The Interest Rate Pass-through from Policy Rates to Interbank Interest Rates in the Romanian Financial System

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Abstract

To know and to understand the specific features of the interest rate transmission mechanism (one of Romania's most important monetary policy transmission channel) is of great importance for the National Bank of Romania and for the achievement of its monetary policy objectives. This paper investigates the interest rate pass-through from policy interest rates to interbank money market rates in the case of Romania for the period May 2003 – June 2011. In our research, we also focus our attention upon the effects of the recent financial market turmoil on the effectiveness of the interest rate pass-through in Romania. Results show that the reaction of the interbank interest rates to the modifications made by NBR with regard to the monetary policy interest rate was slow over the period May 2003 – September 2008, and "violent" in the period following October 2008. The empirical results obtained in this study might be useful for the increase of the efficiency of monetary policy implementation and provides useful information to whoever is eager to look inside Bernanke's and Gertler's famous "black box" (in our case, the Romanian monetary policy transmission mechanism).

Keywords:
Interest rate *pass-through*, policy interest rate, interbank money market interest rates, vector error correction model, autoregressive distributed lag model, cointegration vector analysis

JEL Classification: E43, E50, E52, E58, G20, G21

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[‡] This work was partially supported by the the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/88/1.5/S/47646].

1. INTRODUCTION

Financial intermediation is of great importance not only to economic growth but also to the well functioning of our society. Although researchers and policy makers use different terms like financial development, financial markets, financial system or finance (and many others) they stress the same issue that of *financial intermediation by banks*. Because of the fact that banks take on such a significant role in the process of financial intermediation they are considered to be important players in the financial system, especially in the Euro Area (where banks are the primary source of financing for the real economy).

But these financial intermediaries (banks) don't play by their own rules. The main figure in this pyramidal structure is the central bank. While the monetary authorities develop and implement monetary policy decisions regarding the path of an economy, banks play an significant part in the process of monetary policy implementation thus being "important conveyers of monetary policy impulses" [17: 462].

The transmission of monetary policy decisions in the real economy is achieved in different ways which will eventually reflect themselves when the results appear, in the amplitude and meaning of the decisions made, and, at the same time, in the duration and persistence of the resulted effects. The *monetary policy transmission mechanism* is made up of all the economic channels through which the monetary policy affects, for a certain time period, the evolution of the macroeconomic indicators specific to the real economy. The knowledge by the authorities that make the decisions related to monetary policy of the particularities of the transmission mechanism they implement, as well as of the economic environment in which monetary policy decisions are made, is extremely necessary both from the theoreticians' standpoint and from the perspective of professionals and political policy makers. The transmission channels receive and transmit adequate monetary policy decisions in an efficient and fast manner, and this is eventually reflected in the capacity of the central bank to steer real economy in the desired direction.

In this context, this study is aimed at *conducting a qualitative, but mostly a quantitative analysis, focusing on the case of Romania, on the particularities of the interest rate channel*, seen as a critical link between monetary policy decisions and the interbank market. In other words, the objective of our scientific paper is to quantify the reactions of the interest rates on the monetary market to the modifications occurred in the main instruments available to the National Bank of Romania (NBR), and especially in the monetary policy interest rate, as well as to outline the impact of the global financial crisis on the efficiency of the *pass-through*

of interest rates and the potential mutations that may occur at the level of this transmission channel. The study is part of a broader analysis of the *pass-through* of the interest rate from the monetary policy interest rates to the macroeconomic variables targeted by it.

2. THEORETICAL CONSIDERATIONS

The traditional channels of the interest rate constitute the basis of the well known Keynesian model dealt with in most economy textbooks, the IS/LM model. The following concise presentation is meant to explain the effects of monetary expansion with the help of the above mentioned transmission channel [12: 4]:

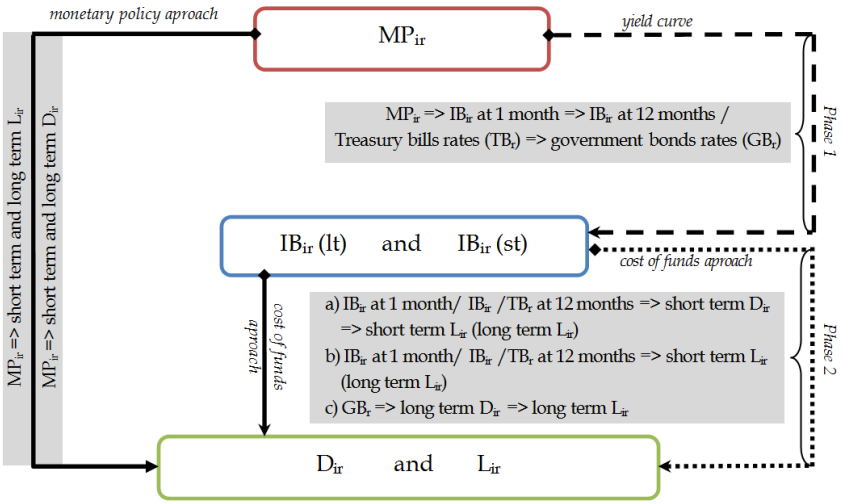
$$M \uparrow \Rightarrow ir \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow$$

According to the model, an expansionary monetary policy ($M \uparrow$) leads to a decrease in interest rates ($i_r \downarrow$) which lowers the cost of capital and increases investment ($I \uparrow$). This increase in investment will lead in time to an overall increase in output ($Y \uparrow$). Further investigations showed that in the case of the households segment, the variable I is represented by spending on durable goods and housing.

