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### THE IMPACT OF MONETARY VARIABLES ON THE ECONOMIC GROWTH AND SUSTAINABLE DEVELOPMENT: CASE OF SELECTED COUNTRIES

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**Abstract.** For establishing the best monetary policy it is essential to know if in practice monetary variables determine gross domestic product (GDP) in constant prices. Price stability contributes to the formation of stable environment for the development of commercially sustainable activities and expresses the responsibility of central banks for sustainable industrial development. It contributes to maximizing the GDP, employment, stable interest rates and sustainable economic development which have consequences for households' welfare as well as enterprises' value maximization. For a set of more monetary variables, we identified that in Romania money aggregates M2 and M3 as well as internal credit were strongly correlated with GDP over the time period 1995:Q1-2015:Q4, while in Slovakia only M2 and M3 were strongly correlated with GDP in the same time period. Contrary to expectations, according to a Bayesian linear regression, the internal credit changes had a negative impact on economic growth on the overall period. This conclusion is consistent with other empirical studies. This paper's analysis discovered that the aforementioned negative correlation is due to the crisis period, because the regime-switching Bayesian model indicated that only in times of economic contraction changes in internal credit negatively affected economic growth.

**Keywords:** money; GDP; credit; regime-switching model; Bayesian model, sustainable development

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**JEL Classifications:** C11; C13; C51

## 1. Introduction

The main goal of Eurosystem, which consists of European Central Bank (ECB) and national central banks of member states that have accepted the common currency of Euro, is to ensure the price stability. Since there is a general agreement on mid-term to long-term price development being a currency phenomenon, the development of the volume of money held by the public can reveal useful information on future price movements and thus provide an important monetary policy guideline. Analyses of monetary aggregates can moreover contribute to general evaluation of the development of financial system and broader economy.

Monetary aggregate can be defined as a sum of emitted currency in circulation and account of some liabilities

of financial institutions with high moneyless or liquidity in broader sense. The Eurosystem defines a narrow aggregate (M1), mid aggregate (M2) and broad aggregate (M3). These aggregates differ by liquidity of included assets. According to the analyses performed by ECB and their forerunner, European Monetary Institute, it may be that the broad monetary aggregates of Eurozone are less controllable in the short-term, but from the aspect of stability and ability to indicate the mid-term price development they are more favourable than the narrow aggregates. The strategy of monetary policy of Eurosystem requires to assess a monetary aggregate which is going to be a stable and reliable short-term indicator of inflation. Therefore, the Governing Council of ECB has decided that a reference value for yearly dynamics of M3 monetary aggregate growth is to be assessed. Thereby they have given this aggregate a prominent role in the strategy of monetary policy.

The main aim of this paper is to put into light the causality between output and some monetary variables by combining traditional econometric approaches (Granger causality on stationary data, vector error correction models) with some Bayesian techniques (Bayesian linear regression, regime-switching Bayesian regressions). A complex analysis is conducted by studying the phenomenon from different perspectives. The importance of this research topic is given by necessity of the monetary policies to be adjusted by taking into account the effects of the policy measures on the economic growth of the country and its sustainable development (Mentel & Brożyna, 2015). The economic policies have to be adjusted to avoid coming total financial crisis (Smrčka & Arltová 2012; Doležal et al. 2015; Njaramba et al. 2015; Kaźmierczyk, Aptacy 2016; Jurevičienė, Skvarciany 2016; Tamulevičienė 2016; Bikas, Bikas 2016; Korauš et al. 2016; Astrauskaitė, Paškevičius 2016; Kulišauskas, Galinienė 2015; Stasytė 2015; Munteanu, Tamošiūnienė. 2015; Giriūnienė, Giriūnas 2015; Fuschi, Tvaronavičienė 2014; Vasiliūnaitė 2014).

For emergent economies of Central and Eastern Europe the disadvantage of short data sets might be eliminated if Bayesian models are used. Special conditions of regularity are not required in case of Bayesian techniques and the characteristics of non-optimal estimators could be studied. A certain degree of subjectivity is allowed by defining the prior distribution which are the expert's opinion concerning the parameters and the error variance. The disadvantages of Bayesian methods, as Gamerman and Lopes (2006) indicated are the difficulty in computing the marginal likelihood and in normalizing the Bayesian factor.

