The Role of Monetary and Fiscal Policies in Ensuring Macroeconomic Stability in Romania

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ABSTRACT
The purpose of this paper is to make an analysis of the dynamics of macroeconomic mechanisms of propagation of shocks in the Romanian economy based on a dynamic stochastic general equilibrium model (DSGE) that is based on optimizing behaviour of economic agents, using micro-foundations incorporating nominal rigidities in prices and wages. The model developed is Neo-Keynesian type model and is described based on the Christiano et al (2005) and Smets and Wouters (2003). It incorporates persistence in consumption, sticky prices and wages in Calvo sense, costs of adjustment of investment, variable capacity utilization and fixed costs in production. The model takes into account also the liquidity constraints consumers - rule of thumb, element introduced by Galí et al (2007). Another assumption of the model is the consideration of imports as an input in production, under the approach of McCallum and Nelson (2001). Changes over the standard dynamic stochastic equilibrium are related to inflation inertia generated by the learning process. An innovative element is the consideration of two monetary regimes considering adopting inflation targeting strategy in Romania in August 2005. Structural break is explicitly considered by considering two sub-samples and the estimation process of parameters is in two stages similar to the approach proposed by Jakab (2008).

KEYWORDS: *Ricardian consumption, Fiscal rule, Bayesian estimation, Monetary Regime, DSGE*

JEL CLASSIFICATION*: C32, E4, E10, E32*

INTRODUCTION

The geopolitical and economic realities of the last two decades have resulted in a convergence of Romanian economy to the European economic mechanism. The last decade has been one of significant progress made by our country in terms of convergence towards European structures. This convergence has been economic, institutional and legal. As a result of the new economic realities, the mechanism of functioning of the Romanian economy is significant changed comparing to the beginning of 2000.

Considering all these, in this paper the aim was to synthesize these changes in the economic mechanism and to point out their implications. To achieve this objective, the work was structured around two important levels: the monetary and fiscal. Chronologically speaking, the first change in strategy as a result of the transition to developed economic structures was performed by the National Bank of Romania by targeting price stability. Because of

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this, the structure of the paper contains a third party, at the intersection of the other two, and it has been designed to capture the effects of changing monetary strategy on other structures.

The paper is organized as follows: the second section provides a review of literature and the description of the model. The next section describes the data used for estimation and the empirical results and the last section concludes.

1. THEORETICAL BACKGROUND

The basic framework of the model follows the setup of Christiano et al (2005) and Smets and Wouters (2003). The model incorporates external habit formation in consumption, Calvo type price and wage rigidity, adjustment costs of investments and of capacity of utilization and fixed cost in production. The model takes into account also the liquidity constrained rule of thumb consumers introduced by Gali et al (2007). Rule of thumb price setters increases their prices by the "perceived underlying "rate on inflation (Yun (1996)) and to some extent by the difference between the past inflation the " perceived inflation" as presented by Christiano et al (2001) and Smets and Wouters (2003). Inflation has two endogenous components: filtered inflation and the cyclical inflation. The learning rule governs the component of the perceived underlying inflation. In this respect the model has an adaptive learning mechanism incorporated in order to explain inflation dynamics. In order to take into account the monetary regimes the model considers different two sub-periods in order to handle the transition between regimes. The DSGE model is a multi sectorial model considering domestic production and export.

The model is an extension of the Smets and Wouters (2003) DSGE model. For domestic production beyond labour and capital, import is considered while some part of the production is exported. The model considers the presence of non-Ricardian rule of thumb consumers in order to replicate the empirical co-movement of private and government consumption.

Households

The domestic economy is populated by a continuum of infinitely-lived households. A fraction of households choose their consumption stream in the standard rational optimizing manner. The utility function of household *j* is given by:

$$\sum_{t=0}^{\infty} \beta^t E_0[(1+\eta_t^c)\{u(H_t^o(j)-(1+\eta_t^l)v(l_t(j))\}] \tag{1}$$

Where $H_t^o(j)=\frac{(c_t^o(j)-hc_{t-1}^o)^{1-\sigma}}{1-\sigma}$ is the consumption utility of household *j* under external consumption habits, $c_t^o(j)$ is the consumption of household *j* at date *t*, $l_t(j)$ is the number of working hours spent by consumer j in the corporate sector, β is the discount factor, η_t^c and η_t^l preference shocks to consumption, respectively leisure, *h* is the strength of habit formation, $u(H)=\frac{H^{1-\sigma}}{1-\sigma}$; $v(l)=\frac{l^{1+\varphi}}{1+\varphi}$ and φ denotes the inter-temporal elasticity of labour while σ is the inter-temporal elasticity of the individual households' utility.

