ANALYSIS OF THE INFLUENCE OF ROMANIA'S MONETARY POLICY INTEREST RATE ON THE ANNUAL AVERAGE EURO-RON EXCHANGE RATE

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ABSTRACT: *This paper investigates the relationship between the monetary policy interest rate (MPIR) and the annual average euro-ron exchange rate (AAER) using a Vector Error Correction Model (VECM). The analyzed data covers a period of 20 years (2005-2024), and the results indicate the existence of a cointegration relationship between the variables, suggesting a long-term equilibrium. The error correction term is significant for the AAER equation, indicating that AAER adjusts towards the long-term equilibrium determined by MPIR. Additionally, there is a significant short-term relationship between MPIR(-1) and AAER, suggesting that changes in MPIR have an impact on changes in AAER. The VECM model provides a detailed understanding of the dynamic relationship between MPIR and AAER, highlighting both short-term effects and the adjustment towards long-term equilibrium.*

KEY WORDS: *monetary policy interest rate, exchange rate, Vector Error Correction Model, cointegration, long-term equilibrium*

JEL CLASSIFICATIONS: *C32, E43, E52, F31*

1. INTRODUCTION

The analysis of the short-term and long-term influence between the monetary policy interest rate and the exchange rate in Romania is an important one, especially considering their impact on the economy. Over time, research has shown that there is a real connection between these two variables. Specifically, through the increase in interest rates, the local currency is influenced in the sense of appreciation against other foreign currencies.

Within this study, we aim to determine the extent to which, in Romania, there is an influence of the interest rate on the exchange rate, or whether this, along with the adopted monetary policies, only influences the national currency.

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The evolution of the exchange rate in any country is extremely important, as its changes produce effects on the national economy. An increase in the exchange rate, along with other economic factors, leads to an increase in prices and, consequently, a decrease in purchasing power. On the other hand, variations in interest rates influence the spending decisions of the population and businesses.

The monetary policy interest rate represents the interest rate used for the main market operations of the National Bank of Romania, directly influencing the amount of money in circulation. Thus, when the monetary policy interest rate decreases, the money supply increases, allowing commercial banks, the population, and businesses to benefit from low loan rates. Conversely, an increase in the interest rate leads to a decrease in the money supply, the monetary policy is considered restrictive, consumer spending decreases, and therefore economic growth is affected.

In recent years, both the European Central Bank and the National Bank of Romania have lowered the monetary policy interest rate to historical levels, reaching 1.25% as an annual average in 2021. The graphs below show the evolution of the two variables over time.

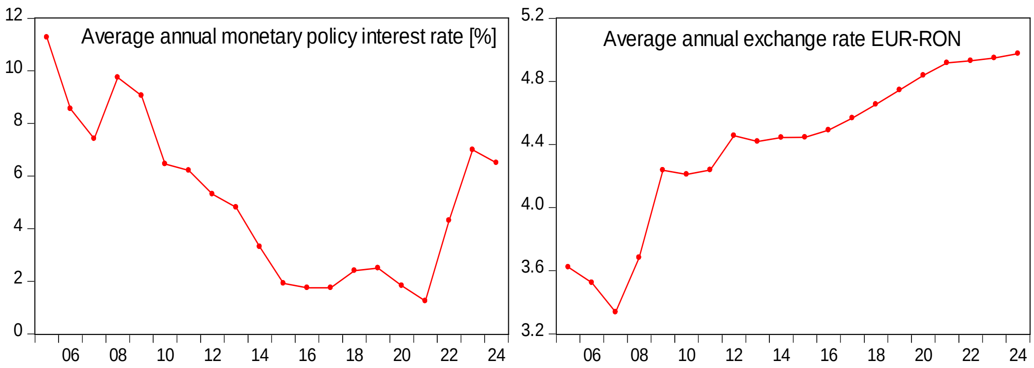

Figure 1. Time evolutions of the annual average EURO-RON exchange rate (right) and the annual average interest rate (left)

As can be seen from the above graphical representations, while the annual average monetary policy interest rate has a downward trend until 2021, with an increase between 2022-2024, the annual average exchange rate has an upward trend.