The national banks frequently use Bayesian models to establish the best monetary policy and to make predictions regarding economic growth and monetary variables. For designing the monetary policy, the Bayesian New Neo-classical Synthesis is a suitable framework, according to Smets and Wouters (2005). The connection between real business cycles and monetary policy in China was studied using a DSGE model based on Bayesian estimation methods. In this context, Sun and Sen (2011) showed that the monetary transmission of China economy is characterized by the fact that global production supports the existence of the channel for assets price.

The Bayesian methods were employed by Berger and Österholm (2009) to study the causality in Granger terms between money and output growth in the USA. The Great Moderation generated a strong causality from money to economic growth over 1960-2005. After 2005, money had no influence on output growth in the USA. The same result was obtained by Caraianni (2012) who used wavelets approach. Simionescu (2015, 2016) proposed some Bayesian models for GDP rate in Romania considering inflation as explanatory variable, but not other monetary aggregates. Błażejowski et al., (2016) used Bayesian model averaging in the studies on economic growth in the EU regions.

In the next section, we will consider the methodological framework based on Bayesian models that will be employed in this study.

## 2. Methodology

We consider a linear regression model in matrix form:

$$Y_t = AX_t + u_t, \text{ where } u_t \rightarrow N(0, \sigma^2) \quad (1)$$

$n$  is the data series length

$k$  is the number of regressors

$Y$  is the dependent variable ( $n \times 1$  matrix)

$X$  represents the regressors ( $n \times k$  matrix)

$A$  is the parameters' matrix

$u_t$  - errors that follow a normal distribution ( $N(0, \sigma^2)$ )

The Bayesian approach is used to estimate the coefficients' matrix and the errors' variance  $\sigma^2$ . In our particular case, for Bayesian linear regression model, the following form is used:

$$Y_t = \beta \cdot X_t + e_t \quad (2)$$

$$\beta \sim N(m_u, V)$$

$$s_e^2 \sim IG(a, b)$$

$Y$  - dependent variable

$X$  - regressors

$\beta$  - vector of parameters

$e_t$  - error

$s_e^2$  - errors' variance

$n$  - number of observations for each variable

$m_u, V$  - parameters of normal distribution

$a, b$  - parameters of inverse-gamma distribution

Conditional posterior for parameter  $\beta$  follows a normal distribution while conditional posterior of  $s_e^2$  follows an inverse-gamma distribution:  $IG \sim \left( \frac{n}{2} + a, \frac{2b}{b \cdot RSS + 2} \right)$ . In this case,  $a$  and  $b$  are parameters of prior inverse-gamma distribution, RSS represents sum of square residuals and  $n$  is the number of observations. The regime switching models are used when different shocks influence the economy or when we have to identify the periods of economic crisis or boom, as Kim and Kim (2013) showed. In this case, the time switching regime has a uniform prior. The posterior distribution is proportional to likelihood function in the case when interruptions appear at a particular moment. Jiang and Fang (2014) also used switching-regime models for identifying the regime in post-war economic growth of the USA.

We denoted the time by  $t$  and it is not known. The regime-switching Bayesian models are represented as:

$$Y_t = X_t \cdot \beta_1 + u_t, \text{ where } u_t \rightarrow N(0, s_1^2) \text{ and } t \leq \omega \quad (3)$$

$$Y_t = X_t \cdot \beta_2 + u_t, \text{ where } u_t \rightarrow N(0, s_2^2) \text{ and } t \geq \omega \quad (4)$$

For estimation, Gibbs sampling method is used, when priors follow the next distributions:

$$\beta_1 \rightarrow N(m_u, V)$$

$$\beta_2 \rightarrow N(m_u, V)$$

$$s_1^2 \rightarrow IG(a, b)$$

$$s_2^2 \rightarrow IG(a, b)$$

Conjugate posterior are normally distributed (N) in case of parameters and inversely-gamma distributed (IG) in case of errors variances

$$\omega \rightarrow U(i_l, s_l)$$

The posterior distribution of  $\omega$  is proportional to likelihood estimation when the switch appears at a particular moment.

