection systems is a priority for public policy makers and for the management of private pension systems. In this study, the authors were interested in the dynamics and interdependencies between the main indicators of the private pension system Pillar III in Romania, namely the index of change in net income, the average monthly contribution per person of net assets and the number of participants, as well as inflation and unemployment rates, integrating the perspective of the financial and institutional management of pension funds. The methodology uses some statistical-econometric analysis methods and models, such as ARDL/ECM and VAR, capable of capturing both long-term equilibrium relationships and short-term adjustments and the mechanisms of transmission of economic shocks on the performance and management of funds. The study highlights the role of prudent investment strategies, risk management and the predictability of the legislative framework in maintaining financial stability and participant confidence. The study confirms the significant influence of income and inflation on contributions and assets, essential elements for portfolio management decisions. Forecasts on the t+12 horizon indicate a relatively stable evolution, with moderate fluctuations, under the conditions of maintaining the current macroeconomic and institutional framework. The conclusions provide empirical support for the substantiation of management strategies and economic policies aimed at strengthening the sustainability of the Pillar III private pension system.

Keywords: Private Pensions; Inflation; Income; Volatility; Dynamics.

JEL Classification: C10; C50; J32.

1. Introduction

The voluntary private pensions Pillar III represent a relevant component of the Romanian social security system, being designed to supplement the income obtained from the public pension Pillar I and from the mandatory privately administered pensions Pillar II. Introduced by Law no. 204/2006, these schemes operate on the basis of voluntary contributions of the participants, offering a long-term savings instrument, fiscally stimulated and administered by specialized entities, under the supervision of the Financial Supervisory Authority.

A distinctive element of Pillar III is the flexibility of contributions, in the sense that participants can direct up to 15% of their monthly gross salary income to a voluntary pension fund, and the tax legislation allows deductions within an annual ceiling, for both the employee and the employer. This facility transforms the voluntary pension into a frequently used instrument in the extra-salary benefit packages offered by companies, while also contributing to increasing the degree of financial education and consolidating a culture of savings.

From an investment perspective, Pillar III private pension funds adopt prudent, diversified strategies focused on government securities, corporate bonds, listed shares and other financial instruments, in accordance with risk management regulations. The performance of these funds has generally been positive over the long term, although returns may vary depending on market conditions. The importance of a long-term perspective is essential, as capital accumulation and the effect of compound interest become significant over two or three decades of constant contributions.

This research analyzed the interdependencies between the main indicators relevant to the economic phenomenon studied, namely the net income change index (IVN), the average monthly contribution change index per person (IC), the net asset change index (IAN), the number of participants change index (IP), the inflation rate (INF) and the unemployment rate (RS), using in this sense some statistical analysis methods and models, such as dynamic analysis, comparative study, the graphical method, but also some econometric methods, such as ARDL/ECM and VAR models. The choice of these models is motivated by their ability to capture both long-term relationships and short-term adjustments between variables, as well as to highlight the mechanisms through which economic shocks are transmitted within the analyzed system.

The ARDL (AutoRegressive Distributed Lag) model allows the estimation of relationships between variables regardless of their order of integration, being particularly useful in situations where the analyzed series are mixed, stationary and non-stationary. Its transformation into an ECM (Error Correction Model) model offers the possibility of separating short-term effects from long-term ones and identifying the speed with which variables return to long-term equilibrium after a shock. Thus, ECM analysis highlights the correction mechanisms that ensure the stability of the system and its capacity to adapt to changes in the economic environment.

In addition, the VAR (Vector Autoregression) model allows the investigation of dynamic interdependencies between stationary variables, treating each variable as endogenous and explaining its evolution through its own lagged values and through the lagged values of the other variables in the system. This approach is useful for analyzing the transmission of shocks and for making short- and medium-term forecasts in the absence of rigid theoretical restrictions on causality.

The importance of the study is amplified by its implications for the formulation of economic and social policies. The evolution of contributions and assets directly depends on the dynamics of income, the stability of the labor market and the level of inflation, factors that can influence financial sustainability. Under conditions of persistent inflationary pressures or imbalances in the labor market, the accumulation mechanisms can be significantly affected, which justifies the need for rigorous predictive analyses.

The methodology used in the paper includes testing the statistical properties of time series, estimating econometric models, assessing the stability and significance of parameters, as well as making forecasts over a 12-month horizon. The interpretation of the results is carried out both from a statistical perspective and from the perspective of economic implications, with an emphasis on the relevance for economic policy decisions. In this sense, the analysis aims to highlight the extent to which the analyzed system is able to absorb shocks and return to a sustainable growth trajectory.

The structure of the paper reflects this integrated approach. The first part is dedicated to the dynamic analysis of the indicators taken into account, followed by the stage of theoretical and methodological substantiation of the models used, presenting the essential concepts regarding time series, stationarity and cointegration, and subsequently the empirical analysis itself, the estimation of ARDL/ECM and VAR models and the interpretation of the obtained results are presented. Finally, the forecasts for the analyzed indicators and their implications for future developments are presented, as well as general conclusions regarding the stability and sustainability of the system.

Therefore, the paper aims to provide a comprehensive assessment of the dynamics of the analyzed indicators and to contribute to the understanding of the economic mechanisms underlying their evolution, highlighting the role of statistical-econometric tools in substantiating economic and financial policy decisions.

2. Literature Review

The analysis of the literature on pension systems highlights significant structural differences between countries, determined by the institutional architecture, demographic context and level of economic development. Thus, the importance of complementarity between public and private pensions in ensuring the adequacy of retirement income is highlighted, especially in the context of accelerated population aging and fiscal pressures on public systems. From this point of view, voluntary private Pillar III pensions are increasingly analyzed as instruments for diversifying risks and strengthening individual financial security.

Recent research on the behavior of participants in private schemes indicates the determining role of socioeconomic and demographic factors in decisions related to annuitization and accumulation. The study conducted by Baláž V. (2023) on participants in the private pillar in Slovakia highlights the influence of income, liquidity constraints, household structure and family responsibilities on the preference for annuities or inheritance. Formal sources of information, such as professional advice, increase the likelihood of choosing annuities, while informal information is associated with preferences for transferring wealth to heirs, especially in rural areas. The results suggest the need for public policies aimed at financial education and adapting pension rules to the diversity of family situations.

The evaluation of the performance of retirement savings products is another major research direction. Berardi A. and Tebaldi C. (2024) demonstrate that ignoring long-term macroeconomic trends can lead to distorted assessments of risk and return. Comparative analysis between funds with a target date over the life cycle and products with a minimum guarantee indicates the advantage of flexible strategies with higher exposure to equities, which offer superior prospects for return and capital protection in the long term. These findings highlight the importance of investment flexibility and the integration of systematic risks in the design of retirement products.

Structural changes in pension systems, in particular the shift from defined benefit to defined contribution schemes, have major implications for income distribution. Bonizzi B. et al. (2025) show that DC systems shift risk to the individual and can amplify inequality in pension wealth through differences in contributions, the absence of redistributive mechanisms and unequal

capacity to assume investment risks. Inequalities in the labour market are thus reflected in retirement income, which raises issues regarding the social equity of individualised systems.

A vulnerable segment in relation to saving for retirement is the self-employed. The analysis carried out by Cribb J. et al. (2024) in the United Kingdom shows very low participation rates in private pensions among them, mainly due to the lack of automatic enrolment and reliance on individual initiative. Projections indicate that most self-employed workers will not reach retirement income adequacy standards, highlighting the need for public policy interventions to stimulate participation and diversify savings instruments.

In the case of public systems, pension indexation mechanisms are a key factor in maintaining purchasing power and financial sustainability. Dedák I. and Fišer N. (2025) highlight the existence of a structural trade-off between the degree of indexation and the initial replacement rate, emphasizing that the effects depend on the level of analysis, individual or aggregate. Although the indexation method influences individual income trajectories, the aggregate level of benefits remains decisive for the well-being of pensioners. In this context, price indexation can provide a more favorable balance between income protection and system sustainability. The expansion of private pensions also raises the issue of income inequality at retirement age. The empirical analysis carried out by Doctrinal L. (2024) on European countries shows that the effects of privatization depend on the interaction between the pillars of the system and fiscal policies. Although private pensions can amplify inequality, the effects can be compensated by redistribution through public pensions or by the decrease in the importance of other concentrated sources of income. Thus, assessing the impact of reforms requires a systemic perspective on the entire retirement income mix.

In emerging economies and low-income countries, participation in pension systems is influenced by non-financial barriers, such as low levels of financial literacy and limited trust in institutions. Giles J. et al. (2025) show that interventions targeting these barriers, including personalized information and simplified administrative procedures, can increase participation, but financial incentives remain essential. This conclusion highlights the need for integrated policies that combine contributory instruments with social programs.

