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Interest rate channel in Romania: assessing the effectiveness transmission of monetary policy impulses to inflation and economic growth

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Abstract. *The purpose of our paper is to evaluate the effectiveness of monetary policy transmission mechanism in Romania, via interest rate channel. Using a Vector Error Correction Model and impulse response analysis, we study the impact of a positive monetary policy shock via short term interest rate on macroeconomic variables over the period 2003M01-2012M06. Our empirical results are in line with economic theory and we can say that we are witnessing to an improvement in the transmission effectiveness of monetary policy impulses via interest rate channel.*

Keywords: monetary policy; interest rate; vector error correction model; Romania; financial stability.

JEL Codes: E52, C58, E43, P48.
REL Codes: 8E, 8J.

1. Introduction

The interest in analyzing the monetary policy transmission mechanism has increased in the last decade and vector autoregressive model (VAR), proposed by Sims (1980), has been extensively used in the empirical approach.

The purpose of our paper is to evaluate the effectiveness of monetary policy transmission mechanism in Romania, via interest rate channel. In this endeavor, we start from VAR approach but we take into account the number of cointegrating relationships resulting Vector Error Correction methodology (VECM).

Thus, using a Vector Error Correction Model and impulse response analysis, we study the impact of a positive monetary policy shock of National Bank of Romania, via short term interest rate, on macroeconomic variables, over the period 2003M01-2012M06.

The study of the monetary policy transmission mechanism is a widely debated issue in the literature in the field, but the empirical results for Central and Eastern European countries (CEE) are less robust. First of all, we should mention that, despite of many studies carried out on the example of USA, UK or Euro zone, we find a few analyzes on the example of CEE countries: Ganev et al. (2002), Elbourne and de Haan (2006), Coricelli, Egbert & MacDonald (2006), Anzuini and Levy (2007), Minea and Rault (2008), Gavin and Kemme (2009), Jarocinski (2010), Minea and Rault (2011), Pirovano (2011), Spulbăr et al. (2012). Secondly, the academic literature does not provide any consensus regarding the sign and the size of macroeconomic variables responses. Sometimes inconsistent results for the same country appear.

Therefore, the contradictory results previously obtained for the candidate countries motivate our empirical research.

The paper is organized as follows. The next section lays out the data and the methodology used. Section 3 evaluates the empirical results. Section 4 concludes and states future research developments.

2. The methodological context

The transmission of monetary policy impulses via interest rates to inflation and economic growth is analyzed using a Vector Error Correction Model, in order to capture the dynamic interactions between the variables.

2.1. The data

We define a six dimensional VECM model with the following variables:

- log of industrial industrial production index (log_pi);

- log of consumer price index (log_ipc);
- three months short term interest rate (rds);
- log of total loans for the banking system (log_cr);
- log of stock prices (log_ib);
- log of exchange rate measured as local currency versus the single European currency (log_cs).

The data series are expressed in logarithm in order to stabilize the variance, and seasonally adjusted, except short-term interest rate. This variable is the instrument of monetary policy in our empirical research. The analysis is based on monthly data series spanning the period between January 2003-June 2012, which means 114 observations. The start of the analyzed period is given by the availability of data series, which are taken from IMF-IFS statistics (via Datastream).

In the aftermath of the crisis, were discussed the virtues of inflation targeting strategy and how a low inflation rate ensures financial stability and economic growth. Thus, the economic and financial crisis has determined central banks to pay greater attention to financial stability, because a stable financial system provides necessary conditions for robust implementation of an efficient monetary policy. Also, there is a bi-univocal relationship between financial stability and economic growth (Voinea, 2011):

- financial stability contributes to economic growth and the efficient functioning of the real economy due to confidence in the allocation and effective utilization of financial resources;
- the economic growth is the fundamental premise of financial stability, because it provides the necessary resources to meet the requirements of economic development and raising living standards.

Thus, the theoretical framework of selected variables is based on previous specifications. We have considered the consumer price index as proxy variable for inflation and industrial production as proxy for economic growth. In addition, we have included one proxy for major markets which conceal risks that may affect the stability of the domestic financial system, as follows:

- loan portfolio as proxy for banking system;
- stock index as proxy for capital market;
- exchange rate measured by local currency versus euro as proxy for foreign exchange market.

In line with Jarocinski (2010), we have not included monetary aggregates in the baseline model. It is assumed that central banks target short-term interest rates and adjust the monetary aggregates accordingly with this objective.

