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ANALYSIS OF THE INFLUENCE OF THE AVERAGE MONTHLY CONTRIBUTION PER PARTICIPANT OF THE PRIVATELY MANAGED MANDATORY PENSION FUND BRD

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Abstract
Starting with the first month of 2018, policy makers have taken measures to reduce the percentage of contributions to privately administered mandatory pension funds (Pillar II) in Romania. In this way, it decreased from 5.1%, as it was at the end of 2017, to 3.75%, starting with January 2018, which negatively affected the evolution of the average contribution / participant to the pension funds from Pillar II. This is why I propose an analysis through a unifactorial model of regression of the influence of the average contribution to a pension fund on the VUAN and thus on the pension that future retirees will receive. from Pillar II. I will try to obtain an econometric model that can be used to make forecasts using specialized software and statistical data published by the Financial Supervisory Authority from 2010-2019.

Key words: *voluntary pension funds; pilar II; econometric model; linear regression; net asset value*

JEL Classification: *G23; G28; G29*

I. INTRODUCTION

Based on my own research in the field of privately managed mandatory pension funds, I created an econometric model using Eviews 10. I have included in this model two indicators: the real values of the average contribution / participant in Pillar II and the unit value of net assets for the fund of privately administered mandatory pensions BRD, because this fund had the lowest performances in terms of the unit value of net assets.

The equation is:

$$VUAN = \beta_0+\beta_1*CM \quad (1)$$

Where:

VUAN –the explained variable, i.e. the unit value of the net assets of the voluntary pension fund on 31 December of the years 2009-2019;

CM – the exogenous variable, represented by the average monthly contribution / participant to a privately administered mandatory pension fund (Pillar II) in Romania, registered on December 31 of each year subject to analysis.

To analyze the connection between the two chosen variables, I will use annual data, respectively the values from the last day of each year in the analyzed interval. These data are taken from the online reports of the Romanian Financial Supervisory Authority.

Using the least squares method, I will generate with the help of EViews 10+ Student Version Lite software, a model for which I will check the validity, solvency and statistical significance of the included parameters. The model is a one-factor regression model, based on which the VUAN level for the period 2020-2025 can be predicted.

II. RESEARCH METHODOLOGY

The unit value of the net asset is the indicator based on which the amount of money actually available in the personal account of each member is established. The average contribution per participant to the Pillar II pension funds increased from year to year, however, in the case of the BRD fund, it had the least accentuated growth trend of all the existing funds.

From the statistical data provided by EViews 10+ Student Version Lite and presented in Figure 1 results that the average level of the average contribution / participant for the period between 2010 and 2016 was of 96.21668 lei / participant for the BRD fund, with a standard deviation of 42.97872. The distributions show a slight positive asymmetry, which means that higher values are present on the left, which is highlighted by the Skewness asymmetry coefficient which has the value 0.168688. At the same time, the Kurtosis flattening coefficient has the

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value 1.661697, less than 3, which shows that we have a platicurtic distribution of the average contribution values per participant.

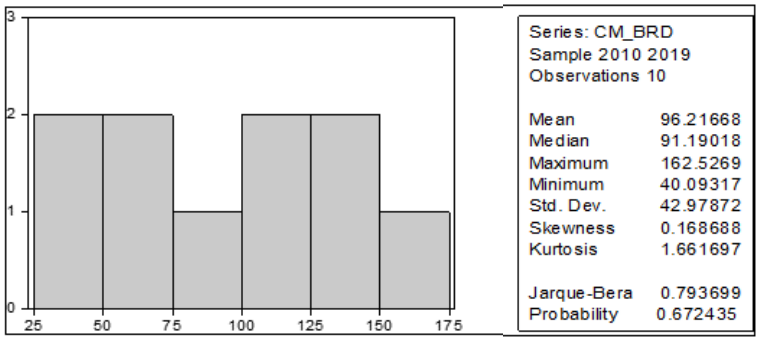

Figure 1 – Descriptive statistics of the average contribution / participant of the BRD fund
Source: C. Durac, 2020

The value of the average monthly contribution / participant increased from a minimum of 40.09317 lei / participant in 2010 to a maximum of 162.5296 lei / participant reached in 2019 in the case of the BRD fund. The unit value of net assets (VUAN) is the indicator used to calculate the amount of money actually available in the personal account of each participant at a given time, by multiplying it by the number of fund units available at that date. " The profitability of each pension fund is reflected in the value of the VUAN. The annualized rate of return of a pension fund is the main performance indicator of a privately managed pension fund, whose calculation formulas are set by the rules issued by the Romanian Financial Supervisory Authority" (Durac, 2018).

