6 AN ANALYSIS OF DOMESTIC AND EXTERNAL SHOCKS ON ROMANIAN ECONOMY USING A DSGE MODEL

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Abstract

In this paper, I study the impact of the domestic and external shocks on the Romanian economy. I use an open economy DSGE model and estimate it for the Romanian economy using Bayesian techniques. The impact of the domestic shocks is moderate but not persistent. The Euro Area demand and interest rate shocks have a moderate impact on the domestic output. The Euro Area supply and interest rate shocks have significant and persistent impacts on the domestic inflation. I also perform a long-run variance decomposition of the domestic variables.

Keywords: DSGE models, small open economy, Romania, Euro Area, monetary policy.

JEL Classification: C11, E40, F41.

1. Introduction

The perspective of the Euro integration raises the issue of a correct assessment of the impact of the Euro Area shocks on the Romanian economy. In order to estimate the impact of Euro Area shocks and to compare their impact with the impact of the domestic shocks I apply an open economy dynamic stochastic general equilibrium model (DSGE, hereafter) for the Romanian economy.

The open economy DSGE models were built for the first time by Obstfeld and Rogoff (1995, 2000), under the framework of the so-called new open economy macroeconomics (NOEM, henceforth). Following their work, several papers extended their contribution and consolidated the NOEM field, like the ones of Gali and Monacelli (2005), Monacelli (2003), Lubik and Schorfheide (2005), or Adolfson *et al*. (2007).

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Most of the models were constructed and estimated for large open economies, such as those for the Euro Area, like in Adolfson *et al*. (2007), or for the industrialized countries, Canada, Australia, or New Zealand, like in Justiniano and Preston (2004), Liu (2005), or Dib (2003). This paper extends the ongoing work to the case of a small open economy, namely for the case of the Romanian economy.

Several studies were done on the impact of economic shocks on the Romanian economy, but they were done under the classical VAR framework. Pelinescu and Țurlea (2004) used a VAR model to estimate the impact of domestic and foreign shocks on inflation dynamics and found that inflation was a monetary phenomenon. Pelinescu and Dospinescu (2005) used a VAR instrument to simulate and study the impact of changes in money, foreign exchange and the impact of external shocks on the inflation dynamics. They found that the exchange rate has a significant influence on the inflation and that the oil price influence on inflation dies out quickly. Scutaru and Stănică (2005) evaluated the impact of the inflationary shocks, productivity shocks and labor market shocks on the Romanian economy using the Blanchard-Quah decomposition.

Under the DSGE framework, one may note the contribution of Caraiani (2007), who estimated a closed economy New Keynesian model with sticky prices for the 1991-2002 period and found that the NK model can replicate the stylized facts of the real data. He also found moderate and persistent effects of the monetary policy shocks. This paper extends the previous study by considering an open economy model for the post 2000 period for Romanian economy.

The purpose of this paper is to use an open economy New Keynesian model in order to estimate it using Bayesian techniques, and also to use the results in the analysis of the effect of domestic and external shocks from the Euro Area on the domestic economy. I also assess how much each shock matters for the dynamics of the domestic variables.

This paper is organized as follows. The following section outlines the model and discusses its building blocks. I estimate the model in the third section using Bayesian techniques and also discuss the implications of the results. In the fourth section I analyze the impact of domestic and external shocks on the domestic economy. In the last section I conclude and draw some possible policy implications.

2. The Model

The model used in this study is that of Buncic and Melecky (2007). They extended the work of Clarida *et al*. (1999) to the small open economy case. The model is a two–country model composed of a domestic and a foreign economy. The foreign economy is that of the Euro Area, which is taken as a proxy for the world economy. Here I consider a structural version of the foreign economy, as in Lubik and Schorfheide (2007). Some of the studies in the NOEM field consider AR (1) processes for the foreign block, like Liu (2005). It is also possible to consider VAR models for the foreign economy, as in Justiniano and Preston (2004). I consider that a structural model for the foreign block is more proper for the analysis of the impact of foreign shocks on domestic inflation.

