Transmission Mechanisms of Monetary Policy in Romania: a Bayesian VAR Model

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Abstract: In this study we use the Bayesian VAR framework to provide an analysis of the transmission mechanism of the monetary policy. We develop a BVAR model for the Romanian economy in order to identify the major shock in Romania of the last 10 years and to provide information concerning the evolution of the economy response to these shocks. That’s why, we have included in the analysis variables that emphasize the industrial production evolution, the exchange rate, the inflation, the real estate prices, the monetary aggregate M2 and the interest rate. The analysis shows important conclusions. The exchange rate remains an important mechanism that influences significantly the variables of the real economy, but the channel of the interest rate is being more and more consistent in the last years. The positive aspect that emerges from this study is related to the absence of output puzzle and price puzzle.

Key-Words: monetary policy analysis, BVAR model, small open economy, Bayesian analysis, model comparison, Romanian macroeconomic environment

1 Introduction
Recent research carried out in the specialized literature, based on DSGE models or on BVAR or VAR models play an important role in the process of creation and implementation of monetary policy. This role stems from the importance of the information provided to the central bank, and to the public. Information regarding the evolution and the persistence of the inflation, the testing of the hypotheses concerning the nominal rigidities existent in case of prices and salaries, the factors determined in establishing prices, the estimation of Taylor’s rule coefficient, but also the impact of an expansionist monetary shock upon a group of variables, are useful in providing an overall image of the economic evolution of a country. In order to provide information concerning the aspects aforementioned, but taking into consideration the last 10 years overall image of the monetary situation, we set as an objective of this work to extend the area of research in this field.

The contribution of this study to the specialized literature is important and original from different points of view. Firstly, as far as we know, BVAR modelling has not been frequently used for the purpose of a macro monetary analysis of the Romanian economy. Secondly, the number of variables introduced in the analysis is big enough, comprising monthly dates over a ten year period. Thirdly, an original step is represented by introducing into the analysis an index of real estate assets prices, being widely known that evolutions in the real estate market have a major economic effect upon the economic activity and especially for Romania during the expansion period starting from 2004 to the end of the third trimester of the year 2008. On the other hand, the assets prices deviation from the economic foundations can lead to inadequate investments that diminish the economy efficiency. That’s why we consider that it is necessary to introduce in the analysis an index of real estate prices. This work is structured as follows. The second section describes the econometric methodology and the data used for this study. In the third section, the main results obtained are presented and the last section is dedicated to the presentation of the conclusions.

2 Econometric methodology and the data used for this study
In the present study, we will estimate a Bayesian autoregressive vector. In order to strengthen the validity of the obtained data, we carried out a double check. Thus, we will firstly use prior distribution suggested in [1], and then the validity of the obtained data will be also verified by means of prior distribution of [2].

ISBN: 978-1-61804-003-9
Consider the following VAR(p) model:

\[ y_t = a_0 + \sum_{l=1}^{p} A_l y_{t-l} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma) \]  

(1)

where \( y_t \) is an \( m \times 1 \) vector of \( t = 1, \ldots, T \) observations on \( m \) time-series variables, \( a_0 \) is an \( m \times 1 \) vector of intercepts, and \( A_l \) is a \( m \times m \) matrix of regression coefficients for the \( l \)th lag with the \( p \) maximum number of lags.

If we define \( Y \) to be a \( T \times m \) matrix which stacks the \( T \) observations on each dependent variable in columns next to one another. In particular, by denoting:

\[ X = \begin{bmatrix} x_1 \\ \vdots \\ x_T \end{bmatrix}, \quad B = \begin{bmatrix} a_0 \\ A_1 \\ \vdots \\ A_p \end{bmatrix} \]

(2)

and \( \beta = \text{vec}(B) \), the VAR model can be rewritten:

\[ y_{mT \times 1} = X_{T \times (mp+1)} B_{(mp+1) \times m} + E_{T \times m}, \quad E \sim N(0, \Sigma) \]  

(3)

The choice of prior has always been a contentious issue in Bayesian analysis. If you choose the Sims-Zha prior, the model (1) is rewritten as:

\[ y_t = c + \sum_{l=1}^{p} y_{t-l} B_l + u_t, \quad u_t \sim N(0, I_M) \]  