The numerous theoretic and empirical studies conducted during the last decades, which abound in information on the properties and particularities of this mechanism, prove the importance and the need to know the transmission mechanism of the monetary policy impulses (TMMP). The most recent research works in this respect are the ones undertaken in *the black-box of the interest rate pash-through*, which present different results and conclusions, depending on the analyzed countries, markets or periods. At the same time, there are few studies which take into consideration the impact of the international financial crisis on the TMMP in general and on the interest rate channel in particular. Such a study [9] reveals the fact that the transmission of the impulses from the monetary policy rates to the interest rates on the market has been interrupted, and we may see that the results of this process were different in the Euro area and in the USA: the "policy rate – short-term interest rates" channel has been affected to a smaller extent in the Euro area, whereas the "policy rate – long-term interest rates" channel has been severely affected in both regions [11: 327]. Other studies [3] draw attention on the efficiency of the transmission channels of the interest rate (in the euro zone) from the interbank market to the retail market. Another study conducted by ECB [6] shows that, during the financial crisis, the interest rates on the retail market responded in a satisfactory manner to the volatility of the EURIBOR rate and of other long-term interest rates.

In a study conducted by Egert and MacDonald [8] on the monetary transmission mechanism in Transition Economies (on the interest rate channel, credit channel, exchange rate channel and other assets price channel) they have reached the following conclusions: 1) in a framework characterized by price stickiness an innovation in short-term nominal interest rates will lead to variations in both short-term and long-term real interest rates; 2) investment spending for companies and households alike (spending on durable goods and housing) is sensitive to movements in real interest rates; 3) changes in real interest rates lead to variations in the income of holders of interest-bearing assets (as result of the *income effect*) and in the consumption/savings ratio (as result of the *substitution effect*); 4) the responses to impulses from the MPTM to real output and inflation occur with different lags that are unpredictable and vary over time and across countries.

Fig. 1 *The interest rate transmission mechanism*



Legend: [7], [8] author's calculation

The fundamental relation between *monetary policy rates*, the interest rates on the *interbank market* and the interest rates on the *retail market* is schematically presented in figure 1. Defined in literature as the "tumbling" [14: 62] or *pass-through* of the interest rate, it can be broken down into two stages. The first stage analyzes the impact of the modifications occurred at the level of the interest rates on the interbank market (IB_{ir}) for the entire spectrum of maturities (short term and long term), following the variations of the monetary policy interest rate (MP_{ir}), whereas

the second stage focuses on the transmission channel of the impulses from the interbank monetary market to the interest rates charged by the credit institutions (R_{ir}) from their customers (D_{ir} for deposit interest rates and L_{ir} for credit interest rates).

The literature in the field distinguishes among three important research directions (can be deduced from figure 1). On the one hand, there are studies which focus exclusively on the IB_{ir} – R_{ir} relation (for example [15]). This approach is based on the *cost of funds approach* [4]. Other authors (Tieman [18] among others) focuse on the direct impact of MP_{ir} on D_{ir} and L_{ir}, approach that Sander and Kleimer [17] name the *monetary policy aproach*. The third research direction analyzes the two distinct stages of the interest rate *pass-through* discussed in the previous paragraph [2]. Thus, the stability of the yield curve is of utmost importance for the analysis of the first stage of this research direction (MP_{ir} – IB_{ir}), whereas the second stage (IB_{ir} – D_{ir}/L_{ir}) can be studied by using the approach based on the *cost of funds approach*.

The main idea of the interest rate *pass-through* consists in: adjustments in the MP_{ir} generate modifications of the market rates, starting with the maturities of less than 12 months and moving through the yield curve towards the rates with longer maturities. Subsequently, the modifications which occur on the interbank market are transferred in the credit and deposit interest rates of commercial banks which influence, in their turn, during the final stage of monetary transmission, the level of savings, investments and consumptions and, thus, of overall demand and prices.

One of the reference points of this analysis has been the study conducted by Antohi *et al.* [1], in which the authors empirically analyze the transmission of monetary policy impulses on the financial variables of the Romanian economy by considering both segments of the transmission process. Another significant study is the one undertaken by Tieman [18], which focuses on the transmission channel of the interest rates for the countries belonging to Central and Eastern Europe and uses monthly data from the 1995:01–2004:02 perioud. Tieman managed to refute the hypothesis according to which the *pass-through* of the interest rates from the monetary policy to the interest rates plays a minor role in Romania in comparison with the role played in other transition economies. The investigation performed at NBR [15] with regard to the transmission of the variations of the interbank interest rates to the interest rates of the non-banking customers' credits and deposits over the 2003:05–2009:12 period confirmed the slow paced adjustment of the *pass-through* in the case of the Romanian economy, this behavior being given, among others, by the characteristics of the credit/deposit contracts.