In the next paragraphs, I present the model I use in the estimation and the analysis from the next sections. The model comprises the following variables: y_t, $\pi_{,t}$, q_t, r_t, y_t^*, π_t^*, r_t^* representing domestic output, domestic inflation, real exchange rate, domestic nominal interest rate, foreign output, foreign inflation, and foreign nominal interest rate. The model is already in log-linear form.

$$\pi_t = \rho_\pi E_t \pi_{t+1} + (1-\rho_\pi)\pi_{t-1} + \lambda_1 y_t + \lambda_2 q_t + \varepsilon_{\pi,t} \quad (1)$$

$$y_t = \rho_y E_t y_{t+1} + (1-\rho_y) y_{t-1} - \delta_1 (r_{t-1} - E_{t-1}\pi_t) + \delta_2 q_{t-1} + \delta_3 y_t^* + \varepsilon_{y,t} \quad (2)$$

$$r_t = \rho_r r_{t-1} + (1-\rho_r)(\psi_\pi \pi_t + \psi_y y_t) + \varepsilon_{M,t} \quad (3)$$

$$E_t \Delta q_{t+1} = (r_t - E_t \pi_{t+1}) - (r_t^* - E_t \pi_{t+1}^*) + \varepsilon_{q,t} \quad (4)$$

$$\pi_t^* = \rho_\pi^* E_t \pi_{t+1}^* + (1-\rho_\pi^*)\pi_{t-1}^* + \lambda^* y_t^* + \varepsilon_{\pi,t}^* \quad (5)$$

$$y_t^* = \rho_y^* E_t y_{t+1}^* + (1-\rho_y^*) y_{t-1}^* - \delta^* (r_{t-1}^* - E_{t-1}\pi_t^*) + \varepsilon_{y,t}^* \quad (6)$$

$$r_t^* = \rho_{rf} r_{t-1}^* + (1-\rho_{rf})(\psi_{\pi f} \pi_t^* + \psi_{yf} y_t^*) + \varepsilon_{M,t}^* \quad (7)$$

Equation (1) is an open economy New Keynesian Phillips Curve. This curve is derived from the profit maximization decision of the domestic firms under the monopolistic competition and sticky prices. The NK Phillips Curve is forward looking, as expectations about future inflation influence the current inflation. It also comprises a backward looking element in inflation, so that past inflation matters for current inflation. This extension due to Gali and Gertler (1999) improves the inertia of the inflation. Since it is an open economy Phillips curve, the exchange rate also enters this equation.

The second equation is an open economy IS curve. Since the IS curve results from the optimizing decision of household who maximize their lifetime utility, a forward looking element appears. The backward looking element is the result of either external habit formation, or adjustment costs in capital (see Buncic and Melecky, 2007). Moreover, since it characterizes an open economy, the domestic output is influenced by both the real exchange rate and by the foreign output.

The monetary policy rule equation, (3), is a typical Taylorian rule. Here, the standard Taylor formulation is modified to allow for interest rate smoothing, as proposed by Clarida *et al*. (1999). The fact that the exchange rate is not included in the reaction function can be argued from the existing literature that founds little or no statistical evidence that the monetary authority reacts to the exchange rate fluctuations, see Lubik and Schorfheide (2007).

Equation (4) specifies the real exchange rate dynamics. The real exchange rate follows the uncovered interest parity to which a shock is added in order to take into account the measurement errors. The same approach was also followed by Justiniano and Preston (2004).

Equations (5)–(7) specify the foreign economy, in this case the Euro Area. The foreign economy is similar in structure to the domestic economy. Since the foreign economy is taken as a large economy, no open-economy elements appear in the equation that characterize it.

3. Data and Estimation of the Model

I estimate the model given in the equations (1)-(7) using Bayesian techniques. In order to obtain data which is similar in interpretation to the variables in the model, I apply the logarithm, and de-trend all the variables in the model, except the nominal interest rate in the Euro Area. The nominal interest rate in Romania is de-trended due to the fact that it contains a decreasing trend.

The estimation is done for the period between 2000 and 2006, using quarterly data. The quarterly interest rate is the average of the monthly interest rate during the current quarter. Quarterly inflation is also obtained using the same procedure. I use the HICP for both Euro Area and Romania.

I run two Metropolis Hastings chains each of 50000 draws. The acceptance ratio was about 46.9% for both. The smoothed shocks (see Annex A) indicate that the estimation results are accurate. As for the convergence statistics, the multivariate convergence statistics proposed by Brooks and Gelman (1998), (see Annex B), indicate that the convergence was achieved. We also observe that the marginal posterior distributions indicate that there are differences between posterior means and prior means.