The budget constraint presents the situation when individual household supply labour and receive labour income based on wage. Part of this income is used for paying income tax to the government and the other part is either consumed (subject to a consumption tax) or saved (either invested into physical or into risk-free bonds that yields interest income).

$$(1+\tau_t^c)P_t c_t^o(j) + P_t I_t(j) + \frac{B_t(j)}{1+i_t} \\ = B_{t-1}(j) + X_t^w(j) + (1-\tau_t^l)W_t(j)l_t(j) + P_t r_t^k u_t(j)k_{t-1}(j) \\ - \Psi(u_t(j)P_t k_{t-1}(j) + Div_t - OT_t$$

Where $W_t(j)$ is the wage, $\tau_t^l$is the income tax paid to the government, Consumption $c_t^o(j)$ is subject to consumption tax τ_t^c, the consumer either saves or invests in risk free bonds $B_t(j)$ with interest i_t, investments $I_t(j)$ increase the stock of available capital goods $k_{t-1}(j)$, r_t^k is the capital income, Ψ is the cost of the capital utilization rate, $\Psi(u_t) = r^k\psi\left[\exp\left(\frac{u_t-1}{\psi}\right)-1\right]$ and Div_t are the dividend in case the firms realize profits and OT_t is the lump-sum taxes of government.

Physical capital accumulation is:

$$k_t = (1-\delta)k_{t-1} + [1-\Phi_I(\frac{(1+\eta_t^I)I_t}{I_{t-1}})]I_t \tag{3}$$

Where $\Phi_I(\frac{(1+\eta_t^I)I_t}{I_{t-1}}$ is a convex investment adjustment cost, η_t^I is the shock to the adjustment function, $\Phi_I\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}\right) = \frac{\Phi_I}{2}\left(\frac{(1+\eta_t^I)I_t}{I_{t-1}}-1\right)^2, \phi_I > 0$ this mean that at steady state $\Phi_I'(1) = \Phi_I(1) = 0$.

The first order condition with respect to B_t leads to Euler equation:

$$\frac{\lambda_t}{(1+\tau_t^c)P_t} = \beta(1+i_t)E_t\left[\frac{\lambda_{t+1}}{(1+\tau_{t+1}^c)P_{t+1}}\right] \tag{4}$$

In respect with non-optimizing households, these agents are liquidity constrained, do not supply labour and only consume their income and financial transfers.

$$(1+\tau_t^c)P_t c_t^{no} = (1-\tau_t^l)W_t l_t + \frac{TR_t}{1-\varpi} \tag{5}$$

Households supply different types of labour, the monopolistic competition in the labour implies a set up of wages with a mark-up. The composite labour good of the economy is a CES function:

$$l_t = \left(\int_0^1 l_t(j)^{\frac{\theta_w-1}{\theta_w}}dj\right)^{\frac{\theta_w}{\theta_w-1}} \tag{6}$$

θ_w>1 is the elasticity of substitution between different types of labour. The individual demand for each labour service supplied by household *j* is defined as:

$$l_t(j) = \left(\frac{W_t}{W_t(j)}\right)^{\theta_w} l_t \tag{7}$$

Where the aggregate wage index is the form:

$$W_t = \left(\int_0^1 W_t(j)^{1-\theta_w} dj\right)^{\frac{1}{1-\theta_w}} \tag{8}$$

One assumption of the model is sticky wage setting. In this respect, only a fraction of households, 1- γ^w are able to set the nominal wage. The other fraction of households follows a non-optimizing rule of thumb indexation to past inflation:

$$\begin{aligned} &W_T(i) = W_t(i)\Pi_{T,t}^{I_w} = P_t(i)\Pi_T^{I_w}\Pi_{T-1}^{I_w}\cdots\Pi_t^{I_w} \ ; \\ &\Pi_t^{I_w} = \left(\frac{\Pi_t^w}{\overline{\Pi}_t}\right)^{\vartheta_w}\overline{\Pi}_{t+1}; \quad \Pi_t^w = \frac{W_t}{W_{t-1}} \end{aligned} \tag{9}$$

ϑ_w is the degree of indexation according to past inflation

The recursive process of choosing wage optimally at date t leads the following objective function that has to be maximized:

$$max\sum_{t=T}^{\infty}(\gamma_w\beta)^{T-t}E_t\left[(1+\eta_t^c)\left\{\frac{w^oU(H_t^o)+w^{no}U(H_t^{no})}{w^o+w^{no}} - (1-\eta_t^l)v(l_T(j))\right\}\right] \quad ($$

