Modelling the correlations between interest rate and other components of economic policy

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Abstract. *Both the government and the monetary authorities have accepted that a strong nominal anchor is vital in establishing and implementing a sound monetary policy. The special importance of the interest rate in the proper functioning of the modern economy cannot be underestimated. The way it varies is relevant in establishing the level of economic well-being of each individual or business organization within the country. At the same time, the credibility of economic policy promoted by the government is very often measured by the level of the most representative interest rates. Therefore, it is important to analyze how the variation in interest rates influences the macroeconomic variables of the economy.*

Keywords: interest rate, inflation, model, exchange rate, monetary aggregate, regression.

JEL classification: E47, E58.

1. General considerations

The analysis of correlations between monetary policy interest rates and macroeconomic variables has been and is always a matter for researchers. On the basis of the theoretical and empirical studies, a bidirectional causal relationship has been established between the reference interest rate and the inflation rate. Also, economic theories indicate that a high interest rate generates a high level of inflation, which will primarily affect real balances and the decline in currency in circulation. According to Keynesian doctrine, the decline in the supply of currency causes a distortion of the whole economy, and creates an imbalance in the economic activity. Therefore, there is a direct causal relationship between the inflation rate and the interest rate. The mechanism of influencing the interest rate on inflation can be explained in several ways. One method is to apply the cost of using the capital. Increasing the interest rate increases the cost of capital use (Branson, 1979), which leads to higher production costs. Also, the change in the interest rate has an impact on inflation by influencing the volume of money. In endogenous monetary models where the money supply is a function of the interest rate, the monetary contribution is increased when the interest rate increases. So, raising money supply results in short and long-term inflation. Monetary supply does not have a significant effect on inflation during the recession, its impact on inflation can be seen under normal conditions and over longer periods of time. This debate was presented by William Douglas before 1840 and taken over by Henry Thornton who used the same idea to explain the relationship between the nominal interest rate and the real interest rate.

2. Research methodology

We considered useful to research the interest rate policy promoted by the National Bank of Romania during the period 2007-2016, where we highlighted the correlations between the interest rate promoted by the National Bank of Romania and certain macroeconomic indicators, trying to verify the compliance with the studies in this field. We have achieved this econometric modeling through the statistical program SPSS 17 (Statistical Package for Social Sciences) and the method used in the program is the Backward method. It is important to note that the SPSS 17 program is considered one of the most frequently used programs for analyzing statistical data correlations. It originated in 1968, and then experienced continuous development, now reaching version no. 17. Its applicability has widened over time, so it is currently used for analysis and forecasting in education, economy, health, etc. We stated the study by analyzing the links between the interest rate and the selected indicators: GDP, exchange rate, inflation, M3 monetary aggregate and consumption in order to highlight the correlations existing between these indicators, but also the way they are influenced directly or indirectly, the intensity of this correlation being the element that justifies the need to create the econometric model. In order to obtain the data necessary for the analysis, the Annual Reports of the National Bank of Romania for the period 2007 - 2016 were used. The selected indicators were collected in table no. 1 then they were processed with SPSS 17 to determine the correlations formed and their interpretation.

The input data selected for the econometric model and their values over the time series necessary for the econometric modeling are shown in table no. 1. They will analyze the correlations built between the nominal interest rate and the macroeconomic variables using the Pearson index as the instrument to determine the strength of the correlation between the dependent variable - the interest rate and the independent variables - the annual average exchange rate, GDP, monetary aggregate, consumption and inflation

Table no. 1 Indicators used in SPSS analysis

YEAR	Reference interest rate	Annual average Exchange rate EUR	Average annual inflation	GDP (billion EUR)	Monetary aggregate M3 (billion EUR)	Total consumption (billion EUR)
2007	7.42	3.3373	4.83	121.4	436.13	104.10
2008	9.75	3.6727	7.86	142.3	521.77	113.65
2009	9.06	4.2373	1.60	120.4	512.09	91.47
2010	6.46	4.2099	6.10	126.7	551.34	100.51
2011	6.21	4.2379	1.80	133.3	571.90	103.59
2012	1.31	4.4560	3.30	133.5	590.82	104.31
2013	4.81	4.4190	4.01	144.2	620.34	108.49
2014	3.31	4.4446	1.10	150.3	658.69	113.89
2015	1.92	4.4450	-0.60	159.9	710.28	121.01
2016	1.75	4.4908	-1.50	169.5	783.42	128.73

Source: adaptation and processing by the author - Annual Reports of the National Bank of Romania for the periods 2007-2016, www.bnro.ro - site accessed on 10 October 2017

3. Interpretation of results

The perfect correlation is established when the index value is close to or equal to ± 1, and the interpretation of the results must be made taking into account the following ranges:

- [0 ; 0,2] – very poor correlation;
- [0,2 ; 0,4] – poor correlation;
- [0,4 ; 0,6] – reasonable correlation;
- [0,6 ; 0,8] – high correlation;
- [0,8 ; 1] – very high correlation.