3. Data used and research methodology

3.1 Data used in the study

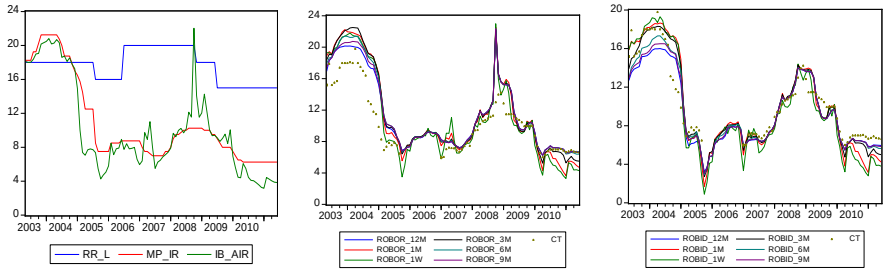
When analyzing the interest rate transmission mechanism we used data series at monthly frequency specified in Table 1 (the evolution of the indicators is presented in figure 2), covering the period May 2003 – June 2011 (this study is part of a broader analysis of the interest rate *pass-through*, reason for which the data refer to the period starting from May 2003). These data were taken from monthly reports of the NBR and processed in the EViews 5.1 program.

Table 1. *Data series used in the analysis of the interest rate pass-through*

Simbol	Description
MP_{ir}	monetary policy interest rate
RR_l	reserve requirements ratio denominated in lei
IB_{air}	average interest rate on transactions (interbank deposits)
T-bills	yields on treasury bills with discount (period 2004:09 – 2005:09) and yields on government bonds with interest (period 2007:12 – 2008:03)
ROBOR_1W	Romanian Interbank Offer Rate at 1 week over spot - a.r.
ROBOR_xM	Romanian Interbank Offer Rate with maturity of 1, 3, 6, 9, 12 months - a.r.
ROBID_1W	Romanian Interbank Bid Rate at 1 week over spot - a.r.
ROBID_xM	Romanian Interbank Bid Rate with maturity of 1, 3, 6, 9, 12 months - a.r.

Legend: measured in percentage points; a.r. = average rates

Fig. 2. *The evolution of the interest rates and other financial variables*



The analysis was performed on the following samples:

- *Sample no. 1* (data from the May 2003 – June 2011 period); this is the full sample containing 98 observations.

- *Sample no. 2* consists in data from the May 2003 – September 2008 period; the data from this sample are prior to the the effects of the international financial crisis felt in the Romanian economy following Lehman Brothers' bankruptcy.
- *Sample no. 3*; the period under consideration is October 2008 – June 2011.

Taking into consideration the fact that the interest rates are endogenously determined variables and show stochastic properties we focused our attention upon the *cointegration vector analysis* and the *vector error correction model.* Before using these analyses we tested the data using the Granger Causality test and the Correlations test.

3.2 Research methodology and the model

Before estimating a model that includes time series, it is vital to test the stationarity of the data; that way, one may conclude if the series are stationary (or I(0)) or if there is the possibility that they are cointegrated (the series have the same number of unit roots and the residuals are stationary). In the last case, the model represents a *long-run equilibrium relationship* between the cointegrated variables.

1. Testing the series for stationarity

To determine the unit root properties of the variables under investigation we apply two types of tests: the Augmented Dickey-Fuller (ADF) test [5] [16] and the Phillips-Perron (PP) test [13]. If the the results for the unit root tests will show that the time series in levels are I(1) and at first differences are stationary then we will consider that the interest rates are I(1) and further tests can be performed.

2. Granger Causality tests

To see how much of the current value of one variable can be explained by past values of another variable within the MPTM we used Granger Causality tests. The results will show if there are Granger-type causality relations between the NBR's monetary policy instruments and IB_{ir} thus testing the hypothesis that there is a functional and efficient interest rate channel. We will also be able to test if certain variables are endogenous or exogenous.

3. Correlation analysis

We will use the EViews econometric programme to estimate the degree of correlation between MP_{ir} and IB_{ir}. Empirical analysis uses simple correlations in the

raw series (level) for different lags. The results will show if there are weak or strong corrrelations and how fast interest rates react to changes in different exogenous variables. Also, the correlation coefficients will help us to determine the most appropriate interest rates to continue our empirical analysis.

4. Cointegration tests

To determine if there is a long-run equilibrium relationship among non-stationary time variables, i.e. the series are cointegrated or not, we use the methodology developed by Johansen [10] (the Johansen test).

5. Models of interest rate pass-through

The connection between MP_{ir} and IB_{ir} can be formalized in the following equation (1) using the *cost of funds* approach [4].

$$IB_{ir} = \alpha + \beta * MP_{ir} + \varepsilon \qquad \textbf{(1)}$$

where, IB_{ir} stands for the interbank interest rate,

MP_{ir} is the monetary policy interest rate,

β is the long-run pass-through coefficient, and **α** is the intercept.

The empirical literature on the interest rate transmission mechanism models focuses on the *error correction model* and it usually takes the following form (equation 2), provided the interest rate series are nonstationary processes and are cointegrated:

$$\Delta IB_{ir_t} = c + \omega_1 * \Delta IB_{ir_{t-1}} + \omega_2 * \Delta IB_{ir_{t-2}} + \boldsymbol{\mu_0} * \Delta MP_{ir_t} + \mu_1 * \Delta MP_{ir_{t-1}} + \mu_2 * \Delta MP_{ir_{t-2}} + \boldsymbol{\gamma_1} * ECM_{t-1} + \varepsilon \quad \textbf{(2)}$$

$$\text{and} \quad ECM_t = IB_{ir_t} - \alpha - \beta * MP_{ir_t}$$

where, **β** is the long-run multiplier,

$\boldsymbol{\mu_0}$ measures the immediate or the short-term pass-through,

$\boldsymbol{\gamma_1}$ measures the speed of adjustment of the short-run dynamics to the long-run equilibrium relationship (it shows how much of the gap created by a change in the policy interest rate is closed in one month).