The exchange rate, also known as the foreign exchange rate, is the price of a country's currency expressed in the currency of another country. More precisely, the exchange rate represents the price at which one currency is exchanged for another, i.e., the ratio between the national currency and the foreign currency.

The exchange rate can be official or market-based. The official exchange rate (reference exchange rate) is set by the National Bank of Romania based on the ratio between the demand and supply of foreign currencies. This is a reference rate, meaning it does not dictate the exchange rate level within banks or exchange offices, but it is the value to which these entities refer.

The exchange rate is determined by the demand and supply of foreign currency, which is only valid in a free market. A large supply of foreign currency means that its price will decrease, and the national currency will appreciate, while a high demand for foreign currency means that its price will increase, depreciating the national currency.

There are a number of factors that directly influence the exchange rate in a country, these factors producing fluctuations in a relatively short time. These can be internal or external. Among the internal factors that affect the evolution of the exchange rate, we can list: political stability and economic performance, trade conditions, monetary policy interest rate, inflation, budget deficit, or public debt.

The external factors that affect the exchange rate are the ratio between supply and demand regarding the currencies traded worldwide, as well as the political and social factors at the global level.

Additionally, speculative actions can destabilize the exchange rate through massive infusions or withdrawals in a short time. The central bank's policy is another factor that can influence the exchange rate.

This study analyzes the relationship between the monetary policy interest rate (MPIR) and the annual average euro-ron exchange rate (AAER) using a Vector Error Correction Model (VECM). The VECM model provides a detailed understanding of the dynamic relationship between MPIR and AAER, highlighting both short-term effects and the adjustment towards long-term equilibrium.

2. LITERATURE REVIEW

Over time, both domestic and international specialized literature has provided a series of studies regarding the analysis of an inverse dependency between the interest rate and the exchange rate. Thus, at the international level, among those who have studied the connection between the exchange rate and the interest rate are Calvo and Reinhart. The authors of the study analyze the behavior of exchange rates, reserves, monetary aggregates, interest rates, and commodity prices for 154 exchange rate arrangements in 29 countries (Calvo & Reinhart, 2002). The results obtained show that countries that claim to allow the exchange rate to float mostly do not. In these states, there is the so-called "fear of floating."

Another reduced-form model that analyzes the real exchange rate, using the multilateral cointegration method, is implemented by MacDonald for the real exchange rate of the dollar, the mark, and the yen (MacDonald, 1997).

Obstfeld and Rogoff (Obstfeld & Rogoff, 2000) demonstrate in their research that the relationship between the exchange rate and monetary policy is both important and bilateral.

Recent studies, such as the one conducted by Ahmed and Mazlan (Ahmed & Mazlan, 2021), examine the effects of interest rate changes on the exchange rate of ASEAN countries (Association of Southeast Asian Nations). Both linear autoregressive distributed lag (ARDL) and nonlinear ARDL (NARDL) approaches are used. The results indicate that the effects of these changes vary from one country to another.

On the other hand, Dăianu (Dăianu, et al., 2004) studies the premise of EU accession at the anticipated time and the requirements for integration into ERM2

(European Exchange Rate Mechanism), also establishing the requirements for subsequent accession to ERM2. Additionally, the authors aim to identify the determining factors of the policies to be implemented.

In his work, Hândoreanu aims to establish a series of characteristics regarding the impact of the interest rate on exchange rate volatility. This type of analysis regarding the link between interest rate differential and exchange rate is called Uncovered Interest Parity (Hatmanu, et al., 2008). Hatmanu also examines the influence of the monetary policy interest rate, the real exchange rate, and the business climate in the euro area on economic growth in Romania. The results show that in the short term, economic growth is negatively influenced by the interest rate and positively by the exchange rate (Hatmanu, et al., 2020). A comparative analysis of models determining the relationship between GDP and interest rate, inflation, and public debt is described in Stoicuța and Stanciu (Stoicuța & Stanciu, 2010).

