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The relationship between gross domestic product and monetary variables in Romania. A Bayesian approach

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ABSTRACT

For establishing the suitable monetary policy it is essential to know if there is a relevant relationship in practice between gross domestic product (G.D.P.) variations and monetary variables. The purpose of this study is to analyse the causality between output variation and money aggregate in Romania for quarterly data in the period 2000:Q1–2015:Q2. Moreover the impact on G.D.P. growth of other variables connected with money demand is assessed using Bayesian techniques. The results indicated a bidirectional relationship between G.D.P. variations and rate of real money demand in the mentioned period. The Granger causality test combined with stochastic search variable selection indicated that active interest rate and discount rate mostly explained G.D.P. variations. According to results based on Bayesian regime-switching models, contrary to expectations, the interest rate increases continued to generate higher output variations, the consumption being the engine of economic growth in Romania. In periods of economic recession, the lower interest rate stimulated the recovery of the economy.

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1. Introduction

The main aim of this research is related to the analysis of the relationship between output variation and various monetary variables. Most of the studies from literature are interested only in the Granger causality between variables applying various methods, but this research will not resume to this. The results of Granger causality tests will be combined with a Bayesian procedure for variable selection in order to identify the most relevant variables in explaining output fluctuations. Moreover, based on the results of these analyses, some Bayesian models will be proposed for quantifying the impact of the monetary variables on G.D.P. variation.

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Table 1. The results of Phillips–Perron test for real G.D.P. rate data series, M0 and M2.

Variable	Model	PP statistic	Critical values
Real G.D.P.	A1	-4.349400	-3.5398
			-2.9092
			-2.5919
	A2	-6.909542	-4.1135
			-3.4836
			-3.1696
	A3	0.651606	-2.6006
			-1.9458
			-1.6186
Real G.D.P. in first difference	A1	-24.04704	-3.5417
			-2.9101
			-2.5923
	A2	-24.74599	-4.1162
			-3.4849
			-3.1703
	A3	-22.87427	-2.6013
			-1.9459
			-1.6186
M0	A1	-0.555961	-3.5398
			-2.9092
			-2.5919
	A2	-3.293460	-4.1135
			-3.4836
			-3.1696
	A3	2.085828	-2.6006
			-1.9458
			-1.6186
Rate of M0	A1	-11.22013	-3.5417
			-2.9101
			-2.5923
	A2	-12.95043	-4.1162
			-3.4849
			-3.1703
	A3	-8.782215	-2.6013
			-1.9459
			-1.6186
Rate of M2	A1	-6.109838	-3.5417
			-2.9101
			-2.5923
	A2	-9.533994	-4.1162
			-3.4849
			-3.1703
	A3	-3.440405	-2.6013
			-1.9459
			-1.6186

Note: Critical values are considered at 1%, 5% and 10% level of significance.

Source: Authors' calculations.

In the empirical study for Romania, we will find the answer to more research questions:

- Is it a causal relationship in Granger sense between money and output in Romania?
- Could output variation be explained by other variables connected to money demand?
- Is the relationship between G.D.P. growth and these variables sensitive to the phases of business cycle?

The novelty of the research is given by the improvement in the analysis by developing the methodological framework. The most relevant causes of output fluctuations are identified by combining traditional approach with the Bayesian one. On the other hand, the analysis

Table 2. Granger causality test on stationary data.

Null hypothesis	F-statistic	Probability
Rate of M0 does not Granger cause variation in real G.D.P.	13.9387	1.3E-05
Variation in G.D.P. rate does not Granger cause rate of M0	0.64334	0.52951
Rate of M2 does not Granger cause variation in real G.D.P.	9.93322	0.00021
Variation in real G.D.P. rate does not Granger cause rate of M2	9.37185	0.00032
Euro/R.O.N. exchange rate does not Granger cause variation in real G.D.P.	0.94517	0.39495
Active interest rate does not Granger cause variation in real G.D.P.	0.36459	0.69618
Passive interest rate does not Granger cause variation in real G.D.P.	0.28319	0.75449
Total credit does not Granger cause variation in real G.D.P.	0.30913	0.73538
Discount rate does not Granger cause variation in real G.D.P.	0.02645	0.97391
C.P.I. does not Granger cause variation in real G.D.P.	0.29339	0.74691
Total credit does not Granger cause rate of M2	5.33436	0.00763
Discount rate does not Granger cause rate of M2	4.14214	0.02110
Active rate does not Granger cause rate of M2	4.66385	0.01346

Source: Authors' calculations.

