Testing the Three Vicious Circles of the Romanian Economy: A Novel Approach*

Ioan - Gabriel Stavre†

Doctoral School of Finance and Banking, Bucharest University of Economic Studies

October 24, 2017

Abstract

The functioning of fiscal stimulus may adversely affect the normal adjustment mechanism of the economy, in other words we say we are caught in a vicious circle if a number of processes are perpetuated in a harmful and reversible way. The aim of this paper is to investigate a number of three vicious circles that (presumably) act on the Romanian economy and have the power to explain (i) the lack of competitiveness of local firms, (ii) the size of the informal economy and the catalyst of the three circles, namely (iii) the procyclical behavior of fiscal policy. Croitoru & Târhoacă (1997) were the first to put forward the mechanism driving this disequilibrium. Until now there has been no work attempting to validate the presence of the vicious circles using a quantitative assessment. We tackle this challenge head on: we use a Structural Vector Autoregressive model using *proxy* variables, identified using sign restrictions derived from the aforementioned paper and analyze the response of the unrestricted variables. Our results do not point in the direction of the authors, thus we cannot confirm the presence of these circles in our economy (at least with the current methodology).

Keywords: vicious circle, fiscal policy, savings, competitiveness, informal economy, sign restrictions, SVAR

JEL code: B23, E26, E62, F32.

*This paper was prepared for Costin Murgescu Contest (FGDB). It contains 27 pages (including first page, bibliography and appendices).

†Email: *gabriel.stavre@gmail.com*

1 Introduction

The functioning of fiscal stimulus may adversely affect the normal adjustment mechanism of the economy, in other words we say we are caught in a vicious circle if a number of processes are perpetuated in a harmful and reversible way.

The aim of this paper is to investigate a number of three vicious circles that (presumably) act on the Romanian economy and have the power to explain (i) the lack of competitiveness of local firms, (ii) the size of the informal economy and the catalyst of the three circles, namely (iii) the procyclical behavior of fiscal policy. Croitoru & Târhoacă (1997) were the first to put forward the mechanism driving this disequilibrium by means of the vicious circle of savings, of fiscal policy and of the informal economy. With respect to the past period, the economy was still under intense structural reforms and this *vicious* behavior was to some extent inevitable, but as shown in recent work, Croitoru (2015) reaffirms the presence of the three vicious circles nowadays.

The downside of this papers is the lack of empirical foundation, more precise the presence of an econometric methodology. A first attempt of modelling this problem was proposed during my bachelor degree studies: the outcome is that we cannot confirm the presence of any vicious circle acting on the economy. Unfortunately some disadvantages are still present: lack of dynamic interactions, large number of variables relative to the small sample. An parsimonious approach is mandatory.

Besides our primary goal, we want to encourage authentic research themes, that tackle domestic problems, since our economy has specific characteristics. Why aren't we applying general frameworks to the specific problems of our economy and always resort to replicate foreign papers that tell others story? We hope that this paper is only a starting point.

Here we propose an extended methodology of analysis by using a structural vector autoregressive model (SVAR), estimated using Bayesian techniques and identify through sign restrictions approach, derived from the theory of the vicious circles. All have the purpose to produce impulse response functions which can be interpreted as structural innovations hitting the economy and can give us economic intuition about the presence of the three vicious circles. Using different set of restriction schemes and variables definition we can obtain robustness of our results and we can make a reliable analysis for the policy decision side. In this way we are using *a general framework* to analyze the *specific problems of our economy.*