The first order conditions imply that the aggregate wage setting has the following form

$$\begin{aligned} &W_t = \left(\frac{\theta^w}{\theta^w-1}\frac{\Re_t^{w1}}{\Re_t^{w2}}\right)^{1+\theta^w\varphi} \\ &\Re_t^{w1} = (1+\eta_t^c)(1-\eta_t^l)l_t^{\varphi+1} + \beta\gamma_w E_t\left[\left(\frac{\Pi_{t+1}^w}{\Pi_t^{I_w}}\right)^{\theta_t^w(1+\varphi)-1}\Re_{t+1}^{w1}\right] \\ &\Re_t^{w2} = (1-\tau_t^l)\Lambda_t^L l_t + \beta\gamma_w E_t\left[\left(\frac{\Pi_{t+1}^w}{\Pi_t^{I_w}}\right)^{\theta_t^w-1}\Re_{t+1}^{w2}\right] \end{aligned} \tag{11}$$

The final wage index becomes:

$$W_t^{1-\theta_w} = \frac{1-\gamma_w\left(\frac{\Pi_{t+1}^w}{\Pi_t^{I_w}}\right)^{\theta_w-1}}{1-\gamma_w} \tag{12}$$

The resulting log-linearized wage Phillips Curve is:

$$\widetilde{\pi_t^w} = \frac{(1-\gamma^w)(1-\beta\gamma^w)}{\gamma^w(1+\theta^w\varphi)(1+\beta\vartheta^w)}\left\{\varphi l_t - w_t + \eta_t^l + \frac{\sigma}{1-h}(c_t^l - hc_{t-1}^l) + \frac{\tau^c}{1+\tau^c}\tau_t^c + \frac{\tau^l}{1+\tau^l}\tau_t^l + \xi_t^w\right\} + \frac{\beta}{1+\beta\vartheta^w}E_t\widetilde{\pi_{t+1}^w} + \frac{\vartheta^w}{1+\beta\vartheta^w}\widetilde{\pi_{t-1}^w}$$

Where ϑ^w is the rate of indexation, θ^w is labour market elasticity, c_t^l is the weighed marginal utility of the two types of consumers in the period t and ξ_t^w is the mark-up shock

Firms

The structure of production is the following: labour and imported inputs are transformed into intermediate input, afterwards the intermediate input and capital are used in the production of the differentiated goods in a monopolistically industry. The final stage assumes that a homogenous final good is produced by the differentiated goods in a perfectly competitive industry. There are two sectors in the economy, the domestic sector and the exports sector, named *d* and x. The final good y_t^s in sector *s* is produced in a competitive market by a technology of type constant-returns to scale from a continuum of differentiated intermediated goods $y_t^s(i)$.

The production process is realized in two phases, the first one produce a homogenous intermediate product z_t through a CES production function by using labour (l_t) and import (m_t) as input

$$z_t = \left(a^{\frac{1}{\varrho_z}}[(1+\phi_1)^{-1}l_t]^{\frac{\varrho_z-1}{\varrho_z}} + (1-a)^{\frac{1}{\varrho_z}}[(1+\phi_2)^{-1}m_t]^{\frac{\varrho_z-1}{\varrho_z}}\right)^{\frac{\varrho_z}{\varrho_z-1}} \quad (14)$$

Where ϱ_z is the elasticity of substitution between factors, ϕ_1 and ϕ_2 are quadratic adjustments cost and *a* is the share of labour used in production.

The technology is represented by the following CES production function:

$$y_t^s = \left(\int_0^1 y_t(i)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}} \quad (15)$$

Where $\theta > 1$ measures the degree of the elasticity of substitution. The price index P_t^s is given by

$$P_t^s = \left(\int_0^1 P_t^s(i)^{1-\theta} di\right)^{\frac{1}{1-\theta}} \quad (16)$$

Where $P_t^s(i)$ denotes the prices and the demand for $y_t^s(i)$ is determined by

$$y_t^s(i) = \left(\frac{P_t^s}{P_t^s(i)}\right)^{\theta} y_t^s \quad (17)$$

The homogenous intermediate product is purchased by monopolistically competitive firms and combined through a CES production function with the accumulated capital supplied by households, yielding the final output

$$y_t(i) = (1+\eta_t^A)\left(\alpha^{\frac{1}{\varrho}}\bar{k}_t(i)^{\frac{\varrho-1}{\varrho}} + (1-\alpha)^{\frac{1}{\varrho}}z_t(i)^{\frac{\varrho-1}{\varrho}}\right)^{\frac{\varrho}{\varrho-1}} - y\bar{f} \tag{18}$$

Where α share of capital in the production, ϱ elasticity of substitution and $\bar{f}$ is the fixed cost of production. Solving the cost minimization problem yields the marginal cost of the final product and the demand for each production factor.