The role of pension funds as institutional investors is also analyzed from the perspective of sustainability objectives. Golka P. and Zwan N. (2025) show that Dutch funds face institutional constraints that limit the capacity to finance the green transition, while Otchere I. et al. (2025) identify possible costs of ESG strategies on fund asset growth in OECD countries. These results suggest a trade-off between sustainability goals and long-term financial performance.

Early retirement reforms can significantly influence labor market behavior. Hernæs E. et al. (2024) show that changes introduced in Norway increased the participation of older people in the economic activity and reduced the pressure on disability programs, highlighting the interdependence of different exit routes.

Recent literature also explores behavioral aspects of retirement planning. Research by Innocenti S. et al. (2024) highlights the existence of a vicious circle between current financial difficulties and lack of long-term planning. Trust in the system is also a crucial determinant of voluntary saving, as shown by Mangan M. et al. (2025).

Other research directions aim at optimizing investment strategies in DC schemes, integrating financial and demographic risks, as well as the impact of reforms on fiscal sustainability. Studies by Li W. and Wei P. (2024), Ng K.T.H. and Chong W.F. (2024) or Inzunza A. and Madeira C. (2025) emphasize the importance of flexibility of pension products and structural adjustments, such as increasing contributions or postponing the retirement age.

An important direction of recent research aims at the development of voluntary pension pillars in emerging economies and the institutional performance of private providers. In this regard, Shi Y. (2025) analyzes the evolution of the third pillar of the pension system in China, in a context

marked by rapid population aging and pressures on public schemes. The study highlights the low level of participation in voluntary private pensions, explained by insufficient population coverage, limited tax incentives, lack of investment advisory services and rigidity of individual accounts.

In a complementary perspective, Umut M. (2023) investigates the performance of private pension companies in Turkey during the period 2016–2022, using the grey relational analysis method, suitable for small samples. The Turkish private pension system, introduced in 2003 and subsequently strengthened through government contributions and the automatic enrollment mechanism implemented in 2017, aims to maintain the standard of living in retirement and stimulate long-term saving. The empirical analysis, based on a sample of 15 companies and six performance indicators, highlights a general trend of deteriorating performance and decreasing participation, despite incentive measures. The results, also confirmed by alternative methods of efficiency analysis, indicate that increasing the government contribution and extending participation to the young population are beneficial measures, but sustainable growth in participation depends on strengthening automatic enrollment mechanisms and optimizing the investment strategies of the funds.

The review of the specialized literature highlights the complexity of pension systems and the need for an integrated approach that combines financial sustainability, income adequacy and social equity. The role of voluntary private pensions is becoming increasingly important in complementing public systems, but their efficiency depends on the institutional design, the behavior of participants and the macroeconomic context. Future reforms must take into account the interdependence between the pillars of the system, demographic developments and behavioral factors, in order to ensure the financial security of the population at retirement age.

2.1. Data and Results

Regarding the data analysis, the dynamics of the economic and financial indicators considered over the time horizon of January 2020 - October 2025, monthly data, were taken into account. Of course, following this approach, each indicator was analyzed independently and for easier visualization and interpretation, the graphical method will be used, drawing a graph for each data series related to the variables taken into account. Thus, Figure 1 shows the evolution of the net income change index (IVN).

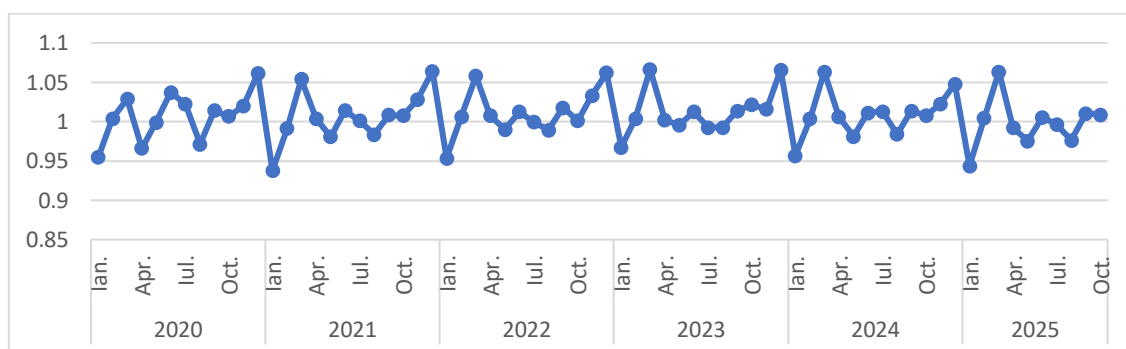


Fig. 1. Net Income Change Index (IVN)

Source: National Institute of Statistics. Data processed by the authors.

By analyzing the dynamics, we find that the net income change index (IVN) shows an average monthly increase of approximately 0.76%, with moderate volatility. The lowest value of 0.937845 corresponds to January 2021, which indicates an episode of relatively strong contraction of net income. It is also noted that in other years the minimum values correspond to January. Maximum values are recorded in December and March during the period under analysis. Basically, this evolution suggests some seasonal effects, the existence of episodes of

salary adjustments concentrated in certain months and possible reactions to inflation and the labor market. The analysis of descriptive statistics for the net income change index (IVN) is presented in Figure 2.

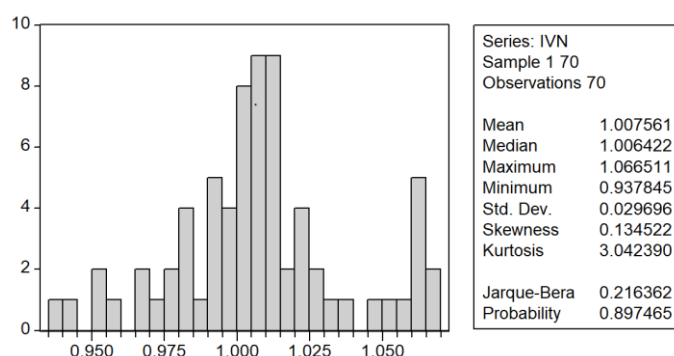


Fig. 2. Histogram and Descriptive Statistics for IVN

Source: Data processed by the authors.

According to the results presented in Figure 2, the series regarding the net income change indices (IVN) presents an average value of 1.0076, very close to the median, respectively 1.0064, which indicates an almost symmetrical distribution of the data and the absence of dominant extreme values. The variation interval is relatively small, between the minimum of 0.9378 and the maximum of 1.0665, and the standard deviation is small, respectively 0.0297, suggesting a low volatility of the net income change index during the analyzed period. At the same time, the Skewness coefficient of 0.135 is close to zero, indicating an almost symmetrical distribution, slightly oriented to the right, and the Kurtosis of 3.042 is very close to the value 3 specific to the normal distribution.

The Jarque–Bera test (0.216 with $p = 0.897$) does not reject the null hypothesis of normality at usual significance levels, which indicates that the IVN series can be considered approximately normally distributed.

Figure 3 shows the evolution of the indices of change in the average monthly contribution/person (IC).

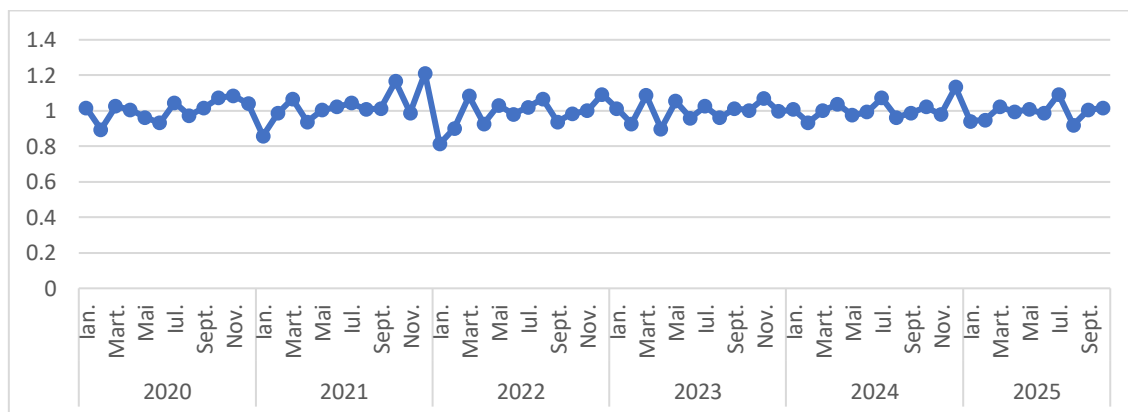


Fig. 3. Index of Change in Average Monthly Contribution/Person (IC)

Source: National Institute of Statistics. Data processed by the authors.

Regarding the index of change in the average monthly contribution/person (IC), some stronger oscillations are observed. This indicates a modest average monthly increase of approximately 0.39%, but with large fluctuations, compatible with administrative interventions, changes in the calculation base, pronounced seasonality or public policy events. At the same time, the minimum value is 0.812950 and corresponds to January 2022, representing a significant

decrease. The maximum of 1.212010 appears in December 2021, suggesting an episode of exceptional growth in a specific month.