Thus, as we can see, when the Pearson index registers a value close to zero, the correlation is considered to be of no economic significance. The direct correlation is recorded when the coefficient records values close to 1, and when it reaches values close to -1 we can speak of an inverse correlation. The Sig coefficient (2-tailed) is used to signal the importance of correlation from a statistical perspective. In order for the correlation to be significant, its value should be less than 0.01.

The values obtained at the level of the indicators evaluated through the Pearson index are those in Table 2.

Table no. 2 The degree of correlation determined by the Pearson index

Correlations							
		Annual average interest rate on the NBR monetary policy	Annual average exchange rate EUR	Annual average inflation	GDP (billion EUR)	Monetary Aggregate M3 (billion EUR)	Total consumption (billion EUR)
Pearson Correlation	Annual average interest rate on the NBR monetary policy	1.000	.673	.934	.662	.891	.711
	Annual average exchange rate EUR	-.673	1.000	-.584	.374	.776	.274
	Annual average inflation	.934	-.584	1.000	-.742	-.859	-.752
	GDP (billion EUR)	-.662	.374	-.742	1.000	.842	.967
	Monetary Aggregate M3 (billion EUR)	-.891	.776	-.859	.842	1.000	.809
	Total consumption (billion EUR)	-.711	.274	-.752	.967	.809	1.000
Sig. (1-tailed)	Annual average interest rate on the NBR monetary policy		.017	.000	.019	.000	.011
	Annual average exchange rate EUR	.017		.038	.143	.004	.222
	Annual average inflation	.000	.038		.007	.001	.006
	GDP (billion EUR)	.019	.143	.007		.001	.000
	Monetary Aggregate M3 (billion EUR)	.000	.004	.001	.001		.002
	Total consumption (billion EUR)	.011	.222	.006	.000	.002	
N	Annual average interest rate on the NBR monetary policy	10	10	10	10	10	10
	Annual average exchange rate EUR	10	10	10	10	10	10
	Annual average inflation	10	10	10	10	10	10
	GDP (billion EUR)	10	10	10	10	10	10
	Monetary Aggregate M3 (billion EUR)	10	10	10	10	10	10
	Total consumption (billion EUR)	10	10	10	10	10	10

Source: the author's processing with SPSS 17 application program

Based on the data presented, we can analyze the correlations formed between the National Bank of Romania interest rate and the analyzed indicators. Thus, there is a strong direct correlation between the interest rate and inflation (p = + 0.934) which is due to the National Bank of Romania establishing a new target of monetary policy that is targeting inflation since 2005, when all attention of monetary policy was directed towards achieving and maintaining this goal. It can be said that between the two variables there

is a strong interdependence (Sig almost zero, Sig optimal value must be less than 0.05), resulting even an almost perfect correlation.

It can also be noticed the existence of another correlation, but this time negative, between the M3 monetary aggregate and the National Bank of Romania interest rate (p = - 0.891), an increase in the interest rate causes a decrease in the money supply in circulation and a decrease causes excessive liquidity in the market. The correlation is almost perfect as it also results from Sig data that is near zero.

Concerning the correlation between the interest rate and the gross domestic product, we find the results obtained as negatively or inversely correlated (p = -0.798). Starting from the fact that among the components of GDP, one of the most important macroeconomic aggregates is consumption, we have also researched the connection established between this indicator and the interest rate. Moreover, as it was normal, the sign and direction of the previously obtained correlation, was maintained strongly negative (p = - 0.711). There is also a strong interdependence in this case, the Sig index registers a value close to zero Sig in the case of GDP is 0.03 and the Sig obtained for the consumption variable is 0.017, Sig <0.01. Thus, high interest rates are accompanied by a decrease in consumption and, implicitly, economic growth and vice versa.

Another correlation is the one formed between the exchange rate and the interest rate. In this case, a relatively strong negative correlation was obtained (p = - 673). The Central Bank, with effective interest rate control, may even influence the population's motivation to keep savings in foreign or national currency and, as a result, the exchange rate. But the way the exchange rate fluctuates is due to the influence of several variables (political factors, risk aversion, external or internal macroeconomic imbalances, etc.) against which monetary policy cannot exert its influence.