(4)

where \( \Sigma = A_0^{-1} A_0^{-1} \) and \( A_0 \) is nonsingular. By denoting:

\[ B = \begin{bmatrix} B_1 \\ \vdots \\ B_p \\ c \end{bmatrix}, \quad \varepsilon = a_0 A_0^{-1}, \quad B_1 = A_1 A_0^{-1}, \quad u_t = \varepsilon_i A_0^{-1}, \]

(5)

one can relate this model to the reduced form in equation (2). Following Sims-Zha notations, this model can be also written in compact form:

\[ YA_0 - XA_+ = U \]  

(6)

\[ ZA = U \]  

(7)

where

\[ Z = [Y - X] \quad \text{and} \quad A = \begin{bmatrix} A_0 \\ A_+ \end{bmatrix} \]

(8)

Unlike the independent hyperprior specification (i.e. \( \pi(A_0) \pi(A_+) \)), Sims and Zha suggests the conditional prior (Sims-Zha prior):

\[ \pi(A) = \pi(A_0) \pi(A_+) | A_0 = \pi(A_0) \phi(B_0, \Psi_0) \]  

(9)
where $\pi(.)$ is a marginal distribution of $A_0$, and $\phi(.)$ is the standard normal density with mean $B_0$ and covariance $\Psi_0$. Each element of $\Psi_0$ is written as:

$$\Psi_{0i,j} = \left( \frac{\lambda_i \lambda_j}{\sigma_j^2} \right)^2, \quad i,j = 1, \ldots, m, \quad (10)$$

where $\sigma_j^2$ is the $j$th element of $\Sigma$ for the $l$th lag of variable $i$ in equation $j$. Note that the hyperparameters such as $\lambda_0, \lambda_1$ and $\lambda_3$ reflect the general beliefs about the series being modelled. For the estimation of the model we use the Normal-Wishart prior distributions. In order to obtain more robust results we will estimate the model using the Ko-Ko Minnesota/Litterman prior [2].

In the analysis are included monthly data regarding the evolution of the industrial production, the real exchange rate (expressed as an index, this index growth indicating a leu's real appreciation against the currencies of the commercial partners of Romania), the consumption prices index, the M2 monetary aggregate, the Leu-Euro exchange rate (1 euro for x units of currency of a country), the interest rate of the interbank market and the real estate prices index for a period between 2001-2010. These data come from the database of the International Monetary Fund (International Financial Statistics), from the database of the European Central Bank (Statistical Data Warehouse). The real estate index is taken from the site http://indeximobiliar.blogspot.com. Comparing to the index calculated by the National Statistics Institute of Romania, starting with the year 2009, differences are very small, approximately up to 0.79%. All the data are seasonal adjusted, excepting the exchange rate and the interest rate. All the data are expressed in logarithm (excepting the interest rate), and then the prime difference operator is applied.

### 3 Main results obtained

The response of the variables introduced in the analysis to a positive shock of the industrial production. A positive shock of the industrial production (Annex no.1 and no.2) will lead to an appreciation of the real rate exchange and to a reduction in the inflation. Normally, the inflation response to a positive shock of the demand should be positive, but the appreciation of the exchange rate absorbs rapidly this effect. Also, the positive variation of the production will trigger a negative variation of the Leu-Euro exchange rate and a growth in the M2 monetary aggregate.

The response of the variables introduced in the analysis to a positive shock of the real exchange rate. Conventionally, in the case of the real exchange rate shock, that is a national currency appreciation, we will assist to the prices decrease. The national currency appreciation will grow the exports price and will reduce the imports price. The decrease of the imported products prices will also lead, in a competitive economy, to the decrease of the autochthon products prices. There from the prices diminution will result.