The analysis of descriptive statistics for the index of change in the average monthly contribution/person (IC) is presented in Figure 4.

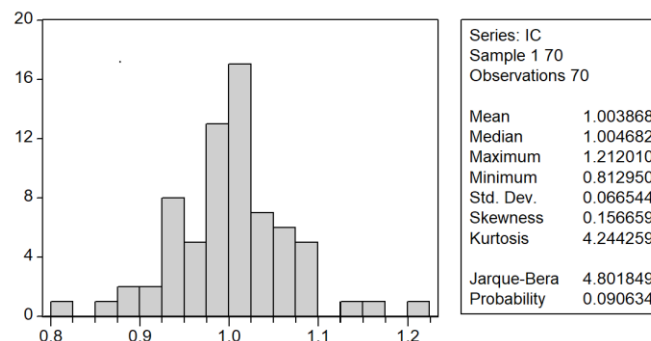


Fig. 4. Histogram and Descriptive Statistics for IC

Source: Data processed by the authors.

Interpreting the results presented in Figure 4, it is found that the IC series has an average value of 1.0039, very close to the median, respectively 1.0047, which indicates a relatively symmetrical distribution of the data. The variation interval is wider than in the case of the net income change index (IVN), respectively between the minimum of 0.8129 and the maximum of 1.2120, and the standard deviation of 0.0665 suggests a moderate volatility of the average monthly contributions in the analyzed period. At the same time, the asymmetry coefficient Skewness of 0.157 is positive, indicating a slight asymmetry to the right, and Kurtosis of 4.244 exceeds the value 3 characteristic of the normal distribution, which indicates a leptokurtic distribution, with a higher probability of extreme values compared to the normal distribution.

The Jarque–Bera test (4.802 with $p = 0.091$) does not reject the hypothesis of normality at the 5% significance level, but shows a slight deviation from normality (at 10% it would be marginally significant). Thus, the IC distribution can be considered approximately normal, but with a tendency to have thicker tails.

Figure 5 shows the evolution of the net asset change indices (IAN).

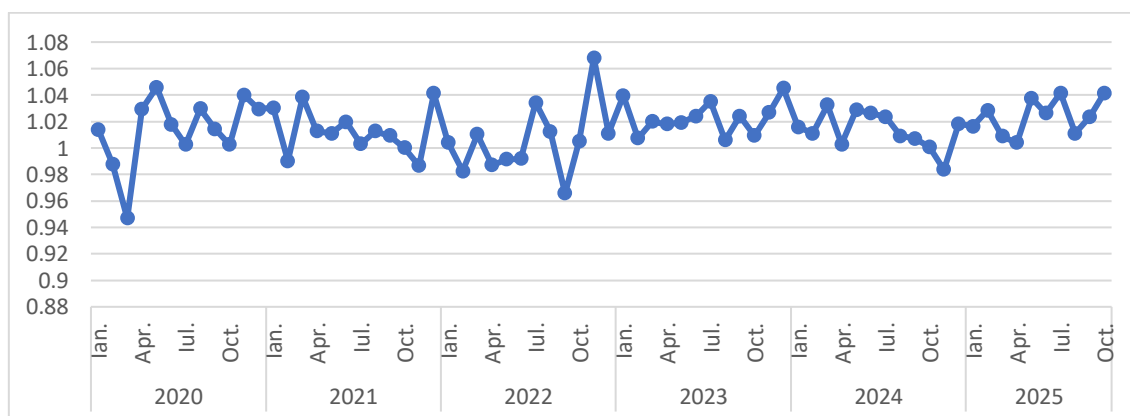


Fig. 5. Net Asset Change Index (IAN)

Source: National Institute of Statistics. Data processed by the authors.

Analyzing the evolution of the net asset change index (IAN), we find that this series is relatively stable and growth-oriented, with an average monthly increase of approximately 1.5%, with moderate volatility, lower than the IVN and much lower than the IC. The minimum of 0.946822 corresponds to March 2020, and the maximum of 1.067892 occurs in November 2022, at a stage

in which asset nomenclature and flows can be amplified by the inflationary environment and nominal yields.

The analysis of descriptive statistics for the net asset change index (IAN) is presented in Figure 6.

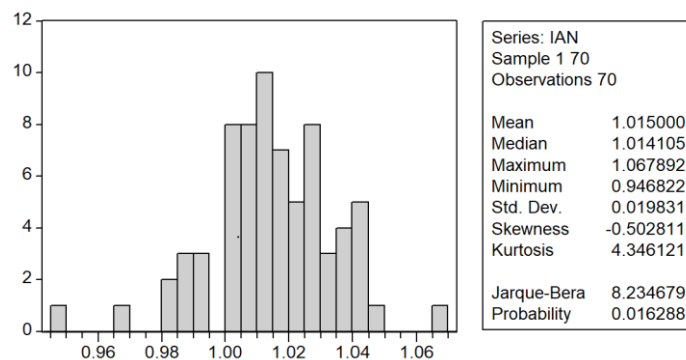


Fig. 6. Histogram and Descriptive Statistics for IAN

Source: Data processed by the authors.

Interpreting the results presented in Figure 6, it is found that the IAN series has an average value of 1.0150, very close to the median, respectively 1.0141, which indicates a relatively balanced distribution of the data. The variation range is reduced, with a minimum of 0.9468 and a maximum of 1.0679, and the low standard deviation of 0.0198 suggests a reduced volatility of the net asset compared to the other indicators, indicating a relatively stable evolution over time. At the same time, the Skewness coefficient of -0.503 is negative, which indicates an asymmetric distribution to the left, suggesting the presence of occasional lower values, and the Kurtosis of 4.346 is above the value 3 specific to the normal distribution, indicating a leptokurtic distribution, characterized by thicker tails and a higher probability of extreme values.

The Jarque–Bera test (8.235 with $p = 0.016$) rejects the null hypothesis of normality at the 5% significance level, indicating that the IAN series is not normally distributed. This deviation from normality must be taken into account in the econometric analysis, as it may affect the validity of some statistical tests based on the assumption of normality of errors.

Figure 7 shows the evolution of the indices of change in the number of participants (IP).

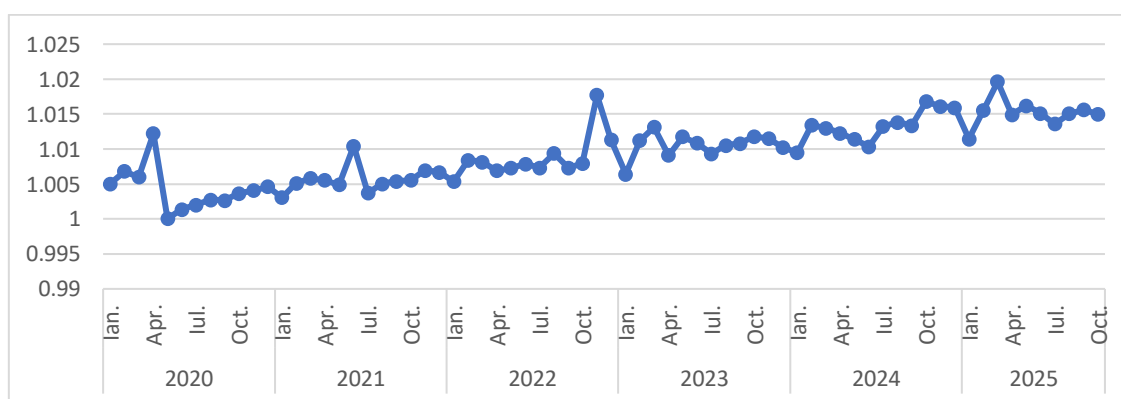


Fig. 7. Index of Change in Number of Participants (IP)

Source: National Institute of Statistics. Data processed by the authors.

Regarding the index of change in the number of participants (IP), we note that this variable records an average monthly increase of approximately 0.95% with very low variations. The minimum value of 1.000031 corresponds to May 2020, and the maximum of 1.019620 appears in March 2025, suggesting an episode of faster growth in the number of participants. Overall,

the series shows a relatively constant growth throughout the period under study. At the same time, the stability of the series can be determined by employment and the legal framework, which justifies the evolution of this variable as having a strong trend and slow reactions to shocks.

The analysis of descriptive statistics for the index of change in the number of participants (IP) is presented in Figure 8.

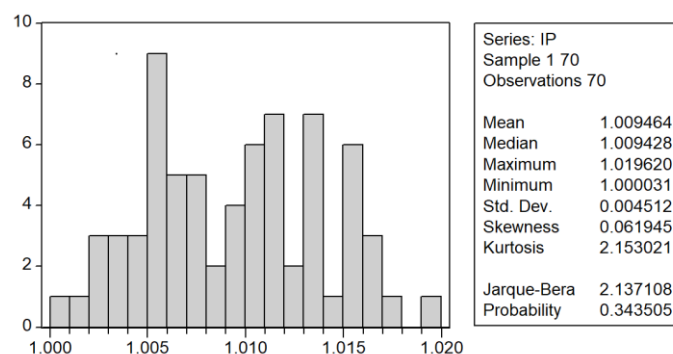


Fig. 8. Histogram and Descriptive Statistics for IP

Source: Data processed by the authors.