Chow Break-Point and Chow forecast tests highlight statistically significant results in terms of structural breaks in data (p-value ≤ 0.05), due to financial crisis. In order to check whether a structural analysis is still valid for the whole sample, we have compared impulse responses of different subsamples and we find that the patterns remain unchanged. In line with other studies (Rosenkranz, 2009, Gerke et al., 2008) we conclude that the whole sample remains adequate for the empirical research.

2.2. The methodology

The VAR model assumes that the economy can be described by the following equation:

$Y_t = \nu + A_1 \times Y_{t-1} + \ldots A_p \times Y_{t-p} + u_t$

where Y_t is an n × 1 vector of endogenous variables, ν is a n × 1 vector of constants, A_i are n × n coefficient matrices and u_t is an n × 1 vector of structural disturbances with $E(u_t u_t') = \sum_u$. The endogenous variables include log of industrial industrial production index, log of consumer price index, 3 months short term interest rate, log of stock prices, log of total loans for the banking system, log of exchange rate measured as local currency versus the single European currency. The vector of endogenous variables Y_t is

$$Y_t = \begin{bmatrix} \text{Industrial production index} \\ \text{Consumer price index} \\ \text{Short term interest rate} \\ \text{Loan portfolio} \\ \text{Stock index} \\ \text{Exchange rate EUR/RON} \end{bmatrix}$$

Taking into consideration the fact that our empirical analysis focuses on six variables, there is the possibility of equilibrium relationships between them. Therefore, we have tested the number of cointegrating relationships using the Johansen trace test. On the basis of our cointegration analysis results, we started out from a VECM form

$\Delta Y_t = \prod Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + u_t$

with cointegration rank r and the lag orders one less than the VAR orders.

In order to check if the fitted VECM provides a good representation of the time series set, we have tested against the residual autocorrelation, nonnormality, ARCH effects and parameter instability.

Next, we assume that structural shocks are orthogonal and we consider a VECM form, where the deterministic trend is dropped out and all the observable stochastic variables are modelled as endogenous:

$A\ \Delta Y_t = \prod^* Y_{t-1} + \Gamma_1^* \Delta Y_{t-1} + ... + \Gamma_{p-1}^* \Delta Y_{t-p+1} + \varepsilon_{t.}$

Premultiplying the previous relation with A^{-1} we obtain the reduced form:

$Y_t = \prod Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{p-1} \Delta Y_{t-p+1} + A^{-1}\varepsilon_{t,}$

where

$\prod = A^{-1} \prod^*$, $\Gamma_j = A^{-1}\Gamma_j^*$ with $j=1,...,p-1$.

The relationship between the vector of structural shocks ε_t and the vector of VECM innovations u_t is the following:

$u_t = B \times \varepsilon_t,$

where B is a lower triangular matrix obtained from a Cholesky decomposition of the covariance matrix $\sum_u$, such that $BB' = \sum_{u.}$ ε_{rds} is the monetary policy shock.

The orthogonalized shocks are given by

$\varepsilon_t = B^{-1} \times u_t$

Taking into consideration that the effects of shocks are easily seen in terms of moving average representation:

$y_t = \Phi_0 u_t + \Phi_1 u_{t-1} + \Phi_2 u_{t-2} + ...,$

we obtain the following form:

$y_t = \omega_0 \varepsilon_t + \omega_1\ \varepsilon_{t-1+...,}$

where $\omega_i = \Phi_i \times B$, $\omega_0 = B$. $\Phi_i \times B$ are the matrices of impulse response function.

VECM analysis ends within three types of results (Botel, 2002): impulse response function, the forecast error variance decomposition and Granger causality. In our research, we have focused on the first two.

Variance decomposition calculates, in percentage, the proportions from changes in a variable which is due to own innovations and innovations to other variables. The results should be interpreted with caution since "the total effect upon a variable is assigned, in whole, to variables included in the system" (Botel, 2002). In our research, we have analyzed, mainly, the percentage change in macroeconomic variables explained by an innovation in interest rate.

3. Empirical results

The stationarity of the time series was analyzed using Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. All the variables are integrated of order one, I (1). In order to preserve space, we report only the results of the ADF test (Table 1).