Table 1

Bayesian Estimation Results

Parameters	Prior Mean	Posterior Mean	Confidence Interval	Confidence Interval	Prior Distribution	StandArd Deviation
ψ_π	1.65	1.36	1.06	1.64	Normal	0.20
ψ_y	0.5	0.56	0.27	0.88	Normal	0.20
ρ_r	0.5	0.12	0.02	0.23	Beta	0.20
ρ_π	0.5	0.48	0.13	0.80	Beta	0.20
ρ_y	0.5	0.67	0.52	0.78	Beta	0.20
δ_1	0.015	0.02	0.004	0.03	Normal	0.01
δ_2	0.002	0.17	0.008	0.35	Normal	0.10
δ_3	0.05	0.06	-0.08	0.26	Normal	0.10
λ_1	0.01	0.12	0.0001	0.29	Normal	0.20
λ_2	0.001	0.70	0.42	0.98	Beta	0.20
ρ_{rf}	0.5	0.91	0.86	0.97	Beta	0.20
ψ_{if}	1.65	1.62	1.19	1.98	Normal	0.25
ψ_{yf}	0.25	0.27	-0.13	0.69	Normal	0.25
$\rho_{\pi f}$	0.6	0.63	0.38	0.94	Beta	0.20
ρ_{yf}	0.6	0.88	0.78	0.99	Beta	0.10
δ_f	0.01	0.005	-0.007	0.019	Normal	0.10
λ_f	0.03	0.028	-0.05	0.13	Normal	0.10
$\sigma\pi$	1.0	3.05	2.27	3.58	Inv. Gamma	Infinite
σy	1.0	2.25	1.75	2.78	Inv. Gamma	Infinite
σq	1.0	6.10	4.71	7.46	Inv. Gamma	Infinite
σyf	1.0	0.50	0.39	0.60	Inv. Gamma	Infinite

Parameters	Prior Mean	Posterior Mean	Confidence Interval	Confidence Interval	Prior Distribution	StandArd Deviation
σπf	1.0	0.35	0.27	0.45	Inv. Gamma	Infinite
σr	1.0	6.56	5.03	8.04	Inv. Gamma	Infinite
σrf	1.0	0.35	0.28	0.42	Inv. Gamma	Infinite

Source: Author's own computations.

The estimates of the Taylor rule for the Romanian economy indicate that the weight on inflation is high confirming the fact that the National Bank pursued first of all to stabilize the prices as it has prepared for and then it has adopted the inflation targeting regime during the studied sample. At the same time, the weight put on the output gap is considerable. There is a low inertia in the adjustment of the interest rate suggesting that the National Bank of Romania is not so gradual.

The estimated coefficient associated to the forward looking output gap, ρ_y, is more important than the estimated coefficient associated to the forward looking inflation, ρ_π. The estimate of the domestic Phillips curve also shows a very significant coefficient for the exchange rate. The exchange rate movements thus are confirmed to have an important influence on the domestic inflation changes.

From the estimation of the domestic IS curve we obtain that the real interest rate, the exchange rate and the domestic output influence the dynamics of the domestic demand. The coefficient associated to the exchange rate is considerable.

I turn now to the estimates of the foreign block, namely to the Euro area structural equations. The estimates of the Taylor rule result in values within the estimates of the literature in the field, as in Smets and Wouters (2002), Rabanal and Rubio-Ramirez (2003).

For the IS and Phillips curves for the Euro Area I obtained values that are close to those obtained by Buncic and Melecky (2007) in their estimation for the USA. Since the two economies are similar in their structures, I can conclude that the estimates are reasonable. The only significant difference is that of the coefficient of the expected output gap in the IS curve, which is estimated by me at 0.88.

4. The Analysis of the Impulse Response Functions

In this section, I analyze the impulse response functions of the endogenous variables to the external and internal shocks. I simulate the model with the parameters set to the mean values of the posterior distributions.

Shocks are unanticipated and appear in period one. They represent 1% positive temporary shocks and they are not auto correlated.

