6. FORECASTING THE ROMANIAN GDP IN THE LONG RUN USING A MONETARY DSGE[1]

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Abstract

In this study, I estimate a monetary DSGE model using Bayesian techniques and I use the estimated model to forecast the Romanian GDP in the long run. For the 2008-2010 period, the forecasts with the model confirm the present consensus among the economists about a growth potential of 5 to 6% for Romania. In the long run, the model forecasts a stable annual growth rate of about 4.9%.

Keywords: forecasting methods, DSGE models, Bayesian methods, real business cycles

JEL Classification: E60, C68

1. Introduction

One of the fundamental issues in macroeconomics is as accurate a forecasting as possible of the future dynamics of the economy and of the main macroeconomic variables. For an emerging economy like Romania this is even more important, given the need of adopting economic policies that encourage the economic development.

There are several approaches in forecasting the dynamics of Romania using macroeconomic models. One of the more recent studies which approach the economic growth in Romania is that of Croitoru and Târhoacă (2003). They calibrated a CGE model for Romania which they used in order to estimate the growth rate in the medium run. They obtained a growing growth rate, which tends toward 6% at the end of the forecasting period, namely 2010. We can also notice Albu and Roudoi (2003) study regarding the application of the production functions to the analysis of the economic growth in Romania.

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Caraiani (2007a) simulated a Solow model in order to do long run forecasts for the GDP growth rate. He calibrated the Solow model using the data regarding the dynamics of the Romanian economy during the transition period. He showed that for the 2020 horizon the growth potential of the Romanian economy was of almost 4%.

We can also notice the yearly forecasts with the Dobrescu macromodel. A description of the Dobrescu model can be found in Dobrescu (2006).

In the field of macroeconomics, the dominant paradigm today is that of the dynamic stochastic general equilibrium models (DSGE, hereafter). The DSGE approach is based on micro foundations, rational expectations, optimizing agents (household, firms), and different types of rigidities, either nominal or real. The DSGE approach is a continuation of the modeling approach started by Kydland and Prescott (1982), who proposed the real business cycle models (RBC, hereafter) as an alternative to the traditional Keynesian models.

One of the first studies to apply a DSGE model to the forecast of the Romanian economy is that in Caraiani (2008). He estimated a RBC model for the Romanian economy using Bayesian techniques, and used the estimated model to forecast GDP for the 2007-2010 period. He estimated an annual growth rate of about 6% for this period.

In the present study, I propose the use of a DSGE model with cash in advance constraint in order to forecast the Romanian GDP. The monetary DSGE models are models which extend the standard RBC by introducing money. The introduction of money in a DSGE model is a topic which continues to be debated, as there is no agreement on the right introduction of money in a DSGE model.

One possible approach to this problem is the introduction of money in the utility function (MIU, hereafter). This approach assumes that some utility is derived from the presence of money and this justifies the incorporation of monetary balance in the utility function. This model is characterized by super-neutrality – that is, not even that the model has the neutrality property, but, as Walsh (2003) noticed, even the changes in the money growth rate do not have real effects. However, the MIU approach has one severe limitation, as Walsh (2003) showed, namely that it does not actually answer to the question of why money produce utility.

One model that departs from the MIU approach but answers better to the monetary issues is the CIA (cash-in-advance) model. The CIA models require that the monetary balance are possessed in order to finance certain types of goods, that is, money are required to buy certain goods, Walsh (2003).

The monetary CIA models were used in several studies in order to investigate the relationship between money and production, or the relationship between inflation and production, or the cost of inflation. Thus, Cooley and Hansen (1989) incorporated money in a real business cycles model using a cash-in-advance constraint. They used the model in order to study the impact of inflation on the welfare, and also to study the long-run differences between low inflation economies and high inflation economies. They showed that 10% inflation implies a welfare loss of 0.387% of GDP.

Cogley and Nason (1994) used several monetary models, including a CIA model, in order to study the degree to which they could replicate the features of the American economy. Although these models are characterized by weak propagation mechanisms, as the authors noticed, they can relatively easy simulate the dynamics of the American economy.

On a topic closer to the present study, Chari, Jones and Manuelli (1995) studied the relationship between inflation and production using several methods, including also a CIA model. They showed that the result according to which there was a negative correlation between inflation and economic growth it was not confirmed when taken into consideration the role of the banks in the financial system.