3. EMPIRICAL FINDINGS

3.1. Sources of Data

In the econometric analysis, the two variables identified are:

- **AAER**: The output variable is given by the annual average exchange rate Euro-Ron.
- **MPIR**: The input variable is given by the annual average monetary policy interest rate in Romania.

The analysis is conducted over a period of 20 years (2005-2024). Both the exchange rate data series and the monetary policy interest rate series were obtained from the BNR website, with values reported as annual averages. Data transformations were performed by the author. It should be noted that starting from September 1, 2011, the reference interest rate became equal to the monetary policy interest rate.

3.2. Descriptive statistics

In Table 1, the values of the main descriptive indicators for the two variables AAER and MPIR are presented. The values of the indicators were calculated using the Eviews 10.1 program.

As can be observed, the values of the central tendency indicators, as well as those of dispersion and shape and distribution, have been determined.

From Table 1, it can be seen that the monetary policy interest rate (MPIR) had an average of 5.16% over the twenty years analyzed and a standard deviation of 3.05%. It also shows a positive skewness of 0.35 and is slightly platykurtic with a kurtosis coefficient of 1.97. On the other hand, this variable has a normal distribution since the Jarque-Bera statistic is 1.29 for a significance level of 5%. Regarding the annual average exchange rate Euro-Ron (AAER), it had an average of 4.38, with a standard deviation of 0.49% and a negative skewness. It is platykurtic and has a normal distribution, given that the Jarque-Bera statistic is 2.07 for a significance level of 3.5%.

Table 1. Descriptive properties of the variables

	MPIR	AAER
Mean	5.168500	4.384180
Median	5.060000	4.450500
Maximum	11.27000	4.975400
Minimum	1.250000	3.337300
Std. Dev.	3.055315	0.497224
Skewness	0.351368	-0.751917
Kurtosis	1.970020	2.525273
Jarque-Bera	1.295580	2.072401
Probability	0.523201	0.354800
Sum	103.3700	87.68360
Sum Sq. Dev.	177.3641	4.697412
Observations	20	20

3.3. Correlation Analysis

To establish the direction of association between the two variables, we will calculate the correlation matrix. For emphasis, the correlation analysis will be discussed based on the key variables of interest along with the interaction terms. Table 2 captures the Pearson correlation coefficient calculated for the variables.

Table 2. Correlation Matrix

	AAER	MPIR
AAER	1.000	-0.67
MPIR	-0.67	1.000

From Table 2, it can be observed that the two variables analyzed in this study are negatively correlated, which means that the dependency between the two variables is inverse.

3.4 Unit Root Test

To determine the order of integration of the variables, the unit root test is performed. Thus, the Phillips-Perron (PP) test is used. Table 3 presents the results of the unit root test for the two analyzed variables.

If the order of integration is I(0), then the analyzed variable is stationary at level, and if the order of integration is I(1), then the variable is stationary at first difference. For the AAER variable, at first difference, the PP Statistic value is -4.2106, and the probability is 0.0049, which is less than 0.05. This indicates that we can reject the null hypothesis and conclude that the series is stationary at first difference, meaning it is integrated of order I(1).

Table 3. Phillips-Perron Unit Root Test

Variable	ADF Statistic at Level	ADF Statistic at First Difference	Probability	Order of Integration
AAER	-1.1930	-4.2106	0.0049	I(1)
MPIR	-2.1393	-3.4185	0.0241	I(1)

For the MPIR variable, the PP Statistic value at first difference is -3.4185, and the probability is 0.0241, which is less than 0.05. This indicates that we can reject the null hypothesis and conclude that the series is stationary at first difference, meaning it is integrated of order I(1). In conclusion, both the AAER and MPIR series are integrated of order 1, i.e., I(1). Therefore, we will be able to apply the VECM model to these series.