Table 3. The explanatory variables selected by stochastic searching algorithm at 0.5 acceptance probability.

Selected variables	Posterior mean for variable inclusion probability	Posterior mean of coefficient
Active interest rate	0.559	0.109
Discount rate	0.571	0.117

Source: Authors' calculations.

Table 4. Bayesian linear regression models for explaining G.D.P. variation in Romania using monetary variables.

Model	Exogenous variable	Posterior mean	Posterior standard deviation
Model 1	Constant	0.0294	10.0151
	Rate of M2	0.0559	10.0137
Model 2	Constant	0.0131	9.9903
	Active interest rate	0.9403	9.5077
Model 3	Constant	0.0644	10.0181
	Discount rate	0.8724	9.7262

Source: Authors' calculations.

Table 5. Unrestricted regime-switching model for explaining G.D.P. fluctuations in Romania.

Coefficient for:	Before regime switching		After regime switching	
	Posterior mean	Posterior standard deviation	Posterior mean	Posterior standard deviation
Constant	1.4414	10.0420	0.1714	9.9976
Discount rate	52.1701	0.2871	0.6626	9.7894
Switching	–	–	1	0
Constant	0.0967	9.9858	–0.0411	10.0078
Active interest rate	2.6961	9.1912	0.1847	9.7667
Switching	–	–	11.9678	6.2590

Source: Authors' calculations.

is focused on Romania, even if most of the studies used U.S.A. data. Bayesian linear models and regime-switching models had not been used yet in literature for studying the connection between money and output, but these methods bring valuable information. Based on the results, some macroeconomic policies could be recommended in order to have a sustainable

Table 6. Connected regime-switching model for explaining G.D.P. variation in Romania.

	Posterior mean	Posterior standard deviation
Constant	0.0573	9.9781
Active interest rate before	0.8391	9.6448
Active interest rate after	0.5955	13.9663
Switching	21.0327	8.8874
Constant	0.0499	9.9892
Discount rate before	0.9406	9.7669
Discount rate after	0.7906	13.9738
Switching	18.1854	10.0871

Source: Authors' calculations.

growth, mostly in expansion periods. These policies are necessary also in the context of the preparation for monetary union as Yildirim (2015) and Smirna (2015) explained. For entering the European Monetary Union, according to Findreng (2014), Romania should implement some measures to achieve the convergence with developed countries. A reciprocal causality was identified between money and output fluctuations, but the increase in interest rate in expansion periods did not slow the economic growth in Romania. Active interest rate better explained the G.D.P. growth than credit or other economic variables (exchange rate, inflation, etc.). The presence of unit roots is checked in Table 1. The Granger causality on stationary data sets is verified and the results are presented in Table 2. Various types of Bayesian regression models are estimated in Table 3, Table 4, Table 5 and Table 6.

After this introduction, the article focuses on literature review, methodological background and the empirical analysis of the money-output relationship in Romania. The last part concludes.

2. Literature review

In the studies regarding the relationship between money and output, one key question is: is there a causal relationship from money to output? One of the answers to this research question was given for post-war U.S.A. data. In this case, money did not Granger cause output.

Later research considered that this causality is dependent on the data sample, type of econometric model and the monetary aggregate, as Stock and Watson (1989) showed. Recent studies in literature consider other econometric models for analysing the relationship between the two types of macroeconomic indicators. Using vector-autoregressive (V.A.R.) models with time-varying parameters, Ravn, Psaradakis, and Sola (2005) obtained that the causality between output and money varies across time. Out-of-sample predictions were made by Berger and Österholm (2009) using Bayesian V.A.R. models by introducing or excluding M2 monetary aggregate. For U.S.A. data, the causality from money to output was identified. Another methodological alternative is represented by D.S.G.E. models augmented with money, surpassing the limit of the New Keynesian model that did not consider any monetary aggregate, as Galí (2008) explained. In this context, Favara and Giordani (2009) showed that money indicators explain only output fluctuations. On the other hand, Andrés, López-Salido, and Nelson (2009) extended the work of Ireland (2004), who suggested that money aggregates have an important role in the business cycle inside the dynamic general equilibrium approach. The role of money in crisis periods inside the business cycles was presented by Bilan, Gazda, and Godziszewski (2012) and Clowes and Bilan (2015). The conclusions of Andrés et al. (2009) were turned to account by Castelnouvo (2012) in a

D.S.G.E. extended with money that explained the U.S.A. output evolution better than the standard New Keynesian model.