In a study which proposed a new econometric method to evaluate the DSGE models, Schorfheide (2002) evaluated two monetary models, namely the CIA and the PAC (portfolio adjustment cost model) using a loss function. His approach was based on the Bayesian methodology. He answered to the classical questions regarding the prediction of the monetary models, namely of how well they reproduce the stylized facts regarding inflation and production, of how well the model reveals the correlation between inflation and production, and of how well such models could be used to simulate the impact of shocks in nominal growth rate on the economic growth. He concluded that the CIA model is superior in posterior odds ratios and in the quality of the estimation. Moreover, these models confirmed the negative relation between production and inflation, but the correlation appeared as overestimated. The disadvantage of the CIA model was that it could not reproduce the positive effect of the modification in money supply on the production.

This paper starts from the results in Schorfheide (2000) and proposes itself to apply a monetary CIA model for the Romanian economy. The model is presented in the second section. The third section presents the data used for Romania and discusses the results of the Bayesian estimation. In the fourth section I use the model to forecast the quarterly GDP. The last section concludes and outlines some possible extensions of this study.

2. The Model

I present in this section the CIA model as outlined in Schorfheide (2000), and also used in Cogley and Nason (1994). The model is composed from a household sector, a firms sector, a banking sector and a monetary authority.

The problem of households is to choose consumption C_t, the work time H_t (which is normalized between 0 and 1), and the money supply M_{t+1}, as well as the deposits D_t so that it maximizes the expected total lifetime utility given by:

$$\max E_0\left[\sum_{t=0}^{\infty}\beta^t\left[(1-\phi)\ln(C_t)+\phi\ln(1-H_t)\right]\right] \tag{1}$$

The constraints are given by the following equations:

$$P_tC_t \le M_t - D_t + W_tH_t \tag{2}$$

which signifies the CIA constraint

$$0 \le D_t \tag{3}$$

That shows that the household do not borrow from banks.

$$M_{t+1} = (M_t - D_t + W_t H_t - P_t C_t) + R_{H,t} D_t + F_t + B_t \tag{4}$$

which is the budgetary constraint.

The firms maximize the present expected value of future dividends. The maximization problem consist in the optimal choice of dividends F_t, capital stock K_{t+1}, labor force demand N_t and loans L_t from banks in order to maximize:

$$\max E_0 \left[\sum_{t=0}^{\infty} \beta^{t+1} \frac{F_t}{C_{t+1} P_{t+1}} \right] \tag{5}$$

Under the constraint given by:

$$F_t \leq L_t + P_t \left[K_t^{\alpha} (A_t N_t)^{1-\alpha} - K_{t+1} + (1-\delta) K_t \right] - W_t N_t - L_t R_{F,t} \tag{6}$$

Here β is the discount factor, δ the depreciation rate, while α is the capital share.

And by:

$$W_t N_t \leq L_t \tag{7}$$

The third type of agent, the representative financial intermediary, solves the following problem by optimally choosing B_t, L_t and D_t:

$$\max E_0 \left[\sum_{t=1}^{\infty} \beta^{t+1} \frac{B_t}{C_{t+1} P_{t+1}} \right] \tag{8}$$

The banks in the banking sector receive cash dividends from the households, and money from the central bank. The money are used to give credits, L_t, to firms, and the return of the credits is $R_{F,t}$-1. The behavior of banks is characterized by the following two equations:

$$L_t \leq X_t + D_t \tag{9}$$

which stands for the equilibrium condition in the credit market. The following equation expresses the bonds:

$$B_t = D_t + R_{F,t} L_t - R_{H,t} D_t - L_t + X_t \tag{10}$$

The model is closed by adding the equilibrium conditions for the labor force:

$$H_t = N_t \tag{11}$$

for the money market:

$$P_t C_t = M_t + X_t \tag{12}$$

and for the goods market:

$$C_t + (K_{t+1} - (1-\delta) K_t) = K_t^{\alpha} (A_t N_t)^{1-\alpha} \tag{13}$$

In the equilibrium the following relation stands:

$$R_{H,t} = R_{F,t} \tag{14}$$

The production function is a Cobb Douglas one and is given below:

$$Y_t = K_t^{\alpha} (A_t N_t)^{1-\alpha} \tag{15}$$

Two types of perturbations are introduced, one standing for the technological shocks, which follow:

$$\ln A_t = \gamma + \ln A_{t-1} + \varepsilon_{a,t} \tag{16}$$

While the second stands for the monetary shocks:

$$\ln m_t = (1-\rho)\ln m^* + \rho \ln m_{t-1} + \varepsilon_{m,t} \tag{17}$$

Here ρ is the autocorrelation of the innovations in the money growth rate while m^* is the unconditional mean of the money growth rate. γ is the deterministic trend of the technology growth.