Interpreting the descriptive statistics of the IP series for the 70 observations, we find a stable and close to normal distribution, without extreme deviations or high volatility. The mean of 1.009464 and the median of 1.009428 are very close, which suggests a symmetrical distribution of values and the absence of significant outliers. The variation interval is reduced, starting from a minimum of 1.000031 and reaching a maximum of 1.019620, and the standard deviation is low at 0.004512 and indicates a low volatility of the series, suggesting stability of the IP indicator over the analyzed period. Regarding the Skewness coefficient of 0.061945, it is very close to zero, confirming the symmetry of the distribution, while the Kurtosis of 2.153021 is below the value of 3, which indicates a platykurtic distribution, i.e. flatter than the normal distribution and with a lower probability of extreme values.

The Jarque–Bera test of 2.137108 has a probability of $0.343505 > 0.05$, which leads to the non-rejection of the null hypothesis of normality. Therefore, the IP series can be considered approximately normally distributed, which validates the use of econometric methods based on this hypothesis.

Figure 9 shows the evolution of inflation (INF).

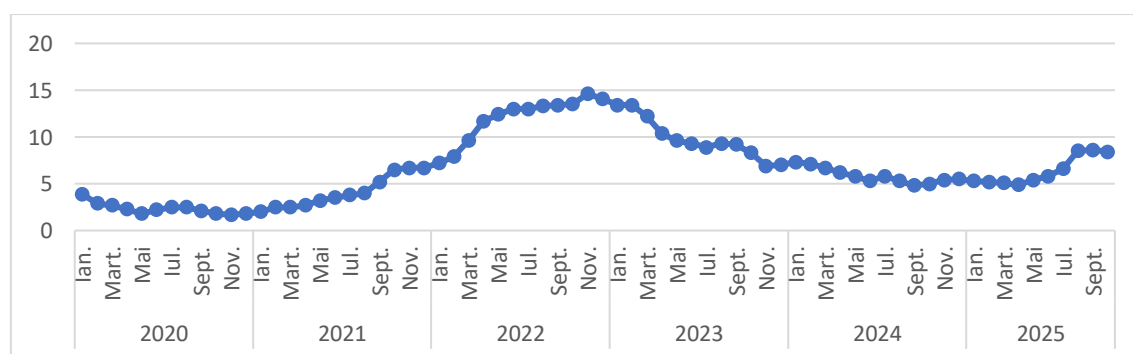


Fig. 9. Inflation % (INF)

Source: National Institute of Statistics. Data processed by the authors.

Regarding the evolution of inflation, we note a minimum of 1.7%, which corresponds to November 2020, and a maximum of 14.6%, which appears in November 2022. To more clearly reflect the evolution, it will be interpreted by sub-periods. Thus, if we consider the period 2020–

2021, we find that an average of 3.2292 and a maximum of 6.7% is recorded in November 2021. In 2022, the average was 11.9750% and the maximum was 14.6% in November 2022, and in the period 2023–2025, an average of 7.4088% was recorded, a minimum of 4.8% in September 2024 and a maximum of 13.4% in January 2023. This analysis on the sub-period highlights the fact that there were two inflationary regimes in 2022 and 2025, with direct effects on the interpretation of the models and, subsequently, on the forecast.

The analysis of descriptive statistics for inflation (INF) is presented in Figure 10.

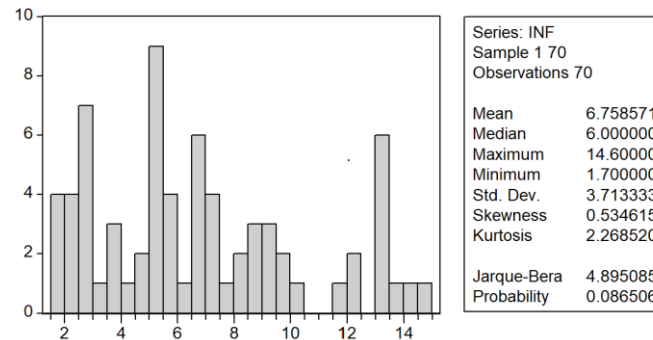


Fig. 10. Histogram and Descriptive Statistics for INF

Source: Data processed by the authors.

The data series on the evolution of inflation presents high volatility and a wide variation of values, characterized by a slightly positive asymmetric and platykurtic distribution, which indicates the presence of episodes of sharp price increases, and the Jarque–Bera test suggests that the distribution does not differ significantly from normality at the 5% significance level, allowing the use of standard econometric models and methods based on the normality hypothesis.

Figure 11 shows the evolution of the unemployment rate (RS).

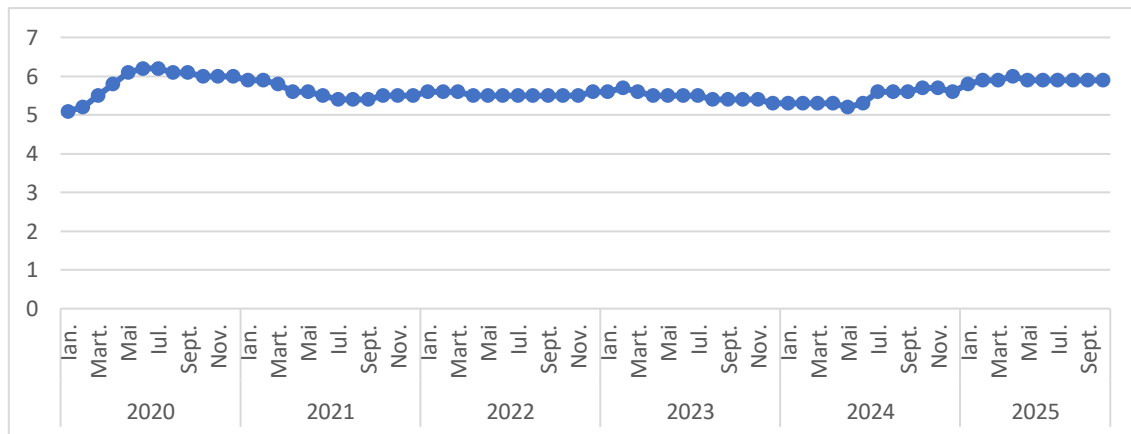


Fig. 11. Unemployment Rate % (RS)

Source: National Institute of Statistics. Data processed by the authors.

Regarding the unemployment rate, a minimum of 5.1% is recorded, which corresponds to January 2020, and a maximum of 6.2%, which occurs in June of the same year. The evolution of this variable indicates a remarkable stability compared to the other variables. Consequently, this indicator may be relevant in equilibrium relations and adjustment mechanisms, through the impact on contribution flows and on the stability of participation.

The analysis of descriptive statistics for the unemployment rate (RS) is presented in Figure 12.

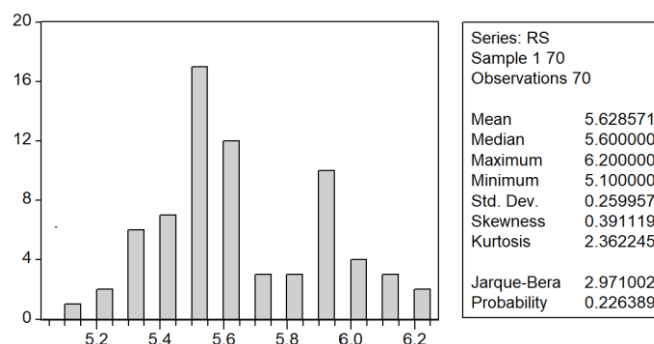


Fig. 12. Histogram and Descriptive Statistics for RS

Source: Data processed by the authors.

The statistical analysis of the data series on the evolution of the unemployment rate in Romania during the period under analysis highlights some interesting aspects. First of all, the average unemployment rate during the analyzed period is 5.63%, and the median value is very close, namely 5.60%, which indicates a relatively symmetric distribution, without the significant influence of extreme values. The extreme values of the series are 5.10% (minimum) and 6.20% (maximum), and the relatively low standard deviation of 0.26 suggests a modest variability of the unemployment rate, which reflects its stability in the analyzed interval.

As for the asymmetry coefficient, it is positive (0.39) and indicates a slight trend towards higher values, and the kurtosis of 2.36, below the value of 3, signals a platykurtic distribution, i.e. flatter than the standard normal distribution. The Jarque-Bera test (2.97 with $p = 0.226$) does not indicate significant deviations from normality, allowing the hypothesis that the distribution of the unemployment rate can be considered approximately normal.