The data shown in Figure 2 are obtained using the software Eviews 10+ Student version. It can be observed that the average value of VUAN was 17,48529 lei, and the standard deviation was 3.082487, for the study period.

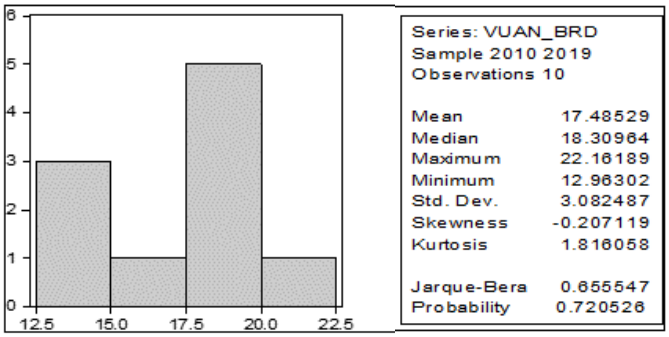

Figure 2 – Descriptive statistics on the unit value of net assets for the privately managed mandatory pension fund BRD
Source: developed by the author

The asymmetry coefficient Skewness had the value of - 0.207119 (negative asymmetry) The coefficient Kurtosis had the value of 1.816058, which indicates the existence of a platicurtic distribution.

For the BRD fund, in the analyzed period, we can observe the increase of VUAN from 12.96302 in 2010 to the level of 22.16189 lei in 2019.

III. THE RESULTS OF EMPIRICAL RESEARCH

Establishing the level of correlation between CM and VUAN (the value from the last day of each year in the analyzed interval) will show us the intensity of the connection between the two variables." The correlation indicates the intensity of the connection between the two variables included in the econometric model by measuring the degree of scattering of the data recorded around the regression line. For this, I will calculate the Pearson correlation coefficients for the BRD pension fund from Pillar II using EViews 10+ Student Version Lite" (Durac, 2018).

For the BRD fund, the correlation coefficient has the value, $r_{CM,VUAN} = \sqrt{R^2} = R = 0{,}968572$ which can be easily observed in the correlation matrix generated by EViews 10+ Student Version Lite in Table 1.

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Table 1. The correlation matrix of VUAN and CM for the BRD fund

	VUAN_BRD	CM_BRD
VUAN_BRD	1.000000	0.968572
CM_BRD	0.968572	1.000000

Source: developed by the author

After applying the least squares method to the data series, I estimated the parameters of the regression model, and the results are those in Table 2

There is a direct relationship between the model variables that is observed based on the regression coefficient. The increase by one unit of the average contribution / participant (CM_BRD) will lead to an increase by 0.069467 lei of the VUAN_BRD.

The high value of the free coefficient shows a significant influence of the factors not included in the model on the evolution of VUAN_BRD. The connection between VUAN_BRD and CM_BRD is a direct and very strong one, R-squared = 0.938132, which means that 93.8132% of the variation VUAN_BRD is determined by the evolution of CM_BRD, the rest of the variation can be determined by other factors.

