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A SEMI-STRUCTURAL GENERAL EQUILIBRIUM ANALYSIS OF MOLDOVA'S MONETARY POLICY TRANSMISSION MECHANISM

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Abstract

The aim of the research is to describe a macro-econometric model for the monetary policy transmission channels, in order to assess the particularities of low income countries, as Republic of Moldova. The general equilibrium model is kept simple, capturing main transmission channels, while the empirical results are generated using Bayesian estimations. The variables are treated as exogenous and the natural logarithm of first-order differences of seasonally adjusted series is used. Data with quarterly periodicity cover the period 1st quarter of 2002 - 2nd quarter of 2014. The objective of the paper is to quantify the effects of the demand and exchange rate shocks to inflation and to assess the properties of the model, by simulating responses to standard shocks. We discover that exchange rate shocks to inflation have a higher magnitude that demands shocks In Moldova, while demand shocks close faster.

Keywords: General equilibrium model, Open economy, Calibration, Monetary policy, Moldova

JEL classification: E17, E52

1. Introduction

There is a great interest in the recent literature on the identification of monetary policy transmission channels in small open economies, because monetary policy is seen as a stabilization policy instrument to guide the economy in the direction of achieving price stability and sustainable economic growth. The impact of the monetary policy decisions is always felt throughout the economy, especially in the short run, interest rates and exchange rates which eventually affect the financial markets, economic activities and price levels in the economy.

The effectiveness of the monetary policy depends on the ability of policy makers to make an accurate assessment of the moment and the effects of the policy on economic activities and prices. Starting with January 2012, the National Bank of Moldova, introduced Inflation Target, in order to ensure and maintain price stability over the medium term at the level of 5.0 percent annually (measured by Consumer Price Index) with a possible deviation of ± 1.5 percentage points, considered to be optimal for growth and development of Moldova's economy over the medium term. The inflation target announcement aims at increasing credibility and anchoring inflation expectations. It is useful in establishing the political legitimacy for an independent central bank, especially when taking unpopular decisions. The same situation was also in Central and eastern European countries. The benefits of a low-inflation environment are unquestionable, as price stability is the ultimate objective of monetary policy. In addition, low inflation is a pre-condition for the European Union (EU) accession. There only remains the other critical question, namely, what is the proper strategy to achieve the ultimate objective? Different central banks have adopted different strategies placing a different emphasis on the various pieces of information, or elements of their decision-making process or different aspects of their communication policies. Inflation targeting (IT) is one of those strategies[1].

Noteworthy scholars advanced during last decades different monetary policy strategies, characterized by two basic factors (Taylor, 1999, 2003; Woodford, 2001; McCallum and Nelson, 2004). The first one states that, on the short run, monetary policy has an impact on the real economic activity. This effect comes from the presence of rigidities, which give rise to non-neutral effects of a monetary policy. Shocks hitting the economy aren't persistent; the economy is persistent alone due to a nominal price. The second factor is a considerable improvement in the underlying theoretical frameworks used for monetary policy analysis. Therefore, for the decision of monetary policy with the appropriate force and in the right direction policy makers need to have a clear understanding of the propagation mechanism of the monetary policy shock and the relative importance of the various channels, interest rates and exchange rates in affecting the real sectors of the economy.

The complexity of the behavior of the economic transmission mechanism is underlined by many studies with sometimes conflicting conclusions (Walsh, 2003). One key element in the monetary transmission mechanism is represented by the volatility of the exchange rate. The short-term volatility of the exchange rate is the deviation of its size from the long-term equilibrium level results from the Purchase Power Parity (PPP) theory, advanced by Rogoff (1996). Price steadiness models explain the movements of the currency exchange rates as an effect of the monetary impacts, translated to the actual currency exchange rate as long as prices are established for long term. In this line, Huizinga (1987) employs the Beveridge-Nelson decomposition to investigate the importance of the permanent component in real exchange rates. Similar, Stockman (1987) demonstrates that the exchange rate variations might be caused by permanent shocks, while Messe and Rogoff (1988) and Clarida and Gali (1994) show that only a small part may be the result of the actual interest rate differential. Benigno (2004) argues in its turn that the persistent deviations of the currency exchange rate from the long-term equilibrium value given by the PPP are consistent with the monetary theory. They show that, in the case when the monetary policy is coordinated by inertia, the actual currency