3. Data and the Estimation of the Model

For the estimation of the model, I used two time series, namely GDP and inflation. Both series are used at quarterly levels. For GDP, I used the quarterly GDP in 1995 constant prices. The inflation data is given by the quarterly GDP deflator. Although both series feature a trend, I used the time series as given (I only de-seasonalized them), as the model I use allows for the presence of a trend in the production and inflation.

The set of parameters to be estimated is given by $\{\alpha, \beta, \delta, \gamma, m^*, \rho, \phi, \sigma_a, \sigma_m\}$. Several of these parameters were calibrated using the results in Caraiani (2007b). The elasticity of production with respect to capital α, the capital share, was calibrated to 0.40. The depreciation rate δ was fixed to 0.024. Using the results in Caraiani (2007b), I also could set the discount factor β to 0.98.

The estimation was done using Bayesian techniques. I used two Metropolis–Hastings chains, each one of 50.000 extractions. The convergence criteria as proposed by Brooks and Gelman (1998) showed that the convergence was achieved. In Appendix, the results of the estimation are presented.

Table 1

Bayesian Estimation Results

Parameters	Prior mean	Posterior mean	Confidence interval	Confidence interval	Prior distribution	Standard deviation
γ	0.009	0.0116	0.0076	0.015	Normal	0.003
m^*	1.00	0.99	0.98	1.007	Normal	0.007
ρ	0.90	0.836	0.752	0.918	Beta	0.05
φ	0.65	0.623	0.537	0.706	Beta	0.05
σ_a	0.1	0.020	0.015	0.024	Gamma Inv.	Infinite
σ_m	0.1	0.025	0.020	0.032	Gamma Inv.	Infinite

Source: Author's own computations.

Table 1 presents the results of the estimation. From Appendix, we also can notice that the posterior distributions are characterized not by variability, but also by significant differences with respect to prior distributions. This shows that the estimation results were significantly influenced by the distributions of the data used.

For the ρ coefficient, which characterizes the autocorrelation of the money growth rate, we got a quite high value, implying a high persistence in the money injection shocks.

The γ parameter, which refers to the deterministic component of the technology process, was estimated at a higher value than the prior mean, underlining the fact that Romania was characterized by higher than usual growth rates during the analyzed period, at least growth rates higher than the long-run growth rate of the developed economies. The parameter characterizing the money supply growth mean, m^*, is estimated at a value close to the parameter mean.

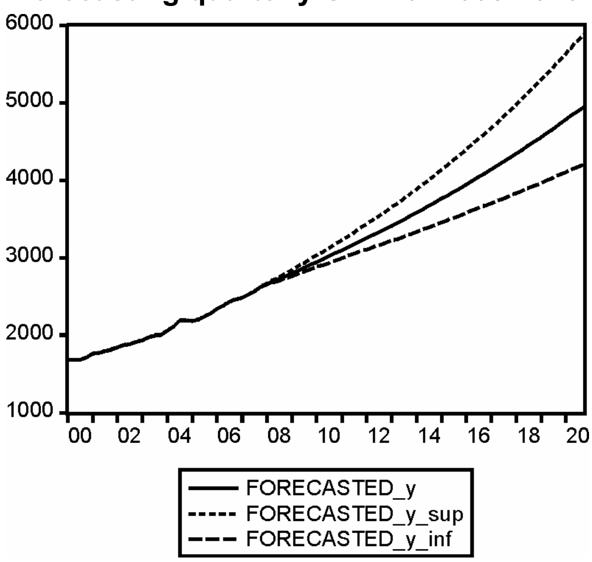
4. Forecasting GDP in the long run

In this section, I made a few forecasts regarding the economic growth of Romania by using the estimated model. The first forecasting exercise projected the quarterly GDP for the period between quarter 1 - 2008 and quarter 4 - 2020. Although the quarterly models are used most of the time to forecast the GDP for 8 to 10 quarters, the fact that this model includes the trend suggests the possibility of using this model to forecast the long run tendencies of the Romanian economy. At the same time, since this model is a structural one, one can derive a characterization of the long-run behavior of the economy based on the deep parameters.

I also computed a confidence interval given by considering the uncertainty with respect to both shocks and parameters. Figure 1 shows a steady tendency to grow for the 2015–2020 horizon. At the same time, the confidence interval showed a certain uncertainty with respect to the growth rate.