4.1. The Domestic Economy Shocks

4.1.1. The Interest Rate Shock

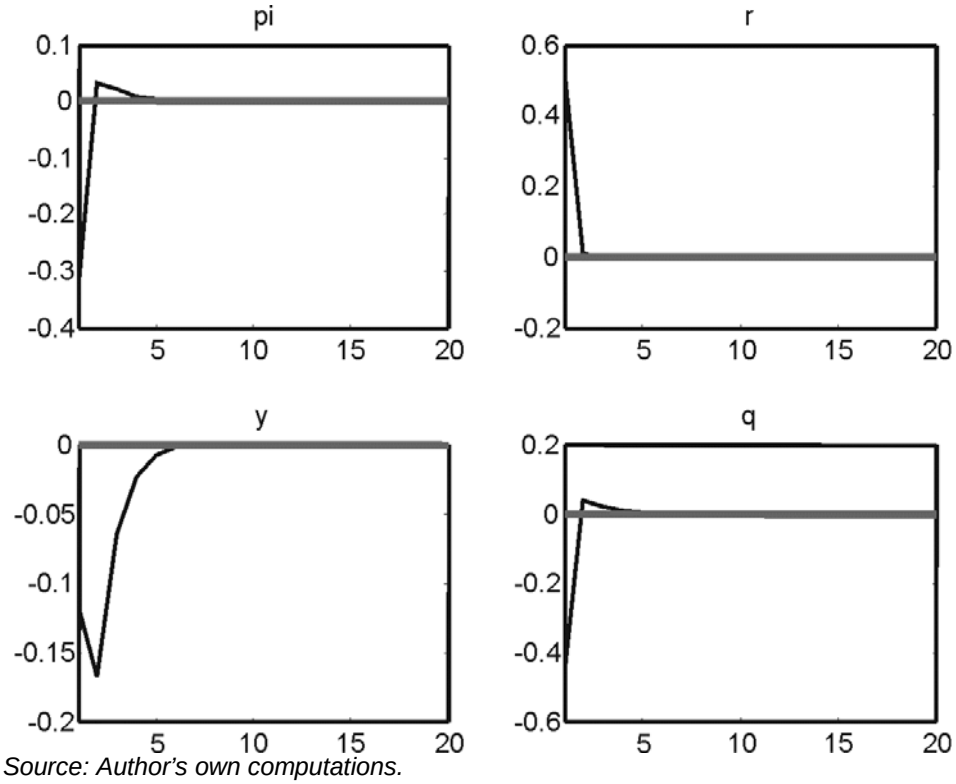
Figure 1 presents the impulse response functions to the domestic interest rate. The domestic interest rate increases less than 1% since the output gap and the inflation respond negatively from the first period to the interest rate shock.

The impact on the domestic variables is not persistent. The inflation decreases by 0.3%, but the effect lasts for about two quarters. The impact on the output gap is slightly more persistent. Output decreases by more than 0.15% and the negative effect lasts for about six quarters. One may notice that output reacts in a realistic way, with a hump-shaped response to the interest rate shock.

The exchange rate appreciates by 0.4% but the effect lasts for only two quarters.