In respect with prices, the hypothesis of sticky prices of Calvo (1983) is used. Each intermediate good producer at a given period changes its price in an optimizing framework with a probability of $1-\gamma^d$. The rule of thumb for price setters that don't optimize their prices is set as in Yun (1996):

$$P_t(i) = P_{t-1}(i)\Pi_{t-1}^I = P_{t-1}(i)\left(\frac{\Pi_{t-1}}{\bar{\Pi}_{t-1}}\right)^{\vartheta_d}\bar{\Pi}_t \tag{19}$$

Where $\Pi_{t-1} = \frac{P_{t-1}}{P_{t-2}}$, $\bar{\Pi}_t$ is the "perceived underlying inflation and ϑ_d is the degree of indexation according to past inflation. If a given firm doesn't optimize between t+1 and T its price at T moment is:

$$P_T(i) = P_t(i)\Pi_{T,t}^I = P_t(i)\Pi_T^I\Pi_{T-1}^I\cdots\Pi_t^I \tag{20}$$

If firm *i* sets its price optimally at date *t* the following maximization problem shall be solved:

$$\max_{P_t(i)} = E_t\left[\sum_{T=t}^{\infty}(\gamma^d)^{T-t}D_{T,t}V_T\big(P_t(i)\big)\right] \tag{21}$$

Where V_T denotes the profit, $D_{T,t}$ is the stochastic discount factor, $D_{T,t} = \beta^{T-t}\frac{\Lambda_T^o/P_T}{\Lambda_t^o/P_t}$ and Λ_t^o is the marginal utility of consumption of optimizing consumers who own the firms.

The price setting assumption implies that the evolution aggregated price index has the following form:

$$P_t^{1-\theta} = \frac{1-\gamma^d\left(\frac{\Pi_t}{\Pi_{t-1}^I}\right)^{\theta-1}}{1-\gamma^d} \tag{22}$$

The log-linear form for NKPC for domestic inflation is:

$$\widehat{\pi_t} = \frac{(1-\gamma^d)(1-\beta\gamma^d)}{\gamma^d(1+\beta\vartheta^d)}\{mc_t + \xi_t^d\} + \frac{\beta}{1+\beta\vartheta^d}E_t\widehat{\pi_{t+1}} + \frac{\vartheta^d}{1+\beta\vartheta^d}\widehat{\pi_{t-1}} \tag{23}$$

Analogue the Phillips Curve for export price inflation

$$\widehat{\pi_t^{x*}} = \frac{(1-\gamma^x)(1-\beta\gamma^x)}{\gamma^x(1+\beta\vartheta^x)}\{-P_t^{x*} - q_t + \xi_t^x\} + \frac{\beta}{1+\beta\vartheta^x}E_t\widehat{\pi_{t+1}^{x*}} + \frac{\vartheta^x}{1+\beta\vartheta^x}\widehat{\pi_{t-1}^{x*}}$$

Where ϑ^x is the rate of indexation, ξ_t^x is the mark-up shock and P_t^{x*} is export price measured in foreign currency. Regarding inflation, agents "learn" trend inflation by the previous period's trend inflation and actual inflation, having in place an "adaptive learning algorithm"

$$(1+\overline{\pi_t}) = (1+\overline{\pi_{t-1}})^{\rho_\pi}\left(\frac{1+\pi_t}{1+\overline{\pi_t}}\right)^g \tag{25}$$

Where ρ_π the persistence of trend inflation and g is the learning speed parameter.

The monetary authority sets the interest rate based on a Taylor type rule.

$$\frac{1+i_t}{1+r} = \left(\frac{1+i_{t-1}}{1+r}\right)^{\zeta_i}\left((1+\pi_t)^{\zeta_\pi}e_r{}^{\zeta_e}\right)^{1-\zeta_i}(1+\eta_t^i) \tag{26}$$

Where ζ_i interest rate smoothing, ζ_π weight on inflation, ζ_e weight on nominal exchange rate, R is the long-term interest rate and η_t^i is an exogenous stochastic shock.

Fiscal policy

Fiscal policy is implemented through a set of simple fiscal rules. The government can finance its expenditure either from raising tax revenues (value added tax, personal income tax or employers' social security contributions) or from deficit. A first assumption is that financial transfers are devoted to non-optimiser households. The government budget constraint is:

$$OT_t + \tau_t^c c_t + \tau_t^l w_t l_t + \tau_t^s w_t l_t = P_t(1+\eta_t^G)G + TR_t + D_t - \frac{1+i_t}{1+\pi_{t+1}^{gross}}D_{t-1} \tag{27}$$

Where G is the steady value of volume of government purchases of goods and services, η_t^G is the shock to government expenditures, TR_t financial transfers to non-optimizers, τ_t^c value added tax rate, τ_t^l personal income tax rate, τ_t^s employers' social security contribution tax rate, OT_t are other net revenues and D_t is the government debt.