Table 2. Estimation of parameters by MCMMP (Least squares) for the BRD fund

Dependent Variable: VUAN_BRD
Method: Least Squares
Date: 03/11/20 Time: 17:59
Sample: 2010 2019
Included observations: 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CM_BRD	0.069467	0.006307	11.01397	0.0000
C	10.80138	0.659097	16.38816	0.0000

R-squared	0.938132	Mean dependent var	17.48529
Adjusted R-squared	0.930398	S.D. dependent var	3.082487
S.E. of regression	0.813225	Akaike info criterion	2.601239
Sum squared resid	5.290679	Schwarz criterion	2.661756
Log likelihood	-11.00619	Hannan-Quinn criter.	2.534852
F-statistic	121.3075	Durbin-Watson stat	0.944570
Prob(F-statistic)	0.000004		

Source: developed by the author

The equation of the econometric model is:

$$VUAN\_BRD = \beta_{0BRD} + \beta_{1BRD} * CM\_BRD \quad (2)$$

$$VUAN\_BRD = 10{,}80138 + 0{,}069467 * CM\_BRD \quad (3)$$

The adjusted coefficient of determination has the value 0.930398, R= 0,968572 (very close to 1) and S.E. of regression is 0.813225.

The Pearson correlation coefficient is completed by the regression coefficient which indicates a direct link between the variables of the model. The increase by 1,0 lei of the average contribution / participant entails the increase by 0.079088 lei of VUAN.

Next, I will verify the significance of the parameters for the econometric model using the t-Statistic test, which determines the ability of the independent variable to significantly influence the level of the explained variable.

IV. TESTING THE SIGNIFICANCE OF THE PARAMETERS

Testing the significance of the parameters is performed using the t-Student test (t-Statistic) in several stages. In a first stage the hypotheses are formulated (null hypothesis and alternative hypothesis), a significance threshold is chosen (in economic practice this threshold has the value of 5%) and if H_{0BRD} is not accepted it means that the link between the model variables is significant.

Testing the significance of the parameters begins with defining the two hypotheses:

H_{0BRD}: $\beta_{0BRD}=0$; $\beta_{1BRD}=0$ (parameters are not statistically significant, the model is not valid)

H_{1BRD}: $\beta_{0BRD}\neq0$; $\beta_{1BRD}\neq0$ (parameters are statistically significant, the model is valid)

With EViews 10+ Student Version Lite you get the value of the t test statistic that is generated in the t-

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Statistic column, on the line of each estimated parameter, as seen in Table 2.

It can be noticed that β_{0BRD}:$|t_{calcBRD}|$=16,38816, and β_{1BRD}:$|t_{calcBRD}|$=11,01397. The values are compared with the value in the table of the t-Statistic distribution (t_{tabBRD}=2,306), for n-2 degrees of freedom and a chosen significance threshold of 5%.

Where: n = length of data series included in the model (included observations = 10).

Given that the parameter β_{0BRD}:$|t_{calcBRD}|$>t_{tabBRD} and the parameter β_{1BRD}:$|t_{calcBRD}|$>t_{tabBRD}, it results that the H_{1BRD} is accepted, which shows that all parameters are <5%.

The parameters are statistically significant (Prob. Associated C = 0.0000 <5% and Prob. Associated CM = 0.0000 <5%).

V. TESTING THE VALIDITY OF THE MODEL

The hypotheses are:

H_0: not statistically valid;

H_1: statistically valid.

"In order to test the validity of the regression model, the F test is used, having the following form:

$$F = \frac{R^2}{1-R^2} \times \frac{n-k}{k-1} \qquad (4)$$

Where n is the number of observations and k - the number of model parameters. From the Fisher distribution table, depending on a significance threshold α = 0.05 and the number of degrees of freedom" (Andrei T., 2008, p. 120), $v_1 = k - 1 = 1$ şi $v_2 = n - k = 11 - 2 = 9$,, is taken over: $F_{critic}=F_{(0,05;1;9)}$=5,117.

For our case, H_{0BRD} is rejected and H_{1BRD} is accepted because F-statisticBRD = 121,3075>$F_{criticBRD}$=5,32, which means that the model is statistically significant. (Prob.(F-statistic) = 0.000004 <5%.

VI. VERIFICATION OF THE FULFILLMENT OF THE HYPOTHESES OF THE UNIFACTORIAL LINEAR REGRESSION MODEL

In order to be able to estimate the parameters of the regression models it is necessary to verify if the classical hypotheses of the simple linear regression model are fulfilled.