[1] For example Romania implemented an IT regime in 2005 and its inflation came down from over 40 percent in 2001 to 4.9 percent in 2006.

exchange rate keeps being deviated from the equilibrium level, and the adjustment through the interest differential is also slow, within a certain time interval. Moreover, he considers that the existence of the contracts in the nominal terms within the economy is another explanation of the deviations persistence and of the way to understand the relationship between the actual currency exchange rate and the monetary impacts. According to the author, the exchange rate behavior shall be explained by connecting it with the behavior of the other key variables in the monetary transmission mechanisms, such as the interest rate.

The impact of the monetary policy on the economy is an open question, especially in low income countries. While, due to its strategy, the monetary policy reacts only to the inflation deviations from the established target, the current exchange rate is isolated by the productivity impacts and, thus, the monetary policy impacts do not have a persistent effect. The orthogonality of the actual currency exchange rate vs. the supply impacts disappears as soon as we take into account the Taylor's rule, according to which the interest rate reacts to the deviations of the inflation and of the gross domestic product from their long run equilibrium. According to Taylor's (2003) rule, the monetary policy impacts have no persistent effect. As long as the rigidity degree is the same or is close among countries, the inertia of the monetary policy is necessary to make an actual currency exchange rate keep its trajectory in case of an unpredictable nominal impact.

In recent years, economists have learned how to build simple, coherent, and plausible models of the monetary transmission mechanism. In the New Keynesian synthesis, there has been a convergence between the useful empirically motivated IS/LM models developed in several policymaking institutions and dynamic stochastic general equilibrium approaches that take expectations seriously and are built on solid microeconomic foundations. For example, Berg et al. (2006) develop a simple workhorse model, which summarizes all aspects discussed and consists of an aggregate demand (or IS) curve, a price-setting (or Phillips) curve, and a policy reaction function relating the policy interest rate to variables like output and inflation. This type of techniques is used in the present paper, in the case of Republic of Moldova, to estimate the impact of monetary policy instruments on the inflation and the output gap.

As far as we know, this is the first paper assessing the empirical performance of different monetary transmission channels for Moldova. Indeed, Gigineishvili (2008) assess the performance of the interest rate channel for Moldova, but applying simple Ordinary Least Square (OLS) regressions. However, different form this study we start the analysis form a general Dynamic Stochastic General Equilibrium (DSGE) theoretic framework and we perform several empirical simulations, assessing both the demand and exchange rate channels, using a Bayesian Vector Autoregression (BVAR) model. Furthermore, we provide an up-to-date analysis given the Moldova's new European orientation.

The reminder of the paper is as follows. Section 2 describes the model. Section 3 presents the data and the empirical findings. The last section concludes.

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2. The open economy model

The model blends the New Keynesian emphasis on nominal and real rigidities and the role of aggregate demand in output determination, with the real business cycle traditional methods of Dynamic Stochastic General Equilibrium modeling with rational expectations. The model is structural; each of its equations has an economic interpretation. Causality and identification are not in question. Policy interventions have counterparts in changes in parameters or shocks, and their influence can be analyzed by studying the resulting changes in the model's outcomes. It is a general equilibrium model, because the main variables of interest are endogenous and depend on each other. Since random shocks affect each endogenous variable and it is possible to use the model to derive measures of uncertainty in the underlying baseline forecasts, the model can be called stochastic. It incorporates rational expectations, because expectations depend on the model's own forecasts, so there is no way to consistently fool economic agents.

Most of the key equations of the model are presented in Berg et al. (2006). The equations follow a similar structure as in the canonical model except that has been modified to reflect a key feature of the Moldavian economy.