Figure 1

The impulse response function to the domestic interest rate shock



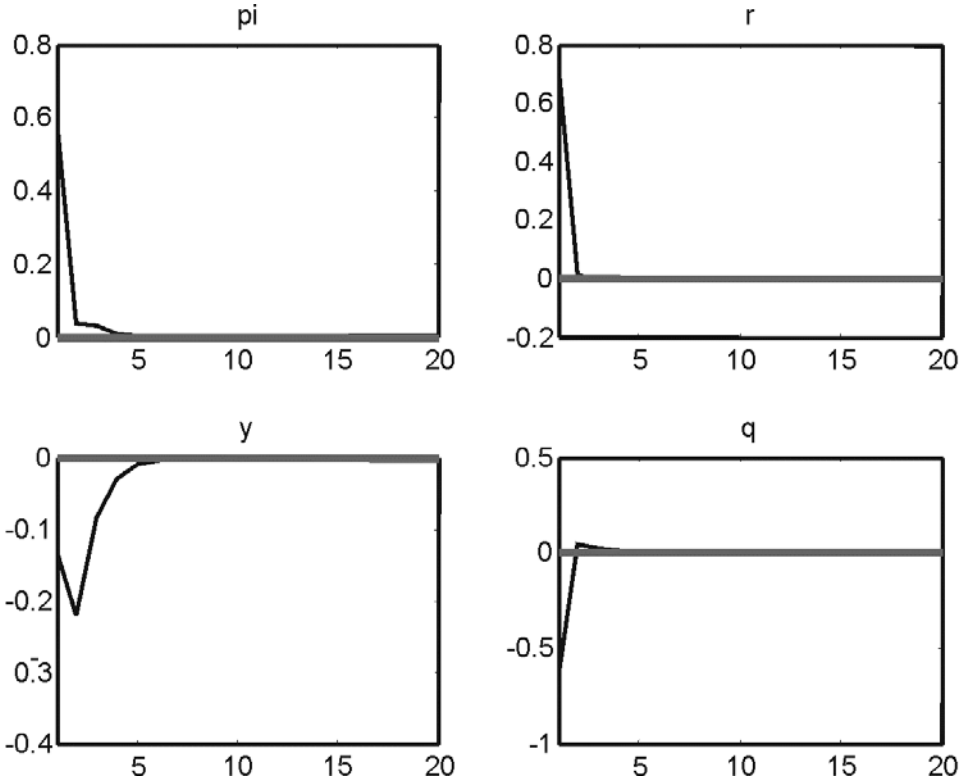
Source: Author's own computations.

4.1.2. The supply shock

A one percent temporary positive supply shock leads to a 0.6% increase in the interest rate. The increase in the interest rate leads to an actual increase in the inflation of about 0.5%. The increase in the interest rate leads to a negative effect on the output gap. The output gap reacts again in a realistic way. The response is moderate and the maximum peak is reached after two quarters at about -0.2%.

Figure 2

The impulse response function to the domestic supply shock



Source: Author's own computations.

4.1.3. The demand shock

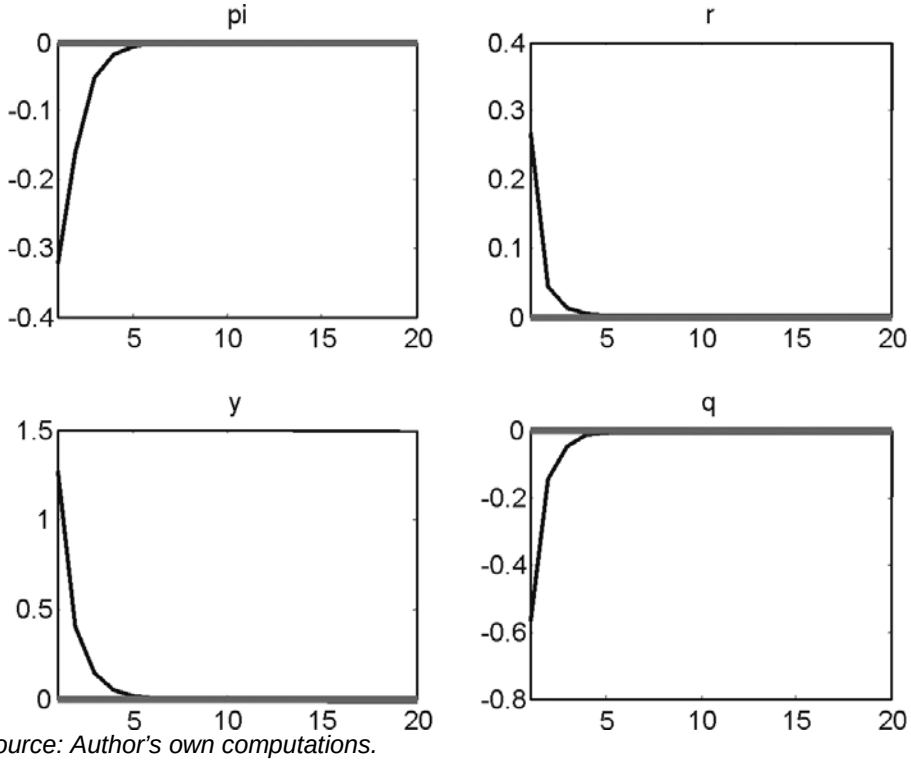
A demand shock leads to a strong response of the output, which increases more than one percent. The persistence is moderate, as the effect completely dies out after five quarters.