If the interest rate series are I(1) processes but are not cointegrated we will use the Autoregressive Distributed Lag model (ARDL) specified in equation 3.

$$\Delta IB_{ir_t} = c + \omega_1 * \Delta IB_{ir_{t-1}} + \omega_2 * \Delta IB_{ir_{t-2}} + \boldsymbol{\mu_0} * \Delta MP_{ir_t} + \mu_1 * \Delta MP_{ir_{t-1}} + \mu_2 * \Delta MP_{ir_{t-2}} + \varepsilon \qquad \textbf{(3)}$$

$$\text{and} \quad \boldsymbol{\beta} = (\boldsymbol{\mu_0} + \mu_1 + \mu_2)/(1 - (\omega_1 + \omega_2))$$

where, **β** is the long-run pass-through coefficient (value computed),

μ_0 measures the immediate or the short-term pass-through.

To select the lag length we used the following information criteria: LR, FPE, AIC, SC and HQ (priority was given to the Schwarz and the Hannan–Quinn information criteria) progressively eliminating insignificant results.

4. EMPIRICAL REULTS

4.1 Testing the series for stationarity

The results for the unit root tests are outlined in Table 2. We used the ADF test (with intercept) and the PP test (with intercept) and the number of lags was chosen using the AIC and the SC.

Table 2. *Determination of integration order for selected interest rate series*

Variables	Type of test	**Sample 1**	**Sample 2**	**Sample 3**
		Integration order		
MP_{ir} and RR_l	ADF[1] and PP[2]	I(1)*	I(1)*	I(1)*
ROBID (1W, 1M, 3M)		I(1)*	I(1)*	I(1)*
ROBID (6M, 9M, 12M)		I(1)*	I(1)*	I(1)**
ROBOR (1W, 1M, 3M)		I(1)*	I(1)*	I(1)*
ROBOR (6M, 9M, 12M)		I(1)*	I(1)**	I(1)*
IB_{air} and T-bills		I(1)*	I(1)*	I(1)*

Legend: [1] the Augmented Dickey-Fuller test (with intercept); [2] the Phillips Perron test (with intercept); *, **, *** denote significance on 1, 5 and 10 percent level, respectively.

According to the results in Table 2, the data series are nonstationary processes. We can say thus with a 95% confidence level that the data for the three samples, according to ADF and PP test results, are I(1) processes. In conclusion, the nonstationarity of all the series allows us to continue our analysis by conducting Granger tests, correlation analysis and cointegration tests to identify the presence of a long-run equilibrium.

4.2 Granger Causality tests

Table 3 summarises the results for the Granger Causality tests. According to the null hypothesis an instrument at NBR's disposal (MP_{ir} and RR_l) *does not* Granger-cause a certain interest rate (ROBID, ROBOR and IB_{air}). It is clearly that there is a number of cases in which the null hypothesis is rejected therefore the instruments of

monetary policy *Granger causes* the interbank interest rates as well as the average yields of the T-Bills.