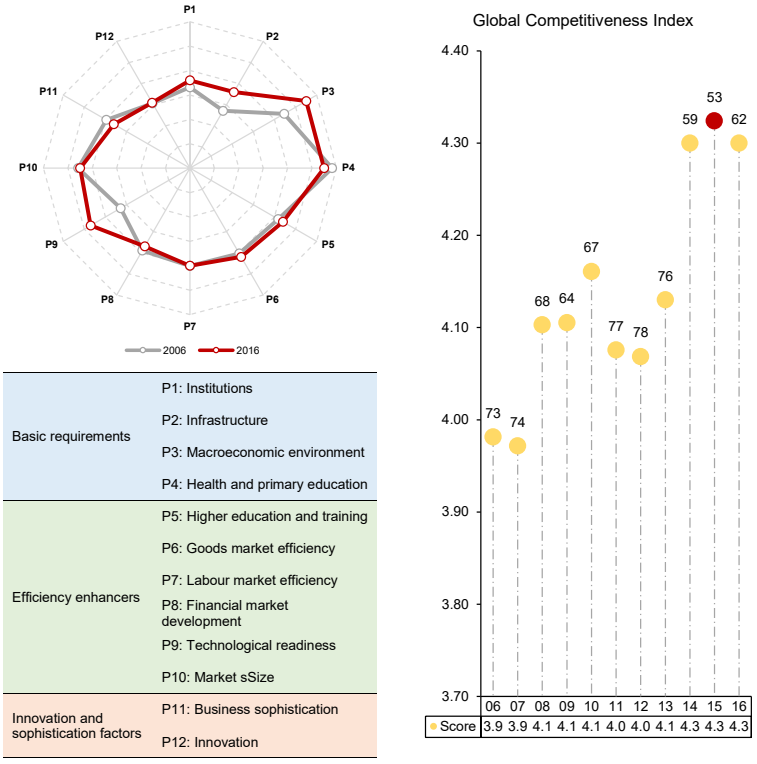
Before proceeding with this paper it is important to gauge on current economic development through the means of a set of stylized facts: competitiveness position of our economy, alongside essential driven factors, the behavior of fiscal policy and their impact on external position and the capacity of private and government sector to adjust.

A comprehensive measure of overall competitiveness and a benchmark to compare the performance of economics is the Global Competitiveness Index (GCI), which comprises of 12 pillars, defining the general orientation of an economy (i.e. on factors, efficiency or innovation).

According to the classification proposed by Schwab & Sala-i-Martín (2016), Romania is positioned in efficiency-driven bucket of development (the next is innovation-driven economies). As compared to 2006 we can distinguish minor modifications with respect to each pillar. Infrastructure and the general environment improved (P2, P3), while primary services (P4) actually is lower. Also, a significant improvement is in our readiness for technology (P9), but for business sophistication (P11) we have a declining contribution. All in all our competitiveness has improved over the years and it's worth mentioning that in 2015 we had the highest score recorded so far and we ranked the 53rd position (see figure 1).

Also within the same report there is available a ranking of the *most problematic factors for doing business*: access to financing (generally link to investment decisions), inefficient government bureaucracy and tax rates. All of this factors are link to the conduit of fiscal policy and may be related to the presence of the three vicious circles.

Figure 1: Competitiveness position



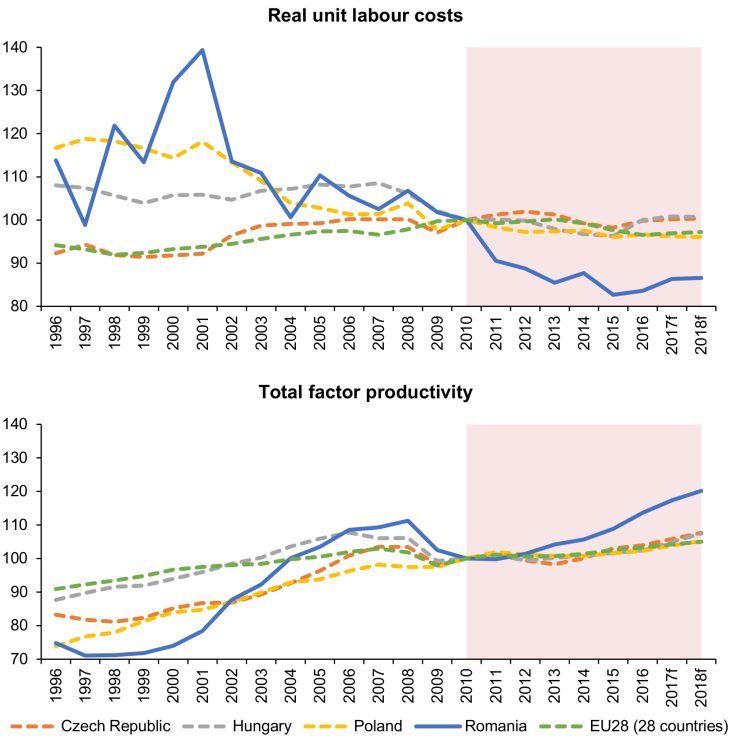
Note: Above the bullet is the rank of Romania in each year, while under the axis we have the overall score of the GCI.
Source: Schwab & Sala-i-Martín (2016)