Aggregate demand: The aggregate spending relationship corresponds to the open economy version of the traditional IS curve and takes the form:

$$\hat{y}_t = a_1 \hat{y}_{t-1} - a_4 rmci + a_3 \hat{y}_t^* + \xi_t^y , \quad (1)$$

$$rmci = a_2 \hat{z}_t + (1 - a_2)\hat{r}_t^d , \quad (2)$$

where, $\hat{y}_t$ is the deviation of the log of output from its noninflationary level, or in other words output gap is measure of the difference between actual output and potential output; *rmci* is a real monetary condition index, that is defined as a weighted average of a deviation of the long-term real interest rate on deposits $\widehat{r_t^d}$, the positive real interest rate deposits gap indicating tight monetary conditions induce a decline of the output gap and deviation of the real exchange rate, $\hat{z}_t$ from its trend level; $\hat{y}^*$ represents the foreign output gap and ξ_t^y is the aggregate demand shock. The aggregate demand shocks are governed by a normal distribution and have no serial correlation. The coefficients: a_1 - captures the persistence of output gap; a_2 - the impact of monetary conditions on real economic activity; a_3 - the impact of the foreign environment; a_3 - is the relative weight of the real interest rate and real exchange rate in real monetary conditions in the IS curve.

Aggregate supply: The aggregate supply equation is defined as follows:

$$\pi_t = w_1 \pi_{c,t} + w_2 \pi_{f,t} + w_3 \pi_{e,t} + w_4 \pi_{a,t} , \quad (3)$$

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where, $\pi_{c,t}$ is the annualized quarterly change in core inflation; $\pi_{f,t}$ is the annualized quarterly change in food inflation; $\pi_{e,t}$ is the annualized quarterly change in energy inflation; $\pi_{a,t}$ is the annualized quarterly change in regulated prices and w_1, w_2, w_3 and w_4 are the weights of the above mentioned inflations, based on National Statistical Bureau reports, and w_4 is calculated as the difference between 1and sum of, w_1, w_2 and w_3. Core inflation is typically viewed as an aggregate inflation excluding the contribution of changes in the price of food, energy and regulated prices. The standard rationale for confining attention to a more narrow measure of inflation is that the excluded components are "volatile" and add noise to price data. The equation (the Phillips curve) is defined as follow:

$$\pi_{c,t} = \beta_{c1}\pi_{c,t-1} + \beta_{c2}\pi_{c,t}^{imp} + (1-\beta_{c1}-\beta_{c2})\pi_{c,t+1}^{e} + \beta_{c3}rmc_{c,t} + \xi_t^{\pi_c}, \qquad (4)$$

where $\pi_{c,t}^{imp}$ is the imported core inflation; $\pi_{c,t+1}^{e}$ denotes model-consistent inflation expectation; $rmc_{c,t}$ is the gap in firm's real marginal costs; and $\xi_t^{\pi_c}$ is a core inflation shock. Similar to demand, supply shock is governed by a Normal distribution and has no serial correlation. The supply relationship encompasses multi-period, overlapping nominal contracts of domestic producers, as well as importers. The latter is an important feature of small open economy, which typically has a powerful exchange rate channel of monetary transmission. That is why the equation contains the real marginal cost of core inflation $rmc_{c,t}$, as a weighted average of output gap (domestic producers), the gap in real exchange rate (importers), with the coefficient $(1-\beta_{c4})$ approximating the weight of imported goods, which are part of the core inflation basket. The spread gap $\hat{sp}_t$ represents the impact of the interest rate channel and is computing the difference between spreads of lending and deposit rates in domestic and in foreign currency. $\hat{z}_t$ denotes deviations of the real exchange rate from its noninflationary level.

$$rmc_{c,t} = \beta_{c4}\hat{y}_t + (1-\beta_{c4})\hat{z}_t + \beta_{c5}\hat{sp}_t, \qquad (5)$$

Uncovered Interest Parity (UIP): It is possible to derive a standard log-linear version of uncovered interest parity condition, under complete international asset markets. An exchange rate persistency or persistent version of UIP is strongly related to the partial adjustment of import prices (i.e. incomplete exchange rate pass-through). The UIP is fully forward-looking, without any restriction. The adjustment in this equation is just pragmatic and based only on empirical evidence. The change of the equation grounds on expectations, which are partially backward looking.

$$s_t = s_{t+1}^{e} + \frac{i_{dd,t} - \overline{sp}_{dd,t} - i_t^{*} - prem}{4} + \xi_t^{s}, \qquad (6)$$

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The first part of the adjusted UIP relation represents the expected exchange rate, one-quarter ahead. The remaining part is the difference between domestic and foreign interest rates, interest rate differential. The expectation term in the equation has a special structure. The lagged exchange rate is reduced by twice of the inflation differential between the domestic and the foreign economy. It is therefore the measure of where the spot exchange rate will be one-quarter ahead, all else equal. This is combined with the models' forecast of the exchange rate, one-quarter ahead. The weighted average of these two terms is the models' representation of the expected exchange rate.