Table 3. *Results for the Granger Causality test*

Null Hypothesis	Sample 1					Sample 2					Sample 3				
	2003:05 – 2011:06					2003:05 – 2008:09					2008:10 – 2011:06				
	Lag(s) ★					Lag(s) ★					Lag(s) ★				
	1	2	3	6	12	1	2	3	6	12	1	2	3	6	12
MP_{IR} does not Granger Cause ROBID_1W	0.51	4.38*	4.15**	2.76*	0.90	0.07	3.33*	3.30*	2.25	0.98	4.42*	3.51*	3.06*	4.02*	2.24
MP_{IR} does not Granger Cause ROBID_1M	0.20	5.49**	4.71**	3.27**	0.97	0.42	4.69*	4.41**	2.74*	0.80	2.25	3.06	3.79*	1.86	0.52
MP_{IR} does not Granger Cause ROBID_3M	0.10	5.03**	4.27**	2.86*	0.77	0.75	3.85*	3.74*	2.18	0.47	0.43	3.15	3.64*	1.52	0.84
MP_{IR} does not Granger Cause ROBID_6M	0.07	3.93*	3.60*	2.52*	0.79	0.86	3.05	3.19*	1.94	0.40	0.01	2.81	2.38	1.44	1.32
MP_{IR} does not Granger Cause ROBID_9M	0.01	4.64*	3.59*	2.71*	1.07	1.44	3.87*	3.24*	1.91	0.57	0.01	2.85	2.50	1.51	1.36
MP_{IR} does not Granger Cause ROBID_12M	0.00	4.51*	3.69*	2.89*	1.18	2.11	3.80*	3.39*	2.03	0.74	0.00	2.83	2.54	1.54	1.37
MP_{IR} does not Granger Cause ROBOR_1W	4.34*	5.04**	4.86**	2.27*	1.22	0.08	3.85*	3.99*	2.33*	0.98	11.23**	5.87**	4.94**	3.78*	3.72*
MP_{IR} does not Granger Cause ROBOR_1M	2.68	4.60*	3.99	1.80	0.98	3.56	3.10	2.53	1.41	0.54	9.20**	5.57**	5.15**	2.82*	3.23
MP_{IR} does not Granger Cause ROBOR_3M	2.47	4.97**	4.01**	1.88	0.86	8.78**	1.69	1.03	1.12	0.38	8.12**	5.94**	5.91**	3.22*	3.97*
MP_{IR} does not Granger Cause ROBOR_6M	2.74	4.55	3.96	1.84	0.89	13.69**	0.77	0.77	1.37	0.54	8.53**	6.38**	6.35**	3.79*	5.52*
MP_{IR} does not Granger Cause ROBOR_9M	3.01	4.74	4.00	1.92	0.93	13.85**	1.44	0.99	1.48	0.46	8.62**	6.49**	6.56**	4.00**	6.27**
MP_{IR} does not Granger Cause ROBOR_12M	2.37	4.43*	3.66*	1.78	0.90	14.93**	1.98	1.41	1.00	0.51	8.24**	6.39**	6.53**	4.03**	6.38**
MP_{IR} does not Granger Cause IB_{air}	6.55*	4.87**	4.04**	2.07	1.05	0.12	3.09	2.76	1.59	0.90	15.75**	6.87**	4.89**	2.97*	2.85
MP_{IR} does not Granger Cause T-bills	0.04	3.66*	4.43**	2.32*	1.40	0.87	3.29*	3.22*	1.37	1.16	4.44*	12.97**	5.83**	7.05**	5.69**
RR_I does not Granger Cause ROBID_1W	1.62	1.18	0.87	1.38	0.95	0.22	1.10	0.75	0.91	3.00**	2.56	1.29	1.69	3.90**	2.09
RR_I does not Granger Cause ROBID_1M	1.63	0.53	0.34	0.77	0.77	0.21	0.30	0.23	0.32	1.60	1.49	1.18	1.21	3.84*	2.94
RR_I does not Granger Cause ROBID_3M	1.75	0.36	0.27	0.67	0.88	0.31	0.09	0.18	0.29	2.00	1.10	1.29	1.25	4.40**	2.32
RR_I does not Granger Cause ROBID_6M	1.92	0.33	0.26	0.55	0.99	0.38	0.09	0.15	0.22	1.96	1.31	1.57	1.36	6.05**	1.71
RR_I does not Granger Cause ROBID_9M	2.11	0.35	0.25	0.57	0.80	0.51	0.09	0.13	0.23	1.19	1.44	1.68	1.44	6.88**	2.03
RR_I does not Granger Cause ROBID_12M	2.24	0.35	0.28	0.68	0.94	0.59	0.20	0.21	0.33	1.60	1.50	1.71	1.46	7.32**	2.27
RR_I does not Granger Cause ROBOR_1W	1.61	1.36	0.90	0.75	0.56	0.23	0.90	0.58	0.48	2.21*	9.18**	4.03*	2.92	3.71*	3.00
RR_I does not Granger Cause ROBOR_1M	1.67	0.97	0.65	0.60	0.46	0.56	0.20	0.12	0.24	1.36	7.69**	3.64*	2.75	3.93**	3.05
RR_I does not Granger Cause ROBOR_3M	1.58	0.88	0.58	0.49	0.35	0.89	0.01	0.01	0.22	1.04	9.45**	4.50*	3.37*	5.23**	8.71**
RR_I does not Granger Cause ROBOR_6M	1.52	0.94	0.62	0.44	0.28	1.14	0.04	0.03	0.35	0.95	12.39**	5.89**	4.31*	6.36**	16.0**
RR_I does not Granger Cause ROBOR_9M	1.56	1.00	0.66	0.46	0.28	1.32	0.04	0.06	0.52	0.77	12.96**	6.15**	4.51*	6.75**	17.9**
RR_I does not Granger Cause ROBOR_12M	1.61	1.01	0.68	0.47	0.28	1.31	0.02	0.01	0.35	0.76	12.65**	6.04**	4.47*	6.90**	18.2**
RR_I does not Granger Cause IB_{air}	1.74	1.54	1.02	0.84	0.55	0.26	0.80	0.45	0.42	0.94	11.13**	4.62*	2.95	2.93*	3.69*

Legend: * (**) denote significance on 5% (1%) level; ★ no. months

According to the results presented in Table 3, we identify the following conclusions:
- the test results confirm the NBR capacity of influencing, by means of its instruments (primarily through the open-market operations and the reserve requirements mechanism) the great majority of interest rates on the interbank monetary market, as well as the average yield of the treasury certificates.
- there is a stable short-term and long-term relation (up to 6 months) between the monetary policy rates, as exogenous variables, and the interest rates on the interbank market, respectively the yield of the treasury certificates, as endogenous variables.
- at the level of sample 1 (data from the 2003:05 – 2011:06 period) the policy rate exercised the most significant influence on the other analyzed interest rates; there is a considerable Granger-type causality relation between the monetary policy interest rate and interbank interest rates with maturities of 1 week to 3 months.
- at the level of sample 2 (data from the 2003:05 – 2008:09 period), we may notice a relation of causality, only for the short-term (of up to one month), between MP_{ir} and

ROBOR rates (maturities of 3 to 12 months); we may also notice a Granger causality relation for the medium term (2-3 months) between MP_{ir} and ROBID rates (for the entire maturity spectrum) and the yields of the treasury certificates; as concerns the level of reserve requirements, we can not reject the null hypothesis of no Granger causality.