The analysis will be further developed by determining the intensity of the connection between the variables, calculating in this sense the Pearson correlation coefficient using the relationship:

$$r_{x/y} = \frac{\sum_{t=1}^n (x_t - \bar{x}) \cdot (y_t - \bar{y})}{n \cdot \sigma_x \cdot \sigma_y} \quad (1)$$

where: $r_{x/y}$ = Pearson linear correlation coefficient;

x and y = indices of change of the variables taken into account;

n = number of observations;

σ_x and σ_y = the standard deviations of the variables considered.

Table 1 presents the results regarding the correlations between variables.

Table 1. Correlation Matrix

	IVN	IC	IAN	IP	INF	RS
IVN	1.000000	0.462700	0.034118	0.144526	0.094797	0.003234
IC	0.462700	1.000000	0.212077	0.057512	0.002256	-0.015681
IAN	0.034118	0.212077	1.000000	0.155125	-0.013468	0.164735
IP	0.144526	0.057512	0.155125	1.000000	0.314189	-0.121386
INF	0.094797	0.002256	-0.013468	0.314189	1.000000	-0.377700
RS	0.003234	-0.015681	0.164735	-0.121386	-0.377700	1.000000

Source: Data processed by the authors.

Interpreting the results presented in Table 1, we find that there is a moderate correlation between the index of change in the average monthly contribution/person (IC) and the index of change in net income (IVN), the correlation coefficient being $r_{IC/IVN} = 0.46$, as well as between inflation (INF) and the unemployment rate (RS). At the same time, some weaker links are found between the index of change in net income (IVN) and the index of change in the number of participants (IP) or the index of change in the number of participants.

In order to identify the optimal econometric model for analyzing the links between variables and so that the forecast can be made with a minimum of error, it is necessary to verify the order of integration of the variables by applying unit root tests. Thus, Augmented Dickey-Fuller (ADF) tests were performed for each variable both in level and in first difference, with the inclusion of the constant and, where applicable, the deterministic trend (Table 2).

Table 2. Synthetic Results of ADF Stationarity Tests

Variable	ADF (level)	p-value	ADF (1%)	ADF (5%)	ADF (10%)	Conclusion
IVN	-4.2542	0.0012	-3.5441	-2.9108	-2.5931	Stationary I(0)
IC	-11.3237	0.0001	-3.5285	-2.9042	-2.5896	Stationary I(0)
IAN	-7.5684	0.0000	-3.5285	-2.9042	-2.5896	Stationary I(0)
IP	-0.5234	0.8791	-3.5366	-2.9077	-2.5914	Nonstationary
INF	-4.2542	0.0012	-3.5441	-2.9108	-2.5931	Stationary I(0)
RS	-2.7359	0.0734	-3.5332	-2.9062	-2.5906	Nonstationary

Source: Data processed by the authors.

To verify whether the data series related to the index of change in the number of participants (IP) and the unemployment rate (RS) are stationary I(1), the ADF test will be repeated on the differentiated series, and the results are presented in Table 3.

Table 3. Results of ADF Tests for The Differenced Series d(IP) and d(RS)

Variable	ADF (level)	p-value	ADF (1%)	ADF (5%)	ADF (10%)	Conclusion
d(IP)	-6.1010	0.0000	-3.5366	-2.9077	-2.5913	Stationary I(1)
d(RS)	-4.3022	0.0010	-3.5332	-2.9062	-2.5906	Stationary I(1)

Source: Data processed by the authors.

Following the ADF test applied to the differentiated series, the results indicate that d(IP) and d(RS) are stationary, confirming that the index of change in the number of participants and the unemployment rate are integrated of the first order.

The results of the ADF test applied to the differentiated series indicate that the index of change in the number of participants and the unemployment rate are integrated of the first order, and the variables IC, IVN, IAN and INF are stationary in level. Given the mix of variables I(0) and I(1), the appropriate methodological choice for estimating dynamic relationships and making forecasts regarding the studied economic phenomenon is the statistical-econometric ARDL (Auto Regressive Distributed Lag) model.

The lag structure of the ARDL model was determined through successive estimates, starting from a general model and gradually reducing statistically insignificant lags, and the final choice was made based on the Akaike and Schwarz information criteria, as well as the economic and statistical significance of the coefficients. Thus, the mathematical equation regarding the evolution of IC can be written in the form presented below, and the results of the analysis are presented in Table 4.

$$IC_t = \alpha_0 + \alpha_1 IC_{t-1} + \alpha_2 IVN_t + \alpha_3 IVN_{t-1} + \alpha_4 IAN_t + \alpha_5 IAN_{t-1} + \alpha_6 INF_t + \alpha_7 RS_t + \alpha_8 RS_{t-1} + \alpha_9 IP_t + \alpha_{10} IP_{t-1} + \varepsilon_t \quad (2)$$

Table 4. Results of ARLD Analysis for IC

Dependent Variable: IC				
Method: Least Squares				
Sample(adjusted): 2 70				
Included observations: 69 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.108432	1.746311	-0.062092	0.9507
IC(-1)	-0.292092	0.120740	-2.419180	0.0187
IVN	1.008549	0.246439	4.092494	0.0001
IVN(-1)	0.544015	0.271625	2.002820	0.0499
IAN	0.787287	0.356922	2.205766	0.0314
IAN(-1)	-0.680321	0.366451	-1.856513	0.0685
INF	-0.000973	0.002089	-0.465702	0.6432
RS	0.028560	0.074229	0.384749	0.7018
RS(-1)	-0.038773	0.071765	-0.540281	0.5911
IP	-1.659926	2.566130	-0.646860	0.5203
IP(-1)	1.457172	2.584791	0.563749	0.5751
R-squared	0.411791	Mean dependent var		1.003685
Adjusted R-squared	0.310375	S.D. dependent var		0.067014
S.E. of regression	0.055651	Akaike info criterion		-2.794263
Sum squared resid	0.179627	Schwarz criterion		-2.438101
Log likelihood	107.4021	F-statistic		4.060435
Durbin-Watson stat	1.806437	Prob(F-statistic)		0.000297

Source: Data processed by the authors.

Interpreting the results of the analysis, we find that the lag of the dependent variable IC_{t-1} is negative and significant. Also, the net income index (IVN) is significant, having a positive effect, and its lag IVN_{t-1} has a significant and positive delayed effect. Net assets (IAN) helps to increase IC, and its lag IAN_{t-1} to significantly decrease it to 10%. The rest of the coefficients do not have a significant short-term effect on the evolution of IC. However, the R-squared value of 0.412 indicates that the model is explained in proportion to 41%, and the results of the F-statistic test = 4.06, a value higher than the tabulated one, validate the model.

For short- and medium-term forecasting, it is useful to transform the ARDL (Auto Regressive Distributed Lag) model in terms of changes, i.e. differences, and to include the correction term ECM (Error Correction Model), which practically adjusts the dependent variable towards the long-term equilibrium.

The results of the model in differences for IC are presented in Table 5.

Table 5. Results of the Difference Model for IC

Dependent Variable: ΔIC				
Method: Least Squares				
Sample(adjusted): 3 70				
Included observations: 68 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001221	0.008450	0.144432	0.8856
ΔIVN	1.105132	0.191682	5.765442	0.0000
ΔIAN	1.034787	0.318780	3.246085	0.0019
ΔINF	-0.000157	0.012877	-0.012171	0.9903
ΔRS	-0.000262	0.085235	-0.003068	0.9976
ΔIP	-2.563669	2.979927	-0.860312	0.3930
ECM IC	-1.213216	0.164072	-7.394434	0.0000
R-squared	0.634395	Mean dependent var		0.001823
Adjusted R-squared	0.598434	S.D. dependent var		0.108376
S.E. of regression	0.068677	Akaike info criterion		-2.421550
Sum squared resid	0.287710	Schwarz criterion		-2.193071
Log likelihood	89.33270	F-statistic		17.64113
Durbin-Watson stat	2.233003	Prob(F-statistic)		0.000000

Source: Data processed by the authors.

The ECM model highlights that changes in the average monthly contribution are positively influenced by changes in net income and net assets, while changes in the number of participants, inflation and the unemployment rate have a negative impact. The error correction term is negative and significant, indicating a rapid adjustment process towards the long-term equilibrium. The mathematical equation that can be used for short-term forecasting has the following form:

$$\Delta \widehat{IC}_{t+1/t} = 0.001221 + 1.105132 \cdot \Delta IVN_{t/t-1} + 1.034787 \cdot \Delta IAN_{t/t-1} - 0.000157 \cdot \Delta INF_{t/t-1} - 0.000262 \cdot \Delta RS_{t/t-1} - 2.563669 \cdot \Delta IP_{t/t-1} - 1.213216 \cdot ECM_IC_t \quad (3)$$

To highlight the evolution of the index of change in the average monthly contribution per person, the relationship will be used:

$$\widehat{IC}_{t+1} = IC_t + \Delta \widehat{IC}_{t+1/t} \quad (4)$$

where: IC_t = the current value of the IC variable at time t ;

$\widehat{IC}_{t+1}$ = the predicted value of IC for the next period ($t+1$);

$\Delta \widehat{IC}_{t+1/t}$ = the predicted value of the change in IC between period t and $t+1$.