The connection in time and frequency between money and output was analysed by Caraiani (2010) for U.S.A. data using wavelets. The results indicated that during the Great Moderation there was a weak relationship between money and output, but during the Great Depression the connection was more intense. For quarterly U.S.A. data from 1966:Q1–2013:Q4, Caraiani (2016) used a D.S.G.E. model extended with money and obtained causality from money to output, even if there are not shocks in money.

In the monetary policy study, Smets and Wouters (2005) recommended the use of Bayesian New Neoclassical Synthesis. The Bayesian models help central banks in designing the better monetary policy and also in forecasting output and the monetary variables.

Sun and Sen (2011) analysed the relationship between monetary policy and real business cycles using a D.S.G.E. model for China in a Bayesian framework. The authors showed that production supports the asset price channel existence in monetary transmission of China economy. Berger and Österholm (2009) employed Bayesian techniques to analyse the Granger causality between money and economic growth in the U.S.A. Over a long period, from 1960 to 2005, the authors obtained a strong causality from money to output due to the period before Great Moderation, because after this period there is no influence of money on output. According to Friedman and Schwartz (1975), after the Great Depression, economists considered that real economy factors determined economic fluctuations and actually not the monetary factors. In the context of Keynesian revolution, considering the investments as driver of economic growth, the money took a passive role.

Our research is focused on another methodological route – Bayesian techniques – but it brings several novel aspects:

- The Bayesian models employed in the current study have not been used yet in literature to analyse the money–output relationship (stochastic search variable selection, Bayesian regime-switching models, Bayesian models).
- The study is based on data on Romanian economy, not on U.S.A. data like in most of the previous studies.
- The causality between variables is not judged only on a Granger approach (results based on stochastic search variable selection are combined with those based on Granger causality test).
- This research does not resume only to the causality between money and output.

There are only few studies for the Romanian economy that employed Bayesian techniques to describe the evolution of macroeconomic indicators. For example, Simionescu (2015) modelled the real G.D.P. rate in Romania using the following types of Bayesian models: Bayesian linear models; Bayesian vector-autoregressive (B.V.A.R.) model; and switching-regime models. These models were used to make medium-run forecasts on the horizon 2011–2014. Previously, Caraiani (2010) built more B.V.A.R. models for quarterly G.D.P. in Romania making short-term predictions that outperformed the forecasts based on standard V.A.R. or linear regressions. On the other hand, Bayesian models were built in Romania for other macroeconomic variables like inflation, as Simionescu (2014) did. The author built a Bayesian autoregressive model for index of consumer prices in Romania.

3. Methodological framework

This research analyses the relationship between money and output by combining the traditional approach based on Granger causality with some Bayesian approaches. In order to identify the monetary variables that better explain the output fluctuations, first we apply the Granger causality test between money demand and output variation. Moreover, this approach was enriched with the economic theory, considering that output variation might be indirectly affected by variables that are causes of money demand. The results of the Granger test were combined with stochastic search variable selection, a Bayesian procedure, to determine the variables that have the highest impact on economic growth. Moreover, some linear Bayesian models were built with these explanatory variables. Then the analysis is extended even to Bayesian regime-switching models to check if the relationship between these variables and output fluctuations are dependent on the phases of economic cycle. Taking into consideration the methods that will be used in the empirical analysis, we consider it necessary to present some methodological hints regarding Bayesian linear regression models, presenting Gibbs sampling algorithm of estimation and Bayesian regime-switching models.

Let us consider a linear regression model in matrix form:

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

where: n is the number of values for each data series corresponding to each variable;

k is the number of explanatory variables;

Y is the dependent variable considered as $n \times 1$ matrix;

X represents the explanatory variables organised as $n \times k$ matrix;

A is the matrix of parameters; and

u_t - error term following a normal distribution of null average and a variance equaled to σ^2 .