Through the Taylor rule, the interest rate reacts positively, but moderately. The 0.3% increase in the interest rate leads to a negative response in the inflation that decreases by 0.3%.

Due to the uncovered interest parity condition, the national currency appreciates by more than 0.5%.

Figure 3

The impulse response function to the domestic demand shock



Source: Author's own computations.

4.2. The Euro Area Shocks

4.2.1. The monetary policy shock

I simulate here the impact of an unanticipated 1% temporary positive shock in the Euro Area interest rate. Since in this model the Euro Area economy is the large economy, while Romanian economy is the small open economy, shocks that are produced in the Euro Area economy influence the Romanian economy.

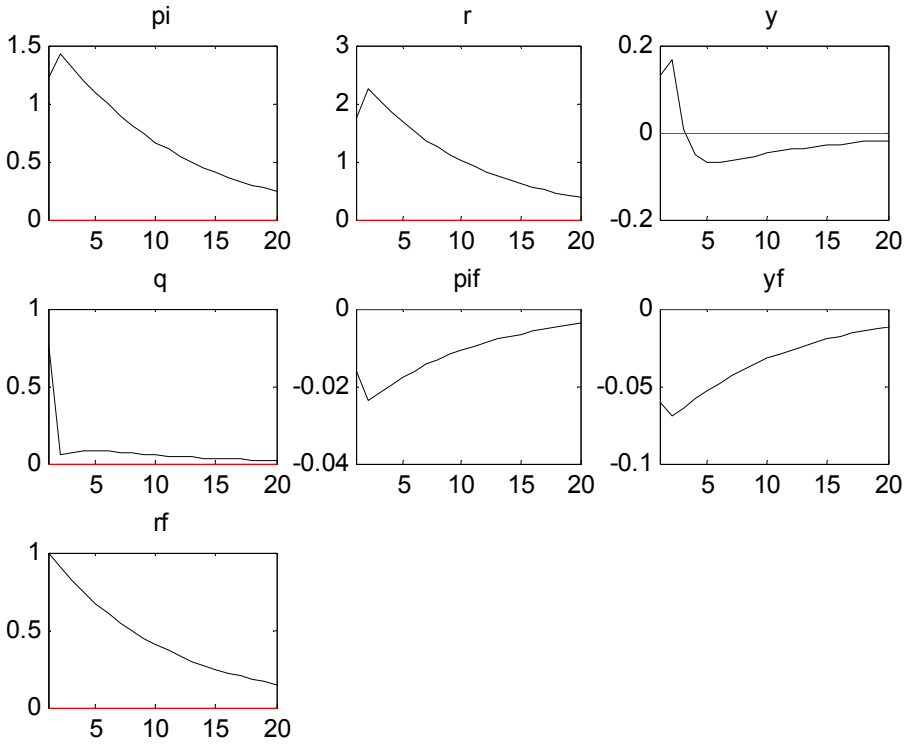
One may notice that the foreign interest rate shock leads to much more persistent responses in both domestic and foreign variables.

Domestic output increases by 0.2% and the positive effect lasts for about one year. The impact on domestic inflation is much more persistent. This is also due to the fact that the domestic currency depreciates in a considerable way. The inflation response reaches a peak after one quarter and the positive effect lasts for more than five years.

The increase in the domestic inflation leads to an increase in the domestic interest rate which reacts strongly by 2%. This leads to a decrease in the output gap with a lag of one year.

Figure 4

The impulse response function to the foreign interest rate shock



Source: Author's own computations.