The one-step forward forecast is performed using the information available at time t , according to the ECM specification, in which the variation of the dependent variable at time $t+1$ is determined by the variations of the explanatory variables and the error correction term at time t .

The analysis of the error correction term indicates a rapid adjustment process towards the long-term equilibrium. The magnitude of the ECM coefficient suggests an accelerated correction of imbalances, which leads to the gradual decrease of the variations of the monthly average contribution index and its stabilization around the equilibrium value. The mathematical equation regarding the adjustment towards the equilibrium of the ECM has the following form:

$$ECM_{t+k} = (1 + \lambda)^k \cdot ECM_t \quad (5)$$

where: ECM_{t+k} = ECM value at time $t+k$;

ECM_t = ECM value at time t ;

k = number of forecast periods;

λ = adjustment coefficient.

Of course, for time $t+2$ it is necessary to know the values of the explanatory variables at time $t+1$. Under these conditions, the influences of the factorial variables on the other variables considered dependent were similarly analyzed. Thus, the variables IVN, IP and IAN will be treated similarly, and the mathematical equations for the forecast are presented below.

$$\Delta \widehat{IVN}_{t+1/t} = 0.0000647 + 0.230063 \cdot \Delta IC_{t/t-1} - 0.212738 \cdot \Delta IAN_{t/t-1} - 0.001268 \cdot \Delta INF_{t/t-1} - 0.018104 \cdot \Delta RS_{t/t-1} + 1.015145 \cdot \Delta IP_{t/t-1} - 1.268966 \cdot ECM_IC_t \quad (6)$$

$$\Delta \widehat{IP}_{t+1/t} = 0.0000877 - 0.000313 \cdot \Delta IC_{t/t-1} + 0.021591 \Delta IVN_{t/t-1} + 0.021022 \cdot \Delta IAN_{t/t-1} + 0.000437 \cdot \Delta INF_{t/t-1} - 0.002345 \cdot \Delta RS_{t/t-1} - 0.476839 \cdot ECM_IC_t \quad (7)$$

$$\Delta \widehat{IAN}_{t+1/t} = 0.000743 + 0.054658 \cdot \Delta IC_{t/t-1} - 0.044771 \Delta IVN_{t/t-1} - 0.002111 \cdot \Delta INF_{t/t-1} - 0.015824 \cdot \Delta RS_{t/t-1} + 0.716028 \cdot \Delta IP_{t/t-1} - 0.996160 \cdot ECM_IC_t \quad (8)$$

Considering the evolution of the data series regarding RS and INF and the factors influencing these macroeconomic variables, which are not found in the other variables considered in the analysis of the economic phenomenon under study, the econometric model ARCH/GARCH was considered for diagnosis and forecasting. Thus, the results of the analysis for RS, which can capture conditional heteroscedasticity, are presented in Table 6.

Table 6. RS Analysis Results

Dependent Variable: RS				
Method: ML - ARCH (Marquardt)				
Sample(adjusted): 2 70				
Included observations: 69 after adjusting endpoints				
Convergence achieved after 15 iterations				
Variance backcast: ON				
	Coefficient	Std. Error	z-Statistic	Prob.
C	0.253757	0.286819	0.884726	0.3763
RS(-1)	0.953695	0.051347	18.57371	0.0000
Variance Equation				
C	0.002318	0.001093	2.120679	0.0339
ARCH(1)	0.396787	0.189171	2.097501	0.0359
GARCH(1)	0.325901	0.195621	1.665987	0.0957
R-squared	0.848631	Mean dependent var		5.636232
Adjusted R-squared	0.839170	S.D. dependent var		0.253778
S.E. of regression	0.101774	Akaike info criterion		-1.958092
Sum squared resid	0.662908	Schwarz criterion		-1.796200
Log likelihood	72.55416	F-statistic		89.70200
Durbin-Watson stat	1.138037	Prob(F-statistic)		0.000000

Source: Data processed by the authors.

Interpreting the results, we find that RS is strongly autocorrelated and depends on the previous value $t-1$ (coefficient = 0.95 and $p=0.00$), and the free term is statistically insignificant (coefficient = 0.25 and $p=0.37>0.05$). In economic terms, the existence of a persistent volatility effect can be interpreted, in the sense that periods with more volatile unemployment propagate over time. In other words, unemployment has a high inertia, and recent values influence future values almost directly.

To test whether there is heteroscedasticity in the model residuals, the ARCH LM test was performed. In this sense, the following hypotheses were considered:

H_0 : There is no ARCH effect (constant variance, homoscedasticity);

H_1 : There is an ARCH effect (conditional heteroscedasticity).

The results are presented in Table 7:

Table 7. ARCH LM Test Results for RS

ARCH Test:				
F-statistic	0.274218	Probability		0.602270
Obs*R-squared	0.281358	Probability		0.595812
Test Equation:				
Dependent Variable: STD_RESID^2				
Method: Least Squares				
Date: 02/12/26 Time: 11:07				
Sample(adjusted): 3 70				
Included observations: 68 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.090972	0.254266	4.290672	0.0001
STD_RESID^2(-1)	-0.064349	0.122883	-0.523658	0.6023
R-squared	0.004138	Mean dependent var		1.024929
Adjusted R-squared	-0.010951	S.D. dependent var		1.810741
S.E. of regression	1.820628	Akaike info criterion		4.065211
Sum squared resid	218.7694	Schwarz criterion		4.130491
Log likelihood	-136.2172	F-statistic		0.274218
Durbin-Watson stat	1.891484	Prob(F-statistic)		0.602270

Source: Data processed by the authors.

Interpreting the results, it was found that $p\text{-value} = 0.60 > 0.05$, which means that we do not reject H_0 and that there is no heteroscedasticity in the residuals of the model. Also, the coefficient of the squared lag of the residuals ($STD_RESID^2(-1)$) is insignificant, and the R^2 which is very small (0.004) confirms that there is no explanation of the residual variance by the ARCH term. In conclusion, the equation for the short and medium term forecast of the RS evolution has the following mathematical form:

$$RS_{t+1} = 0.2538 + 0.9537 \cdot RS_t \quad (9)$$

Of course, for the transformation into differences for the ARDL/ECM model, the mathematical relation of the form will be used:

$$\Delta RS_{t+1} = RS_{t+1} - RS_t \quad (10)$$

Similarly, the data series capturing inflation was tested and the ARCH LM test applied to the residuals of the INF model indicates the absence of the ARCH effect ($p = 0.779$), which suggests that the variance of the residuals is constant and that the use of the AR(1) model for inflation forecasting is appropriate without adjustments for conditional heteroscedasticity. In this sense, the mathematical equation for the forecast has the following form:

$$INF_{t+1} = 0.163692 + 0.966355 \cdot INF_t \quad (11)$$

Of course, for the transformation into differences for the ARDL/ECM model, the mathematical relation of the form will be used:

$$\Delta INF_{t+1} = INF_{t+1} - INF_t \quad (12)$$

To make the short-term forecast, the mathematical relationships mentioned above will be used, and the results are presented suggestively in Figure 13.

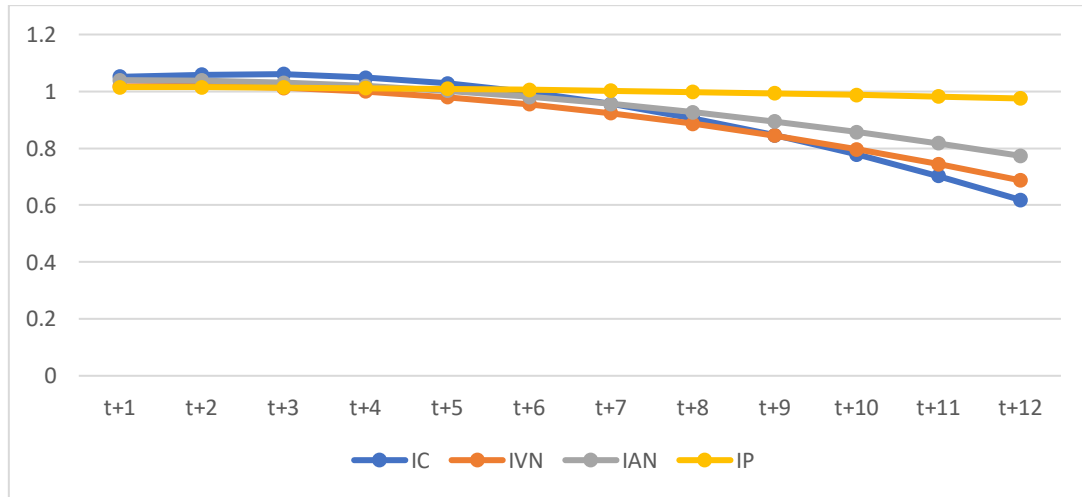


Fig. 13. Forecast for Horizon t+12 for IC, IVN, IAN and IP

Source: Data processed by the authors.

