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The behaviour of the Romanian economy analysed based on a dynamic stochastic general equilibrium model

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ABSTRACT

This paper aims to reveal the dynamic behaviour of the Romanian economy over a period of 14 and a half years, from 2000Q1 to 2014Q2, considering the stochastic action of 20 structural shocks. The study is based on a well-known dynamic stochastic general equilibrium model developed for the Swedish economy, which is adjusted to allow the author to capture the essential characteristics of the target country. Subsequent to the selection of the equations to be implemented for the effective estimation, the calibration of several parameters and the setting of the prior distributions for others, a Monte Carlo Markov Chains method is used, namely the Metropolis–Hastings algorithm, in order to reveal the overall results of the estimation process, thereafter properly construed considering their manifestation context.

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1. Introduction

The idea of analysing the economic behaviour of a target country in dynamics, considering the impact of structural shocks, emerged from the intention to test the accuracy of this class of model on an economy less commonly studied from such a perspective.

Based on a standard dynamic stochastic general equilibrium (D.S.G.E.) model developed for the Swedish economy (Adolfson, Laséen, Lindé, & Villani, 2005), having its roots in a well-grounded study (Christiano, Eichenbaum, & Evans, 2005) adjusted accordingly after thorough research in the manner of Almeida (2009), the present paper aims to reveal the particularities of the Romanian economy, opening the way for short and medium-run estimations useful for the construction of reliable macroeconomic policies.

The modelling consists of the building of some basic economic blocks, comprising the paper's modular structure: households, firms (more specifically intermediate domestic goods firms, final goods firms, composite goods firms and import goods

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firms), Government, representing the fiscal-budgetary organism, and foreign sector, envisaged herein by the Euro Area. This continues with the analysis at equilibrium of the input market, the intermediate goods market, the final goods market and the foreign bond market.

The study assumes the new Keynesian approach regarding price, respectively, wage stickiness (Calvo, 1983, Erceg, Henderson, & Levin, 2000, Erceg, Guerrieri, & Gust, 2006), given that at any time, just some firms and households optimise their price or wage, the remainder of them updating according to a standard rule.

A series of structural shocks are considered for inclusion in the model (Smets & Wouters, 2003), among which is the stochastic technological shock (Altig, Christiano, Eichenbaum, & Linde, 2003) that induces a common trend to the real variables of the model.

The entire construction is subject to a series of procedures, such as optimisation and log-linearisation, so as to bring it to a convenient form for being correctly estimated and tested in terms of impulse–response functions.

After briefly discussing several well-known approaches in this area in Section 2, the final equations of the model to be implemented are revealed in Section 3; the data and the preliminary specifications, the latter consisting of the model calibration and in the setting of the priors for the same, are discussed in Section 4; and the estimation results and discussions are found in Section 5. The paper ends with the overall conclusions, in Section 6.

2. Literature review

D.S.G.E. models, originating both in the new classical theory (Kydland & Prescott, 1982), mainly oriented towards the impact of real shocks on business cycle fluctuations, and in the new Keynesian theory (Rotemberg & Woodford, 1997), subsequently developed on the basis thereof (Galí, 2008,Woodford, 2004) and assuming a monopolistic competition characterised by price stickiness, have become increasingly attractive for the estimation of national economies worldwide.

Making use of vector autoregression, Bayesian vector autoregression or other Bayesian analysis instruments, revealing closed economies (Fernandez-Villaverde, 2009, Schorfheide, 2013) or opened economies (Almeida, Castro, Mourinho Félix, & Maria, 2013, Berg, 2016, Liu & Mumtaz, 2011, Merola, 2015, Robinson, 2013), and being exclusively destined for estimation purposes (Almeida et al., 2013, Robinson, 2013) or for forecasting purposes (Costantini, Gunter, & Kunst, 2017, Kirdan, Matheson, & Smith, 2011, Slobodyan & Wouters, 2012, Smets, Warne, & Wouters, 2014), D.S.G.E. models have become more and more reliable, despite criticism or questioning (Blanchard, 2016, Korinek, 2015) and despite being reproduced in studies (Lindé, Smets, & Wouters, 2016) or being the subject of focussed debates (Gürkaynak & Tille, 2017).

The variety of such models is complex, as the same approaches are oriented towards different purposes, such as the identification of the most appropriate measures for controlling market mechanisms (Christiano, Trabandt, & Karl, 2010); outlining the impact of individual forecasts relating to interest rate, inflation rate and gross domestic product on aggregate predictive performance (Smets et al., 2014); investigating, while considering the financial accelerator, the role of financial mechanisms in translating financial market dysfunctions into the real economy (Merola, 2015); considering the effects of goal-based and rule-based frameworks on diminishing macroeconomic policy distortions, and on increasing its flexibility and efficacy only when related to the output efficiency gap (Walsh, 2015); the demonstration that time-varying D.S.G.E. models based on financial frictions increase economic growth and inflation rate forecasting accuracy in periods of tranquillity, the fixed coefficient ones being fit rather for crisis-related periods (Galvão, Giraitis, Kapetanios, & Petrova, 2016); or that, in the absence of observed exchange rate high-volatility replication, considering the real exchange rate mean reversion for long time horizons as well as the international price co-movement present in data, all premises are laid for real exchange rate-pertinent forecasts (Ca'Zorzi, Kolasa, & Rubaszek, 2017); these are just several interesting and useful studies based on this class of models.

However, given the poor literature in this area for the economy targeted by the present paper, it was decided to outline a general estimation pattern, capturing at the same time its reaction to various structural shocks, not only affecting economic life but also impacting, to a large extent, on social life.

3. Model

The model approached in this paper is grounded on the new Keynesian theory, built starting from a well-known construction (Adolfson et al., 2005), based on existing fundamentals (Christiano et al., 2005), but adapted accordingly as in Almeida (2009), mainly as for the rethinking of the structuring pattern, of the grouping of the companies acting on the Romanian territory, as well as of the markets analysed at equilibrium.

As the model has been already described in detail elsewhere (Hudea, 2014) and the present paper has limited space, only the final equations are discussed in brief, subject to implementation, namely a number of 23 log-linearised equations resulting from expansion in Taylor series around the steady state.

3.1. The households' equations

The capital movement equation, which takes into account the rate of capital depreciation, the mechanism transforming investments into capital, as well as the technological growth rate:

$$\hat{\bar{k}}_{t+1} = (1-\delta) \times \frac{1}{\mu_z} \times \left(\hat{\bar{k}}_t - \hat{\mu}_{z,t}\right) + \left(1 - \frac{1-\delta}{\mu_z}\right) \times \left(\hat{\chi}_t + \hat{i}_t\right). \quad (1)$$

The Euler equations of consumption, which reflect the lifetime utility generated by an inter-temporary increased consumption, given the subjective discount factor, the habits in consumption, the one period-related utility function, the previously mentioned technological growth rate, and the inflation and interest rate:

$$\hat{U}_{z,t}^{c,life} = \frac{1}{\mu_z - \theta \times \beta} \times \left(\mu_z \times \hat{U}_{z,t}^{c} - \theta \times \beta \times \hat{U}_{z,t+1}^{c} + \theta \times \beta \times \hat{\mu}_{z,t+1}\right) \tag{2}$$

$$\hat{U}_{z,t}^{c,life} = \hat{U}_{z,t+1}^{c,life} - \hat{\pi}_{t+1} - \hat{\mu}_{z,t+1} + \hat{R}_t. \tag{3}$$