The first step in econometric modelling to establish the regression model implied the establishment of independent and dependent variables. The National Bank of Romania interest rate was set as the dependent variable, and consumption, GDP, exchange rate, inflation rate as independent variables. The next step was to test the intensity of the link that appeared between the dependent variable versus the independent one. As it results from Table no. 3, the indicators were correctly selected because the average value of each indicator is inferior to the standard deviation.

Table no.3 Average and standard deviation level

Descriptive Statistics

	Mean	Std. Deviation	N
Annual average interest rate on the NBR monetary policy	5.60000	2.7474311	10
Annual average exchange rate EUR	4.195050	.3862775	10
Annual average inflation	3.650000	3.0710765	10
GDP (billion EUR)	160.850000	9.1105860	10
Monetary Aggregate M3 (billion EUR)	596.0794	101.78609	10
Total consumption (billion EUR)	109.375000	10.0460976	10

Source: Table obtained from SPSS 17 application program

As a way of introducing the variables in the regression, the Backward method was used, which involves the systematic removal of the variables that are considered insignificant. Thus analyzing the results of the regression it is noticed that GDP,

consumption, M3 monetary aggregate and exchange rate were considered unviable variables within the model and thus they were excluded (models 2, 3, 4 and 5).

Table no.4 Variables excluded from regression calculation

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Total consumption (billion EUR), Annual average exchange rate EUR, Annual average inflation, Monetary Aggregate M3 (billion EUR), GDP (billion EUR)a	.	Enter
2	.	GDP (billion EUR)	Backward (criterion: Probability of F-to-remove >= .100).
3	.	Annual average exchange rate EUR	Backward (criterion: Probability of F-to-remove >= .100).
4	.	Total consumption (billion EUR)	Backward (criterion: Probability of F-to-remove >= .100).
5	.	Monetary Aggregate M3 (billion EUR),	Backward (criterion: Probability of F-to-remove >= .100).

a. All requested variables entered
b. Dependent Variable: Interest rate of monetary policy

The final model resulting from the elimination of the insignificant variables has a very high probability to be the correct one - 93.4%, a conclusion resulting from the analysis of the values obtained through the SPSS 17 program in the R Squared (0.872) and Adjusted R Squared tests (0.856), which justifies the model of regression (Table 5).

Table no.5 Summary SPSS model

Model Summary[f]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.963[a]	.928	.838	1.1071132	.928	10.285	5	4	.021	
2	.956[b]	.914	.845	1.0832490	-.014	.787	1	4	.425	
3	.953[c]	.909	.863	1.0170940	-.005	.290	1	5	.614	
4	.950[d]	.902	.874	.9744064	-.006	.425	1	6	.539	
5	.934[e]	.872	.856	1.0428823	-.030	2.164	1	7	.185	1.654

a. Predictors: (Constant), Total consumption (billion EUR), Annual average exchange rate EUR, Annual average inflation, Monetary mass M3(billion EUR), GDP (billion EUR)
b. Predictors: (Constant), Total consumption (billion EUR), Annual average exchange rate EUR, Annual average inflation, Monetary mass M3(billion EUR)
c. Predictors: (Constant), Total consumption (billion EUR), Annual average inflation, Monetary mass M3(billion EUR)
d. Predictors: (Constant), Annual average inflation, Monetary mass M3(billion EUR)
e. Predictors: (Constant), Annual average inflation
f. Dependent Variable: Interest rate of monetary policy

Source: Table obtained from SPSS 17 application program

The ANOVA test (table no.6) confirms the results obtained in the regression model, the validity and veracity of the model being certified by the values recorded by the F test: 10.285, a value considered well above the level taken as a benchmark in the analyzes drawn up to establish the validity of econometric models. In addition, the Sig. index, which records values below the threshold of 0.05, certifies the significance of the econometric model.