The main aim in this case is to determine the matrix of estimators, when the errors' variance σ^2 is given.

The frequentist econometrics determines the estimators by maximising the likelihood function only using the data series for the model variables. The results are: matrix's A estimator and the estimator for errors' variance. Therefore, the traditional econometrics uses all the data.

On the other hand, the Bayesian approach supposes a complex process in estimating the model's parameters, keeping the estimation of likelihood function:

1. The researcher has some prior beliefs that are represented as probability distributions. These personal beliefs regarding parameters' estimators and errors' variance are based on previous research in literature and the authors' own experience. In many cases, a normal prior distribution is considered for coefficients matrix. A lower variance of errors is given by researcher, if this one is surer about these subjective estimations. In the end, this step consists in proposing a *prior distribution*.
2. This step is also specific to traditional the econometric approach and it consists in collecting data for models variables in order to estimate the likelihood function. Considering the case of a normal distribution, the likelihood function F has the following form, where T is the sign for transposition:

$$F(Y_t|A, \sigma^2) = (2\pi\sigma^2)^{-\frac{n}{2}} \cdot \exp\left(-\frac{(Y_t - axe_t)^T(Y_t - axe_t)}{2\sigma^2}\right) \tag{2}$$

The sign ‘|’ has the meaning of ‘conditioned by’.

3. At the last step, the econometrician updates his subjective priors referring to model parameters by utilising the variables data and the estimation for likelihood function. In this case, the prior distribution from step 1 is combined with the likelihood function from step 2, and the result is the *posterior distribution*, which is represented in the terms of Bayes’ theorem like this:

$$H(A, \sigma^2|Y_t) = \frac{F(Y_t|A, \sigma^2) \times P(A, \sigma^2)}{F(Y)} \tag{3}$$

From this formula, it results that prior distribution is a ration between product of likelihood function $F(Y_t|A, \sigma^2)$ and the prior probability $P(A, \sigma^2)$ and marginal likelihood $F(Y)$.

Gibbs sampling is often used to estimate the parameters for a Bayesian linear regression model. It employs conditional distributions in order to make the approximation of joint and marginal distributions.

Let us consider a joint distribution of k variables: $f(x_1, x_2, \dots, x_k)$.

The marginal distributions that must be determined are: $f(x_i), i = 1, k$

The conditional distributions form must be a prior that is known by the researcher $f(x_i|x_j)$.

Gibbs sampling algorithm starts with the conditional distributions $f(x_i|x_j), i \neq j$ and it approximates the marginal one by considering the next steps:

Step 1: The initial values are: $x_1^0, x_2^0, \dots, x_k^0$, where 0 is the index for the first step.

Step 2: A sample x_1^1 is chosen from the distribution of x_1 that is conditioned by the current values of x_2, \dots, x_k

$$f(x_1^1|x_2^0, \dots, x_k^0)$$

Step 3: A sample x_2^1 is selected from the distribution of x_2 that is conditioned by the current values of x_1, x_3, \dots, x_k

$$f(x_2^1|x_1^1, x_3^0, \dots, x_k^0)$$

Step k: A sample x_k^1 is chosen from the distribution of x_k that is conditioned by the current values of x_1, x_3, \dots, x_{k-1}

$$f(x_k^1|x_1^1, x_2^1, \dots, x_{k-1}^1)$$

According to O’Hagan and West (2010), in the case of infinite convergence of iterations number, the samples draws, which are draws from conditional distributions, converges to marginal or joint distribution of x_i at an exponential rate. For a large enough number of steps, the marginal distribution is approximated with the empirical repartition of x_i . In the case that Gibbs algorithm is applied Q times and the last M draws of x_i are taken

(M values for x_1, x_2, \dots, x_k), the histogram for x_1, x_2, \dots, x_k approximates the marginal density of x_1, x_2, \dots, x_k . An estimator for marginal posterior distribution average in case of x_i is $\frac{\sum_{b=1}^M x_i^b}{M}$, where b represents the number of Gibbs iterations. The number of Gibbs iterations for achieving convergence represents the marginal repartition variance.