The condition of uncovered interest rate parity, where the harmonisation of the internal and external bonds is made via the risk premium element:

$$\hat{R}_t = \hat{R}_t^* - \hat{a}_t + \tilde{\varphi}_t. \tag{4}$$

The investment-related decision, which depends on its one lag and one lead values, on the technology growth rate, on the investment shock and on the investment to capital turning adjustment cost:

$$\hat{p}_t^i = \frac{\hat{\omega}_t}{\hat{\psi}_{z,t}} + \hat{\chi}_t - S''(\mu_z) \times \mu_z{}^2 \times \left[(1+\beta) \times \hat{i}_t - \hat{i}_{t-1} + \hat{\mu}_{z.t} - \beta \times \hat{i}_{t+1} - \beta \times \hat{\mu}_{z.t+1}\right]. \tag{5}$$

The capital stock-related decision, taken while considering the rates of capital depreciation, rental, interest and inflation:

$$\hat{r}_{t+1}^k = \frac{1}{r^k} \times p^i \times \left[\frac{1}{\pi} \times R \times \frac{\hat{\omega}_t}{\hat{\psi}_{z,t}} + \frac{1}{\pi} \times R \times \hat{R}_t - \frac{1}{\pi} \times R \times \hat{\pi}_{t+1} - (1-\delta) \times \frac{\hat{\omega}_{t+1}}{\hat{\psi}_{z,t+1}}\right]. \tag{6}$$

The wage optimisation-related decision, in a monopolistic market with sticky nominal factors, given the past and expected wage, income tax, wage mark-up, the wage indexation parameter, the inverse of labour elasticity as to its marginal disutility, the lifetime utility function, the shock on the households' labour hour preferences or the past, current, future and target wage-specific inflation rate:

$$\hat{w}_t = \frac{1}{\sigma_l \times \lambda_w - b_w \times (1 + \beta \times \xi_w{}^2)} \times \begin{bmatrix} (1-\lambda_w) \times \left(\sigma_l \times \hat{H}_t + \frac{\tau^y}{1-\tau^y} \times \hat{\tau}_t^y + \hat{\zeta}_t^h - \hat{U}_{z,t}^{c,life}\right) - \\ b_w \times \xi_w \times \begin{pmatrix} \beta \times \hat{w}_{t+1} + \beta \times \hat{\pi}_{t+1} + \hat{w}_{t-1} - \\ \hat{\pi}_t + k_w \times \hat{\pi}_{t-1}^c - k_w \times \beta \times \hat{\pi}_t^c + \\ (1-k_w) \times (1 - \beta \times \rho_{\bar{\pi}}) \times \hat{\bar{\pi}}_t \end{pmatrix} \end{bmatrix} \tag{7}$$

3.2. The firms' equations

The capital–labour ratio, depending on wage, labour hours, capital rental rate and on the technological growth rate:

$$\hat{k}_t = \hat{H}_t + \hat{w}_t - \hat{r}_t^k + \hat{\mu}_{z,t}. \tag{8}$$

The optimisation-related decision of intermediate domestic goods firms, in a monopolistic market with sticky prices, considering their marginal costs, the intermediate domestic goods indexation parameter, the intermediate domestic goods price mark-up and the past, future and target associated inflation rate:

$$\hat{\pi}_t^d = \frac{1}{1 + k_d \times \beta} \times \left[\begin{array}{r} (1 - k_d) \times \left(1 - \beta \times \rho_{\bar{\pi}}\right) \times \hat{\bar{\pi}}_t + \beta \times \hat{\pi}_{t+1}^d + k_d \times \hat{\pi}_{t-1}^d + \\ \frac{(1 - \xi_d) \times (1 - \beta \times \xi_d)}{\xi_d} \times \left(m\hat{c}_t^d + \hat{\lambda}_{d,t} \right) \end{array} \right]. \tag{9}$$

The aggregate production function of the intermediate domestic goods firms, which puts together the capital, labour hours, the domestic technological shock, the technological growth rate, the domestic good indexation parameter and the production to capital elasticity:

$$\hat{y}_t = \lambda_d \times \left[\hat{\Omega}_t + \alpha \times \left(\hat{k}_t - \hat{\mu}_{z,t} \right) + (1 - \alpha) \times \hat{H}_t \right]. \tag{10}$$

The optimisation-related decision of import goods firms, in a monopolistic market with sticky prices, considering their marginal costs, the import good indexation parameter, the import goods price mark-up and the past, future and target associated inflation rate:

$$\hat{\pi}_t^m = \frac{1}{1 + k_m \times \beta} \times \left[\begin{array}{r} (1 - k_m) \times \left(1 - \beta \times \rho_{\bar{\pi}}\right) \times \hat{\bar{\pi}}_t + \beta \times \hat{\pi}_{t+1}^m + k_m \times \hat{\pi}_{t-1}^m + \\ \frac{(1 - \xi_m) \times (1 - \beta \times \xi_m)}{\xi_m} \times \left(m\hat{c}_t^m + \hat{\lambda}_{m,t} \right) \end{array} \right]. \tag{11}$$

The import goods firm-specific aggregate production, given the intermediate domestic goods aggregate production, both of them regarded as inputs from the perspective of the composite goods firm, the difference in prices between the import and the domestic goods and their elasticity of substitution:

$$\hat{y}_t^m = (\eta_h + 1) \times \left(\hat{p}_t^d - \hat{p}_t^m \right) + \hat{y}_t. \tag{12}$$

The composite goods firm-established price level, depending on the intermediate domestic goods price and the import goods price, on their elasticity of substitution, as well as on the weight of import goods in overall composite goods production:

$$\hat{p}_t^h = \frac{1}{p^h} \times \left((1 - w_h) \times \left(p^d\right)^{-\eta_h} \times \hat{p}_t^d + w_h \times (p^m)^{-\eta_h} \times \hat{p}_t^m \right). \tag{13}$$

The optimisation-related decision of the final goods firms, in a monopolistic market with sticky prices, considering their marginal costs, the final goods indexation parameter, the final goods price mark-up and the past, future and target associated inflation rate:

$$\hat{\pi}_t^f = \frac{1}{1+k_f \times \beta} \times \left[\begin{array}{r} (1-k_f) \times (1-\beta \times \rho_{\bar{\pi}}) \times \hat{\bar{\pi}}_t + \beta \times \hat{\pi}_{t+1}^f + k_f \times \hat{\pi}_{t-1}^f + \\ \frac{(1-\xi_f) \times (1-\beta \times \xi_f)}{\xi_f} \times \left(m\hat{c}_t^f + \hat{\lambda}_{f,t} \right) \end{array} \right]. \quad (14)$$

3.3. The public sector equations

The Government primary deficit, ignoring the debt service, but including public expenses, such as public consumption, public investment and transfers, and related sources, represented by the state budget revenues, such as income tax and value added tax:

$$d\hat{g}_t^P = \begin{array}{l} \frac{p^g \times g \times (\hat{g}_t + \hat{p}_t^g) + tr \times t\hat{r}_t - \tau^c \times p^c \times c \times (\hat{c}_t + \hat{\tau}_t^c + \hat{p}_t^c)}{p^g \times g + tr - \tau^c \times p^c \times c - \tau^y \times w \times H} - \\ \frac{\tau^y \times w \times H \times (\hat{H}_t + \hat{w}_t + \hat{\tau}_t^y)}{p^g \times g + tr - \tau^c \times p^c \times c - \tau^y \times w \times H} \end{array}. \quad (15)$$

The Government total deficit, encompassing the related primary deficit and the debt service, the latter involving the consideration of the domestic bond past and present interest rate, the inflation rate, as well as the technological growth rate:

$$d\hat{g}_t^T = \frac{dg^P \times d\hat{g}_t^P + \frac{1}{\pi} \times \frac{1}{\mu_z} \times b \times \left[(R-1) \times \left(\hat{b}_t - \hat{\mu}_{z,t} - \hat{\pi}_t \right) + R \times \hat{R}_{t-1} \right]}{dg^P + (R-1) \times b \times \frac{1}{\pi} \times \frac{1}{\mu_z}}. \quad (16)$$