The total deficit is:

$$T_t = PS_t + \left(\frac{1+i_t}{1+\pi_{t+1}^{gross}} - 1\right)D_{t-1} \tag{28}$$

Where T_t is total deficit/surplus and PS_t is the primary balance of the budget

The government debt is an autoregressive process:

$$D_t = D_{t-1} + T_t \tag{29}$$

The third assumption of the treatment of the fiscal policy is that all the taxes are exogenous and the deficit is financed by lump sum taxes. In order to capture the fiscal reactions a set of rules has been used. The fiscal authority might react to current output in order to have a stability role or simply let the automatic stabilizers work. Taxes and expenditures are set such that they react to past deficits or debts.

In this respect the reaction for taxes follows:

$$\widehat{\tau_t^i} = \rho^{\tau^i}\widehat{\tau_{t-1}^i} + \left(1-\rho^{\tau^i}\right)\left(\varphi_{GDP}^{\tau^i} GDP_t - \varphi_T^{\tau^i}\widehat{T_{t-1}}\right) + \xi_t^i \tag{30}$$

Where $i = \{c, s, l\}$ define the three rules corresponding to three taxes and ξ_t^i indicates the shocks. For the financial transfers and government expenditure the rules are applied:

$$\widehat{x_t} = \rho^x \widehat{x_{t-1}} + (1-\rho^x)\left(-\varphi_{GDP}^x GDP_t - \varphi_T^x \widehat{T_{t-1}}\right) + \xi_t^x \tag{31}$$

Where $x = \{TR, \eta_t^G\}$

The goods market equilibrium condition follows from aggregating the individual budget constraints

$$y_t = c_t + I_t + (1+\eta_t^G)G + DP_t^x x_t + \Psi(u_t(j)k_{t-1} \tag{32}$$

Where c_t is the aggregated consumption, $\Psi(u_t(j)k_{t-1}$ is the volume of capital not utilized in production and DP_t^x is the dispersion of export prices

$$GDP_t = y_t + q_t P_t^{x*} x_t - q_t P_t^{m*} m_t - x_t \tag{33}$$

2. EMPIRICAL RESULTS

Estimation of the parameters involves the use of *a priori* values as parameters considered as input variable and the usage of a data sample to obtain *a posteriori* values. Observable variables for the sample period 2000Q1-2013Q1 of the model were taken from the Eurostat database: actual individual consumption of households, gross capital formation, net exports and imports of goods and services to GDP, employment in the economy, real gross wage, income and government spending, value added tax, income tax, employers' social contributions, transfers, government consumption, inflation and monetary policy rate in nominal terms. The data series have been deflated either with GDP deflator or consumer price deflator depending on the source of data. For stationarity of the data, for each variable was used the Hodrick-Prescott filter.

For the Bayesian estimation the necessary input variables are represented by the set of values established *a priori* for the mean, standard deviation and parameters distribution. In order to capture the effect of monetary regime change in Romania in August 2005, the model estimation was performed in two stages. The first step consist in the estimation of the parameters from the first data sample, the *a priori* values from this process were established from other studies or have been estimated. The second phase represents the estimation of the parameters from the second data sample after the switch of the regime. The *a posteriori* values from the first sample estimation were considered as *a priori* values for this step. The aim of this estimation in two steps is to intercept the switch monetary regime through values of the estimated parameters.

A common practice in the literature is the calibration of a number of parameters, they not being included in the estimation process. The parameters chosen to be calibrated relate mostly to three categories: required to determine the steady state, those parameters for which exists reliable estimates from other sources, as well as those parameters whose values are crucial to reproduce the weights of the main key indicators at steady state. The principle used to establish a priori values of the first stage consisted in taking procedures from works in literature of reference, performed on the euro area economy (Smets and Wouters, 2003).

The discount factor, β is established at 0.99 and the annual depreciation rate is 5% according with European Commission studies, this implies an equilibrium interest rate of 6%. Capital rate in production function is 0.33 (The values is assumed to be the one from the research paper of Gălăţescu, Rădulescu şi Copaciu (2007)) while the labour elasticity is 0.8 and the capital elasticity is 1.05 according to Jakab şi Vilagi (2010) established in a research on Hungarian economy. Habit in consumption is fixed at 0.65, this value being estimated on the same sample of data on Romanian economy. The weights of consumers that do not optimize their decisions in consumptions is another important parameters that is set as 0.5.

The parameters of the autoregressive terms, like shocks that affect the economy, the distribution proposed by Smets and Wouters is Beta with mean 0.8 and standard deviation 0.1. These values are comparable with other research papers, Almeida (2010) on Portuguese economy and Jakab et al (2012) on Hungarian economy. For the price and salary rigidities the a priori mean values were set as 0.7, these values corresponding to a frequency of tree quarters and one month and a deviation standard of 0.1. The habit in consumption and the inter-temporal elasticity of substitution follow a Beta distribution, respectively Normal distribution with standard deviation of 0.1 respectively 0.4. The parameters for monetary policy function are established for the second regime, using a Normal distribution with 1.5 for inflation, 0.7 for interest rate smoothing parameter and 0.4 for GDP gap.