Monetary Policy: The way in which the interest rate channel works can be divided into two separate stages: first, the interest rate pass-through and, second, the channel through which aggregate demand and production respond to changes in real interest rate. The idea behind the interest rate pass-through is that innovations to the policy interest rate can be transmitted to the bank deposit and lending rates, usually through an intermediate interbank interest rates stage.

$$i_{d,t} = g_1(s^e_{t+1} - s_t + i^*_t + prem) + \\ + (1-g_1)(f_1 i_{t-1} + (1-f_1)(\pi^e_{t+1} + \bar{r}_t + f_2(\pi^{\exp} - \pi^T) + f_3 y_t)) + \xi^i_t, \quad (7)$$

where, $i_{d,t}$ is the domestic short-term nominal interest rate and ξ^i_t is a policy shock. The monetary authority is forward-looking and uses model-consistent inflation expectations $\pi^{\exp}$. The expression $(\pi^e_{t+1} + \bar{r}_t)$ is the policy-neutral rate; an interest rate that prevails when inflation equals inflation target and the output gap is zero. It is calculated as the sum of the trend real interest rate and model-consistent inflation expectations (see Appendix).

With coefficient g_1 different from zero, the domestic interest rate becomes partially determined by the uncovered interest rate parity and the central bank loses full control over the domestic interest rates. This corresponds to situation when the central bank is involved in foreign exchange interventions and does not fully offset a foreign exchange operation by an operation on the domestic money market. One should have in mind though, that the central bank can lose control of the money up to certain threshold only. Crossing this threshold leaves the system undetermined, unless other changes in model equations are implemented.

The monetary policy transmission mechanism can be analyzed as follows (Figure 1):

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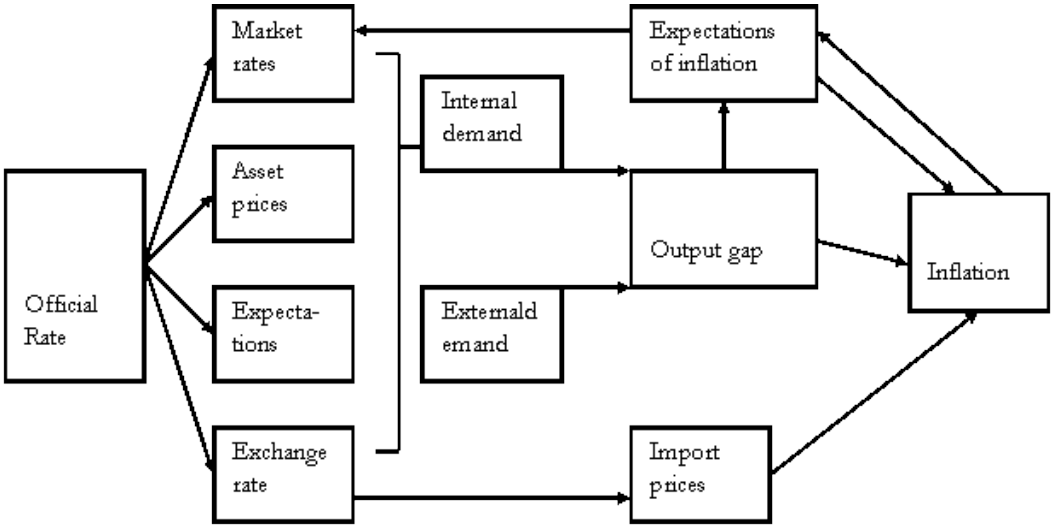

Source: Partachi and Mija (2013), pag. 149

Figure 1 - The transmission mechanism

Figure 1 describes how policy-induced changes in the nominal money stock or the short-term nominal interest rate, asset prices and exchange rate have an impact on real variables.
Under the interest rate channel, an expansionary monetary policy stance leads to lower market and commercial bank deposits and lending rates, which in turn spurs domestic demand, eventually pushing up inflation. These effects usually take place with a lag due to the time it takes for the banks to adjust their portfolios, uncertainty about the persistence of the change in stance, and nominal rigidities.