The budgetary restriction, according to which the state budget revenues should cover the public expenses:

$$\hat{b}_{t+1} = \begin{array}{l} \frac{1}{b} \times \left[\begin{array}{c} p^g \times g \times (\hat{g}_t + \hat{p}_t^g) + tr \times t\hat{r}_t - \tau^c \times p^c \times c \times (\hat{c}_t + \hat{\tau}_t^c + \hat{p}_t^c) - \\ \tau^y \times w \times H \times (\hat{H}_t + \hat{w}_t + \hat{\tau}_t^y) \end{array} \right] + \\ +R \times \frac{1}{\pi} \times \frac{1}{\mu_z} \times \left[\hat{b}_t - \hat{\mu}_{z,t} - \hat{\pi}_t + \hat{R}_{t-1} \right] \end{array}. \quad (17)$$

The Government fiscal rule, aiming at immediately adjusting transfers, whenever needed, so as to compensate any possible deviation of the debt service from its normal trajectory, the desired state budget status being reflected by the long-term convergence towards a target gross domestic product level:

$$d\hat{g}_t^P = \frac{1}{\frac{b}{gdp} - \left(\frac{b}{gdp} \right)_{tg}} \times \frac{1}{gdp} \times b \times \hat{b}_{t+1}. \quad (18)$$

The gross domestic product definition, considering its basic elements: private and public consumption and investments and net exports:

$$gd\hat{p}_t = \frac{1}{c + p^i \times i + p^g \times g} \times \begin{pmatrix} c \times \hat{c}_t + p^i \times i \times \left(\hat{p}_t^i + \hat{i}_t\right) + p^g \times g \times \left(\hat{p}_t^g + \hat{g}_t\right) + \\ + p^x \times x \times \left(\hat{p}_t^x + \hat{x}_t\right) - p^m \times m \times \left(\hat{p}_t^m + \hat{m}_t\right) \end{pmatrix}. \tag{19}$$

3.4. The international trade equation

The foreign bond market equilibrium, reached when the foreign bond supply, namely the import and export firm net position, equals the foreign bond demand, coming from households:

$$\hat{b}_{t+1}^* - R \times \frac{1}{\pi} \times \frac{1}{\mu_z} \times \hat{b}_t^* = m \times \left(\hat{x}_t + \hat{p}_t^x - \hat{m}_t - \hat{p}_t^*\right). \tag{20}$$

3.5. The model shocks-related equation

The model shocks, determined as average of their equilibrium value and their previously registered value:

$$\hat{\xi}_t = \rho_\xi \times \hat{\xi}_{t-1} + \eta_{\xi,t}\bar{\xi} \tag{21}$$

with $\xi = \{\chi, \zeta^c, \zeta^h, \tilde{\varphi}, \Omega, \lambda_d, \lambda_m, \lambda_c, \lambda_c, \lambda_g, \lambda_x, \bar{\pi}, \mu_z, \mu_z^*, \pi^*, y^*, r^*, \tau^y, \tau^c, G\}$.

3.6. Other equations

The private consumption-oriented final goods price, value added tax included:

$$\hat{p}_t^c = -\frac{1}{1 + \tau^c} \times \tau^c \times \hat{\tau}_t^c. \tag{22}$$

The intermediate domestic, import and final goods specific inflation:

$$\hat{\pi}_t^\gamma = \hat{p}_t^\gamma - \hat{p}_{t-1}^\gamma + \hat{\pi}_t. \tag{23}$$

Having noted these log-linearised equations in brief, the description of data is presented, along with the steps to be taken in order to perform a correct Bayesian estimation of the related model.

4. Data and preliminary specifications

For grounding the estimation process and the impulse–response function analysis, some basic and, at the same time, comprehensive information relating to the data used and to the preliminary specifications assumed is discussed.

4.1. Data

For the estimation of the model, 14 variables were selected and analysed quarterly, for a period of 14 and a half years, starting with the first quarter of year 2000 and ending with the second quarter of year 2014. This resulted in a total of 58 observations, subsequently reduced to 56 as result of the differentiation process (including second-order differentiation) and, therefore, of the elimination of the data relating to 2000Q1 and 2000Q2.

The variables considered can be more clearly described by dividing them into three categories, namely:

1. Gross domestic product, consumption, investments, imports and exports, all of them analysed at the level of Romania, and gross domestic product for the foreign sector, represented here by the Euro Area. The variables belonging to this category are used in logarithm and are differentiated (the second-order difference was used for gross domestic product).
2. Number of employees and real wage, the latter expressed as labour cost index. Both variables are used in logarithm, but, unlike the real wage for which the first difference is used, the number of employees is not subject to differentiation, it being stationary in level.
3. Gross domestic product deflator, consumption deflator, investment deflator, exchange rate, domestic interest rate and foreign interest rate, the last two being analysed as ROBOR 3M, respectively EURIBOR 3M. Such variables are used in logarithm, the interest rates being also differentiated.

The data relating to the national gross domestic product and to its components were taken from the Romanian National Institute of Statistics database, while the external national gross domestic product was obtained from the database of the International Monetary Funds (International Financial Statistics). This was also the source of the number of employees, unlike the real wage, determined by resorting to the labour cost index, downloaded from Eurostat. The data relating to the exchange rate and interest rate were supplied by the statistics of the National Bank of Romania (for the exchange rate and for ROBOR) and the National Bank of France (for EURIBOR), respectively. All initial transformations of the time series data were made by means of the econometric software Eviews 7.

4.2. Preliminary specifications

Before implementing the equations, based on the related data mentioned above, it is necessary to resort to some preliminary specifications consisting of calibrating the model and setting the prior distribution, therefore creating a probabilistic structure that makes possible the generation of the associated posterior distribution; these steps are discussed below.

4.2.1. Preliminary calibration

A first step in initiating the procedure of estimation of D.S.G.E. models consists of calibrating certain parameters, considered as such throughout the estimation process. The calibration of parameters can be done by taking specific values from the specialty literature, by using the steady-state value of the same, or by considering the real level of such items, as the case may be.

Thus, the subjective discount factor (β), encountered in the literature at a threshold of 0.992 (Andrés, Burriel, & Estrada, 2006) or at a similar value of 0.999 (Adolfson et al., 2005, Adolfson, Andersson, Lindé, Villani, & Vredin, 2007a, Adolfson, Laséen, Lindé, & Villani, 2007b, Smets & Wouters, 2003) is used here; the α parameter is set to 0.32, in compliance with previous estimation results obtained by the author for the studied economy.

The consumption habit persistence (θ) is calibrated to 0.65, starting from well-grounded premises (Adolfson et al., 2005, Christiano et al., 2005), also applicable to Romania, while the capital depreciation rate (δ) is considered with a value of 0.03 (Andrés et al., 2006), and the labour elasticity (σ_L), based on existing information (Almeida, Castro, & Felix, 2008), with a value of 2.

The technological growth rate (μ_z) reaches 2% per year (Adolfson et al., 2005), fully compliant with the annual potential output level estimated for the Euro Zone (Musso & Westermann, 2005), for which reason it is calibrated here to 1.005.

The target level of the ratio debt to gross domestic product ($(b/gdp)_{tg}$) is established to the maximum limit imposed by the Treaty of Maastricht, more precisely to 60%, and the transfer correction factor (d_g), to 0.90 (Almeida, 2009).

As for the long-run inflation target ($\bar{\pi}$), determined according to the Euro Area goals, the annual level reaches 2.02%, meaning a quarterly value of about 0.5%.

At equilibrium, the weight of the governmental consumption in gross domestic product (*g/gdp*) is calibrated so as to correspond to the average of the sample relating to the said ratio, leading to a value of 0.39.