In Table 1 are presented the key estimated parameters for both regimes. The habit in consumption, having a mean of 0.6726 indicates a higher value than the considered a priori value but close to the one estimated. This parameter denotes the fact the almost 67% of the households take their decisions based on past consumption.

Tabel 1 Estimated parameters

	A priori	Distribuţion	Std	A posteriori	
				Regime1	Regime2
h_c	0,65	Beta	0,05	0,6726	0.6595
$\bar{\omega}$	0,5	Beta	0,15	0,5445	0.678
σ	2	Normal	0,4	2,0426	2,12
γ^x	0,7	Beta	0,1	0,6693	0.4916
γ^w	0,7	Beta	0,1	0,6531	0.7172
γ^d	0,7	Beta	0,1	0,8548	0.6444
ϑ^w	0,7	Beta	0,1	0,5515	0.3752
ϑ^x	0,7	Beta	0,1	0,6621	0.4053
ϑ^d	0,7	Beta	0,1	0,7838	0.4098
ζ_i	0,7	Normal	0,1		0.6402
ζ_π	1,5	Normal	0,1		1.5662
ζ_{PIB}	0,4	Normal	0,1		0.4491
ρ_π	0,8	Beta	0,1	0,7570	0.6834
g	0,2	Beta	0,1	0,1602	0.0831

Source: Own estimation

The weight of the Ricardian agents from economy has an a priori value for 50%, this value being proposed by Gali et al (2007) used for US economy and is the lowest value from the range of the other studies 'proposals.

For euro zone, the researchers Coenen and Straub (2005) respectively Forni et al (2007) proposed in their studies that the weight of the optimal agents to be 75% respectively 65%. Stork (2011), using household characteristics of Czech economy, split the population in categories of employees and estimates a value of 63% of the optimal consumption weight. In this paper the *a priori* values are assigned in order to not affect in one direction or another the estimation and using a standard deviation of 0.15 the output horizon of the *a posteriori* value is extended. The estimated result of 55% indicates the fact the weight of the consumers that do not optimize their decision in consumption is 45%. The value of the substitution elasticity 2.04 is close to the estimation of 2.16 obtained by Murăraşu on Romanian economy.

The estimated values denotes an indexation degree of 48% for internal prices, respectively 55% for salary indexation. An explanation of these values can be that the capital account liberalization in Romania began in 2005. The autoregressive terms of shocks estimated values are around 0.8 *a priori* indicating a high persistence of shocks affecting the economy of Romania. As already mentioned before, this first step estimation is conducted on a sample of data up to the switch of the monetary regime in order to capture the effect out from the data. *A posteriori* values are considered in the second stage as *a priori* values for Bayesian estimation and the importance of the results lies in observing changes related to the new estimated parameters of inflation and monetary policy.

If prices were perfectly flexible, in which all firms adjust their prices, those parameters would be zero and a higher degree of indexing the higher the retrospective component of the inflation process. It is noted that domestic price rigidity is higher than wage rigidity in the first estimate regime. Wage rigidities and export prices are lower than the values set as a priori average, while domestic price rigidity is 85%.

Habit in consumption coefficient decreases to a value of 66% showing a decrease in the backward component of consumption behaviour. The share of the Ricardian agents in the economy reaches 67%, a value that is consistent with studies for the euro area economy. The fact that this share has increased due to the development of financial markets bank in Romania, for example, the Hungarian economy, Jakab (2008) sets the parameter to 75% of quantification based on a survey of consumers interacting with the banking system. Elasticity of substitution in consumption parameter register the same value close to 2.

For the learning parameter it has been assigned a value of 0.2 *a priori* and the result is 0.16 for the first regime. What can be seen in the second regime is a decrease of this parameter to 0.08. This practice emphasizes that learning adaptive parameter decreased considerably with the transition to inflation targeting regime.

Looking forward coefficient parameter, of the expectations of inflation in the Phillips curve, has a value of 0.53 for the first regime, namely 0.60 in the second regime. This indicates a higher anchoring expectations and linking with the decrease of the appealing of the agents to use the adaptive learning lowering effect, it can be said that adapting the inflation targeting, agents formed their expectations and used it in forecasting. McDermott and McMenamin (2008) in a study assessing the inflation targeting regime in Latin America, points out that inflation persistence parameter decreases with monetary regime change. This is observed for estimates on Romania's economy where inflation persistence parameter decreased from a value of 0.75 to 0.68.