Bayesian methods are widely applied in economics in order to ensure the support for decision-making process at different levels. At the macroeconomic level, the Bayesian models represented a good alternative to the traditional models from frequentist econometrics. As Simionescu, Ciuiu, Bilan, and Strielkowski (2016) showed, for emergent economies from Central and Eastern Europe where the short data series is a real problem, the use of Bayesian models remains the unique solution. Bayesian techniques do not require special conditions of regularity and they do not suppose testing various assumptions or building confidence intervals. Moreover, these methods are useful in analysing the characteristics of non-optimal estimators. The Bayesian methods admit the subjectivity given by prior distribution that consists in economist beliefs regarding coefficients and error variance values. These beliefs are determined by economist experience and previous studies on the researched domain. Nowadays, even the traditional econometricians make their subjective adjustment; the mechanical takeover of an estimation being surpassed. So, Bayesian models are closer on the economic reality. However, some authors, like Gamerman and Lopes (2006), showed that it is sometimes difficult to calculate marginal likelihood and to normalise the Bayesian factor.

In many cases, when the economy is affected by various types of shocks or when the periods of crisis or boom must be identified, the regime switching models are employed. Therefore, two different regression models are proposed that have different errors variances and different slopes, as Kim and Kim (2013) showed. In the Bayesian approach, time switching regime takes a uniform prior. The posterior distribution is proportional to likelihood when interruptions appear at a certain moment. For the other parameters, the prior and posterior distributions are the ones like in the standard Bayesian linear regression model. The switching-regime models were also employed by Jiang and Fang (2014) in order to identify the regime in post-war economic growth in the U.S.A.

MATLAB software is used to estimate the linear and regime-switching Bayesian models for which time, denoted by t , is an unknown variable.

The regime-switching Bayesian models have the representation:

$$Y_t = X_t \cdot \beta_1 + u_t, \text{ where } u_t \rightarrow N(0, s_1^2) \text{ and } t \leq \omega \quad (4)$$

$$Y_t = X_t \cdot \beta_2 + u_t, \text{ where } u_t \rightarrow N(0, s_2^2) \text{ and } t \geq \omega \quad (5)$$

Gibbs sampling algorithm is also applied here under the hypothesis of the next prior 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 distributions are normal (N) for parameters and inverse-gamma (IG) for errors variances.

$$\omega \rightarrow U(i_t, s_t)$$

The posterior distribution for ω is proportional with the likelihood estimation while the switch appears at a certain moment.

β_1, β_2 – parameters

Y – dependent variable (n x 1 matrix)

X – regressors (n x k matrix)

u_t – error

s_1^2, s_2^2 – errors dispersions

t – time

ω – probability

l_b, i_t – inferior time limit when the regime switching could be observed

u_b, s_t – superior time limit when the regime switching could be observed

Bayesian stochastic search was also employed by Hautsch and Yang (2014) to determine the G.D.P. predictors in a nowcasting model for England.

4. Modelling G.D.P. variation in Romania using monetary variables

The data used in this research refer to the following macroeconomic variables for Romania in the period 2000:Q1–2015:Q2: gross domestic product at comparable prices (chain linked volumes [2010], million euro) – G.D.P., Euro/R.O.N. exchange rate; monetary base M0; money demand M2; discount rate; active interest rate; passive interest rate; total credit; consumer price index (C.P.I.). The data series for G.D.P. is taken from Eurostat database. For the rest of the variables, the data are provided by National Bank of Romania. All the variables are seasonally adjusted.

Active interest rate is the interest rate corresponding to the credits given by a bank. It depends on the credit type and period for which it is accorded. The passive interest rate corresponds to the deposits that bank attracts, and it depends on the value of the deposit, the way of paying the interest, the exchange rate, the source of the money, and the ways of keeping them. The discount rate is defined as the difference between these interest rates. The total credit is the money that the creditor gives to the debtor for a certain level of interest rate.