Table no.6 ANOVA Test from SPSS application program

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	63.033	5	12.607	10.285	.021[a]
	Residual	4.903	4	1.226		
	Total	67.935	9			
2	Regression	62.068	4	11.517	13.224	.007[b]
	Residual	1.867	5	1.173		
	Total	67.935	9			
3	Regression	61.729	3	20.576	19.890	.002[c]
	Residual	6.207	6	1.034		
	Total	67.935	9			
4	Regression	61.289	2	30.645	32.276	.000[d]
	Residual	6.646	7	.949		
	Total	67.935	9			
5	Regression	59.235	1	59.235	54.463	.000[e]
	Residual	8.701	8	1.088		
	Total	67.935	9			

Source: Table obtained from SPSS 17 application program

Taking into account the above-mentioned elements, but also the information in the table no.7, we can present the last stage of the regression model, namely the estimation of those parameters of the regression equation describing the relationship established between the NBR interest rate and the value of the selected variables (exchange rate, inflation, consumption, GDP, money supply). The set regression model provides the opportunity to establish a series of correlations between the variables considered. Thus, there is a significant indirect link between interest rate and GDP, money supply and consumption, and a strong direct link between interest rate and inflation, a situation that can be considered normal since the main monetary policy objective since 2005 was inflation targeting, and all the steps of the NBR have channeled in this direction.

Table no.7 Coefficients of the regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-23.384	31.751		-.736	.502
	Annual average exchange rate EUR	1.538	6.201	.779	.893	.422
	Annual average inflation	.591	.251	.661	2.358	.078
	GDP (billion EUR)	-.232	.262	-1.336	-.887	.425
	Monetary mass M3	-.033	.036	-1.236	-.935	.403
	Total consumption (billion EUR)	.513	.466	1.875	1.102	.332
2	(Constant)	-6.977	21.251		-.276	.793
	Annual average exchange rate EUR	2.847	1.291	.400	.538	.614
	Annual average inflation	.564	.243	.631	2.318	.068
	Monetary mass M3	-.030	.035	-1.100	-.856	.431
	Total consumption (billion EUR)	.149	.215	.544	.692	.520
3	(Constant)	6.112	6.353		.962	.373
	Annual average inflation	.601	.220	.671	2.734	.034
	Monetary mass M3	-.012	.007	-.427	-1.549	.172
	Total consumption (billion EUR)	.038	.059	.139	.652	.539
4	(Constant)	8.976	4.396		2.042	.080
	Annual average inflation	.574	.207	.642	2.775	.027
	Monetary mass M3	-.009	.006	-.340	-1.471	.185
5	(Constant)	2.551	.529		4.825	.001
	Annual average inflation	.835	.113	.934	7.380	.000

a. Dependant Variables: Interest rate depending on monetary policy

Source: Table obtained from SPSS 17 application program

Starting from the data presented in table no.7, the linear regression model can be transcribed as follows:

R(Interest rate of The National Bank of Romania) = 2.551 + 0.835 * Annual average inflation + ε.

where: ε – error of the regression equation

The last stage of the modeling was the realization of the regression equation graph, which results in almost perfect linear regression. The independent variables we have originally selected grow as the dependent variable increases (Figure no.1).

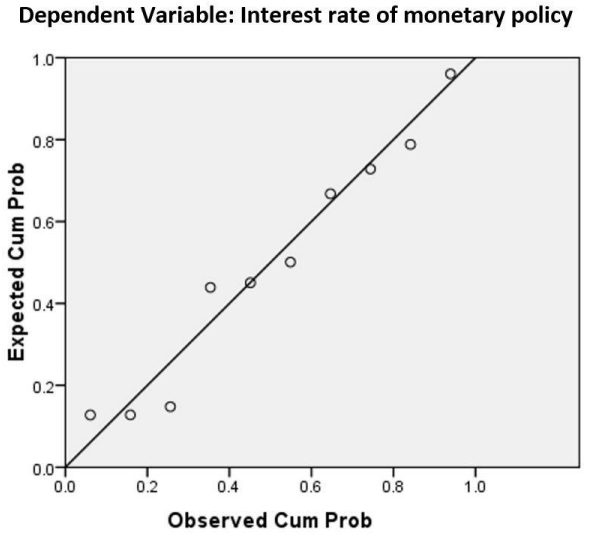

Figure no.1 Regression equation graph

Source: Table obtained from SPSS 17 application program

4. Conclusions

We appreciate that a quantitative assessment must always be accompanied by a qualitative assessment, by which factors that cannot be quantified through econometric modeling are surprised. Thus, when using the results of the econometric models, it must be borne in mind that, although they use impressive mathematical calculations, they are merely simplifications of reality. The benchmark interest rate promised by the National Bank of Romania has an impressive impact on the national economy, often in ways we cannot even imagine. It is not possible to state precisely the direction of interest rates, but it can be stated with certainty that the evolution of this monetary policy instrument will be closely monitored due to its special importance in the global economy as well as in the financial markets.

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