Figure 1

Forecasting quarterly GDP for 2008-2020

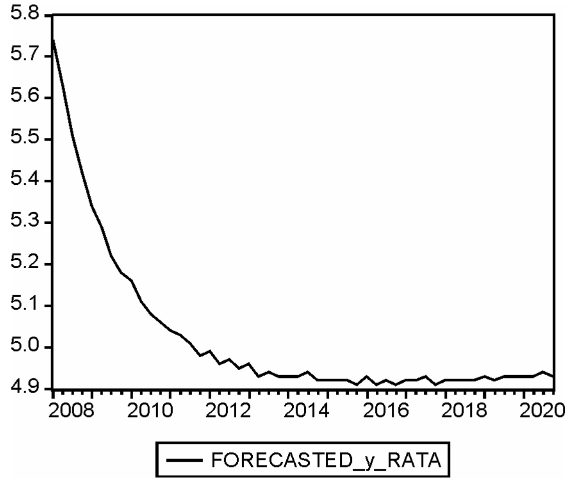


Source: Author's own computations.

The above graph can be better understood when taking into consideration the annualized growth rate of GDP, as shown in Figure 2. The forecast was done for a mean average growth rate for the 2008-2020 horizon. We can see a higher growth potential for the first years. This estimation of the growth potential of over 5.3% in the 2008-2010 period indicates that, in the medium run, the Romanian economy can grow at a high pace. At the same time, given the values of the structural parameters in the model, in the long run the economy tends toward a growth potential of about 4.9%. Obviously, possible modifications in the structural parameters can lead to smaller or higher long-run growth rates.

Figure 2

Forecasting annualized growth rate for quarterly GDP

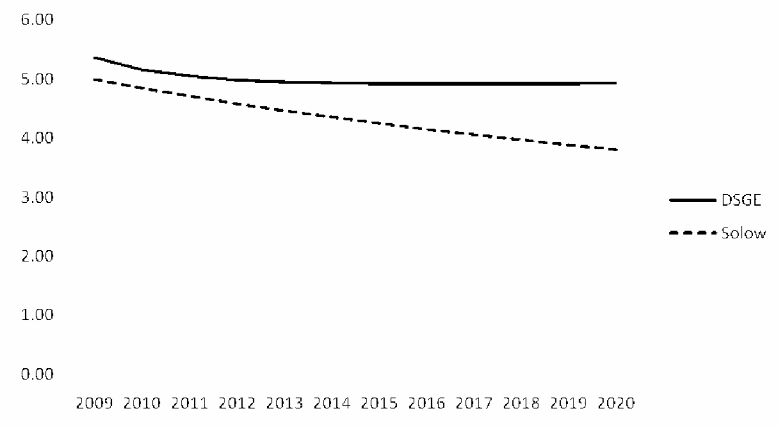


Source: Author's own computations.

In Figure 3, I compare the long-run forecasts of the estimated DSGE model with the long-run forecast of the calibrated model in Solow, as shown in Caraiani (2007a). We can again see again that the forecasted growth rate stabilizes around 4.9% starting in 2012. At the same time, according to the underlying hypothesis, the Solow model predicts a decreasing growth rate which tends, in the long run, to the TFP growth rate, in the present case, 3%. I consider that the forecast of the DSGE model is more credible under the circumstances that I could estimate the structural parameters. Also, it must be said that the forecast of the DSGE model allows for the estimation of a confidence interval, a thing not possible with the calibrated Solow model, which also allows deviations from the forecasted mean.

Figure 3

Forecasting long-run economic growth using the DSGE model and the Solow model



Source: Author's own computations.

The results from the DSGE forecast are also close to the official forecasts from the National Commission for Forecasting (2008). The Commission's forecasts are a bit higher for the 2008-2012 period, but in the long run, towards the 2020 horizon, the differences become small, being higher by less than 0.4%. It must also be said that although the Commission's forecasts are higher than the mean forecast of the DSGE model, they are within the computed confidence interval.

Conclusion

One of the most important applications of a macroeconomic model is forecasting. At the same time, the quality of the forecasting is one of the most significant tests regarding the relevance of a certain macroeconomic model.

In this paper, I estimated a monetary DSGE model which I used in order to forecast the GDP in the long run. This particular DSGE model has two features that differentiate it from other DSGE models applied to Romania. Namely, it is characterized by a banking sector, and also includes the presence of trends in the observables variables, GDP and inflation.

The presence of these features led to particular results for the forecasts of GDP. Thus, for the 2008-2010 horizon, the model confirms the present consensus between economists regarding a growth potential of Romania of 5 to 6%. In the long run, the model predicts a growth rate of over 4.9%.

Due to changes in the structural parameters, which can be influenced by economic policies, or by the behavior of the economic agents, or changes in the trend, it is possible that the actual growth rate be significantly different from the forecasted one.

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Appendix

Bayesian Estimation Results