Table 1

The unit root analysis according to Augmented Dickey-Fuller test

	Variable	Notation	ADF level critical value			ADF t-statistic	ADF first difference critical value			ADF t-statistic	Con-clusion
			1%	5%	10%		1%	5%	10%		
Romania	Log of industrial production index	log_pi	-3.96	-3.41	-3.13	-2.5357	-3.43	-2.86	-2.57	-3.4837	I(1)
	Log of consumer price index	log_ipc	-3.43	-2.86	-2.57	-2.4227	-2.56	-1.94	-1.62	-8.4845	I(1)
	Short term interest rate	rds	-3.43	-2.86	-2.57	-2.0505	-2.56	-1.94	-1.62	-7.9628	I(1)
	Log of total loans	log_cr	-3.96	-3.41	-3.13	0.1095	-3.43	-2.86	-2.57	-4.0858	I(1)
	Log of stock prices	log_ib	-3.96	-3.41	-3.13	-2.1375	-3.43	-2.86	-2.57	-3.9196	I(1)
	Log of exchange rate EUR/RON	log_cs	-3.43	-2.86	-2.57	-1.3678	-2.56	-1.94	-1.62	-6.5852	I(1)

Source: own estimates based on JMulTi.

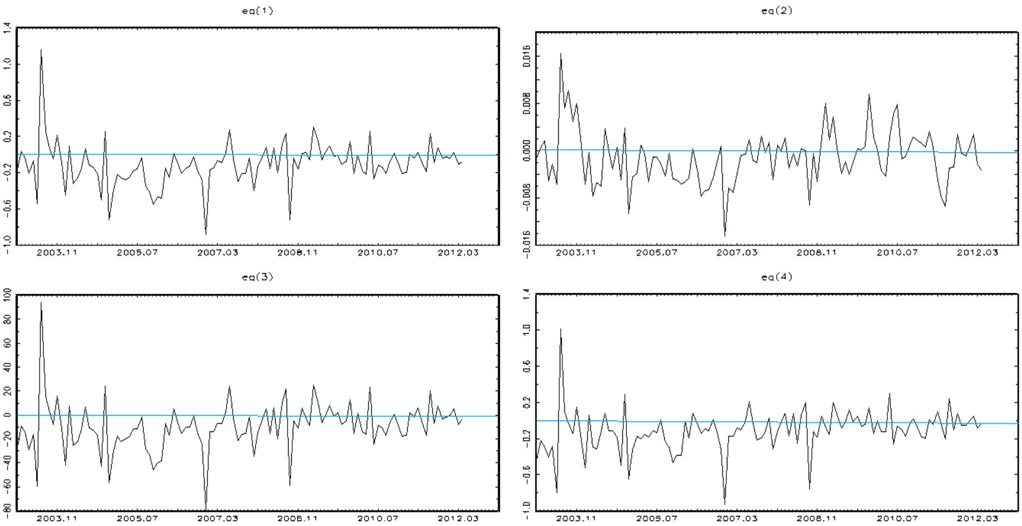
Two lags seem sufficient to capture the dynamic of the system, according to Akaike Info Criterion and Final Prediction Error. Johansen cointegration test emphasizes the existence of four equilibrium relationships between the variables. Within the cointegration analysis, we have considered both cases (constant and trend, respectively trend orthogonal) and we have got the final decision taking into account the results for each bivariate system, separately, considering a risk $\alpha = 0.05$. In order to preserve space we report only the results of cointegration analysis based on the system of six variables (Table 2).

Table 2

Johansen Cointegration test for the six dimensional system

No. of lags	Deterministic term	Null hypothesis	Test statistic	Critical values		Conclusion
				90%	95%	
1	constant and trend	r=0	268.52	112.54	117.45	r=4
		r=1	165.41	84.27	88.55	
		r=2	94.65	60.00	63.66	
		r=3	50.86	39.73	42.77	
		r=4	23.16	23.32	25.73	
		r=5	8.92	10.68	12.45	
	orthogonal trend	r=0	224.82	91.01	95.51	r=4
		r=1	122.29	65.73	69.61	
		r=2	59.58	44.45	47.71	
		r=3	32.17	27.16	29.80	
		r=4	12.81	13.42	15.41	
2	constant and trend	r=0	201.74	112.54	117.45	r=4
		r=1	129.72	84.27	88.55	
		r=2	77.78	60.00	63.66	
		r=3	43.90	39.73	42.77	
		r=4	23.21	23.32	25.73	
		r=5	10.04	10.68	12.45	
	orthogonal trend	r=0	162.12	91.01	95.51	r=3
		r=1	90.38	65.73	69.61	
		r=2	50.36	44.45	47.71	
		r=3	26.48	27.16	29.80	
		r=4	12.85	13.42	15.41	

Source: own estimates based on JMulTi.