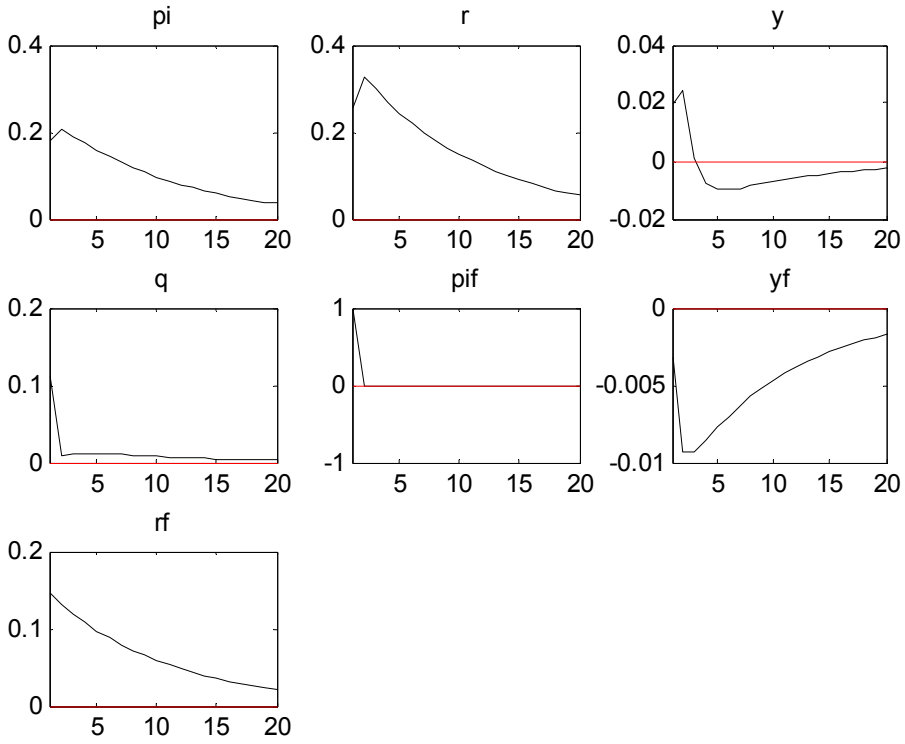
4.2.2. The supply shock

The increase in the Euro Area inflation leads to an increase in the Euro Area interest rate. The increase in the interest rate is moderate, of 0.15%, but persistent, as it lasts for more than five years.

The exchange rate depreciates and this positively influences domestic inflation and domestic output. Inflation rises slightly, by 0.2%, and this leads to a positive increase in the interest rate of about 0.3%. The impact on the domestic inflation and domestic interest rate is persistent as it lasts for more than five years.

Figure 5

The impulse response function to the foreign supply shock



Source: Author's own computations.

4.2.3. The demand shock

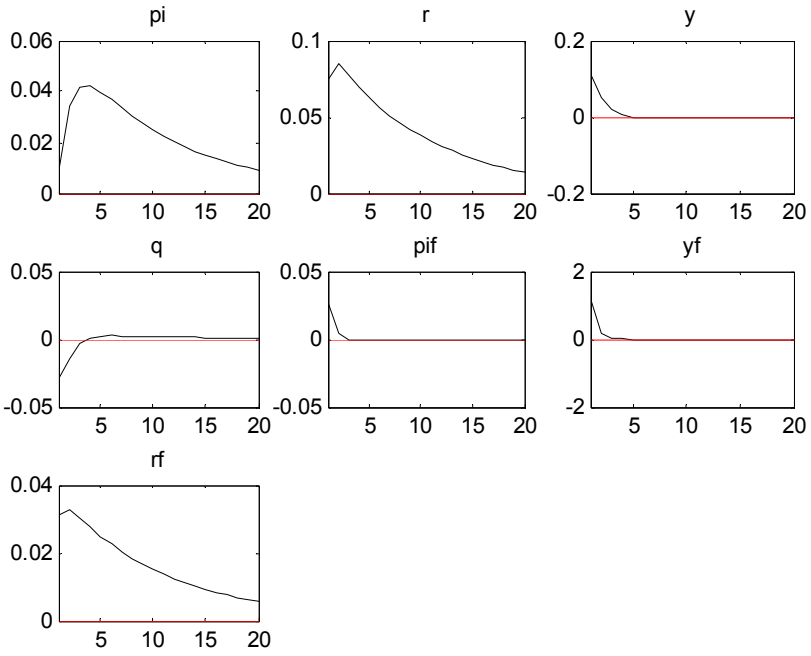
A foreign demand shock leads to weak responses of the domestic variables. The increase in the foreign output positively influences the foreign inflation. This influences the Euro Area interest rate which slightly rises and in a persistent way.

Domestic inflation rises by about 0.04% and the domestic interest rate increases by almost 0.1%. Domestic output increases by 0.1% following the increase in the foreign demand.

The exchange rate appreciates since the domestic interest rate rises more than the foreign interest rate.

Figure 6

The impulse response function to the foreign demand shock



Source: Author's own computations.