The rise in general competitiveness is linked to several improvements, in what follows we present 2 factors driving this upward trend: total factor productivity (whole economy) and real unit labor costs (whole economy)[1]. Real cost have been

[1]Defined as ratio of compensation per employee to nominal GDP per person employed — performance relative to the rest of 37 industrial countries.

situated on a declining path starting from the early 2000. Following the abrupt correction in 2010 (when wages in the public sector were reduced by far as 20%) our compensations have been well under European Union benchmark and countries we generally compared to[2]. Total factor productivity (TFP) — indicator of efficiency and progress — continues to rise on a steady pace, while the other counterparties remain on a flat development path (see figure 2). The development of these 2 factors suggest that our economy has huge potential at disposal: an one hand it runs on efficiency reserves (through lower costs) and on the other it continues to innovate (TFP component).

Figure 2: Factors driving competitiveness



Note: Index: 2010=100; f — forecast
Source: AMECO

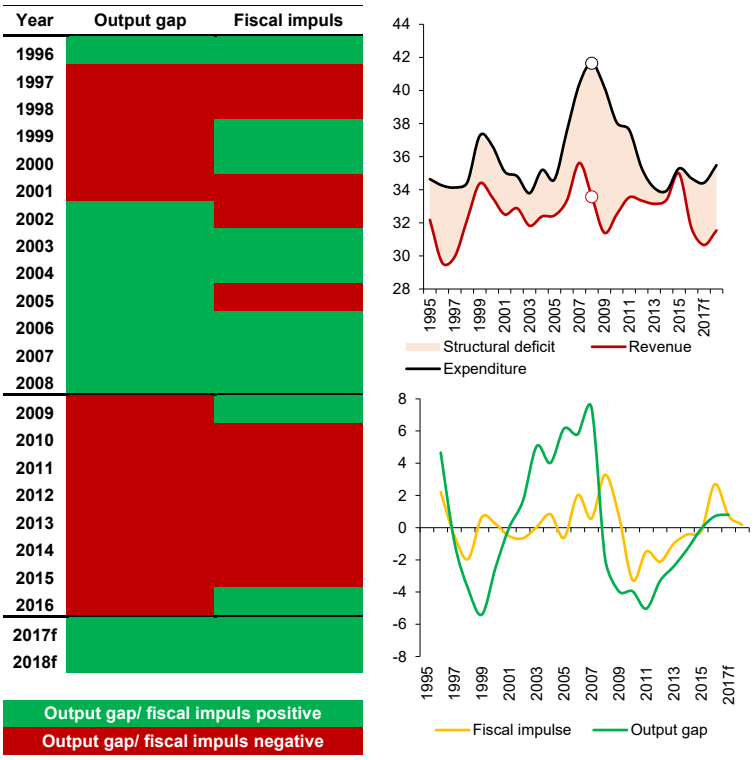
In order to get a better understanding of the fiscal stance in response to macroeconomic imbalances we resort to the analysis of fiscal impulse (i.e. negative delta modifications of structural deficit — a rise translates to a expansionary fiscal policy) *vis-à-vis* output gap (excess demand from potential level).