The tax rates are set in accordance with the related specific data of the national economy, namely to 0.16 for the income tax (τ^y), while for the consumption tax (τ^c), representing value added tax, to a weighted arithmetic average of 0.197, considering its fluctuating evolution during the analysed period, from 0.18 in 1996 to 0.22 since February 1998, then to 0.19 since January 2000, and finally to 0.24 since June 2010 and continuing inclusively to the date of writing.

4.2.2. Prior distribution setting

In order to perform a Bayesian analysis, the prior distribution of the parameters to be estimated has to be set, therefore providing some preliminary information before the effective observation of the real data.

To determine such priors, given the lack of previous consistent information regarding the studied economy, the author adopted the position of grounded related papers from abroad (Altig et al., 2003, Smets & Wouters, 2003) for the establishment of different types of parameter distributions depending on their nature – a position also taken by other specialists (Adolfson et al., 2005, 2007a, 2007b, Almeida, 2009, Fernandez-Villaverde, 2009) – and adjusted as required. More precisely, the Beta distribution was used for parameters between 0 and 1, the Inverse Gamma distribution for the positive parameters that may exceed the value of 1, and the normal distribution for the remainder of parameters.

Therefore, there is a Beta distribution for the parameters reflecting the weight of imports in aggregate consumption (w_h), for the wage stickiness (ξ_w) and the price stickiness of intermediate domestic goods (ξ_d), import goods (ξ_m) and final goods (ξ_f) following the four destinations: private consumption (ξ_c), private investments (ξ_i), public consumption (ξ_g), respectively export (ξ_x), for the indexation parameters relating to the above-mentioned elements (k_w, k_d, k_m, k_c, k_i, k_g, k_x), as well as for the autoregressive parameters of the model shocks (ρ).

Starting from the premise of a quicker adjustment of the final goods prices, their stickiness parameter was assigned a distribution of 0.63 for mean and 0.1 for standard deviation, exceeded only by the modification of the import goods prices, being under the impact of the Euro Area decisions, implying a probability of 0.5 for mean and 0.1 for standard deviation. The prices of domestic intermediate goods seldom register an adaptation to the economic changes, their mean amounting to 0.79, while for the wage modification, with the slowest reaction to market movements, the chosen distribution has a mean of 0.84, the standard deviation being 0.1 for both of them (Almeida 2009).

The indexation parameters received, based on Adolfson et al. (2005), a prior distribution of 0.5 for mean and 0.1 for standard deviation; the autoregressive parameters a unique distribution of 0.6 for mean and 0.1 for standard deviation; and the weight of import in aggregate consumption a probability of 0.4 with a standard deviation of 0.1.

The Inverse Gamma distribution concerned the mark-ups of wages (λ_w), of the domestic intermediate (λ_d), import (λ_m) and final (λ_f) goods prices, the latter being differentiated (λ_c), (λ_i), (λ_g) and (λ_x); the elasticity of substitution between the domestic and the import goods (η_h); the elasticity of substitution, at external level, between the goods exported by the national economy (imported by the foreign sector) and those produced by the foreign sector on its own territory (η_*); and the standard deviations of shocks (σ).

The mark-ups were associated with a mean ranging between 1.05 for the end product prices, and 1.25 for wages, with a standard deviation of 0.2; a mean of 0.5 was used for elasticities, with a standard deviation of 0.1, based on previous results.

As for the shock deviations, considering the absence of relevant prior information, a harmonised and loose homogenous probability was used (Almeida, 2009); for most of them this was set to 0.15, the value found in the related literature (Adolfson et al., 2005, Altig et al., 2003), and to 0.02, a visibly lower value allowing for the successful numerical optimisation of the posterior kernel, the standard deviation being assimilated to such means in order to get, as much as possible, uninformative priors (Almeida, 2009).

For the remaining parameter, representing the investment adjustment cost (S), which can reach values largely exceeding 1, the normal distribution was selected; its mean was set to 7.6 and its standard deviation to 1.5, in compliance with the target economy evidence.

Once this stage was completed, the effective estimation of the model followed, involving the use of specific means.

5. Empirical results and discussion

In order to estimate the parameters of the model used in this paper, a Monte Carlo Markov Chains method was used, namely the Metropolis–Hastings algorithm, implemented in Dynare 4.3.0., Matlab 7.11.0; the output is presented in Table 1.

As a result of the implementation of the model, containing 50 variables (41 predetermined variables, 15 forward-looking variables and six static variables) and 20 stochastic shocks, estimates were obtained for the 65 items: 45 parameters and 20 standard deviations of shocks.

To strengthen the accuracy of results, the prior means have been also included in Table 1, together with the mode obtained by the maximisation of the posterior kernel and with the mean and confidence interval (5th and 95th percentiles) relating to the posterior probabilities, determined based on the Metropolis–Hastings algorithm. Comparison of the arising posterior distribution with the prior distribution and the mode of the simulated posterior distribution with the mode generated by maximising the posterior kernel is necessary in order to certify the results obtained.

As the central purpose of this paper is to reveal the behaviour of the Romanian economy, in parallel with the output presentation the results are interpreted in this particular context. Given the common root of the present study, in terms of D.S.G.E. modelling structure, with the studies of Adolfson at al. (2005), Almeida (2009) and, to a lesser extent, Christiano et al. (2005) (this being exclusively dedicated to the analysis of monetary policy shock), a reasonable and relevant comparison of the obtained results is limited to the same.

According to the information shown in Table 1, a net mark-up (λ_m) of 27.72% was ascertained on the import goods market (in relation to the prior 20% mark-up), reflecting moderate competition, as opposed to the final goods market oriented towards private and public consumption and to exportation, where the extremely reduced level outlines tight competition involving an increased level of product substitution. In exchange, unfortunately, private investment-centred final goods are associated with a mark-up (λ_i) of 38.26%; this indicates the lack of interest of producers for this field, therefore the absence of real market competition. Comparing with related studies, for the mark-up of the import goods market the value obtained by Almeida (2009) is higher, amounting to 37%, as in Adolfson et al. (2007b); this value ranges between 27.5% and 63.3% in Adolfson et al. (2005), given the split of the import goods into import consumption goods and import investment goods.

The domestic intermediate goods market registers a high level of net mark-up (λ_d), 59.79%, mainly revealing the lack of competition and the low level of substitutability of the said products, as well as the tendency of the final goods producers to internalise their activities. This value exceeds the one found for the Swedish economy in Adolfson et al. (2005) (22%), but is certainly a reasonable finding as compared with Almeida (2009), with a rather contestable value of 145%.

Surprisingly from the perspective of its excessively high value is the labour force mark-up (λ_w), reaching 151%; however, this is close to the value of 149% obtained by Almeida (2009). Yet, economically speaking, it is certainly justifiable given income inequalities, with extreme values clearly delimited at the upper level on one hand, and certain issues related to the underground economy, focussed on the covering of real gains, therefore altering the general image on the actual wage levels on the other hand.

The elasticity of substitution between domestic goods and import goods (η_h) is about 0.23, reflecting, provided that the consumption basket is maintained at the same level, an adjustment of 0.23% of the consumed quantity of import goods upon the modification, in the opposite direction, with 1%, of the consumption of domestic goods (a value comparable with that of 0.31 obtained for the Portuguese economy by Almeida, 2009). At the external level, the elasticity between their domestic goods and the target country goods imported by the foreign sector (η_*) amounts to 0.37 (0.46 in Almeida, 2009), a value slightly higher as compared with the one obtained at internal level, yet both of them lower than the previously considered values. In Adolfson et al. (2005), the elasticity between domestic goods and import goods, considered in this paper as a single item, is divided into the elasticity between the domestic consumption goods and import goods and the elasticity between domestic investment goods and import goods. Surprisingly, the values obtained by Adolfson et al. (2005) are quite high, amounting to 1.69 for the elasticity between domestic investment goods and import goods, and 1.48 for the elasticity at external level. The elasticity between domestic consumption goods and import goods, having registered an excessive value during an initial trial, as stated by the authors, has been finally calibrated, therefore not achieving the objective of determining the related posterior distribution.