Under the exchange rate channel, a monetary expansion depreciates the local currency and hence lowers the relative prices of domestic goods, which raises demand and supply of domestic goods and services. Moreover in this case there is an immediate and more direct effect on inflation through the impact of the depreciation on prices of imports. Based on literature the magnitude and speed of these effects depend on the country's degree of openness, dependence on imported goods, and competitiveness. Also, the pass-through to prices can be asymmetric if prices are downward sticky, whereby inflation is slower to adjust downward following appreciation than upward following depreciation.

3. Data and empirical analysis

3.1. Data

Time-series of the aforementioned variables are defined as first-order differences of the natural logarithms seasonally adjusted and are placed in the model as exogenous variables, with quarterly periodicity for the period Q_1 2002-Q_2 2014. We have seasonally adjusted the series (real exchange rate, real interest rate, GDP) based on smoothed historical data, using the Kalman Filter (see Appendix). This sample includes a formal inflation-targeting regime that started in 2010.

3.2. Empirical results

The calibration of the Bayesian VAR is made based on Hurnik (2011). We provide the simulation results for the aggregate demand block of the DSGE model (for the other blocks, the results can be obtained under request).

Thus, for the output gap persistence, a_1 = 0.6. -. Based on the International Monetary Fund (IMF) the output gap persistence varies between 0.1 (extremely low persistence) to 0.95 (high persistence). For the relative weight of the real interest rate and real exchange rate in real monetary conditions in the IS curve, we have a_2 = 0.7, and usually - varies between 0.3 (open economy) and 0.8 (closed economy). For the pass-through from foreign economy to the real economy we have a_3 = 0.6 and varies between 0.1 (extremely low impact from the other economy) to 0.9 (high impact from the other economy). Finally, the pass-through from monetary conditions to the real economy we have a_4 = -0.15 and can varies between -0.1 (low impact) to -0.5 (high impact). The higher the parameter the more responsive is the output gap to changes in monetary policy. Table 1 reports the Bayesian estimation results, while the output gap persistence and the shocks pass-through are presented in Figures 2 and 3.

Table 1 - Bayesian estimation results

Coefficients	Prior			Posterior	
	shape	mean	std.-err.	mode	std.-err.
a1	beta	0.6	0.1	0.434	0.057
a2	beta	0.7	0.01	0.687	0.01
a4	diffuse	-0.15	0.01	-0.108	0.026
a3	beta	0.6	0.1	0.428	0.066
shock	inv_gamma	0.85	0.1	1.322	0.098

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The chosen calibration in order to assess the transmission of monetary policy in Republic of Moldova is verified by the use of impulse response functions, in order to see how the model fit the data, and by in-sample forecast results. In this line Figure 4shows how the model fit the data for the domestic aggregate demand, and also is possible to see how the fitted data capture the crisis period at the end of 2008.