On the other hand this response depends on the existent structure between the exports and the imports. The inflation diminution, as a consequence of a national currency appreciation will be more consistent if the imports are predominant in the national consumption. This argument seems to ply with the economy of Romania (Annex no.1 and no.2) where the inflation diminished as a result of the leu's appreciation between 2004 and the end of 2007, appreciation that took place on the background of a high consumption oriented towards the imports and the low saving, increasing both the current account deficit and also the external debt. The national currency appreciation in a period in which the current account deficit was substantial can seem ungrounded. It based preponderantly on the capital account liberalization and on the admissions of foreign currency in Romania, admissions that were sustained by the leu’s positive interest differential against other currencies, mainly against euro. Along with the financial crisis outbreak, at the end of 2007 in United States, the foreign capital started to be withdrawn from Romania fact that led to significant national currency depreciation. This depreciation would have led to a significant inflation growth if it hadn’t been accompanied, due to the economic crisis, by a strong contraction of the production (a negative output gap) and of a current account correction (the consumption that was directed towards imported goods significantly diminished). This mixture of events determined the maintenance of inflation on the descending trend.
The deflationist impact of a positive shock of the real effective exchange rate is reabsorbed through a diminution of the interest rate on short term. This mechanism aligns with the “exchange rate-prices-interest rate” tridimensional relation. Indeed, the unexpected national currency appreciation incites the economic agents to hold an inferior currency stock, which determines an interest rate decrease on short term. In an economy such as the Romanian economy which adopted the inflation target strategy, the absorption and the competitiveness deterioration (a real effective exchange rate appreciation) through the usual method that is the massive intervention of the monetary authorities on the exchange market through the accumulation reserve fund, is conflictual. This intervention, if it takes place, will generate a growth of the monetary offer and, implicitly of the inflationist pressures. In this way we can explain the central bank's non-intervention when the leu appreciated against the other currencies. Thus, the central bank will be exposed to the dilemma of practicing a new inflation target and the limitation of the national currency appreciation. Herman states that the monetary authorities’ intervention in order to absorb the national currency appreciation within the inflation target system could be profitable only in the conditions in which the economy operates under its potential [5]. Thus an expansionist monetary policy generated by the intervention on the exchange market will favour the realization of the inflation target. This situation isn’t also met in Romania, because the output gap was far superior to the economy potential within the period 2004-2008. On the other hand, the adjustment of the national currency appreciation can be realized through an interest rate growth in order to fight against the inflationist pressures generated by the monetary authorities’ intervention on the exchange market and the national currency depreciation. However the interest rate growth will cause at its turn a national currency appreciation due to the attraction of the capital waves towards the economy, capital waves attracted by the high interest differential.

Montiel and Ostry underline the fact that in the context of the free capital flow, the monetary policy task of acting against the inflation is very difficult [4]. The offer of currency cannot be controlled very easy through a restrictive monetary policy (sterilization). As far as the economic agents can obtain foreign liquidities, the direct monetary instruments of enclosing the credit doesn’t influence the money supply and thus the inflation. That is why the vocation of an inflation target strategy is the one of anchoring the inflationist anticipations of the population on a level as low as possible.

The positive shock effect of the real exchange rate on the production is disputed. If we take into account the aggregate demand side the decrease of the imports prices and the decrease of the autochthon goods demand, as a result of the national currency appreciation, will lead to a national production collapse. Thus the deterioration of the competitiveness-prices of the autochthon goods on international level relation will lead to the exports decrease and will generate a production decrease. On the other hand, if we take into account the aggregate offer side, a national currency appreciation will generate a decrease of the imported intermediate goods prices included in the production factors and thus in the production cost. Consequently, it will increase the labour force demand, but also the production. In Romania, the impact of the exchange rate real appreciation upon the industrial production seems to be dominated by the aggregate offer. Also, the positive variation of the real exchange rate will lead to an appreciation of the Leu in comparison to the Euro and will have a strong positive impact upon the real estate prices.

The response of the variables included in the analysis to a positive shock of the inflation. The growth rate of the industrial production will reduce as a consequence of a positive shock in the inflation rate, the response being in accordance with the specialized literature. The response of the M2 monetary aggregate to an unexpected inflation growth (Annex no.1 and no.2) is the one of growing the money supply, unlike the theoretical hypotheses according to which a prices unexpected growth indicates a money supply decrease. However this contradiction was also observed by Kim and Roubini [5]. The inflation persistence will disappear after 7 months. In response to an unexpected growth in the inflation, the real exchange rate falls.

The response of the variables included in the analysis to a positive shock of the monetary aggregate M2. A positive variation of the monetary aggregate M2 (Annex no.1 and no.2) will trigger an inflation growth and a depreciation of the national currency. As it can be observed, the growth in the monetary mass has a significant impact upon real estate prices.