4.3. Variance Decomposition

In order to analyze the long run impact of fluctuations of domestic and foreign shocks on the domestic variables, I decompose the variance of the variables. The decomposition is done for the long run, that is, for an infinite horizon.

Table 2

The Decomposition of Variance

Domestic Variables	Types of Shocks						
	Domestic Supply	Domestic Demand	Domestic Interest rate	Exchange Rate	Foreign Supply	Foreign Demand	Foreign Interest Rate
Output	5.3	69.3	15.4	9.1	0.0	0.1	0.9
Inflation	24.8	6.0	21.0	25.1	0.6	0.0	22.5
Interest Rate	14.4	0.8	41.5	21.8	0.5	0.0	20.9
Exchange Rate	13.3	4.7	37.6	43.3	0.0	0.0	1.1

Source: Author's own computations.

The domestic output gap variance is determined mostly by the demand shocks, but the domestic interest rate shocks, domestic supply shocks and exchange rate shocks also help explain the variance of the output gap.

For the inflation variable one may see that four types of shocks explain most of the variance, namely, the exchange rate shocks, the domestic supply shocks, the domestic and foreign interest rate shocks.

The interest rate variance is determined mostly by its own shocks, but the domestic supply shocks, the exchange rate shocks and the foreign interest shocks contribute to the explanation of the interest rate variance.

The exchange rate variance is mostly explained by its own shocks and by the domestic interest rate shocks.

5. Conclusions

The estimation of the Taylor rule confirmed that the National Bank pursued first of all the prices stabilization. At the same time, it implemented its policy in a less gradual way than the ECB. In the perspective of Euro adoption, the National Bank should improve its gradualism and behave more similar to the ECB.

The estimation of the open economy Phillips curve showed that the exchange rate has a considerable influence on the domestic current inflation. The specification considered a hybrid NK Phillips curve allowing for both expected inflation and past inflation to influence current inflation. At the same time, as Albu (2001) showed how by introducing nonlinearities in the Phillips curves one may obtain complex dynamics that are not possible within the linear Phillips curves, the future DSGE models for Romania should allow for such nonlinearities.

The analysis of the impulse response functions showed that the domestic shocks have a moderate but not persistent impact on the domestic variables. I also showed that the domestic output is influenced in a moderate way by the foreign demand and interest rate shocks. The foreign supply and interest rate shocks have significant and persistent impacts on the domestic inflation.

The variance decomposition exercise showed that the half of the domestic inflation variance is determined by the exchange rate and the domestic supply shocks and that shocks in the domestic interest rate and in the foreign interest rate also help explain inflation variation.

These results emphasize the fact the economic policy in Romania should take into account the impact of the Euro Area shocks on the fluctuations of the domestic variables. A better understanding of the impact of Euro Area shocks could come from a more complex open economy DSGE model which would include richer rigidities.

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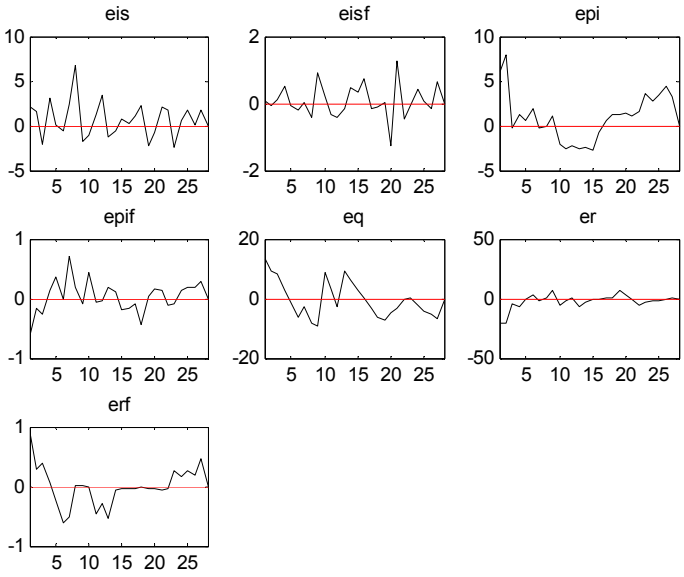
Annex A. Smoothed Shocks



Annex B. Multivariate diagnostic