The forecast for the t+12 horizon for the net income change index (IVN) indicates a continuous decrease in this index from approximately 1.02 to 0.69 by the t+12 horizon, which suggests a persistent deterioration in the real incomes of the population, possibly as a result of high inflation and restrictive economic conditions.

As for the average contribution index, it increases slightly in the first periods, after which it enters a sharp downward trajectory to approximately 0.62, indicating a significant decrease in the contribution capacity, probably determined by the decrease in income and employment.

The net asset change index (IAN) shows a gradual downward trend from approximately 1.04 to 0.77, suggesting the erosion of the value of net assets, possibly under the influence of negative real returns and adverse macroeconomic pressures.

The index of the number of participants (IP) will slowly decrease from around 1.015 to 0.975, indicating a moderate contraction in the monthly participant base, which may indicate a decrease in new entries of participants to the fund. In other words, the short-term forecast indicates a concomitant deterioration in the main indicators of the system, characterized by a decrease in net income (IVN), a decrease in the average contribution per participant (IC), a decrease in the value of net assets (IAN) and a gradual contraction in the number of participants (IP), which suggests the emergence of systemic pressures on financial sustainability. Overall, the estimated developments reflect a possible macroeconomic vicious circle, in which inflation and rising interest rates erode real income and the capacity to save, reducing contributions and returns, and the decrease in the pace of change in the participant base amplifies the imbalance between the system's resources and future obligations. Thus, if the forecasted trends persist, the risk of increasing vulnerability in the medium term is outlined, requiring adjustment measures to maintain financial balance.

In order to deepen the study, an analysis was approached using the econometric model VAR (Vector Autoregression Estimates), taking into account the stationary data series according to Table 2, namely the index of change in net income (IVN), the index of change in average monthly contribution per person (IC), the index of change in net assets (IAN) and inflation (INF). The results of the analysis are presented in Table 8.

Table 8. Results of VAR Analysis

Vector Autoregression Estimates				
Sample(adjusted): 3 70				
Included observations: 68 after adjusting endpoints				
	IVN	IC	IAN	INF
R-squared	0.400238	0.251660	0.069459	0.979265
Adj. R-squared	0.318914	0.150190	-0.056716	0.976453
Sum sq. resids	0.034790	0.219311	0.024545	19.23627
S.E. equation	0.024283	0.060968	0.020396	0.570998
F-statistic	4.921546	2.480140	0.550498	348.2986
Log likelihood	161.1621	98.56236	173.0223	-53.55568
Akaike AIC	-4.475355	-2.634187	-4.824187	1.839873
Schwarz SC	-4.181597	-2.340429	-4.530428	2.133631
Mean dependent	1.008388	1.005305	1.015418	6.857353
S.D. dependent	0.029424	0.066137	0.019841	3.721070
Determinant Residual Covariance		2.27E-10		
Log Likelihood (d.f. adjusted)		369.0316		
Akaike Information Criteria		-9.795048		
Schwarz Criteria		-8.620015		

Source: Data processed by the authors.

Interpreting the results of the Vector Autoregression Estimates (VAR) analysis, it is found that net income (IVN) is significantly influenced by its own previous values, especially by lag 2 (negative and statistically significant coefficient), which indicates a cyclical adjustment process or correction after previous deviations. The influences of the other variables are quite low, suggesting that the dynamics of IVN are predominantly autoregressive. Regarding the average contribution (IC), it is negatively affected by its own lagged values and by the dynamics of net income, which indicates the interdependence between participants' incomes and effective contributions. However, the explanatory power of the model is moderate ($R^2 = 0.25$), suggesting

the existence of the influence of other factors not taken into account. Net assets show a dynamic poorly explained by the variables included ($R^2 = 0.069$ and insignificant coefficients), and inflation is strongly determined by its own previous values, especially INF_{t-1} and INF_{t-2} , with very statistically significant coefficients and a very high R^2 of 0.98.

The results of the VAR model estimation indicate that the analyzed series show a predominantly autoregressive dynamics, characterized by a significant degree of inertia, especially in the case of inflation and financial indicators. Consequently, the future values of the variables can be estimated with a relatively high level of accuracy in the short term, based on the information contained in their previous developments. In this context, the forecast for the next 12 months for net income, contributions and net assets will be generated in order to provide analytical support for substantiating policy decisions and financial management within the analyzed system. In this sense, the mathematical equations used for the forecast on the horizon $t+12$ have the following form:

$$\widehat{IVN}_{t+1} = 2.028496 - 0.252870 IVN_t - 0.569996 IVN_{t-1} - 0.068848 IC_t + 0.031357 IC_{t-1} + 0.022969 IAN_t - 0.181985 IAN_{t-1} - 0.001836 INF_t + 0.003058 INF_{t-1} \quad (13)$$

$$\widehat{IC}_{t+1} = 2.413265 + 0.248985 IVN_t - 0.727657 IVN_{t-1} - 0.286344 IC_t + 0.101819 IC_{t-1} - 0.607715 IAN_t - 0.122377 IAN_{t-1} + 0.003486 INF_t - 0.003522 INF_{t-1} \quad (14)$$

$$\widehat{IAN}_{t+1} = 1.094836 - 0.009529 IVN_t + 0.006689 IVN_{t-1} + 0.017840 IC_t - 0.003266 IC_{t-1} + 0.026536 IAN_t - 0.116426 IAN_{t-1} - 0.006214 INF_t + 0.006280 INF_{t-1} \quad (15)$$

$$\widehat{INF}_{t+1} = 4.114062 - 1.742174 IVN_t + 1.864885 IVN_{t-1} - 0.597787 IC_t - 1.399859 IC_{t-1} + 2.459823 IAN_t - 4.405557 IAN_{t-1} + 1.530045 INF_t - 0.561891 INF_{t-1} \quad (16)$$

The results regarding the forecast for the horizon $t+12$ using the VAR model are presented suggestively in Figure 14.

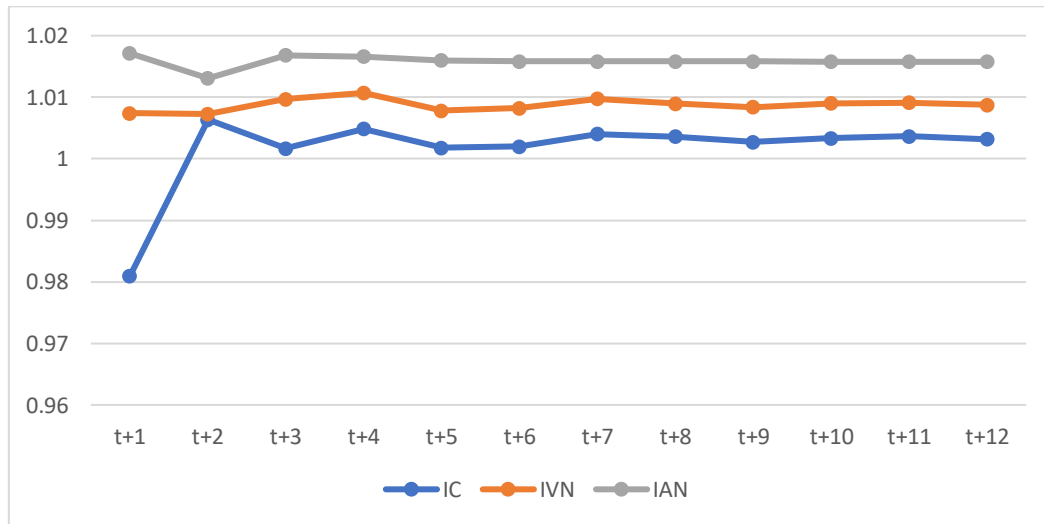


Fig. 14. Forecast for Horizon $t+12$ for IC, IVN and IAN

Source: Data processed by the authors.

Over the 12-month forecast horizon, the average contribution change index (IC) shows an initial sub-unit adjustment, followed by stabilization around 1, suggesting a tendency to return to the equilibrium level and a relatively constant dynamics of contributions in real terms. The net

income change index (IVN) remains above unity throughout the period, indicating a moderate and stable increase in net income, with low fluctuations, which reflects a favorable trend, but without pronounced volatility. As for the net asset change index (IAN), it presents values above unity, but slightly decreasing, suggesting a continuous accumulation of assets, but at a marginally reduced pace during the analyzed interval. Overall, the forecast indicates a convergence of the three indicators towards a stable short-term trajectory, characterized by moderate changes and low volatility, which suggests the absence of major imbalances and the maintenance of a relative balance within the analyzed system.