The functional form is linear for the econometric model for which I will check if the hypotheses of the linear regression model are met is:

VUAN_BRD = 10,80138+0,069467*CM_BRD *(5)*

Normal distribution of random errors and their average

We apply the Jarque-Bera test, with the hypotheses:

H_0: normal distribution;

H_1: don't have normal distribution.

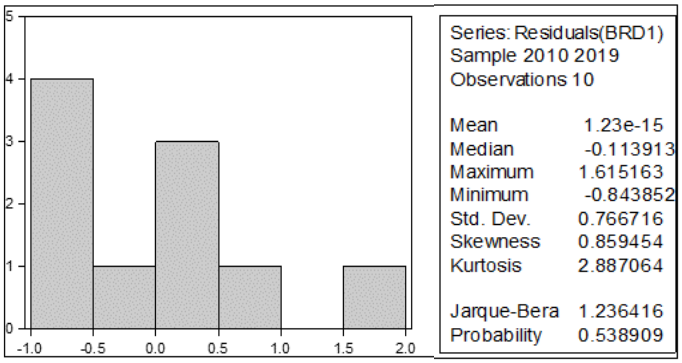

Figure 3 - The Jarque-Bera test for the BRD found
Source: developed by the author

Since the probability associated with the Jarque-Bera test is 0.538909 > 5%, the null hypothesis (H_{0BRD}) will be accepted (Figure 3).

Since the probabilities associated with the Jarque-Bera test are much higher than the chosen significance threshold (5%), we can conclude that the random errors have a normal distribution for the econometric model associated with the BRD fund.

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Homoscedasticity of random errors

We apply the White Test with the hypotheses:

- H_0: homoscedasticity;
- H_1: heteroskedasticity.

Applying the White test in EViews 10+ Student Version Lite generates the results presented in Table 3.

Table 3. The White Test – BRD

Null hypothesis: Homoskedasticity			
F-statistic	0.498328	Prob. F(2,7)	0.6276
Obs*R-squared	1.246341	Prob. Chi-Square(2)	0.5362
Scaled explained SS	0.752616	Prob. Chi-Square(2)	0.6864

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/11/20 Time: 18:15
Sample: 2010 2019
Included observations: 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.776990	1.734097	-0.448066	0.6676
CM_BRD^2	-0.000183	0.000194	-0.940639	0.3782
CM_BRD	0.034314	0.039231	0.874680	0.4108

R-squared	0.124634	Mean dependent var	0.529068
Adjusted R-squared	-0.125470	S.D. dependent var	0.766097
S.E. of regression	0.812738	Akaike info criterion	2.666509
Sum squared resid	4.623802	Schwarz criterion	2.757285
Log likelihood	-10.33255	Hannan-Quinn criter.	2.566929
F-statistic	0.498328	Durbin-Watson stat	2.523369
Prob(F-statistic)	0.627572		

Source: developed by the author

After applying the White Test, for the econometric model associated with the BRD fund, we find that. Since this probability is higher than the chosen significance threshold (5%), we accept the null hypothesis. We can say that in the case of the model associated with the BRD fund there is homoscedasticity.

Non-autocorrelation of random errors

To identify first-order autocorrelation, I will apply the Durbin – Watson Test.

The assumptions for the Durbin-Watson Test are:

H_0: $\rho=0$ (there is no autocorrelation of first order random errors);

H_1: $\rho\neq0$ (there is autocorrelation of first order random errors I).

Durbin-Watson statistics = 0,944570 for the model associated with the BRD fund.

Since the calculated Durbin-Watson statistic is between dL = 0.88 and dU = 1.32 we are in the area of indecision, but quite close to accepting the null hypothesis.

After applying the Durbin-Watson Test in EViews 10+ Student Version Lite, I found that no decision can be made for the econometric model for the BRD fund, which is why I will apply another test to detect autocorrelation. There are stronger tests for analyzing the existence of serial autocorrelation in regression equation errors, such as the Q test or the Breusch-Godfrey test. I decided to apply the Breusch-Godfrey test for the chosen econometric model to determine if there is a serial correlation of residues (errors).