The weight of imports in total production (w_h), initially set as prior to 0.4 (even though significantly increased lately, had registered values below this level during the first periods of the analysis) reached only 0.24, a level lower than anticipated, the same being encountered in Almeida (2009), with an even more decreased value of 0.18. In contrast, a value for the investment adjustment cost (S) of almost 15 was obtained, this exceeding expectation; still a result not so surprising considering the high value encountered in the specialty literature, as in Adolfson et al. (2005) (8.67) or Almeida (2009) (7.98).

Regarding the stickiness à la Erceg, respectively à la Calvo, as expected a high inflexibility of wage level (ξ_w), of 0.71 was observed, and a quick adjustment of import goods prices (ξ_m), of 0.11. It is well known that even if prices increase over time, other than a few cases of deflation, employers, in their attempt to increase their profit margin, do not update the level of wages accordingly. Besides, wages are usually re-negotiated at considerable time intervals, normally exceeding 1 year; this makes a quicker modification of wages unlikely. Regarding import goods prices the situation is slightly different, as importers are able to more easily adjust prices in relation to the evolution of inflation, according to the periods of supply with foreign products. In Adolfson et al. (2005) the wage stickiness is 0.69 and in Almeida (2009) 0.79, reflecting, in these cases also, a consistent inflexible level, for the reasons mentioned above. As concerns the import goods, the stickiness value is visibly different for the Swedish and Portuguese economies, registering a level of 0.44 for consumption goods and 0.72 for investment goods for the former and 0.86 for the latter, therefore reflecting a much more restrictive behaviour regarding changing the import prices as compared with the studied economy importers.

The price stickiness of intermediate domestic goods (ξ_d) and, especially, of final goods (ξ_c, ξ_i, ξ_g, ξ_x) is quite high, registering a value of 0.74, for the former, and values ranging between 0.87 and 0.93 for the others. It should be noted that, in general terms, according to the results revealed by this estimation, Romanian producers respond slowly to price movements. Regarding domestic intermediate goods and final goods destined for private investments, this could be justified by the fact that, benefiting from a substantial profit margin as evidenced by the previously rendered values, producers do not acutely need an alert adjustment of prices. In exchange, regarding consumption, either private or public, and export-oriented final goods characterised by strong competitiveness, the increase of prices is moderate because a quicker adjustment could be problematic from the perspective of the reduction of the number of clients, given the incomplete information and the impossibility of coordinating the decisions of all directly competing economic agents. However, economic reality contradicts, to a certain extent, the values obtained for consumption final goods, these in fact registering a higher adjustment rhythm. The price stickiness for domestic goods for the Swedish economy reaches values around 0.9 (Adolfson et al., 2005), similar to this study findings, in agreement with those of Smets & Wouters (2003) or Altig, Christiano, Eichenbaum, & Lindé (2005), but higher than those registered for the U.S. economy by Christiano et al. (2005) of 0.6, or for the Portuguese economy, by Almeida (2009), between 0.63 and 0.86.

The level of inflation persistence is, in the case of wages (k_w), only 16.61%; this unfortunately reveals a cruel situation, in which the slow adaptation of wages, doubled by an incomplete adjustment, as the previous period inflation is practically imperceptibly considered when increasing wages, leads to a visible decrease of the purchasing power of citizens, with negative effects at consumption and investment levels. As expected, in other, more developed economies, inflation persistence is considered to a larger extent when deciding on adjusting the level of wages, this being reflected by the output obtained in this respect by Adolfson et al. (2005) (49.7%) or by Almeida (2009) (63%).

Inflation persistence reaches its highest value of 89.50% for private consumption final goods (k_c), followed, at 83.54%, by domestic intermediate goods (k_d), strongly connected to the past inflation level, the other final goods adapting to the former period inflation (k_i, k_g, k_x) in a proportion of about 50%, ranging between 44.88% and 66.61%, depending on the destination of the products. Import goods (k_m), being influenced by foreign agents' decisions, are not only flexible in prices, but also relatively correlated with past inflation. The inflation manifested in the foreign sector generates a higher price for products exported by the Euro Area and, implicitly, in the efforts of domestic importers in maintaining their profit margin, an adaptation of the prices of imported goods, correlated with the last period inflation. A much more relaxed persistence of inflation regarding the level of prices is identified for the

Swedish economy by Adolfson et al. (2005), the values fluctuating around 20%, quite low also in the opinion of the authors, suggesting that the estimated Philips curves are mostly forward-looking; Almeida (2009) obtained levels ranging from 35% to 49%, apart from import goods, which had a lower value of 29%. Such values, correlated with those related to inflation persistence regarding the level of wages, underline the differences between the nations regarding the living standard of the population.

The parameters reflecting the persistence of the structural shocks vary, according to the above-mentioned results, from 0.34 for the domestic technological shock (ρ_{Ω}), to 0.98 for foreign inflation ($\rho_{\pi}{}^{*}$), as well as for the mark-up of the export directed final goods ($\rho_{\lambda}{}^{x}$). Given that all such values, similar to those encountered in several works (Adolfson et al., 2005, 2007a, 2007b, Almeida, 2009), are less than unity, implicitly from the perspective of the maximum limit of the confidence interval, the conclusion is drawn that there is no unit root in these processes; in consequence, the surprise element is expected in this area.

The volatility of the structural shocks appears to range from high to very high for the spare time preferences ($\sigma_{\eta\zeta}{}^{h}$), of 0.52, the mark-up of intermediate domestic goods ($\sigma_{\eta\lambda}{}^{d}$), of 0.65, the mark-up of private investment destined final goods ($\sigma_{\eta\lambda}{}^{i}$), of 0.88, and the mark-up of private consumption destined final goods ($\sigma_{\eta\lambda}{}^{c}$) with an extreme value, at the opposite side being the volatility of the shocks on the foreign production ($\sigma_{\eta\ y}{}^{*}$), of 0.005, the domestic technology ($\sigma_{\eta\Omega}$), of 0.01, the consumption tax ($\sigma_{\eta\tau}{}^{c}$), of 0.01, the governmental expenses ($\sigma_{\eta g}$), of 0.03, the mark-up of import and export-oriented final goods ($\sigma_{\eta\lambda}{}^{m}$, $\sigma_{\eta\lambda}{}^{x}$), of 0.05, the technological asymmetry between the domestic and the foreign economy ($\sigma_{\eta}{}^{*}{}_{\mu z}$), of 0.06, and the technological growth rate ($\sigma_{\eta\mu z}$), of 0.07. The obtained values seem to be more plausible than those obtained by Almeida (2009) for the Portuguese economy, ranging between 0.00 and 0.09, Adolfson et al. (2005) providing, in exchange, a broad range of values, with an expected consistent level of about 0.5 for the technological shock volatility.

Analysing Figure 1, it can be ascertained that the prior and posterior distributions differ from one another, to a lesser or greater extent, in terms of mean (issues also revealed by the output contained in the second and fourth columns of Table 1). This suggests that the probabilities established before the beginning of the analysis do not have an exclusive, final influence on the results, the model-related data generating an unquestionable informational consistency.

The above-mentioned graph shows that the mode obtained by the maximisation of the posterior kernel is close, sometimes very close, to the one generated after having determined the posterior probabilities based on the Metropolis–Hastings algorithm, this certifying the correctness of the model layout.