This stabilization of inflation persistence parameter for the Romanian economy is caught in the study realised by Murăraşu (2011) on a sample of monthly data from 2000 to 2012 timeframe. The author estimates the parameters using Bayesian methodology of a regression with time-varying parameters using Gibbs algorithm.

Indexing mechanism was more pronounced in the first regime by the fact that the estimated indexing parameters recorded lower values for the second regime. If in the first regime between indexing of export and domestic prices there is a considerable difference, in the second regime indexing parameter values are close. The significant decrease of price indexation is given by the idea that the indexing in the first regime with higher inflation is higher in comparison to the second regime in which the authorities are committed to achieving the inflation target. In terms of price rigidity is observed that the values are similar between the two regimes, an increased flexibility in the second regime can be explained by the export prices, as evidenced in other studies. Rigidity of wages is lower than the domestic price rigidity which is surprised by the observed data as a priori values of these parameters are equal and a posteriori values are considerably different.

The first conclusion is that the indexing parameters decreased significantly with the process of the inflation targeting regime, the biggest change is observed in the case of domestic prices. This decrease of indexing was reported also by Jakab (2010) on the Hungarian economy, where the regime change occurred from exchange rate targeting to inflation targeting. In terms of rigidity, if the wage rates increased, for prices it was observed an increase in both export prices and the domestic prices.

Taylor monetary policy rule parameters are estimated only for the second regime in which the *a priori* values were used in the literature. The parameter inflation monetary policy rule *a posteriori* recorded a value of 1.56 close to the estimated parameter from other research paper. The smoothing parameter of the interest rate registered a posteriori value of 0.64, which indicates that although this parameter smoothing average recorded values of 0.8, this was mainly due to the pre-adoption of the inflation targeting regime, a fact observed in a MS-VAR analysis, where the first parameter regime of interest rate smoothness recorded values of 0.9, while for second regime this parameter was estimated at 0.61.

Once the parameter estimates are obtained and their accuracy is tested, the next step of the analysis is to asses the impact of certain exogenous stochastic processes affecting the long-term equilibrium of the model. In this respect it was analysed the responses of model variables to a shock affecting households preferences, costs, technology and money. The shocks were considered in the size of a standard deviation, while the response horizon is 5 years, given that the entire data sample size is 12 years.

For a demand shock that is positively affecting household preferences for the purchase of goods and services, GDP increases with about 0.06 percent. In both cases the error bands are very narrow, which gives some plausibility to the results. An important aspect to note here is that usually through expectations mechanism, inflation should remain in positive zone after the impact of the shock preferences. The increase of the interest rates and inflation affects the demand for goods and services and GDP returns to a negative zone in both cases. The impact on the GDP gap diminishes into 6 quarters. Consumption increases with 10 percentage points, but different depending on the category of the representative agents. If the response of the optimal agents is 12 percentage points for those who do not optimize their response is only 3%, and that because this shock directly affects consumption of Ricardian agents.

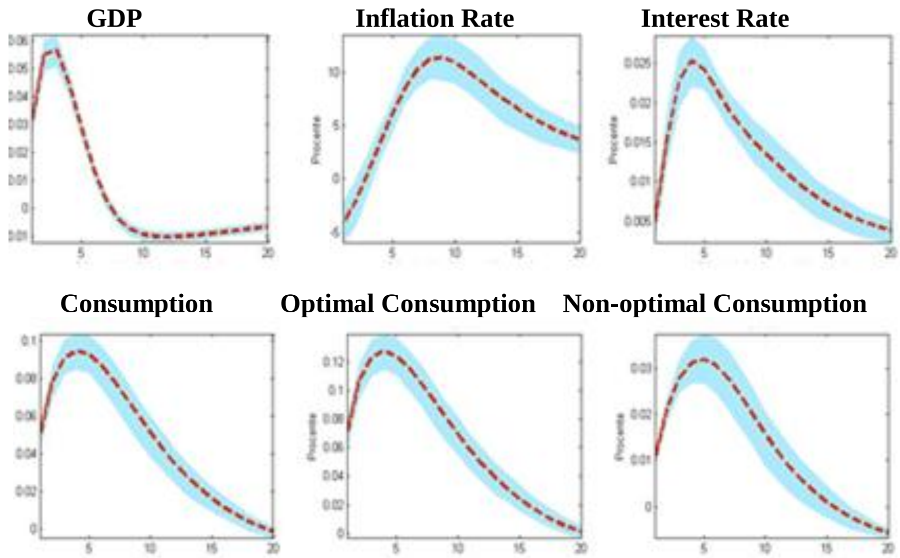

Figure 1. Demand shock
Source: Own estimations

The response of variables in the model to a productivity shock stresses out that technology is the only shock that ensure stable growth in the long-term aggregate production without affecting the level of prices. In the short term, however, inflation decreases. One thing to note is that the Ricardian agents increase immediately their consumption, while naive agents do this after the first two quarters. Ricardian agent's consumption increases as they perceive this productivity shock as an increase of the general welfare, translated into an economic saving of the government that will not change the taxes in the near future, so these agents increase their consumption.