In figure 3 we constructed a heatmap with yearly series of fiscal impulse and output gap to highlight their comovement. In 70% of the cases the 2 variables had the same sign, suggesting the procyclical nature of fiscal policy in response to the economic cycle. In 2009 structural deficit was close to 9% of potential GDP, and although the efforts was on both sides of the balance sheet (revenue and expenditure), the adjustment process took close to 7 years, over-which revenue and expenditure gain similar values 4 to 5 pp (from 31% to 35%, 40% to 35% respectively). This means that the public sector is not flexible on short-run. For 2016 we see a jump in fiscal stance: a 3% deficit associated to a fiscal impulse of 2.7, while for the same

[2]Czech Republic, Hungary, Poland.

year output gap closed and turn positive (0.7%) and the forecast for 2017-2018 strongly suggests the persistence of procyclical behavior.

Figure 3: Fiscal stance



Note: f — forecast
Source: AMECO

The last piece of the puzzle is to add up all the previous results and see how they affect external position through price-competitiveness indicators and the adjustment efforts of the 2 sectors (public and private) through their balances. To get a better grip on how the current account (CA) can reflect internal macroeconomic imbalances, it's worth rewriting it in terms of the twin deficits, starting from basic national accounts relations[3]:

$$Y = C + I + G + NX = C + S + T \tag{A}$$

$$\underbrace{S - I}_{SNG} + \underbrace{T - G}_{SBG} = \underbrace{NX}_{CA} \tag{B}$$

where SNG and SBG stand for private and government balance. Further, in the scope of this paper, each aggregate level of each balance can be decomposed as the difference between savings and investment rates:

$$\underbrace{S_p - I_p}_{SNG} + \underbrace{S_g - I_g}_{SBG} = \underbrace{S_T - I_T}_{CA} \tag{C}$$

[3]With the following legend: Y — income, C — consumption, I — investment, G — government expenditures, NX — net export, S — savings.

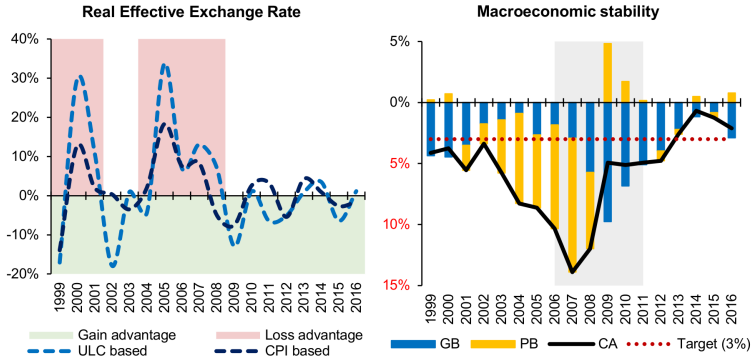
where:

- S_p, S_g and S_T stand for savings in the private and government setor and for the whole economy.
- I_p, I_g and I_T stand for investments in the private and government setor and for the whole economy.

For macroeconomic stability purpose if CA is -6% and the private sector balance is -4% and doesn't have room to adjust anymore, the public budget balance needs to act as a shock adsorbent and keep the deficit at 2%.

Real effective exchange rate (REER) measures the price competitiveness of a country relative to a set of trading partners. It's constructed such that a rise is equivalent to a loss in competitive advantage. Developments prior to 2009 were very volatile, with annual variations of up to 30%, which may be based on the adjustment process the entire economy was going through. In 2007 the CA plunge to nearly -15% of GDP, with private sector balance (PB) having the largest contribution (around 80%). Remarkably, from a deficit of 11%, the private sector not only adjusted, but also managed to be on surplus in less then 2 years. At the same time, the public sector (PB) hit its all time maximum level and the effort to adjust to the target of 3% span to 5 years. In the aftermath of the financial crisis, REER was stable, even gaining competitiveness advantage. With price competitiveness in still water, the CA almost closed. Recent developments indicates that firms efforts to adjust their savings are overtaken by the government budget, hence the dive of the CA in 2016 (see figure 4).

Figure 4: Current account development



Source: EUROSTAT

The rest of the paper is structured as follows: Section 2 contains a description of the three vicious circles and a overview of the literature. In the next section, we present the model used, estimation techniques and how they are implemented, followed by results in Chapter 4. Finally, we present final remarks, references and dedicated appendices.