Since 2000, Romania experienced a period of economic growth that was interrupted in the last quarter of 2008 by the global economic crisis. The first period of decline started in the second quarter of 2001 as an effect of various international events: the oil price decrease; terrorist attacks in 11 September 2001; decline of European Union imports; lower levels of industrial production in euro area. In Romania, the industrial production decrease was associated with the capital market decline in the next three quarters. However, in Romania the external threats did not generate a reduction in G.D.P. and consumption. In the middle of 2007, the first signals of world economic crisis were observed, the confidence indicator decreasing not only for European Union, but also for Romanian economy. In the second semester of 2008, generalised contractions of G.D.P. were met in European Union (E.U.) countries. In the last quarter of 2008, the Romanian economy officially entered into recession, but a decrease in foreign direct investment flow was observed at the beginning of 2009.

In the third quarter of 2010, G.D.P. registered its minimum value. A favourable evolution of G.D.P. was observed at the end of 2010 and at the beginning of 2011, when a recovery of the labour market was also observed. A conjectural decline of G.D.P. was observed in the last quarter of 2010 and at the beginning of 2011.

For checking the presence of unit roots in the data series of the mentioned variables, the Phillips-Perron test is employed with the three variants of autoregressive models (A1– model with intercept; A2– model with trend and intercept; A3– model without trend and intercept). For obtaining stationary data sets, the real G.D.P. rate was first differenced, while for M0 and M2 the rate was calculated. The data series for the rest of the variables are stationary in level.

The Granger causality from G.D.P. rate to M0, respectively to M2 is checked on stationary data. Therefore, we checked the causality from the variation in real G.D.P. to rate of M2, respectively rate of M0.

As expected, the monetary aggregates are a cause for G.D.P. fluctuations. According to the Granger causality test, rate of M0 is a cause for G.D.P. variation, but the relationship is not reciprocal. On the other hand, the causality between rate of M2 and G.D.P. variation is reciprocal. The results are in accordance with expectations. Compared to M0 and M1, M2 includes also highly liquid assets that are not cash. Beside checking deposits and cash, M2 includes near money. The introduction of cards in Romania made M2 more representative and more suitable for explaining economic growth fluctuations.

The rest of the variables were not identified as a cause of variation in G.D.P., but some of them might indirectly influence the economic growth through the money demand. The empirical results showed that total credit, discount rate and active rate are causes in the Granger approach for rate of M2. On the other hand, the economic theory suggests correlations between these three variables also confirmed by empirical results that indicated discount rate and active rate as causes for credit. The problem that we have to solve here is to identify which of these variables is mostly correlated with variation in real G.D.P. The solution is given by the stochastic search variable selection that is applied to explain variation in economic growth.

In this research, we explain the economic fluctuations using monetary variable, but also other indicators that are not directly correlated with G.D.P., but they are causes for money evolution.

The algorithm for stochastic search variable selection is a Bayesian approach that selects the best variables that explain an indicator from a larger set of variables by setting a certain acceptance probability. If a smaller value is given by the researcher for acceptance probability, more variables are chosen than in the case of a higher acceptance probability. This Bayesian procedure is applied to select the monetary variables that mostly influenced Romanian G.D.P. during the period 2000:Q1–2015:Q2. The initial set of explanatory variables is represented by discount rate, active interest rate and credit. In MATLAB, numbers are assigned to exogenous variables in this order: active interest rate (1); credit (2); and discount rate (3). The acceptance probabilities are chosen by the researcher, who reports the objective of the analysis. The aim is to construct a Bayesian regression with many explanatory variables and a Bayesian model with only few exogenous variables. Therefore, low acceptance probabilities were chosen (0.3 and 0.5) and higher ones (0.6, 0.7, 0.8). For probabilities of 0.6 and more, the algorithm excluded all the explanatory variables. For a probability of 0.3, all the exogenous variables were included, while for 0.5, the Bayesian

approach identified the active interest rate and discount rate as the most relevant variables for explaining G.D.P. variation. So, even if the credit was identified as a cause of M2, its influence on G.D.P. variation was lower compared to discount rate and active rate. Actually, the results are according to expectations, since the discount rate is the difference between active and passive interest rates.

According to economic theory, the interest rate level proportionally varies with the business cycle (the interest rate grows in periods of economic expansion and diminishes in recessions). The Central Bank lowers the interest rate for stimulating the economic growth. The lower costs for financing will encourage investing and borrowing. On the other hand, if the interest rates become too low, excessive growth might be caused and probably even inflation which may affect the economic expansion sustainability. The increase in interest rates can slow the inflation and ensure sustainable growth. If the interest rates are too high, the economic growth could be negatively affected.