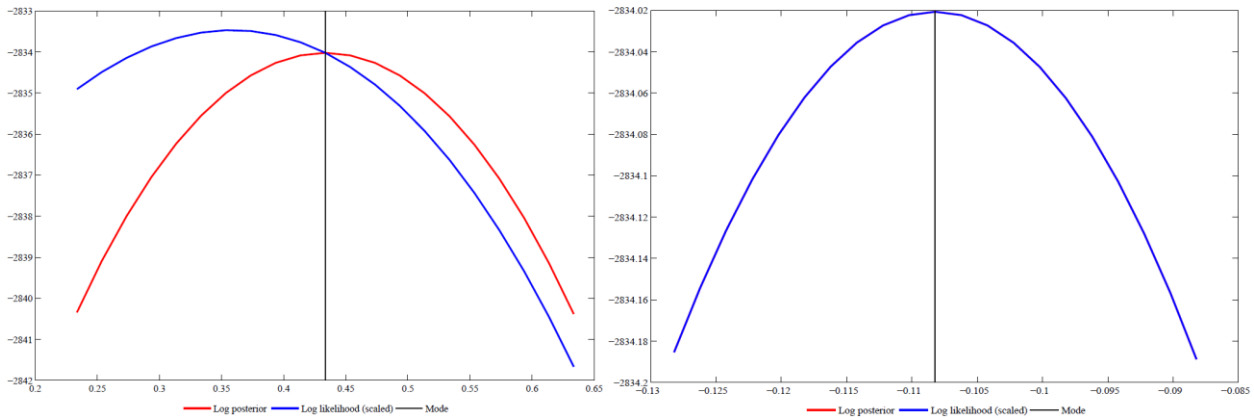

Figure 2 - Output gap persistence (a_2) and pass-through from MC to the real economy results (a_4)

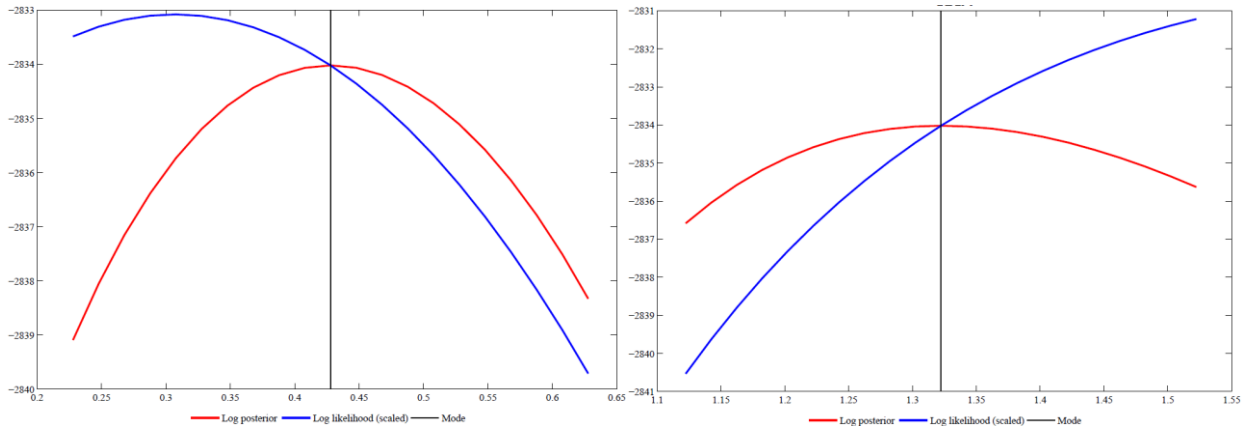

Figure 3 – Shocks pass-through from the foreign economy to the domestic economy (a_3)

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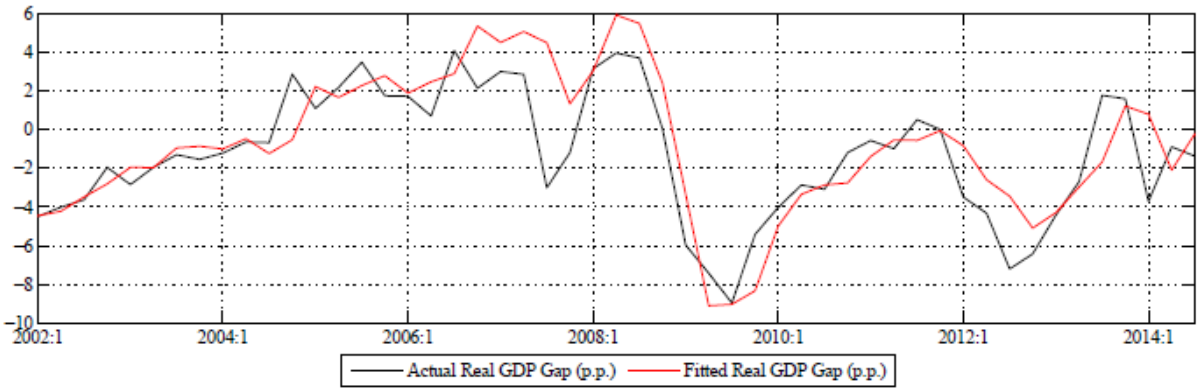

Figure 4 - Actual and fitted data for the domestic aggregate demand

The calibration literature, commonly states that a model has to mimic the real world only along a carefully specified set of dimensions. These dimensions are then compared with the corresponding observed values.