Source: own estimates based on JMulTi.

Figure 1. *The graph of the four cointegration relationships identified in Table 2*

The fitted model VECM (1) with r = 4 satisfies the stability condition, since all inverse characteristic roots of the VECM estimated coefficients matrices have modules less than 1 and lie within the circle of radius 1. Diagnostic analysis shows that residuals are not normally distributed according to Jarque Bera test. But since the hypothesis of constant coefficients is not rejected, we have decided to keep this model as the basis for our analysis. With a comfortable margin, the other tested hypotheses are not rejected at 5% significance level (Table 3).

Table 3

Diagnostic Tests for VECM(1) and r = 4

Diagnostic test	Test statistic	p-value
Portmanteau test (16)	516.4908	0.1209
MARCH-LM (5)	2226.0000	0.3725
LM(2)	75.7348	0.3589

Univariate ARCH LM

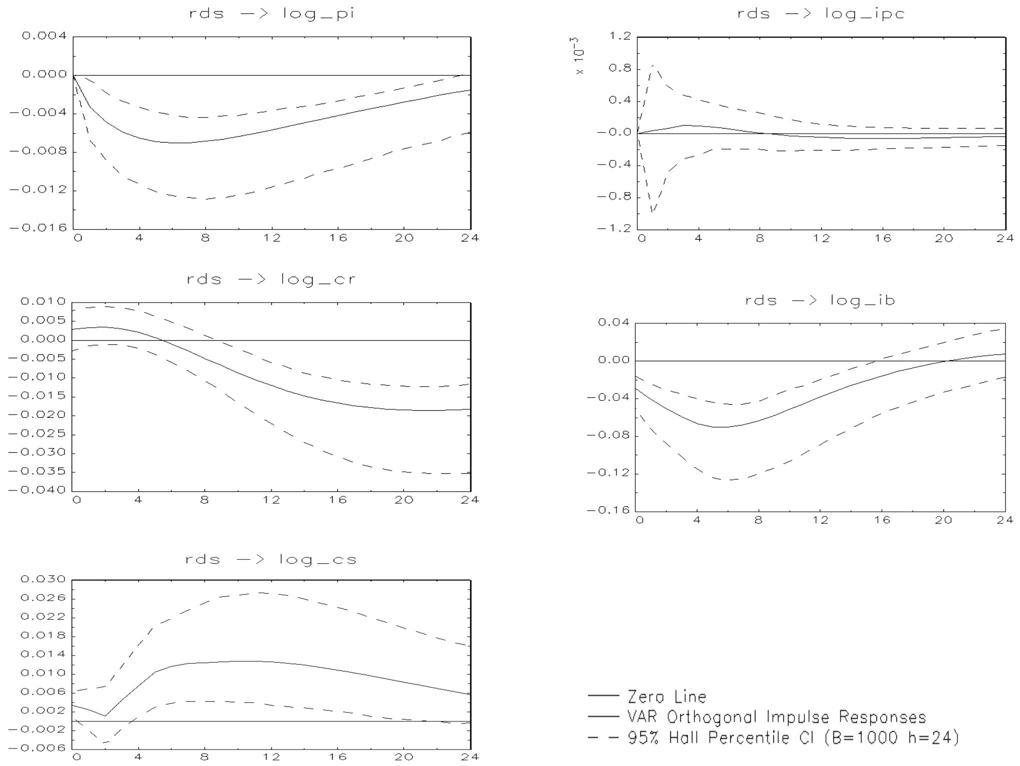
variable	teststat	p-Value(Chi^2)	F stat	p-Value(F)
u1	9.6281	0.8853	0.6696	0.8147
u2	13.6909	0.6217	0.9998	0.4661
u3	12.8450	0.6841	0.9283	0.5410
u4	10.9517	0.8125	0.7737	0.7096
u5	9.4789	0.8924	0.6581	0.8253
u6	24.9708	0.0703	2.1172	0.0154

JARQUE-BERA

variable	teststat	p-Value(Chi^2)	skewness	kurtosis
u1	0.3712	0.8306	0.0491	2.7343
u2	84.3196	0.0000	1.1467	6.6017
u3	605.9364	0.0000	1.5093	14.0409
u4	168.6029	0.0000	0.3957	8.9857
u5	21.1025	0.0000	-0.6291	4.7262
u6	1.4468	0.4851	0.2197	3.3461

Source: own estimates based on JMulTi.