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Table 4. Breusch-Godfrey test (BRD)

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	2.436201	Prob. F(2,6)	0.1681
Obs*R-squared	4.481440	Prob. Chi-Square(2)	0.1064

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/13/20 Time: 21:03
Sample: 2010 2019
Included observations: 10
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CM_BRD	0.002592	0.005772	0.448994	0.6692
C	-0.195340	0.587681	-0.332390	0.7509
RESID(-1)	0.799193	0.366366	2.181405	0.0719
RESID(-2)	-0.625577	0.417202	-1.499459	0.1844

R-squared	0.448144	Mean dependent var	1.23E-15
Adjusted R-squared	0.172216	S.D. dependent var	0.766716
S.E. of regression	0.697578	Akaike info criterion	2.406770
Sum squared resid	2.919693	Schwarz criterion	2.527804
Log likelihood	-8.033852	Hannan-Quinn criter.	2.273996
F-statistic	1.624134	Durbin-Watson stat	2.574340
Prob(F-statistic)	0.280350		

Source: developed by the author

Applying with the Breusch-Godfrey test for the econometric model associated with the BRD fund, the results presented in Table 4. Because it is higher than the chosen significance threshold (5%), we can say that the residues are not serially correlated and the model is good for making predictions.

We can conclude that all the econometric model is correct and can be used successfully to forecasting.

VII. FORECASTS BASED ON THE MODEL

I will forecast the VUAN of the privately managed mandatory pension fund BRD, for the period 2020-2025 in the situation where the average monthly contribution / participant (CM) will maintain its growth trend. To predict CM values, I will use a linear regression in which the average monthly contribution / participant is influenced only by time and constant.

In the absence of the influence of an independent variable, the evolution of the average contribution / participant of the BRD fund can be explained only by the influence of the random variable that varies over time.

In Table 5 presenting the results of the econometric modeling provided by Eviews.

Table 5. Results of the simple linear regression of the average / participant contribution without the influence of an independent variable in the case of the BRD fund

Dependent Variable: CM_BRD
Method: Least Squares
Date: 03/12/20 Time: 12:17
Sample (adjusted): 2010 2019
Included observations: 10 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
@TREND	14.11163	0.544460	25.91858	0.0000
C	32.71436	2.906621	11.25512	0.0000

R-squared	0.988231	Mean dependent var	96.21668
Adjusted R-squared	0.986760	S.D. dependent var	42.97872
S.E. of regression	4.945304	Akaike info criterion	6.211610
Sum squared resid	195.6482	Schwarz criterion	6.272127
Log likelihood	-29.05805	Hannan-Quinn criter.	6.145223
F-statistic	671.7726	Durbin-Watson stat	1.640926
Prob(F-statistic)	0.000000		

Source: developed by the author

The coefficient of determination R_CMBRD^2=0,988231, together with the high value of a, F-

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statistic=671,7726 corroborated with the probability of manifestation Prob.(F-statistic) = 0,000000 < 5%.

In Figure. 4 , I will represent the forecasted values of the average contribution / participant (CM_BRDF) as well as the real values of the average contribution / participant (CM_BRD) in order to observe if the econometric model is good for making forecasts.

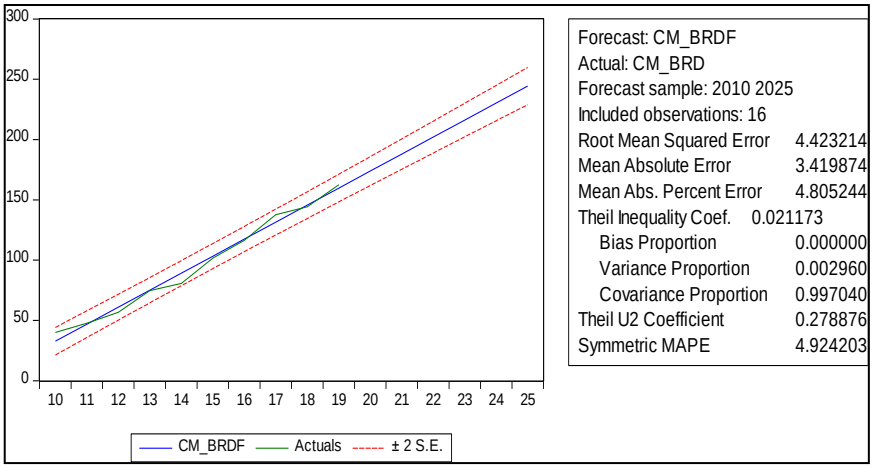

Figure 4 - Graphic representation of the values CM_BRDF and CM_BRD for the BRD fund in the period 2010-2025
Source: developed by the author