Starting from the basic objective and proposed tasks for the determination of monetary policy transmission mechanisms and quantification of shocks' effects to inflation, we assess the properties of the model, by simulating its responses to standard shocks, like demand and exchange rate shocks, which reflect the particularities of the Moldavian economy.

Demand shock: A positive shock in demand (1.0 std.), (generated for example by the EU loans received in 2012), together with a constant supply, will determine a price increase in the same quarter by 0.24 p.p. Targeting inflation, the central bank reacts promptly with a growth in nominal interest rate (0.24 in the same quarter and 0.27 in the next quarter), encouraging the market operations rates. Accordingly, commercial banks raise the deposit rates in domestic currency, tempting the population to save more and to switch their savings from foreign to domestic currency, putting appreciation pressure on the exchange rate. The currency appreciation positively impact on import prices for ready-to-use products, making them cheaper.

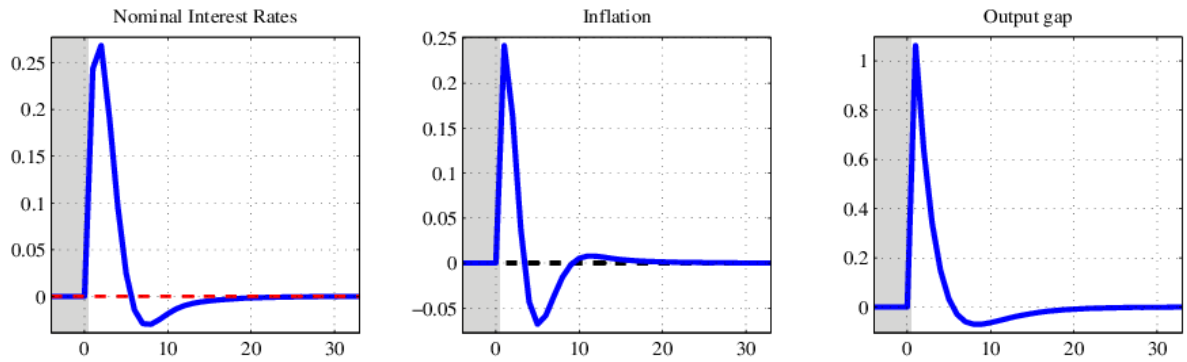

Figure 5 - Impulse response to the demand shock

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The indirect effect of the appreciation is noticed through the costs of production. At the same time, both a higher interest rate and the currency appreciation, in real terms, change the monetary conditions, making them more restrictive, driving after 3-4 quarters the output gap down, and finally smoothing the inflationary pressures. Due to an increased persistence of output gap, the shock in inflation will close over 10-14 quarters.

Exchange rate shock: A currency depreciation shock (by 1.0 std.) has a direct effect on the import prices for ready-to-use products, making them more expensive (Figure 6, green line). The indirect effect of the depreciation manifests through the costs of production (the costs became bigger and the prices for the home produced products will increase by 0.6 p.p.).