A one standard deviation monetary shock is translated into an increase in short-term interest rate of about 1 percentage point. This increase in the cost of financing causes a contraction of activity in the real sector of goods and services of about 1 percent, while inflation is reduced by only 14 basis points. With higher interest rates, saving rates increases and consumption decreases, this effect being observed at the optimal and non-optimal agents that decrease their consumption. An interesting thing to note is that the decrease in consumption is greater for naive agents because the degree of persistence in consumption is slightly lower, so this translates into a greater magnitude in response to shock.

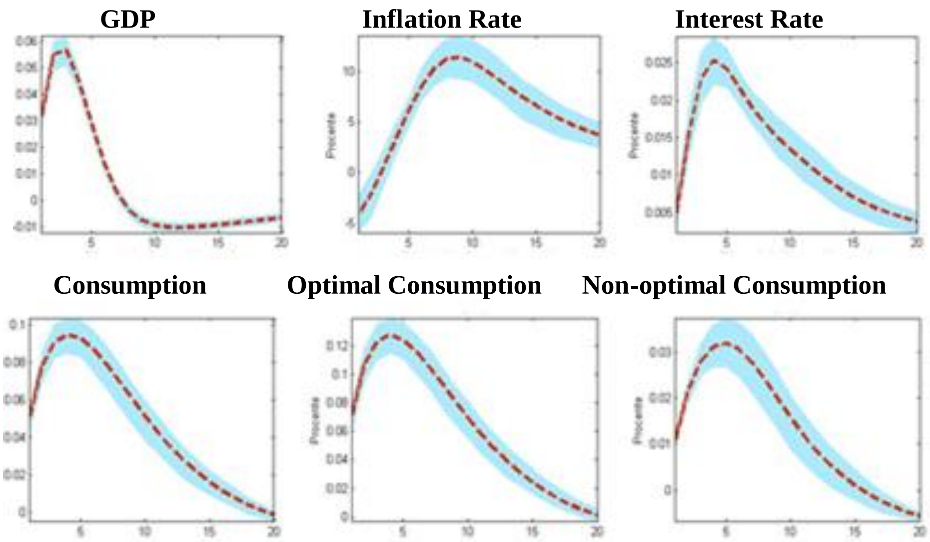

Figure 2 Monetary shock
Source: Own estimations

A positive shock impact on the costs of firms causes a decrease of about 0.06 percent of real sector activity. On the other hand, inflation is adjusted upward by more than 0.2 percent. Between the responses of these two variables to a cost shock is interposed the reaction of short-term interest rate. It increases by 0.2 basis points, due to the fact that a price increases compensates for the decrease in GDP. Responses of the agents that optimize their consumption decisions is to reduce their consumption, this occurs also for naïve agents but the reduced consumption having greater magnitude.

CONCLUSIONS

In order to estimate the parameters given the existence of inflation targeting monetary regime it used a different approach. Model parameters were estimated assuming Taylor function values as calibrated following *a posteriori* values obtained from the model to be considered as *a priori* values set for the second regime. The estimation was carried out on two sub-samples pre and post adoption of the monetary regime. The results surprised monetary regime change in the Romanian economy through a series of elements. The first and most important is that the indexing parameters decreased significantly in the second regime both indexing domestic and export prices and wages. Secondly the pricing flexibility increased with the adoption of inflation targeting regime. Third, the inflation persistence parameter also decreased to 68% from 75%. All these parameters indicates price stability, which led to an improvement of the level of inflation. The adaptive learning parameter surprised this element as follows: starting from a priori value of 0.2, although in the first regime the estimate was 0.16 for the second regime, this parameter decreased by 50%. This emphasizes that the transition to inflation targeting, agents have begun to incorporate more expectations elements in the forecast of inflation than the backward component. They perceived anchoring target as a program that the monetary authority will perform or not, but all efforts will translate to a target near to this. The adaptive learning gradually decreased as the agents that observed that the inflation trend was decreasing and the average past inflation could not be considered a benchmark of forecasting the future inflation. Thus it can be concluded that in terms of inflationary spectrum estimation model in two stages surprised these effects in an efficient manner. The next step was to identify variables 'responses to demand and supply shocks by emphasizing elements optimality of the representative household. The way in which Ricardian agent's consumption was affected by shocks is presented in comparison with how the consumption was affected by shocks for agents that do not optimize their decisions.

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