3.5 Test for Causality

In this paragraph, we will test the causality relationship between the two analyzed variables. In other words, the Granger causality test is applied to see if the monetary policy interest rate (MPIR) can be used to predict the annual average exchange rate Euro/RON (AAER) and vice versa. The following results were obtained in the Eviews program after applying the Pairwise Granger causality test.

Table 4. Pairwise Granger Causality Tests

Sample: 2005 2024
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
AAER does not Granger Cause MPIR	18	2.33178	0.1363
MPIR does not Granger Cause AAER		8.03240	0.0054

The results indicate that the monetary policy interest rate (MPIR) helps in predicting the annual average exchange rate Euro/RON (AAER), but not vice versa. There is a unidirectional Granger causality from MPIR to AAER. These results are useful for understanding the dynamic relationship between the variables.

3.6. Test for Cointegration

To detect if there is a long-term relationship in the model, the cointegration test is applied. To achieve this, the ARDL Bounds test is performed for the first difference relationship. The cointegration test is applied in the Eviews program and is conducted using a significance level of 5% in comparing the upper and lower bounds (Table 5).

To interpret the results of the Engle-Granger cointegration test obtained in EViews, we need to look at the test statistic values and their associated probabilities. The probability values for the tau-statistic are high (0.6371 and 0.9523), indicating that we cannot reject the null hypothesis that the series are not cointegrated.

However, the p-value for the z-statistic in the case of MPIR is very low (0.0000), suggesting the rejection of the null hypothesis and indicating the existence of a cointegration relationship. The results are mixed. While the tau-statistic suggests that the series are not cointegrated, the z-statistic for MPIR indicates the opposite. Therefore, the results suggest that there might be a cointegration relationship between MPIR and AAER.

Table 5. Engel-Granger cointegration test

Series: MPIR AAER
Sample: 2005 2024
Included observations: 20
Null hypothesis: Series are not cointegrated
Cointegrating equation deterministics: C
Automatic lags specification based on Schwarz criterion (maxlag=3)

Dependent	tau-statistic	Prob.*	z-statistic	Prob.*
MPIR	-1.800059	0.6371	-230.8993	0.0000
AAER	-0.642591	0.9523	-6.445549	0.5403

**MacKinnon (1996) p-values.*

For further verification, a stationarity test on the residuals was also conducted. The results show that the residuals are stationary, which means that there is a cointegration relationship between your MPIR and AAER variables. This is an important conclusion because the stationarity of the residuals indicates that the variables are cointegrated and, therefore, there is a long-term equilibrium relationship between them.

4. METHODOLOGY

Based on the above results, considering that the cointegration test indicates the existence of a cointegration relationship and the variables are integrated of order I, we will further apply the VECM model to analyze both the short-term dynamics and the adjustment towards long-term equilibrium between the variables.

The VECM (Vector Error Correction Model) was first introduced by Søren Johansen (Johansen, 1988) and is an extension of the VAR (Vector Autoregression) model, which is used to model the relationships between cointegrated variables. VECM is capable of capturing both the short-term dynamics and the adjustment towards long-term equilibrium between the variables. In the present study, the VECM model has the following representation:

- Cointegration Relationship:

$$z_{t-1} = \mathrm{CointEq1}_t = \alpha_0 + \alpha_1 AAER_{t-1} + \alpha_2 MPIR_{t-1} \quad (1)$$

- Differential Equations:

$$\begin{aligned} \Delta MPIR_t &= \beta_0 + \beta_1 z_{t-1} + \sum_{i=1}^{p-1} \gamma_{1i} \Delta AAER_{t-i} + \sum_{i=1}^{p-1} \delta_{1i} \Delta MPIR_{t-i} + \varepsilon_{1t} \\ \Delta AAERt &= \theta_0 + \theta_1 z_{t-1} + \sum_{i=1}^{p-1} \phi_{1i} \Delta AAER_{t-i} + \sum_{i=1}^{p-1} \psi_{1i} \Delta MPIR_{t-i} + \varepsilon_{2t} \end{aligned} \quad (2)$$

where:

- $\mathrm{CointEq1}_t$ is error correction term, which is the term that reflects the deviation from the long-term equilibrium.
- $\Delta MPIR_t$ and $\Delta AAER_t$ are first-order differences;
- α_0, α_1 and α_2 are the coefficients of the cointegration relationship;
- $\beta_0, \beta_1, \gamma_{1i}$ and δ_{1i} are the coefficients of the equation for $\Delta MPIR_t$;
- $\theta_0, \theta_1\ \phi_{1i}$, ψ_{1i} , are the coefficients of the equation for $\Delta AAER_t$;
- ε_{1t} and ε_{2t} are error terms;
- p is the number of lags introduced in the model.

The model coefficients are determined in the Eviews program. Their values are found in the Table 6.

Table 6. Vector Error Correction Estimates

Sample (adjusted): 2008 2024
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
AAER(-1)	1.000000	
MPIR(-1)	0.038016	
	(0.02591)	
	[1.46720]	
C	-4.617025	
Error Correction:	**D(AAER)**	**D(MPIR)**
CointEq1	-0.307990	0.693097
	(0.07484)	(1.35001)
	[-4.11523]	[0.51340]
D(AAER(-1))	0.073650	-3.276406
	(0.14463)	(2.60888)
	[0.50923]	[-1.25587]
D(AAER(-2))	-0.096368	0.621392
	(0.15405)	(2.77873)

	[-0.62558]	[0.22362]
D(MPIR(-1))	0.053680	0.358978
	(0.01764)	(0.31817)
	[3.04330]	[1.12826]
D(MPIR(-2))	-0.015901	-0.442940
	(0.02169)	(0.39117)
	[-0.73324]	[-1.13234]
C	0.096020	0.024065
	(0.02948)	(0.53175)
	[3.25727]	[0.04526]
R-squared	0.813423	0.393121
Adj. R-squared	0.728615	0.117267
Sum sq. resids	0.067176	21.85748
S.E. equation	0.078146	1.409625
F-statistic	9.591359	1.425105
Log likelihood	22.91415	-26.25826
Akaike AIC	-1.989900	3.795089
Schwarz SC	-1.695825	4.089165
Mean dependent	0.096359	-0.054118
S.D. dependent	0.150009	1.500338
Determinant resid covariance (dof adj.)		0.012033
Determinant resid covariance		0.005038
Log likelihood		-3.272972
Akaike information criterion		2.032114
Schwarz criterion		2.718290
Number of coefficients		14

If we insert the numerical values into relationships (1) and (2), we will obtain the following expressions of the VECM model:

- Cointegrating equation (long-run model):

$$z_{t-1} = \text{CointEq1}_t = -4.617025 + AAER_{t-1} + 0.038016 MPIR_{t-1} \qquad (1)$$

- Differential Equations:

$$\begin{aligned} \Delta MPIR_t &= 0.096020 - 0.307990 z_{t-1} + 0.073650 \Delta AAER_{t-1} - 0.096368 \Delta AAER_{t-2} + \\ &+ 0.053680 \Delta MPIR_{t-1} - 0.015901 \Delta MPIR_{t-1} + \varepsilon_{1t} \\ \Delta AAERt &= 0.024065 + 0.693097 z_{t-1} - 3.276406 \Delta AAER_{t-1} + 0.621392 \Delta AAER_{t-2} + \\ &+ 0.358978 \Delta MPIR_{t-1} - 0.442940 \Delta MPIR_{t-1} + \varepsilon_{2t} \end{aligned} \qquad (2)$$

In Figure 2, the orthogonal residuals obtained through this method are represented, which means that the shocks are considered to be uncorrelated and of unit magnitude. This is a standard method used in econometrics to analyze the dynamic effects of shocks in a system of simultaneous equations, such as the VECM model.