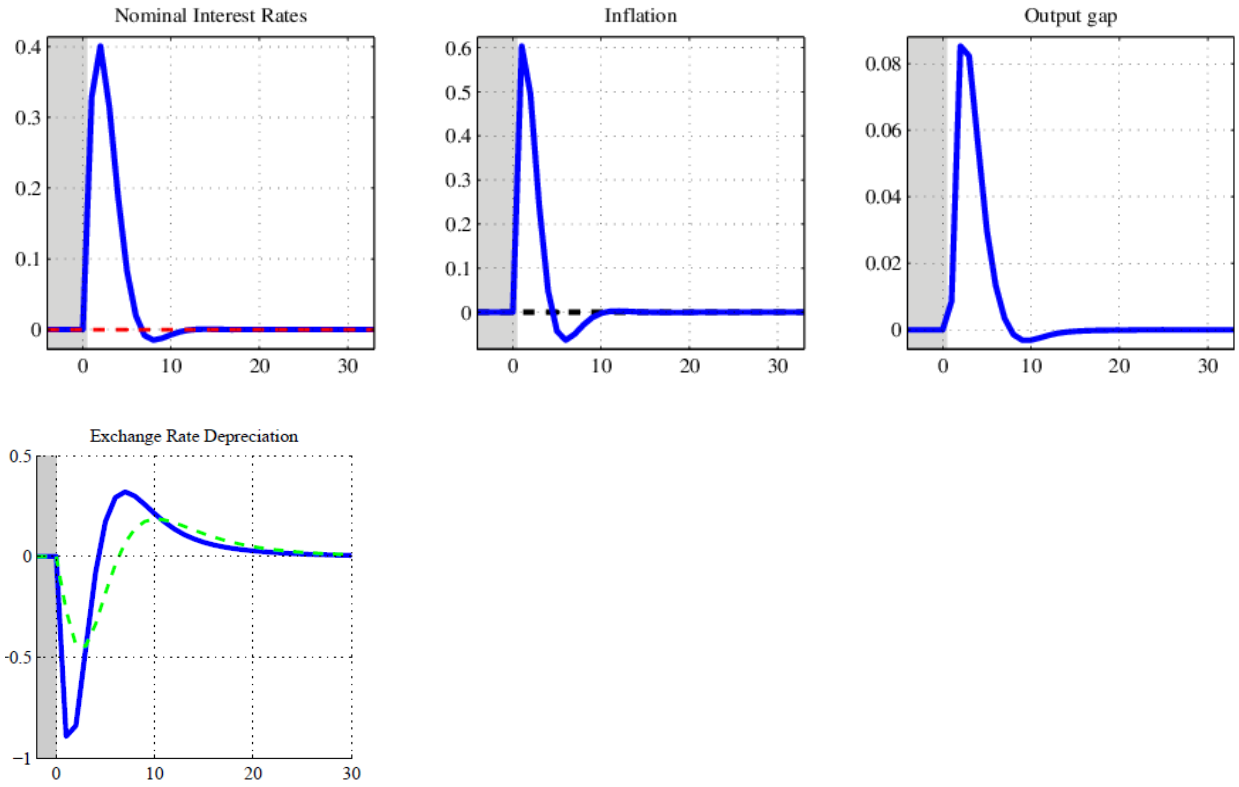

Figure 6 - Impulse response to the exchange rate shock

The central bank reacts by increasing the nominal interest rate (by 0.4 std.) in order to smooth the inflationary pressures, putting pressure on the currency appreciation and decreasing the import prices and the costs of production, driving the inflation down. The shock in inflation will close over 10 quarters.

3. Conclusion

Pursuant to the statutory powers set out in the provisions of the Law on the National Bank of Moldova no.548-XIII of July 21, 1995, the National Bank of Moldova sets and implements the monetary and foreign exchange policy. To ensure and maintain price stability, the central bank implements a direct inflation targeting regime. However, consistent with the inflation target of 5.0 percent as the nominal anchor for monetary policy, the central bank implements a managed floating exchange rate regime, without having a pre-established target for Moldavian Leu (MDL) exchange rate.

Our analysis confirms the stabilization role of the central bank for the macroeconomic environment. In order to assess optimal rule properties, consistently with the current mainstream of monetary policy analyses, it was necessary to develop and calibrate a structural model and derive the second order approximation of the welfare loss. A positive aspect is that a simple small open economy model, derived on including the most important macro-indicators, can offer a framework to understand the monetary policy transmission channels to the real economy. Consider that this small model isn't a result of deficient model structure or bad model calibration, this model has some limiting in interpretation in terms of economic logic. These limits are given by the small numbers of variables, a short time series range, and a short experience in inflation targeting for the National Bank of Moldova.

In spite of all limits, we can conclude that shocks to inflation coming from the exchange rate are higher in magnitude than those coming from aggregate demand, but the later will close faster.

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Appendix

Seasonally adjusted series with the Kalman fiter