Figure 2 illustrates the 20 structural shocks considered, most of them looking like being centred around the zero value, with a relatively constant variance, which provides indices about the validity of the estimated model.

Another essential aspect of the analysis concerns the impulse–response functions of the target economy model variables, under the impact of the previously mentioned structural shocks. The fact that, after such impact, the variables mainly return, within the studied interval, to the steady-state, strengthens confidence in the model stability.

The following lines contain, for exemplification purposes, given the existence of a complementary study in the matter (Hudea, 2014), the selective presentation and

Table 1. Estimation results relating to the model parameters.

Parameter	Prior mean	Mode	Posterior mean	Confidence interval	
λ_w	1.2500	2.5135	2.5147	2.4798	2.5508
λ_d	1.1500	1.6028	1.5979	1.5626	1.6280
λ_m	1.2000	1.2841	1.2772	1.2456	1.3110
λ_c	1.0500	0.9105	0.8997	0.8644	0.9265
λ_i	1.0500	1.3737	1.3826	1.3225	1.4454
λ_g	1.0500	1.0222	1.0281	0.9777	1.1023
λ_x	1.0500	0.8743	0.8643	0.8188	0.9099
η_h	0.5000	0.2348	0.2399	0.2259	0.2632
η_*	0.5000	0.3794	0.3769	0.3455	0.4072
w_h	0.4000	0.2477	0.2458	0.2373	0.2562
S	7.600	14.3737	14.4029	14.1799	14.7231
ξ_w	0.8400	0.7176	0.7188	0.7082	0.7265
ξ_d	0.7900	0.7452	0.7459	0.7365	0.7569
ξ_m	0.5000	0.1174	0.1138	0.1035	0.1251
ξ_c	0.6300	0.9400	0.9387	0.9344	0.9428
ξ_i	0.6300	0.9039	0.9003	0.8927	0.9072
ξ_g	0.6300	0.8946	0.8924	0.8845	0.9010
ξ_x	0.4400	0.8751	0.8748	0.8692	0.8819
k_w	0.5000	0.1729	0.1661	0.1358	0.1829
k_d	0.5000	0.8341	0.8354	0.8091	0.8680
k_m	0.5000	0.5932	0.5979	0.5816	0.6158
k_c	0.5000	0.8955	0.8950	0.8818	0.9112
k_i	0.5000	0.6804	0.6661	0.6459	0.6855
k_g	0.5000	0.4767	0.4764	0.4613	0.4910
k_x	0.5000	0.4439	0.4488	0.4126	0.4744
ρ_{χ}	0.6000	0.4303	0.4335	0.4139	0.4639
ρ_{ζ^c}	0.6000	0.5406	0.5484	0.5194	0.5727
ρ_{ζ^h}	0.6000	0.5460	0.5460	0.5281	0.5608
$\rho_{\tilde{\varnothing}}$	0.6000	0.3784	0.3830	0.3530	0.4094
ρ_{Ω}	0.6000	0.3594	0.3495	0.3258	0.3704
ρ_{λ^d}	0.6000	0.8715	0.8719	0.8596	0.8828
ρ_{λ^m}	0.6000	0.8588	0.8566	0.8391	0.8771
ρ_{λ^c}	0.6000	0.8030	0.8042	0.7936	0.8184
ρ_{λ^i}	0.6000	0.8979	0.8967	0.8849	0.9082
ρ_{λ^g}	0.6000	0.9598	0.9577	0.9471	0.9683
ρ_{λ^x}	0.6000	0.9827	0.9825	0.9785	0.9872
$\rho_{\mu z}$	0.6000	0.8212	0.8194	0.8003	0.8373
$\rho_{\mu^{*} z}$	0.6000	0.8028	0.8092	0.7857	0.8392
ρ_{τ^y}	0.6000	0.4002	0.4055	0.3905	0.4287
ρ_{τ^c}	0.6000	0.3820	0.3799	0.3602	0.4035
ρ_g	0.6000	0.6135	0.6161	0.5948	0.6486
ρ_{π^*}	0.6000	0.9834	0.9837	0.9822	0.9853
ρ_{y^*}	0.6000	0.4914	0.4923	0.4738	0.5080
ρ_{r^*}	0.6000	0.5502	0.5637	0.5440	0.5856
$\rho_{\pi\backslash bar}$	0.6000	0.5296	0.5206	0.5025	0.5383
$\sigma_{\eta\chi}$	0.1500	0.3167	0.3117	0.2709	0.3353
$\sigma_{\eta\zeta^c}$	0.1500	0.2363	0.2206	0.1817	0.2529
$\sigma_{\eta\zeta^h}$	0.1500	0.5091	0.5202	0.4921	0.5477
$\sigma_{\eta\ \tilde{\varnothing}}$	0.0200	0.1542	0.1516	0.1490	0.1542
$\sigma_{\eta\Omega}$	0.0200	0.0103	0.0113	0.0086	0.0149
$\sigma_{\eta\lambda^d}$	0.1500	0.6475	0.6576	0.6305	0.6856
$\sigma_{\eta\lambda^m}$	0.1500	0.0571	0.0568	0.0428	0.0674
$\sigma_{\eta\lambda^c}$	0.1500	2.1090	2.1137	2.0690	2.1574
$\sigma_{\eta\lambda^i}$	0.1500	0.8780	0.8833	0.8307	0.9497
$\sigma_{\eta\lambda^g}$	0.1500	0.2187	0.2233	0.2076	0.2394
$\sigma_{\eta\lambda^x}$	0.1500	0.0518	0.0508	0.0383	0.0685
$\sigma_{\eta\mu z}$	0.1500	0.0795	0.0790	0.0611	0.1020
$\sigma_{\eta^{*}\mu z}$	0.1500	0.0587	0.0623	0.0533	0.0729
$\sigma_{\eta\tau^y}$	0.1500	0.4148	0.4227	0.3928	0.4588
$\sigma_{\eta\tau^c}$	0.0200	0.0127	0.0139	0.0103	0.0164
$\sigma_{\eta g}$	0.0200	0.0333	0.0334	0.0288	0.0378
$\sigma_{\eta\ \pi^*}$	0.0200	0.1234	0.1252	0.1216	0.1287
$\sigma_{\eta\ y^*}$	0.0200	0.0056	0.0055	0.0049	0.0062
$\sigma_{\eta\ r^*}$	0.0200	0.1255	0.1242	0.1181	0.1281
$\sigma_{\eta\ \pi\backslash bar}$	0.0200	0.1115	0.1146	0.1117	0.1184

Source: Author's own estimations.