- at the level of sample 3 (the data from the 2008:10 – 2011:06 period), we may identify a stable and significant relation of Granger causality between MP_{ir} and ROBOR rates (all maturities); we may also notice the fact that the ROBID rates are no longer so sensitive to the variations of the policy interest rates and that the MP_{ir} variations also influence, to a significant extent, the yields of the treasury certificates.
- the influence of the modifications operated by NBR starting with the month of October 2008 (following the decrease of excess liquidity in the banking sector and the reaching by the banks of a state of liquidity shortage) in the level of reserve requirements for the liabilities denominated in lei of the credit institutions can be analyzed from the perspective of their influence on the interest rates. Thus, we may notice the fact that the reduction of the reserve requirements ratio from 20% to 18% (in November 2008) and, later on, to 15%, which is also the current rate, had a considerable impact on the interest rates at which Romanian banks borrow money from one another in the national currency.

As concerns the last analyzed period (2008:10 – 2011:06), we have some reserves with regard to the obtained results, as these may be distorted by the very reduced temporal dimension of the used dataset (33 observations).

4.3 Correlation analysis among the monetary policy instruments and the interbank rates (including T-bills)

According to the Cross Correlation analysis between the monetary policy instruments (MP_{ir} and RR_l) and the interbank rates (including T-bills) shown in Table 4, the central bank has a great influence upon the endogenous variables. In the first sample, the coefficient estimates (for series in level) range from 0.23 to 0.93 and the lags indicate variations from 0 up to 8 months. One can notice a strong correlation between the policy interest rate and the interbank rate (including T-bills yields).

The connection between MP_{ir} and the ROBID (the rate with a one week maturity has the most significant correlation coefficient, of 0.89) and ROBOR (the rate with a 3 months maturity is the one most sensitive to the oscillations of the monetary policy

interest rate, with a correlation coefficient of 0.93) rates is powerful and immediate (the variations are transmitted at a fast pace). The results of the correlation analysis reveal a strong connection between MP_{ir} and the yields of the treasury certificates with a discount (correlation coefficient of 0.87), and a one month lag.

Table 4. *Correlation analysis results among the monetary policy instruments and the interbank rates, including T-bills yields (series in raw data)*

Instruments	Sample 1				Sample 2				Sample 3			
	2003:05 – 2011:06				2003:05 – 2008:09				2008:10 – 2011:06			
NBR	MP_{ir}		RR_l		MP_{ir}		RR_l		MP_{ir}		RR_l	
IB_{ir}	Cor.	Lag*	Cor.	Lag*	Cor.	Lag*	Cor.	Lag*	Cor.	Lag*	Cor.	Lag*
ROBID RATES												
ROBID_1W	**0.8918**	0	0.3136	1	0.9246	1	0.3027	20	0.9531	0	0.8107	0
ROBID_1M	0.8901	0	0.3195	7	0.9292	1	0.3248	20	0.9596	0	0.8258	0
ROBID_3M	0.8883	0	0.2987	8	**0.9320**	1	0.3337	20	0.9668	0	0.8585	0
ROBID_6M	0.8671	0	0.3067	7	0.9223	1	0.3421	19	0.9710	0	0.8800	0
ROBID_9M	0.8516	0	0.3160	7	0.9148	1	0.3497	19	**0.9712**	0	0.8822	0
ROBID_12M	0.8318	0	0.3210	7	0.9042	1	0.3539	19	0.9710	0	0.8833	0
ROBOR RATES												
ROBOR_1W	0.9070	0	0.3339	1	0.9535	1	0.3003	22	0.9058	0	0.8534	0
ROBOR_1M	0.9177	0	0.3221	6	0.9694	1	0.3183	21	**0.9237**	0	0.8748	0
ROBOR_3M	**0.9303**	0	0.2928	1	0.9771	0	0.3211	20	0.9223	0	0.8983	0
ROBOR_6M	0.9231	0	0.2842	6	**0.9777**	0	0.3301	20	0.9160	0	0.9123	0
ROBOR_9M	0.9162	0	0.2914	6	0.9763	0	0.3345	20	0.9147	0	0.9136	0
ROBOR_12M	0.9074	0	0.2961	6	0.9726	1	0.3375	20	0.9162	0	0.9143	0
OTHER RATES												
IB_{air}	0.9069	0	0.3369	1	0.9438	1	0.2991	22	0.8922	0	0.8353	0
T-bills	0.8740	1	0.2293	8	0.9354	2	0.6044	18	0.9734	0	NA	-

Legend: IB_{air} = average interest rate on transactions (interbank deposits); T-bills = yields on treasury bills with discount; Cor = *Correlation*; * no. months

With regard to the ratio of reserve requirements, the connection between this monetary policy instrument and the interest rates on the interbank market is weaker (compared to the MP_{ir}): the correlation coefficients vary between 0.23 and 0.34 and the lags for which the most powerful correlations have been identified vary between 1 and 8 months, thus suggesting the fact that the analyzed interest rates (ROBID, ROBOR and the average interest rate of interbank operations) react at different velocities.