$\beta_1, \beta_2$  - coefficients

Y – dependent variable (n x 1 matrix)

X - regressors (n x k matrix)

$u_t$  - error term

$s_1^2, s_2^2$  – errors' variances

t - time

$\omega$  - probability

$i_l$  – inferior time bound, when regime switching is observed

$s_l$  – superior time bound, when regime switching is observed

### 3. Modelling of GDP in Romania and Slovakia using monetary variables

The data used in this research refer to the following macroeconomic variables for Romania in the period 1995: Q1- 2015: Q4: gross domestic product at market prices (Chain linked volumes (2010), million Euro) denoted by GDP, Euro/RON exchange rate (ER), money demand M2, money supply M3 (liquid liabilities of the banking system), monetary policy interest rate and internal credit. The data series for GDP is taken from Eurostat database, while for the rest of the variables, the data are provided by the National Bank of Romania. For the same time period, for Slovakia due to data availability, only several variables were considered: gross domestic product at market prices (Chain linked volumes (2010), million Euro) denoted by GDP provided by Eurostat, M2, M3 and internal credit provided by the National Bank of Slovakia. Taking into account that the data series have quarterly frequency, the data are seasonally adjusted using Tramo-Seats method. In case of Romania, the adjustment was necessary only for the data set corresponding to GDP, internal credit and money demand M2. The new variables are denoted by GDP\_SA, CREDIT\_SA and M2\_SA. The correlation matrix is constructed for the seasonally adjusted variables and for the rest of the variables.

**Table 1.** Correlation matrix of the variables for Romania

	GDP_SA	CREDIT_SA	ER	INTEREST	M2_SA	M3
GDP_SA	1.000000	0.608712	0.839726	-0.955557	0.954667	0.925780
CREDIT_SA	0.608712	1.000000	0.823233	-0.629019	0.590127	0.499366
ER	0.839726	<b>0.823233</b>	1.000000	-0.895526	0.818865	0.721664
INTEREST	-0.955557	-0.629019	<b>-0.895526</b>	1.000000	-0.909097	-0.851067
M2_SA	0.954667	0.590127	<b>0.818865</b>	<b>-0.909097</b>	1.000000	0.980853
M3	0.925780	0.499366	<b>0.721664</b>	<b>-0.851067</b>	<b>0.980853</b>	1.000000

Source: authors' calculations

According to the values of Pearson's coefficients of correlation, there is a very strong correlation with coefficients greater than 0.9 between GDP and monetary policy interest rate, GDP and M2 and GDP and M3. The negative relationship between GDP and interest rate is consistent with the economic theory, a lower interest rate stimulating investment, which is a component of GDP. On the other hand, the increase in money supply will bring an increase in GDP. The credit expansion generally generates the increase in macroeconomic variables, including GDP. The exchange rate influences the net export. A depreciation of the national currency will increase net export and, consequently, the GDP. In this case, a depreciation of the national currency will encourage the deposits' holders to save more money in foreign currency. In order to avoid multicollinearity, we select as explanatory variables only internal credit and M3.

**Table 2.** Correlation matrix of the variables for Slovakia

	GDP	M2	M3	CREDIT
GDP	1.000000	-0.640649	-0.647900	-0.348196
M2	-0.640649	1.000000	0.989592	0.092473
M3	-0.647900	0.989592	1.000000	0.071083
CREDIT	-0.348196	0.092473	0.071083	1.000000

*Source:* authors' calculations

According to the values of Pearson's coefficients of correlation, there is a strong and negative correlation between GDP and M2 and GDP and M3 in Slovakia. On the other hand, M2 and M3 are very strongly correlated. Actually, M2 and output are negatively correlated in leads. The rates of GDP, internal credit, M2 and M3 are also stationary at 5% level of significance. We consider the case of Bayesian linear regression when the parameters of the model follow a multivariate normal distribution.

**Table 3.** Bayesian linear regression for explaining output rate in Romania based on the rate of internal credit and rate of M3

Exogenous Variable	Romania		Slovakia	
	Posterior mean	Posterior standard deviation	Posterior mean	Posterior standard deviation
Constant	-0.001	0.043	1.0085	0.003
Rate of M3	2.4254	1.130	0.000585	0.001
Rate of internal credit	-0.801	0.856	-4.23E-07	1.31E-05