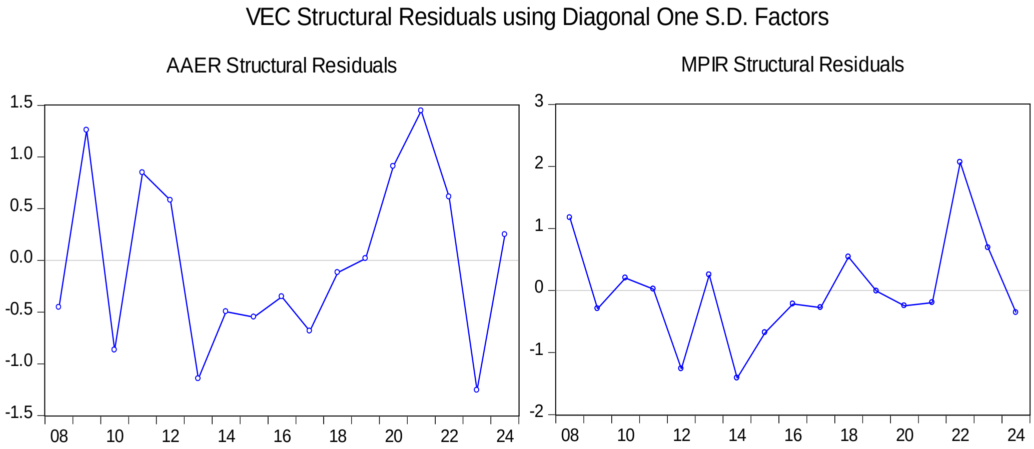

Figure 2. VEC Structural Residuals

Orthogonal residuals are useful in impulse-response analysis because they allow the interpretation of shock effects as being independent of each other. Figure 2 shows the orthogonal residuals obtained through this method, which means that the shocks are considered to be uncorrelated and of unit magnitude.

5. INTERPRETATION OF RESULTS

Analyzing the results obtained using the Eviews 10.1 software package, we can formulate the following interpretations:

Cointegration Relationship:

- There is a long-term equilibrium relationship between MPIR and AAER, suggesting that these variables move together in the long term. Error **Correction Terms:**
- The error correction term for the AAER equation is significant, indicating that AAER adjusts towards the long-term equilibrium determined by MPIR.
- The error correction term for the MPIR equation is not significant, suggesting that MPIR does not adjust towards the long-term equilibrium determined by AAER.
- **Short-term dynamics:**
- There is a significant short-term relationship between MPIR(-1) and AAER, indicating that changes in MPIR have an impact on changes in AAER.
- **Normality of residuals:**
- Normality tests suggest that the model's residuals are approximately normal, although there is some evidence of deviation from normality for component 2 at a 10% significance level.

Based on the above results, we can state that the VECM model indicates that there is a long-term equilibrium relationship between the monetary policy interest rate in Romania and the annual average exchange rate Euro-RON, and the latter adjusts towards this equilibrium. Additionally, there is a short-term dynamic relationship between changes in MPIR and changes in AAER. However, the presence of serial correlation of the residuals suggests that the model could be improved to better capture the dynamics of the data.

6. CONCLUSIONS

This article analyzes the influence of the monetary policy interest rate (MPIR) on the annual average exchange rate Euro-RON (AAER) based on a VECM (Vector Error Correction Model). Thus, the obtained results indicate the existence of a cointegration relationship between the two analyzed variables, suggesting a long-term equilibrium.

The cointegration equation suggests a long-term relationship between the annual average exchange rate EUR/RON (AAER) and the monetary policy interest rate (MPIR). The coefficient for MPIR in the cointegration equation is positive, indicating that an increase in the interest rate is associated with an increase in the exchange rate in the long term.

Additionally, the error correction term is significant for the AAER equation, indicating that AAER adjusts towards the long-term equilibrium determined by MPIR. On the other hand, there is a significant short-term relationship between MPIR(-1) and AAER, suggesting that changes in MPIR have an impact on changes in AAER.

In the current economic context, the results suggest that monetary policy has a significant impact on the exchange rate. An increase in the monetary policy interest rate seems to lead to an appreciation of the national currency in the long term, but also to an increase in short-term volatility.

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