At the level of the data from sample 3, we may notice a stronger connection between the MP_{ir} and ROBID rates in comparison with that between MP_{ir} and ROBOR rates. The most powerful connection is that between MP_{ir} and ROBID at 9 months (correlation coefficient of 0.97), with a lag of 0 months. Both interbank rates react almost immediately to the variations of the monetary policy interest rate, thus managing to show the high capacity of the central bank of influencing market rates.

The relatively weaker correlation (in comparison with the other results) between the monetary policy interest rate and the average interest rate of interbank operations could be due to the smaller maturity of the latter.

The capacity of the central bank of influencing the interbank market is also confirmed by the results of the analyses of the correlation coefficients for the series from the first difference which were no longer included in this paper because of space related constraints. Taking into consideration the results of the Granger tests (Table 3) and the correlation coefficients obtained for the raw series (level) (Table 4), the rest of our analysis will use the monetary policy interest rate as the main monetary policy instrument. At the same time, because of the already mentioned constraints, we will restrict our analysis to the ROBID and ROBOR rates with 3 and 6 months maturities as reference rates of the interbank monetary market.

4.4 Cointegration tests

The results summarized in Table 2 show that all the interest rates are I(1), thus the series might be cointegrated and this is tested using the Johansen [10] statistical test.

Table 5. *The cointegration test results using the Johansen procedure*

MP_{ir} and IB_{ir}	Test type	**Sample 1**		**Sample 2**		**Sample 3**	
		VT[1)]	Ct?[2)]	VT[1)]	Ct?[2)]	VT[1)]	Ct?[2)]
ROBID_3M	Trace test	11.68	NO	11.21	NO	17.74**	YES
	Max-eigenvalue test	9.46	NO	10.21	NO	15.41**	YES
ROBID_6M	Trace test	10.85	NO	9.27	NO	21.76*	YES
	Max-eigenvalue test	8.65	NO	8.35	NO	18.99*	YES
ROBOR_3M	Trace test	16.59**	YES	24.51*	YES	26.47*	YES
	Max-eigenvalue test	15.48**	YES	23.23*	YES	25.15*	YES
ROBOR_6M	Trace test	16.25**	YES	26.25*	YES	28.51*	YES
	Max-eigenvalue test	15.05**	YES	24.94*	YES	27.18*	YES

Legend: *, **, *** denote significance on 1, 5 and 10 percent level, respectively.

[1)] The value of the test used in assessing whether a cointegration relation exists or not; [2)] The answer to the question: "Is there cointegration?"

After employing the Johansen methodology we obtain the values for the eigenvalue and trace tests shown in Table 5. According to the computed data there is a long-run relationship between the monetary policy interest rate and the ROBOR rates in all the samples. Regarding the ROBID rates, there are cointegration relations but only in the third sample. Although there are good results we have to maintain some

reserves as these may be distorted by the very reduced temporal dimension of the used dataset in sample 3 (2008:10 – 2011:06).

4.5 The model of interest rate pass-through

To investigate the pass-through from the monetary policy interest rate to interbank market rates (ROBID and ROBOR) we use the error correction model consisting of a single equation (equation 2). The validity of statistical inference depends on the propriety of the interest rates to be I(0) processes and also to be cointegrated. If the interest rate series are I(1) processes but are not cointegrated we will use the ARDL model specified in equation 3. The results of the estimated models are presented below (see Table 6).

Following the performed analysis we may notice the fact that, at the level of sample 1, the modifications of the monetary policy interest rate are transmitted, on the long term, on the ROBID rates, in a percentage of over 100%. Exceptionally, for the ROBOR rates, the pass-through of the interest rate is incomplete, the effects being transmitted in a percentage of almost 95% for the interest rates with a 3 months maturity and of 87% for interest rates with a 6 months maturity.

Table 6. *The estimated interest rate pass-through from policy rates to interbank market rates*

	Sample 1			**Sample 2**			**Sample 3**		
Coefficients The interest rate	Immediate *pass-through* μ_0	Long term *pass-through* β	Speed of adjust-ment γ_1	Immediate *pass-through* μ_0	Long term *pass-through* β	Speed of adjust-ment γ_1	Immediate *pass-through* μ_0	Long term *pass-through* β	Speed of adjust-ment γ_1
ROBID_3M	0.439*	1.089	-	0.430*	1.081	-	1.752*	1.901*	-0.680*
	(0.140)	-		(0.145)	-		(0.574)	(0.096)	(0.166)
ROBID_6M	0.456*	1.035	-	0.449*	1.019	-	1.792*	1.783*	-0.628*
	(0.119)	-		(0.128)	-		(0.440)	(0.078)	(0.150)
ROBOR_3M	0.693*	0.952*	-0.207*	0.442*	0.891*	-0.134*	4.393*	2.358*	-1.385*
	(0.229)	(0.126)	(0.071)	(0.113)	(0.099)	(0.059)	(1.412)	(0.116)	(0.253)
ROBOR_6M	0.698*	0.864*	-0.193*	0.414*	0.705*	-0.073**	4.572*	2.219*	-1.465*
	(0.222)	(0.131)	(0.070)	(0.095)	(0.152)	(0.035)	(1.340)	(0.104)	(0.252)