In our opinion, two factors have contributed in an essential way to the speculative growth in the real estate prices between the years 2005-2008. Firstly, the appreciation of the national currency (Annex no.1 and no.2) but also the descendent evolution of the reference interest rate has built up very optimistic expectations as regard to the economy behaviour on the long term. Secondly, both non-governmental credit and mortgage credit have grown spectacularly before 2009. This growth was determined by the descending interest rates in
Romanian, the evolution of the exchange rate, but also the lax crediting rules of the commercial banks, Romanian National Bank legislation being very permissive in this respect.

From the Annexe no. 1, it can be observed that the depreciation of the national currency leads to an important reduction of the real estate prices index this situation being a juncture one. This fact can be explained by means of two ways. Firstly, in an unusual way, the prices of this sector are expressed in the European currency, and a growth in the rate will determine a reduction of prices in Euro in order to maintain a constant value of prices in national currency. Secondly, the Romanian economy is strongly dependent on the Euro currency, the majority of mortgage credits being granted in foreign currency. Under these conditions, one the factors that sustained the high demand in the real estate sector, the real estate credit, was affected negatively in the last three years by the next factors: on the one hand, the appreciation of the European currency, USA dollar and the Swiss franc in comparison to the Leu, but also by the reduction in the crediting lines that Romanian banks beneficiated from.

The response of the variables included in the analysis to a positive shock of the nominal exchange rate. A positive shock of the nominal exchange rate (Annex no.1 and no.2), concretized in a leu’s unexpected depreciation against euro will lead to an inflation growth and to a money supply growth. Also, as we have mentioned before, the depreciation of the national currency will have a negative impact upon the real estate prices. As we see, the channel of exchange rate is quite important in the relation of influence over the other variables included in the study. Taking into account this observation, but also the fact that the process of monetary convergence into Euro is a complex process that includes the inflation convergence and also the exchange rate stability and interest rates convergence (Maastricht criteria), a strict form of inflation targeting being insufficient because it does not ensure the exchange rate stability. Thus, a more flexible way of inflation targeting in needed, that allows the targeting of inflation differential predictions in comparison to the Euro zone and a stability of the exchange rate [6].

The response of variables included in the analysis to a positive shock of the interest rate. A positive aspect that emerges from the analysis carried out is represented by the response function of the production and of inflation to a positive variation of the interest rate (Annex no.1 and no.2). A shock of the interest rate will lead to a higher price of money, which will determine people to request less consumption and investments loans, so that both the inflation and the production will diminish, and they will gradually recover after the interest rate shock have disappeared. This answer consolidates the interest rate channel and supports the inflation targeting strategy. Also, a growth in the interest rate will trigger an appreciation of the national currency and a reduction in the monetary aggregate M2, these functions of response being in accordance with the theoretical hypotheses. The interest rate growth does have no influence over the real estate prices, unlike the economic theory of Iacoviello [7].

4 Conclusions
This work had as objective to provide new empirical results in what transmission mechanisms of monetary policy in Romania are concerned, using modern techniques. Therefore, we have built a model, estimated by means of Sims’ and Zha’s prior distribution [1] that highlights the main factors that influenced Romanian economy in the last ten years. That’s why, we have included in the analysis variables that emphasize the industrial production evolution, the exchange rate, the inflation, the real estate prices, the monetary aggregate M2 and the interest rate. Also, in order to consolidate the validity of the data obtained we have carried out a double check. Firstly, we have estimated the Bayesian autoregressive vector using the methodology imposed by Sims and Zha and also the KoKo Minnesota/Litterman technique.

The analysis shows important conclusions. The exchange rate remains an important mechanism that influences significantly the variables of the real economy. Among the factors that contributed to the appreciation of real estate prices, we have identified the monetary aggregate M2, but also the appreciation of the national currency. The positive aspect that emerges from this study is related to the absence of output puzzle and price puzzle, the channel of the interest rate being more and more consistent in the last years.

Definitely, this study will foster new research directions. One of these directions is represented by the extension of the analysis to a broader research of the monetary policy by means of a DSGE model that includes among the variables the gross domestic product evolution and the realization of a comparison between the results obtained in the two models.
References:


Annex no. 1 – The results of the BVAR model using Sims and Zha prior
Annex no. 2 – The results of the BVAR model using KoKo Minnesota/Litterman prior

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This work was supported by CNCSIS-UEFISCDI, project number PNII-IDEI 952/2009