In the phase of expansion, the G.D.P. increases because of the lower interest rate. The empirical results are not in accordance with the economic theory. There is a positive correlation between active interest rate and G.D.P. fluctuations, but this type of correlation is stronger between discount rate and G.D.P. variation. A possible explanation could be the fact that discount rate is higher in Romania than in developed countries.

The selected monetary variables for various acceptance probabilities are used to construct the following models:

model 1: $G.D.P. = f(M2)$

model 2: $G.D.P. = g(\text{active interest rate})$

model 3: $G.D.P. = h(\text{discount rate})$

In all models, on average, the explanatory variables (rate of M2, active interest rate and discount rate) had a positive impact on G.D.P. variation. The monetary liquidity in the economy grows in periods of economic growth, when a certain prices' stability is achieved.

The analysed period from 2000 to 2015 includes periods of economic recovery and recession. It is important to figure out if this tendency is the same for any phase of the economic cycle or the correlation between variables are dependent on the phase of the business cycle. Therefore, a Bayesian model should be constructed for each phase of business cycle. The suitable method in this case is the regime-switching model.

In the case of unrestricted regime-switching model, the switching is made at a moment that is close to the maximum increase in G.D.P. Therefore, before regime change, a period of expansion took place when active interest rates and discount rates were positively correlated with G.D.P. variation. This is contrary to economic theory, because even if active interest rate and discount rate increased, the variation in G.D.P. from a year to another continued to increase. This is explained by the fact that discount rate has a high level. After regime change, in the period of economic contraction, the explanatory variables were positively correlated with G.D.P. In order to surpass the economic crisis, the level of interest rates is grown for encouraging the economic recovery.

Considering a connected switching regime, before regime change the increase in active interest rate and discount rate generated a higher growth in G.D.P. compared to the period after the change. So, in a period of economic growth, even if the interest rate increases, the consumption continues to grow, which alimnts the economic expansion. This is typical for the Romanian economy, where the economic growth is not sustainable, being mainly determined by the increase in consumption.

5. Conclusions

The relationship between G.D.P. and monetary variables has been widely discussed in the context of real business cycles. Recent research, like that of Ellison and Sargent (2015), showed that nominal variables like inflation and money supply do not significantly explain the real production. However, the results are dependent by the type of economy. It is important to identify in what period (decline or economic growth) the monetary variables influence the production in order to design the most suitable monetary policy. In Romania, contrary to studies for developed countries, the monetary variables do influence the G.D.P. variations. So, a better monetary policy could be developed if this aspect is taken into consideration.

For Romania, a reciprocal causality relationship has been identified between money demand rate and output variation starting with the first quarter of 2000. Moreover, some variables that influence rate of M2 can also explain indirectly the output fluctuations. The Granger causality test identified the active interest rate, the credit and the discount rate as determinants of G.D.P. variations. These variables were considered as initial predictors for G.D.P. variation in the stochastic search variable selection, and the results showed that the highest influence is given by active interest rate and discount rate.

These variables are used to construct linear and stochastic regime-switching Bayesian models. The advantage of the regime-switching model is the consideration of the shocks in the economy. Contrary to expectations, the increase in active interest rate and discount rate generated a high G.D.P. increase, a fact explained by the high value of discount rate in Romania compared to developed countries. In-depth research of this issue was made by using Bayesian regime-switching model. In the case of unrestricted and connected regime-switching models, this result is confirmed only for periods of economic growth. In periods of economic expansion, the increase in interest rate stimulated the economic growth, because of the high tendency of consumption in Romania. The economists drew attention the fact that in Romania we do not have healthy growth if the engine of this is only consumption. The economic policies should encourage investment. In the period of economic contraction, the positive shocks in interest rate stimulated the economic recovery.

The limits of the research are given by the fact that G.D.P. fluctuations could be explained also by non-monetary variables, but the purpose of this research was only to have a view of the relationship between output variations and some monetary variables. In future research, we intend to evaluate the impact of fiscal measures on G.D.P. variations and combine this approach with the monetary one.

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