*Source:* authors' calculations

The results of estimations indicated a positive relationship between GDP rate and rate of M3, which is consistent with the economic theory. On the other hand, contrary to expectations, the rate of internal credit was negatively correlated to economic growth and sustainable development. According to Leitão (2013), a consensus regarding the fact that domestic credit promotes economic growth does not exist. For example, Leitão (2010) showed a positive correlation among the two variables using a dynamic panel data in case of the BRIC countries (Brasil, China, India, Russia) and in case of the European Union states over the period 1980-2006. Our results are consistent with the empirical findings of Levine (1997) and Hassan, Sanchez and Yu (2011) who demonstrated a negative influence of domestic credit on economic growth. Actually, the internal credit discourages the saving and the investment that support economic growth in a country. Moreover, Padovano and Galli (2002), Lee and Gordon (2005) and Koch, Schoeman and Tonder (2005) proved that a system based on high taxes discourages economic growth. The fiscal policy might be understood as a control measure or way to make adjustments to inflation or to government spending. We should observe that the influence of M3 rate and internal credit rate on economic growth in Slovakia is very low. We also have to take into account the fact that during the analyzed period from 1995 to 2015, Romania and Slovakia knew periods of economic growth and also periods of recession. The business cycle phases might also influence the relationship between economic growth and monetary variables.

**Table 4.** Unrestricted regime-switching regression for explaining GDP rate (%) in Romania

Country	Romania				Slovakia			
	Before regime switching		After regime switching		Before regime switching		After regime switching	
Variable	Post. mean	Post. standard deviation	Post. mean	Post. standard deviation	Post. mean	Post. standard deviation	Post. mean	Post. standard deviation
Constant	0.1163	1.9873	-0.1403	1.0177	0.9443	0.5639	-0.0248	0.3365
Rate of M3	3.1154	2.0489	1.8043	3.0074	0.0065	1.1123	0.00036	2.2258
Rate of internal credit	0.0491	1.0399	-0.1806	1.9382	0.0007	1.0037	-5.11E-08	0.0036
$s^2$	1.4174	6.0684	7.0849	1.8823	0.83456	2.2254	3.3361	1.9375
Switching	-	-	33.8	84.28	-	-	21.18	75.66

Source: authors' calculations

According to estimations based on the unrestricted regime-switching model, the switching is realized after the economy made was at its maximum. Before regime change, we have a period of expansion characterized by a positive correlation between economic growth and M3 rate and also between economic growth and domestic credit rate. In this period, the internal credit was used for investment and saving, which stimulate the economic growth. On the other hand, after regime change, corresponding to a period of economic contraction, internal credit was negatively correlated to economic growth and sustainable development, because the saving and investment were discouraged.

### Conclusions

The connection between GDP and monetary variables was frequently discussed in the framework of the real business cycles. Long-term sustainability of public finance has economic as well as ethical dimensions and consequences. From the economic aspect, sound public financing is an inevitable pre-requisite for sustainably high economic growth. The ethical dimension resides in securing the intergenerational justice. By means of public budgets, these resources are in fact reallocated not only among individual public groups (based on solidarity principle) but also among generations. The policy of long-term deficits and loan growth automatically runs up a bill to be picked up by future generations who obviously could not have gained advantage from previous benefits.

Even if recent studies (for example, Ellison and Sargent (2015)) indicated that nominal variables like money supply do not influence the real production, the results vary with the economy type. For proposing the best monetary policy it is important to know when monetary variables influence the economic growth (in periods of recession, economic recovery etc.). Contrary to the situation in the developed countries, in Romania, the rate of M3 and internal credit influenced the quarterly GDP rate. On the other hand, in Slovakia the influence of these variables on economic growth was very low. There could be other factors influencing the environment (possible factors mentioned in Čámská, 2015) whose consequence is a difference between results for Romania and Slovakia. Although it seems that the countries' development is comparable from historical, economic or political point of view Slovakia is a country with higher living standards, lower rate of unemployment and since 2009 a member of Eurosystem comparing with Rumania. For Romania and Slovakia, the most relevant variables in explaining the quarterly evolution of Romanian GDP were: money supply M2 and M3 and internal credit. These variables are used to construct linear and stochastic regime-switching Bayesian models. The advantage of regime-switching model is the consideration of the shocks in the economy. Moreover, long-run and short-run causalities were considered in the context of an error correction model. In the case of unrestricted regime-switching model, in the period of expansion the rate of M3 and the internal credit rate were positively correlated with GDP rate. In the period of economic contraction, internal credit rate was negatively correlated with GDP growth and sustainable development. The results are consistent with previous results from literature that explained the low propensity for investment and saving during the economic crises. However, the research might be extended with an approach based on DSGE models and by making comparisons with the phenomena in various countries with the same economic potential.

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