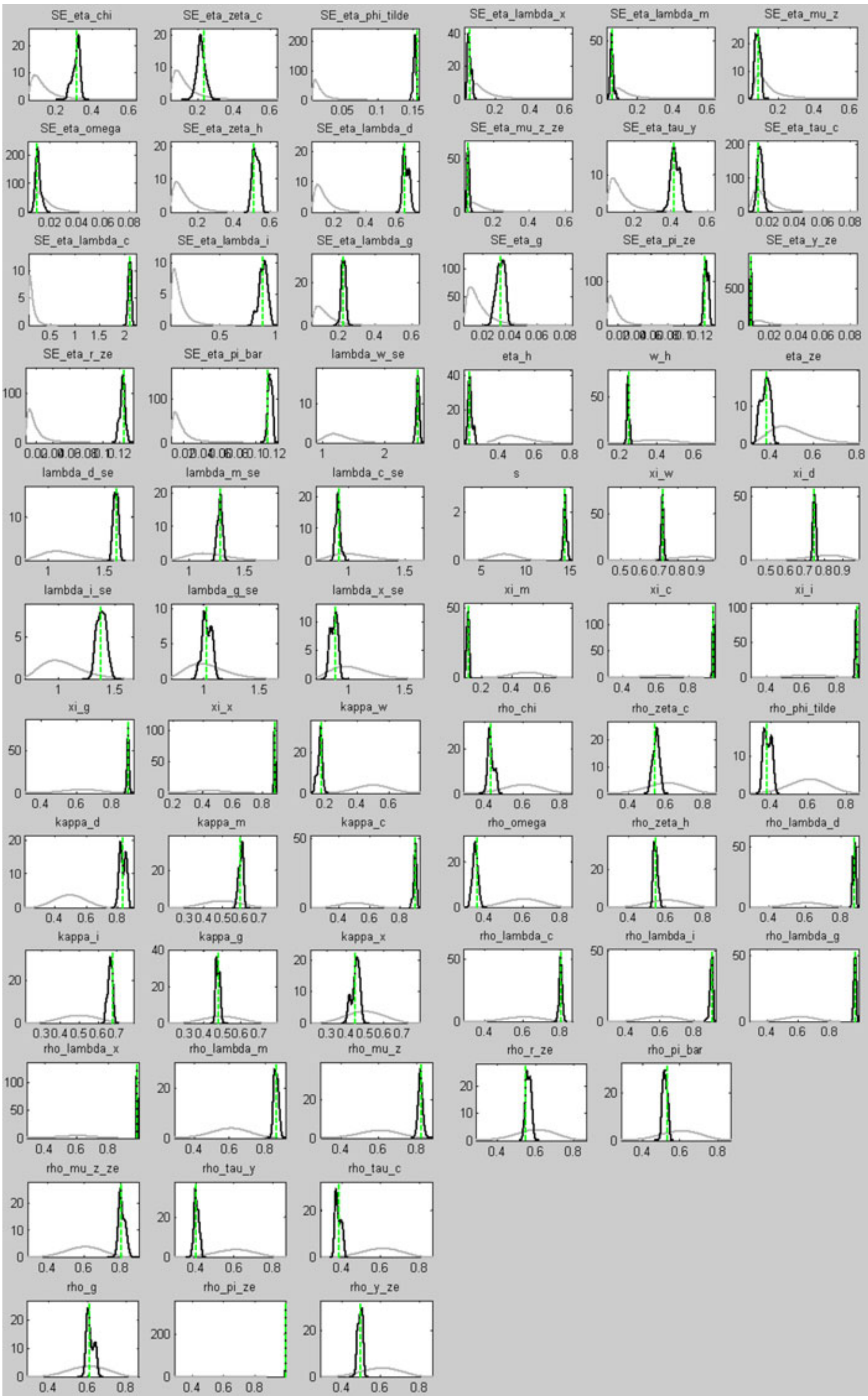

Figure 1. Prior, posterior probabilities and mode generated by Dynare, Matlab. (Source: Author's own contribution)

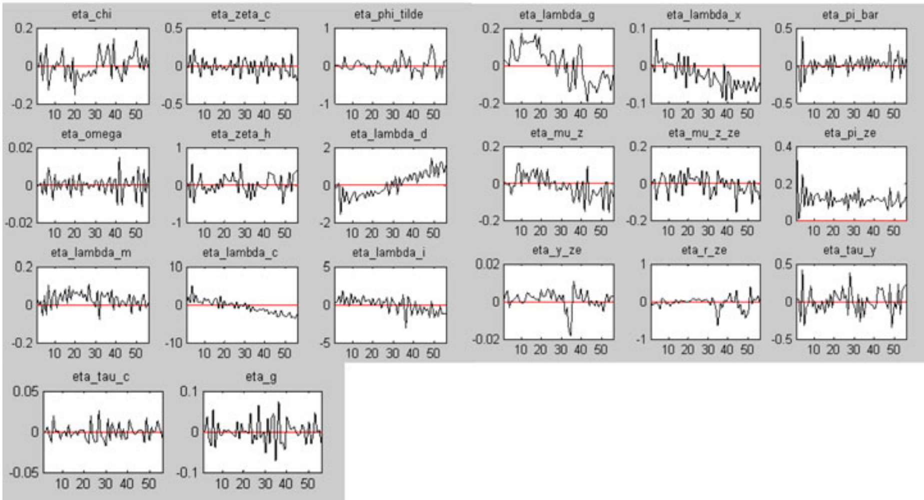

Figure 2. Structural shocks estimates. (Source: Author's own contribution)

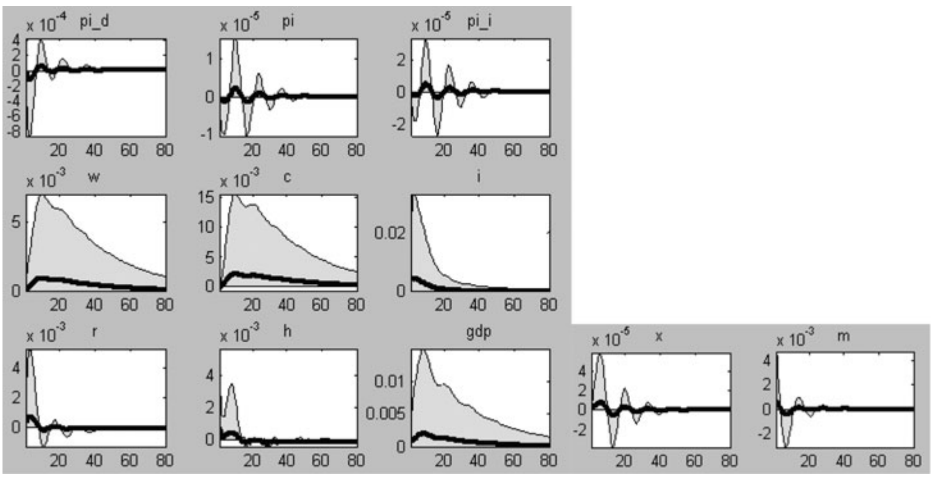

Figure 3. IRFs of variables to a positive investment shock. (Source: Author's own contribution)

analysis of the reaction manifested by the model variables on the occurrence of some specific shocks, such as the investment shock, the consumption preference shock and the domestic technological shock.

On the impact of a positive *shock at the level of investments*, there is, as shown in Figure 3, not only a favourable movement of investments, but also a subsequent increase in consumption, with beneficial effects on gross domestic product, supported, at the same time, by the increase in the net export.

As expected, the upward orientation of investments, also based on crediting, is associated with an initial augmentation of the interest rate, which shortly tends to moderate, allowing for savings, inhibited by the then decreased interest rate, to be directed towards consumption. The ascending investment trend causes an increase of the production capacity, with a slow tendency of price drop due to the reduction of

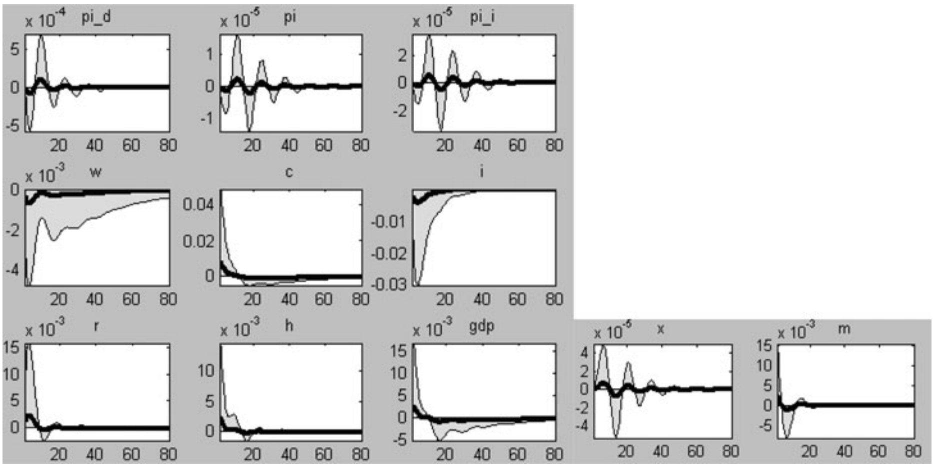

Figure 4. IRFs of variables to a positive consumption preference shock.

the unit cost, therefore explaining the disinflation rate. Yet, given the investment depreciation and the greater demand for goods, prices gradually increase.