From the analysis of the chart, presented in Figure 4, we can notice that the forecasted values do not deviate significantly from the real value (actuals) of the average value of the contribution / participant, which shows that the econometric model associated with the analyzed fund can be used to forecast.

As I appreciate that the projected values of the average / participant contribution are relatively close to the real values recorded by this indicator in the period 2010-2016, I will use these values to make the forecast of the net asset value (NPV) for the BRD fund. To make these forecasts, I use the econometric models obtained previously and whose results were presented in Table 2. I propose to replace the real values of the average contribution / participant with those forecasted for the period 2010-2025 and to obtain the VUAN forecast for the period 2020-2025 related to the analyzed fund.

According to the forecast made by econometric modeling using EViews 10+ Student Version Lite, the level of VUAN of the BRD fund will reach the level of 28 lei at the end of 2025. We can still say with a 95% probability that VUAN_BRD on December 31, 2025 will fall in the range [26; 30].

I appreciate that this econometric model is good to forecast and I represented in Figure 5 results provided for both the predicted values of VUAN (VUAN_BRDF) and the actual values of VUAN (VUAN_BRD). Comparing graphically the evolutions of the two indicators we can conclude that the econometric model can be used to forecast because the forecasted values do not differ significantly from the real values.

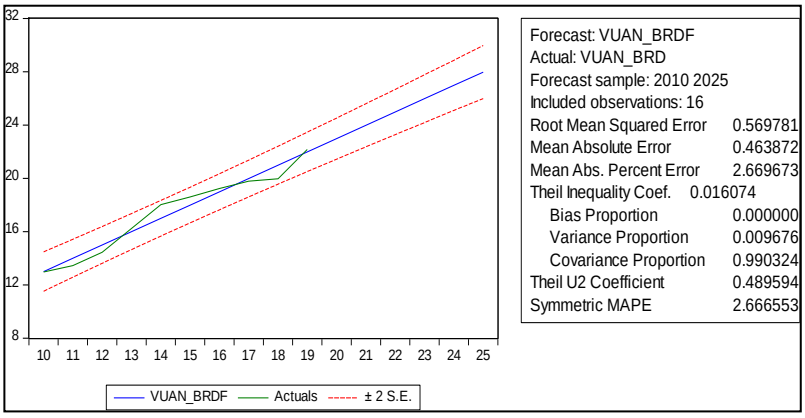

Figure 5 - Forecast of the unit value of the net assets of the BRD fund for the period 2010-2025 (lei)
Source: developed by the author

The forecasted level of VUAN may be useful to the extent that an estimate of the value of a privately managed pension fund participant's account is desired if the number of fund units accumulated at the end of a year

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is known.

VIII. CONCLUSIONS

The econometric model obtained can be used with confidence, because it shows how the evolution of the CM will influence the VUAN.

The regression model is:

$$VUAN\_BRD = 10{,}67658+0{,}070764\times CM\_BRDF \qquad (6)$$

Following the estimation of the econometric model, we obtained the following results:

When you refer to previous research within your article, choose from the following options:

- the coefficients of determination confirm that the level of the average contribution / participant influences the increase of the unit value of the net asset, the value of this coefficient being very high, namely 96.2036% for the model associated with the BRD fund;
- there is a significant direct relationship between the unit values of net assets and those of the average contribution / participant. We can say that an increase by one monetary unit of the average contribution / participant for a fund entails an increase in the unit value of the net asset with values between 0.07 and 0.08 monetary units.

We can say that the econometric model used is good for making predictions and can be improved by adding explanatory variables and transforming the unifactorial econometric model of linear regression into a multifactorial model.

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