Legend: *, **, *** denote significance on 1%, 5% and 10% level, respectively; standard deviations are in ( )

When interpreting the values of the pass-through of the interest rate corresponding to samples 2 and 3, we must pay special attention to the specificity of the data belonging to the two analyzed periods (the period before and after the month of

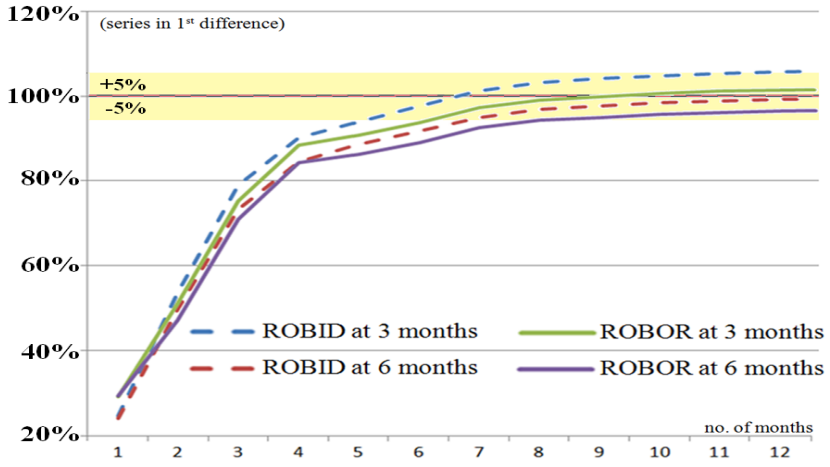
October 2008, when the effects of the international financial crisis were felt in the Romanian economy). Thus, before the effects of the international financial crisis had become more visible: 1) the Romanian economy registered a period of sustained growth, accompanied by a continuous process of disinflation and nominal appreciation of our national currency (with effects on the risk premium); 2) there was a gradual intensification of the competitive process in the banking sector, and the credit institutions used their resources for augmenting their market share; 3) following the loosening of monetary control, there was excess liquidity. After October 2008, following economic and financial shocks, we witnessed: 1) the deterioration of the macroeconomic conditions (including inflation); 2) the powerful increase of competitiveness in the banking sector, focusing on the efficient management of the quality of the credit portfolio and the structure of the balance sheets; 3) the modification of the net position of the banking system, supported by the increasing level of mistrust among credit institutions (the amplification of the risk perceived by banks was one of the main effects).

If, in October 2008, companies were more interested in setting up deposits than in obtaining loans (as a result of excess liquidity), observation resulted by analyzing the values of the parameter β, associated with the ROBID, respectively EURIBOR rates, after this period we may notice a through change in the behavior of the banking sector (the transmission surplus which affected both interest types might have been caused by the firm management by NBR of the liquidity on the monetary market, as well as by the increasing mistrust which existed among credit institutions). The results reveal an *overshooting* of over 170% for ROBID rates and of over 220% for ROBOR rates in response to the variations of the monetary policy interest rates (we may notice the concern of the banks in relation to obtaining financial resources, as external liabilities were no longer an option). The *cash* hunt and the panic specific to data in sample 3 also led to the increase of the values of the μ_0 indicator, practically annihilating any modification at the level of the monetary policy interest rate. Before October 2008 interbank rates would receive, during the first month, approximately 43% of the modification of the monetary policy interest rate. After the manifestation of the effects of the crisis in the Romanian economy, the short-term *pass-through* became very sensitive, registering excessively big values (the ROBID rates would receive during the first month over 175% of the variations of the monetary policy interest rate, whereas values of over 430% were registered for the ROBOR rates). As a result of the very big values registered at the level of parameters β and μ_0, the values of parameter

γ_1 are also high for the data in sample 3, thus suggesting a high adjustment rate of the short-term dynamics, moving towards long-term equilibrium.

The transmission of a temporary shock of the monetary policy interest rate on the interbank market interest rates is illustrated in figure 3. In order to obtain the values, we used an unrestricted VAR with data series in the first difference and the obtained response employed cumulated values. We may notice that the adjustments at the level of the monetary policy interest rate are gradually transmitted to the interbank monetary market with an immediate response of approximately 25% for ROBID rates and of 30% for ROBOR rates.

Fig. 3. *The impulse-response function of MP_{ir} to IB_{ir}*



A simple analysis of each of the two maturities reveals the fact that, although short-term reactions are more marked in the case of ROBOR rates, the ROBID rates undergo an ampler adjustment on the long term. We may thus conclude that the results obtained by using an unrestricted VAR validate the remarks made when using the error correction model.

5. CONCLUSIONS

According to the results obtained in this paper, the reaction of the interbank interest rates to the modifications made by BNR with regard to the monetary policy interest rate was *slow* over the period May 2003- September 2008, and *violent* in the period following October 2008. Among the factors which affected the *pass-through* of the interest rates, it is worth mentioning: the change of the net position of BNR in relation to the banking system, the augmenting mistrust among credit institutions, the increase of risk perception, the deterioration of the expectations of the banking institutions concerning the evolution of the monetary policy interest rate, the lack of financing sources, the deterioration of macroeconomic indicators, etc. The results with this study are in agreement with the conclusions drawn in other specialized papers dealing with the case of Romania (but also with the case of other countries from the Euro area or Central and Eastern Europe Countries).

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