3. Discussion

The statistical-econometric analysis carried out in this research using the ARDL/ECM and VAR models highlights the complementarity of these approaches in investigating the dynamics of the indicators of the analyzed economic phenomenon and in substantiating short-term forecasts. The ARDL model, transformed into terms of changes, i.e. differences, including the ECM (Error Correction Model) correction term, allowed the simultaneous capture of long-term equilibrium relations and short-term adjustments, demonstrating the existence of correction mechanisms, which bring the variables back to the equilibrium trajectory following shocks. The statistical significance and the negative sign of the correction term coefficients confirm the stable nature of the estimated relations and the relatively high adjustment speed, which indicates that deviations from the long-term equilibrium are corrected in a relatively short interval. In this context, the forecasts generated by the ECM model highlight a convergence dynamic, with tendencies of gradual stabilization of the analyzed indicators.

On the other hand, the VAR model estimated for stationary variables allowed capturing the dynamic interdependencies between indicators, each variable being explained by its own lagged values and by the lagged values of the other variables in the system. The results indicated a predominance of autoregressive components and the existence of propagation effects between variables, especially regarding the influence of inflation and income on contributions and assets. The VAR forecast over the 12-month horizon suggests a relatively stable evolution of financial indicators, characterized by moderate fluctuations around the unit value and the absence of major deviations, which confirms the dynamic stability of the economic phenomenon studied under the conditions of maintaining the current economic framework.

Comparing the results of the two approaches, it is found that the ARDL/ECM model is adequate for highlighting structural relationships and adjustment mechanisms towards equilibrium, while the VAR model offers a more flexible perspective on the dynamic interactions and transmission of shocks between variables. The convergence of the conclusions obtained from the two models reinforces the credibility of the forecasts and suggests the absence of major systemic risks in the short term, although the influence of macroeconomic factors, in particular inflation and labor market conditions, persists.

4. Conclusions

The study conducted by the authors draws some theoretical and practical conclusions. Thus, a first conclusion that emerges from this study is that the Pillar III private pension system in Romania presents dynamic stability and a significant capacity to adapt to macroeconomic shocks, but this stability depends essentially on the quality of the financial and institutional management of the funds. The ARDL/ECM models confirm the existence of long-term equilibrium relationships between population income, contributions, assets and macroeconomic variables, and the VAR model highlights the dynamic interdependencies and the propagation of shocks, essential information for the strategic decisions of fund managers.

Another conclusion that emerges from this study is related to investment and risk management, in the sense that inflation and financial market volatility can affect real asset returns, which requires the adoption of prudent strategies for portfolio diversification, optimal asset allocation and continuous performance monitoring. Also, the management of liquidity and contribution flows becomes crucial in periods of economic instability, when population incomes and employment can fluctuate significantly. From the perspective of institutional management, the predictability of the legislative framework and decision-making transparency are determining factors for maintaining participant confidence and attracting new contributors. Stability of rules on contributions, fees and asset management allows for long-term strategic planning and reduces operational risks. At the same time, effective communication with participants and financial education contribute to increasing participation and consolidating the contribution base.

Another conclusion concerns the forecasts, which indicate a relatively stable evolution in the short term, but maintaining this trajectory requires the coordination of macroeconomic policies with fund management strategies. An integrated approach, combining macroeconomic discipline with good corporate governance practices, risk management and orientation towards long-term performance, is essential for the sustainability of the system.

Last but not least, the sustainable development of the Pillar III private pension system depends not only on general economic developments, but also on the efficiency of fund management, institutional stability and the ability of administrators to anticipate and manage risks. Expanding future analyses by including additional indicators could provide a more complete picture of the factors influencing the long-term performance and sustainability of the system.

References

1. Baláž, V. (2023). Household Economics, Information Sources and Annuity Choices: Annuitisation Preferences of Members of the Slovak Private Pension Pillar, *Economies*, 11(4), 123.
<https://doi.org/10.3390/economies11040123>
2. Berardi, A., & Tebaldi, C. (2024). Saving for retirement in Europe: the long-term risk-return tradeoff, *Journal of Pension Economics & Finance*, 23(2), pp. 272 – 293.
<https://doi.org/10.1017/S1474747223000136>
3. Bonizzi, B., Dagdeviren, H., & Tippet, B. (2025). Pension financialization and workplace pension wealth inequality: evidence from Britain, *Socio-Economic Review*, mwaf068.
<https://doi.org/10.1093/ser/mwaf068>
4. Cribb, J., Emmerson, C., O'Brien, L., & Sturrock, D. (2024). Private pensions for the self-employed: challenges and options for reform, *The Institute for Fiscal Studies*, September 2024.
<https://ifs.org.uk/publications/private-pensions-self-employed-challenges-and-options-reform>
5. Dedák, I., & Fiser, N. (2025). Does pension indexation matter? A contribution to the theory of pension indexation, *Quality & Quantity*, Springer Nature, 1334.
<https://doi.org/10.1007/s11135-025-02244-1>
6. Doctrinal, L. (2024). Changes in Private Pensions and Income Inequality in Retirement: A Decomposition Analysis by Income Source in Nine European Countries (1986–2018), *Work, Aging and Retirement*, 10(4), October 2024, pp. 361–372.
<https://doi.org/10.1093/workar/waad017>
7. Golka, P., & Zwan, N. (2025). Asymmetric autonomy: pension fund investing between members and markets, *Socio-Economic Review*, 23(4), pp. 1785–1807.
<https://doi.org/10.1093/ser/mwaf042>
8. Giles, J., Joubert, C., & Tanaka, T. (2025). Participation in Pension Programs in Low- and Middle-Income Countries, *The World Bank Research Observer*.
<https://doi.org/10.1093/wbro/lkaf004>
9. Hernæs, E., Markussen, S., Piggott, J., & Røed, K. (2024). The impact of pension reform on employment, retirement, and disability insurance claims, *Journal of Population Economics*, 37, article number 76.
<https://doi.org/10.1007/s00148-024-01052-5>

10. Huynh, M., Zimmermann, Y.S., & Zimmermann, H. (2025). Characteristics of pension fund financial quality: the role of uncommitted funds, *Springer Nature*, 39, pp. 527–563.
<https://doi.org/10.1007/s11408-025-00477-6>
11. Innocenti, S., Clark, G.L., & McGill, S. (2024). Experience of financial challenges, retirement concerns, and planning: evidence from representative samples of workers in 16 countries, *Journal of Pension Economics & Finance*, 23(2), pp. 183 – 201.
<https://doi.org/10.1017/S1474747223000082>
12. Inzunza, A., & Madeira, C. (2025). The Chilean pension withdrawals and the 2025 reform: Fiscal and retirement consequences, *Cambridge University Press*, March 2025.
<https://doi.org/10.1017/S1474747225000058>
13. Kavonius, I. K. (2025). Pension in the national accounts and wealth surveys: how do they impact economic measures?, *National Accounting Review*, 7, Issue 1: 1-27.
<https://doi.org/10.3934/NAR.2025001>
14. Li, W., & Wei, P. (2024). Optimal defined-contribution pension management with financial and mortality risks, *ASTIN Bulletin: The Journal of the IAA*, 54(3), pp. 546 – 568.
<https://doi.org/10.1017/asb.2024.22>
15. Mangan, M., Mastrogiacono, M., Hochguertel, S., & Goedkoop, F. (2025). Broken promises? Trust and pension savings in turbulent times, *Work, Aging and Retirement*, 11(2), pp. 139–148.
<https://doi.org/10.1093/workar/waae007>
16. Ng, K.T.H., & Chong, W.F. (2024). Optimal investment in defined contribution pension schemes with forward utility preferences, *Mathematics and Economics*, 114, pp. 192-211.
<https://doi.org/10.1016/j.insmatheco.2023.12.001>
17. Otchere, I., Abdulrahman, A., & Wang, J. (2025). Environmental, social, and governance investing and sustainability of pension funds: Evidence from the organisation for economic cooperation and development countries, *Economic Modelling*, Volume 143, 106948.
<https://doi.org/10.1016/j.econmod.2024.106948>
18. OECD and G20 indicators (2023). Pensions at a Glance 2023.
<https://doi.org/10.1787/678055dd-en>
19. Shi, Y. (2025). Optimizing China's Private Pension Scheme via Experiences of Developed Countries, *Journal of Social Systems and Policy Analysis*, 2(4), pp. 203-214.
<https://doi.org/10.62762/JSSPA.2025.825683>
20. Umut, M. (2023). Measuring the Performance of Private Pension Companies in Türkiye by Gray Relational Analysis Method, *J. Risk Financial Manag.*, 16(9), 396.
<https://doi.org/10.3390/jrfm16090396>
21. *** <https://www.asfromania.ro>
22. *** <https://insse.ro/cms/ro>
23. *** <https://ec.europa.eu/eurostat/data/database>