More aggregate supply determines more labour demand and, in consequence, an increased labour force, the latter then decreasing towards the steady-state level, especially given that the price ascendance, involving higher wages and therefore an additional effort from producers, forces the latter to find solutions for stabilising their production costs.

The positive *shock on the consumption preferences* implies, as reflected by Figure 4, an upward orientation of consumption that inhibits the movement of investments in the same direction. The necessity for covering consumption needs involves, on one hand, an increase of the labour force supply, causing a drop of the wage level and, on the other hand, the resort to consumption credits, with negative effects on the interest rate.

A higher demand for consumption goods also generates an increase of the supplied quantity of these goods, causing price oscillations up to the moment of re-establishment of market equilibrium. The expansion of the related supply creates, at the same time, the premises for the increase of the exported quantity that temporarily exceeds the import level.

The positive *technological shock*, as shown in Figure 5, has favourable effects on the increase of gross domestic product, with all its components and, by increasing welfare, on the augmentation of wages, at national level.

A higher productivity causes, in phase I, a slow tendency of price decrease but, as the former is counter-balanced by an increased demand for goods and by the aforementioned higher wages, prices start following an upward trend.

The initial drop of the interest rate might indicate the hypothesis of the covering of investments from current incomes and savings, the decline of its real value being due to inflationary pressure. Yet, as prices find their equilibrium, all other analysed nominal factors, such as wages and interest rate, stabilise as well.

As already noted, the present paper is mainly dedicated to the study, via a D.S.G.E. model, of the basic characteristics of a given economy, considering its

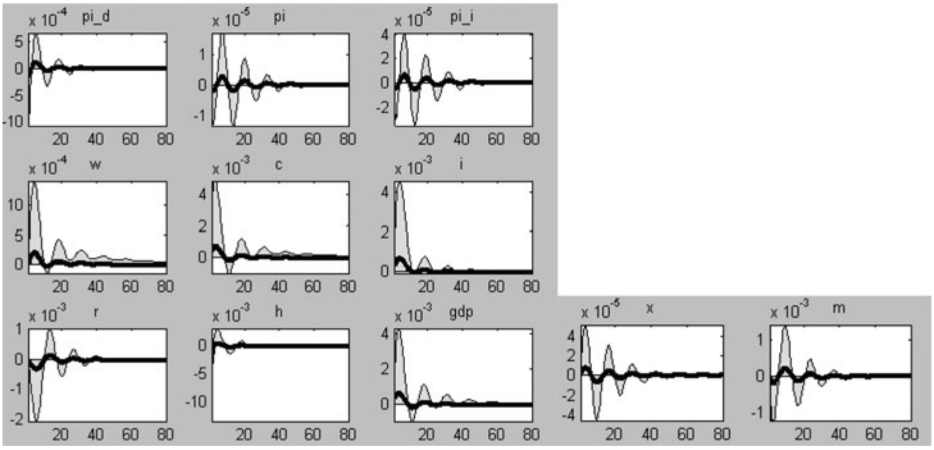

Figure 5. IRFs of variables to a positive domestic technological shock.

reactions to various stimuli. A coherent comparison with the results obtained by other studies for the target economy is almost impossible to achieve; on one hand, D.S.G.E. modelling is still in its infancy for domestic specialists, and on the other hand, the present analysis is made from a rather particular perspective. Comparison with results revealed by studies in other economies is restricted either by different modelling approaches or, in the case of modelling similarities, by the disparity of variables or parameters considered, making such parallel analyses inconsistent or irrelevant.

However, a comparative study, based on a 'double output' D.S.G.E. model, specifically built for a comparative analysis of the target economy as opposed to the Euro Area economy, made the object of a distinct paper of the author (Hudea, 2019).

6. Conclusions

The particularities of the national economy allowed for the selection of the most appropriate modelling pattern, able to capture the essential economic aspects and the consequences of the oscillations induced by shocks occurring along the analysed period, a model developed for a closed economy (Christiano at al., 2005), subsequently slightly modified (Altig et al., 2005) and taken up by other authors for open economies (Adolfson et al., 2005, 2007a, 2007b), approached herein subject to relevant adjustments (Almeida, 2009).

The elements characterising D.S.G.E. models, such as price and wage stickiness, consumption habits and investment adjustment costs, were introduced so as to reflect the persistence registered at the level of the observed variables.

The selection of data for the 14 variables used within this analysis was followed by parameter calibration and by determination of the priors, with different probability distributions, depending on the possible values of the parameters to be estimated: Beta distribution for the parameters with values ranging exclusively between 0 and 1, Inverse Gamma distribution for the positive parameters that can exceed unity, and Normal distribution for the remainder.

The effective estimation process consisted of the determination of the posterior probabilities, based on Bayes' theorem, generating a series of outputs discussed herein from an economic perspective.

The results regarding the mark-ups reveal the absence of competition in the domestic intermediate goods market, a very weak competitiveness in the private investment final goods market, a moderate one on the import goods market, and strong competition in the private and public consumption and export final goods markets, where a high level of product substitution is supported.

The value of the elasticity of substitution between domestic goods and import goods reflects the preferences of Romanian consumers for Euro Area products, while the inflation persistence reveals its importance in making price adjustment decisions during the next period; the only case where past inflation is practically ignored is the wage-related one.

As for Erceg and Calvo-specific stickiness, there is a high rigidity of wages, mainly caused by the producers' attempts to maintain or even decrease their unit costs, and a varied price flexibility level. Thus, the domestic intermediate goods and, especially, the final goods prices are sticky, whereas the import goods prices reveal instead a rapid adjustment. The stickiness of the domestic intermediate goods and of the final goods destined for private investments occur most probably because, given the relaxed competition in such markets, the substantial margin of profit does not place firms in the position of quickly adjusting the prices. Regarding private and public consumption goods and export goods, in which markets there is serious competition, the increase of prices could cause problems to producers, who risk losing their clients, given the incomplete information and the impossibility of coordinating the decisions of all economic agents directly competing with them.

The parameters reflecting the persistence of structural shocks are sub-unitary, revealing no unit root process, and the volatility of structural shocks seems to be quite varied, reaching upper values for the spare time preferences, the mark-up of intermediate domestic goods and the mark-up of private investment and consumption-destined final goods, and lower values for the foreign production, the domestic technology, the consumption tax, the governmental expenses, the mark-up of import and export-oriented final goods, the technological asymmetry between domestic and foreign economy and the technological growth rate.

The figure relating to the prior and posterior probabilities, as well as to the mode resulting from the maximisation of the posterior kernel and to the simulated posterior distribution one, indicates the relatively weakly informative character of priors, the real data used within the model providing the main information necessary for the analysis and revealing the model stability; the graph illustrating the structural shocks reflects their general centring around the steady-state, therefore suggesting the validity of the model.

The shocks on investments, on consumption preferences and the domestic technological shock are also analysed, for exemplification purposes, showing the response of the model variables to the priors in their attempt to regain the steady-state, the results being economically construed, accordingly.

In conclusion, it can be said that the outcomes obtained from this estimation analysis are in compliance, to a large extent, not only with the relevant literature, but also with the economic reality of the time, the out-of-bounds values being partly explained by the economic instability and partly by the impossibility to include in such a model sufficient variables so as to fully reflect all facets of a national economy.

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