In what follows, we report the results of impulse response analysis (Figure 2). Thus, we observe that an increase in interest rates causes a contraction of industrial production index, the negative peak is reached after roughly six months and it is statistically significant. On the short run, the consumer price index increases, but on medium and long run follows a slightly downward trend, according to economic theory. However, the effect is statistically insignificant because of the large error bands. A positive shock of monetary policy via interest rate causes a slowdown, in long-term, of lending activity, the response of loan portfolio is persistent and becomes statistically significant after about 10 months. Also, stock index lose about six percent, and the effect is statistically significant. According to economic theory, the national currency appreciates against the Euro in the short run, but the effect is not statistically significant because of the large error bands. In the long term, the Romanian leu depreciates against the Euro.



Note: Vertical axis-the deviation from the baseline scenario, horizontal axis- the number of months after the shock
Source: own estimates based on JMulTi

Figure 2. *The response of industrial production index, consumer price index, credit portfolio, stock index and exchange rate in Romania to a monetary policy shock together with 95% Hall percentile confidence interval based on 1,000 replications*

Unlike our results, Elbourne and de Haan (2006) find a positive relationship between industrial production and interest rate using a SVAR model with data spanning the period 1998M06-2004M06, authors' explanation being the high level of inflation experienced by our country in that period. Albulescu (2010), using a regression model over the period January 2003-August 2008 find that ROBID three months is not an efficient instrument of central bank in order to correct the imbalances related to the evolution of asset prices. The difference from our results is due to the methodology used and tested period, as well. We can also say that we are witnessing to a consolidation of interest rate, as an instrument of monetary policy transmission in Romania, which is a fulcrum for inflation targeting strategy (Spulbăr et al., 2012).

Table 4

The responses of macroeconomic variables to a monetary policy shock in Romania (2003: M01 2012: M06)

The variable	Resulted from empirical analysis	Expected according to economic theory
Industrial production index	-*	-
Consumer price index	-	-
Loans portfolio	-*	-
Stock prices	-*	-
Exchange rate EUR/RON	-	-

Note: - negative response, + positive response, * statistically significant response at 5% level
Source: own estimates based on JMulTi.

From the perspective of monetary policy, our empirical results highlight the followings:

- all the variables move in the expected direction under the impact of monetary policy shock (Table 4). Therefore, we subscribe to Jarocinski (2010) who states that "we need to go beyond the simple rule that monetary policy is less effective in less financially developed countries".
- we are witnessing to an improvement in the transmission effectiveness of monetary policy impulses via interest rate channel.

From the perspective of ensuring financial stability, our empirical results highlight the followings:

- there is a statistically significant inverse relationship between interest rate and stock prices (Table 4), which means that the interest rate represents an effective instrument of National Bank of Romania in order to prevent the construction of speculative bubbles related to the evolution of stock prices.
- since Romanian stock market is sensitive to unexpected changes in interest rates, a good alternative for investors would be to rely on forecasts regarding the evolution of this indicator when make investment decisions in this market.
- there is an inverse statistically significant nexus between interest rate and loan portfolio for the banking system (Table 4). This shows that the interest rate represents an effective tool of intervention in order to prevent excessive lending to households and companies. Also, loan portfolio responds with delay to a monetary policy shock by raising interest rates compared to stock index. For instance, in Romania, after an unexpected increase in interest rate, loan portfolio responds significantly after roughly 10-11 months. A possible explanation could be the fact that, in the short-term, banks offset reductions in liquidity through the sale of securities, credit supply remaining virtually unchanged. But, in the long-run, a tightening monetary policy determines banks to stop granting new loans.

Table 5

Variance decomposition: percentage of variation for line variables assigned to column variables

Variable	Time horizon (months)	Industrial production	CPI	Short term interest rate	Loan portfolio	Stock index	Exchange rate
Industrial production	1	1.00	0.00	0.00	0.00	0.00	0.00
	6	0.61	0.01	0.25	0.02	0.06	0.04
	12	0.50	0.03	0.34	0.02	0.09	0.02
	18	0.44	0.03	0.39	0.01	0.11	0.01
	24	0.40	0.04	0.43	0.01	0.11	0.01
Consumer Price Index	1	0.03	0.97	0.00	0.00	0.00	0.00
	6	0.04	0.64	0.10	0.20	0.01	0.01
	12	0.04	0.59	0.11	0.22	0.01	0.01
	18	0.05	0.60	0.13	0.18	0.01	0.02
	24	0.06	0.61	0.15	0.14	0.01	0.03
Short term interest rate	1	0.00	0.01	0.99	0.00	0.00	0.00
	6	0.04	0.08	0.49	0.22	0.05	0.13
	12	0.04	0.11	0.42	0.24	0.04	0.15
	18	0.05	0.14	0.34	0.28	0.03	0.16
	24	0.06	0.16	0.30	0.29	0.03	0.16
Loan portfolio	1	0.02	0.00	0.05	0.93	0.00	0.00
	6	0.03	0.02	0.09	0.81	0.01	0.05
	12	0.09	0.02	0.12	0.55	0.12	0.11
	18	0.12	0.01	0.32	0.25	0.20	0.11
	24	0.12	0.01	0.46	0.11	0.21	0.10
Stock index	1	0.01	0.00	0.26	0.03	0.70	0.00
	6	0.07	0.01	0.46	0.03	0.40	0.02
	12	0.08	0.04	0.56	0.01	0.30	0.02
	18	0.09	0.04	0.58	0.01	0.27	0.02
	24	0.10	0.04	0.58	0.01	0.25	0.01
Exchange rate	1	0.00	0.01	0.08	0.26	0.02	0.63
	6	0.01	0.01	0.29	0.36	0.04	0.29
	12	0.02	0.01	0.51	0.24	0.06	0.18
	18	0.02	0.01	0.55	0.21	0.06	0.15
	24	0.02	0.01	0.57	0.20	0.07	0.14

Source: own estimates based on JMulTi.

At six months time horizon, the variation of short-term interest rate, in Romania, is explained in proportion of 49% by its innovations. At longer time horizons, the shocks from loan portfolio and exchange rate become more important, reaching to explain 29% and respectively 16% of the variation in short-term interest rate after 24 months. Innovations in short-term interest rate explains between 26% and 58% of the variation in stock market index. Monetary shocks are an important factor in explaining industrial production, loan portfolio and exchange rate, after 24 months, 43%, 46% and 57% from the variation of previously mentioned variables is due to short-term interest rate

(Table 5). Also, monetary shocks explain less than 15% of the variation in consumer price index in the considered time interval.

The main caveats of the proposed model are:

- the residuals are not normally distributed according to Jargue Bera test;
- the small number of variables included in the system, six in our case.

To preserve as many degrees of freedom, the models do not include more than six to eight variables (Bernanke, Boivin, Eliasz, 2004). This small number of variables does not capture all the information which a monetary authority takes into consideration. On the other hand, the impact of a monetary policy shock can be analyzed only for the variables included in the model.

4. Conclusions

Using a Vector Error Correction Model and impulse response analysis, we have studied the response of macroeconomic variables to a monetary policy shock via interest rate during 2003M01-2012M06.

Our empirical results show that, under the impact of a positive monetary policy shock via interest rate, the macroeconomic variables move in the expected direction: the industrial production index shrinks, the consumer price index follows a slightly downward trend in medium and long-run, the lending activity tempers, stock index reduces and the national currency appreciates against the Euro. These effects are statistically significant for three of the five mentioned variables, namely: industrial production index, stock index and loan portfolio.

The variance decomposition shows that innovations in short-term interest rate explains between 26% and 58% of the variation in stock market index. Monetary shocks are an important factor in explaining industrial production, loan portfolio and exchange rate; after 24 months, 43%, 46% and 57% from the variation of previously mentioned variables is due to short-term interest rate. Also, monetary shocks explain less than 15% of the variation in consumer price index in the considered time interval.

From the perspective of monetary policy, we can say that we are witnessing to an improvement in the transmission effectiveness of monetary policy impulses via interest rate channel. From the perspective of ensuring financial stability, our empirical results show that interest rate represents an effective instrument of intervention in order to prevent the construction of speculative bubbles of stock prices and excessive lending to households and economic agents.

Our paper is useful to those involved in central bank activity, because it assesses the effectiveness transmission of monetary policy impulses via interest rate, as instrument, in an emerging economy-Romania.

Since the main weakness of VEC models is the limited number of variables included in the analysis, as future research directions we suggest using Factor Augmented VAR model (FAVAR) in order to consider a broad set of variables, default external influences, according to Balabanova and Brüggemann (2012).

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Appendix

The data sets used in the empirical analysis: log of industrial production index (log_pi), log of consumer price index (log_ipc), short term interest rate (rds), log of total loans (log_cr), log of stock prices (log_ib), log of exchange rate EUR / RON (log_cs) (January 2003-June 2012