2 Literature Review

The vicious circles in which the Romanian economy is caught were first described by Croitoru & Târhoacă (1999); they noticed that when fiscal policy had to reduce

its deficit to ensure the macroeconomic equilibrium, decisions were based firstly on the increase of taxes, and the selection of expenses, depending on necessity and importance, is bypassed.

Romania's economy was in a severe recession between 1997 and 1998, and fiscal and monetary policy did not have enough leverage to mitigate the economic downturn. It should not be neglected that at that time structural changes took place and were not implemented in a coherent manner, which led to the perpetuation of the recession.

Among the structural changes we can mention: the transition to a market economy, the financing of public enterprises was no longer supported by the NBR (especially the agriculture sector), so subsidies were granted by the State to compensate for limited credit, consumption was expanding, and the companies could not cope with domestic demand, so imports (both raw material and intermediate products) were the main source of trade, so the current account deficit had a massive fall, which required adjustment of the public sector (Croitoru & Târhoacă (1999), Croitoru (2015)). All these structural changes have put significant pressure on the budget, and in order to deal with payments, tax increases seemed the fastest solution (not necessarily the most effective, as we will see below).

From the introduction section (equation (B) and (C)) we shown that in the presence of high external imbalances and low adjustment capacity of the private sector, the government needs to step in and make efforts in reducing their deficit. In these circumstances, deficit reduction was mandatory for several reasons (Croitoru & Târhoacă (1999)): (i) the Ricardian equivalence hypothesis is not verified[4] (the increase in the level of saving in the governmental sector is compensated by the same measure of the reduction of the economies in the non-governmental sector); in line with the reduction of the public deficit, (ii) the real interest rate is reduced without influencing the private sector, and (iii) ensuring the macroeconomic balance implies the limitation of the current account deficit, as an increase of the government sector saving will reduce the external imbalance, as the balance of the private sector remains unchanged.

In what follows we explore the core theory underlying the three vicious circles. Each circles is presented separately.

Vicious circle of savings. In order to meet its macroeconomic stabilization target, the deficit needs to be adjusted in line with the private sector. If this is not possible, and the funding efforts are focused solely on raising taxes, then the external imbalance costs are directed to the private sector. Thus, even if they managed to reduce their own deficit, by imposing new taxes, they will be stripped by them and implicitly the necessary resources for investment. In this way, their competitiveness can not be improved, which is of the utmost importance, especially when you act on a market with strong competition (we can think here of the Euro Area - the main foreign trade partner). Firm's earnings may not increase (or production costs are relatively high), and household disposable income is reduced, which leads to low savings for the formal sector; with limited financial resources, this will lead to an increase in interest rates. With low savings and high interest rates, the

[4]Christiane & Isabel (2008) show that in the presence of high debt households tend to act as in a Ricardian framework.

propensity for investment declines. Under these circumstances, efforts to modernize and increase competitiveness are postponed, and this remains low. As a result, the circle resumes. The vicious circle of saving is associated with economic downturn, and the fall in the private balance has to be offset by the reduction of the budget deficit to the level consistent with the external position sustainability.

Vicious circle of fiscal policy. Fiscal consolidation (reducing the budget deficit to levels compatible with external balance) must be done in a rational manner: the selectivity of public spending, the financing of public investment projects that bring important flows and tax increases in line with fiscal pressure.

The vicious mechanism is triggered by the government's reduced capacity to rationalize spending. Incapacity is favored (in the negative sense) by the majority of voters that are dependent on redistributions from the state budget. In the given situation of the private sector deficit, balance stabilization is achieved by increasing the tax rates and random expenditure cuts. Negative effects on savings are spread over 2 channels: (i) public resources will continue to scatter on unsustainable social security schemes and social assistance programs, along with the promotion of inefficient public-funded projects[5] and (ii) tax increases affect the economic position of firms, especially when the ability to adjust to new taxes is limited. As an economic contraction can be induced, a new deficit adjustment is necessary, and as long as voters dependent on redistributions are overwhelming, the government cannot rationalize public spending. This in turn trains the only way of adjusting the deficit, i.e. raising taxes, so corruption and uncertainty of property rights are maintained and the vicious circle of saving is fed.

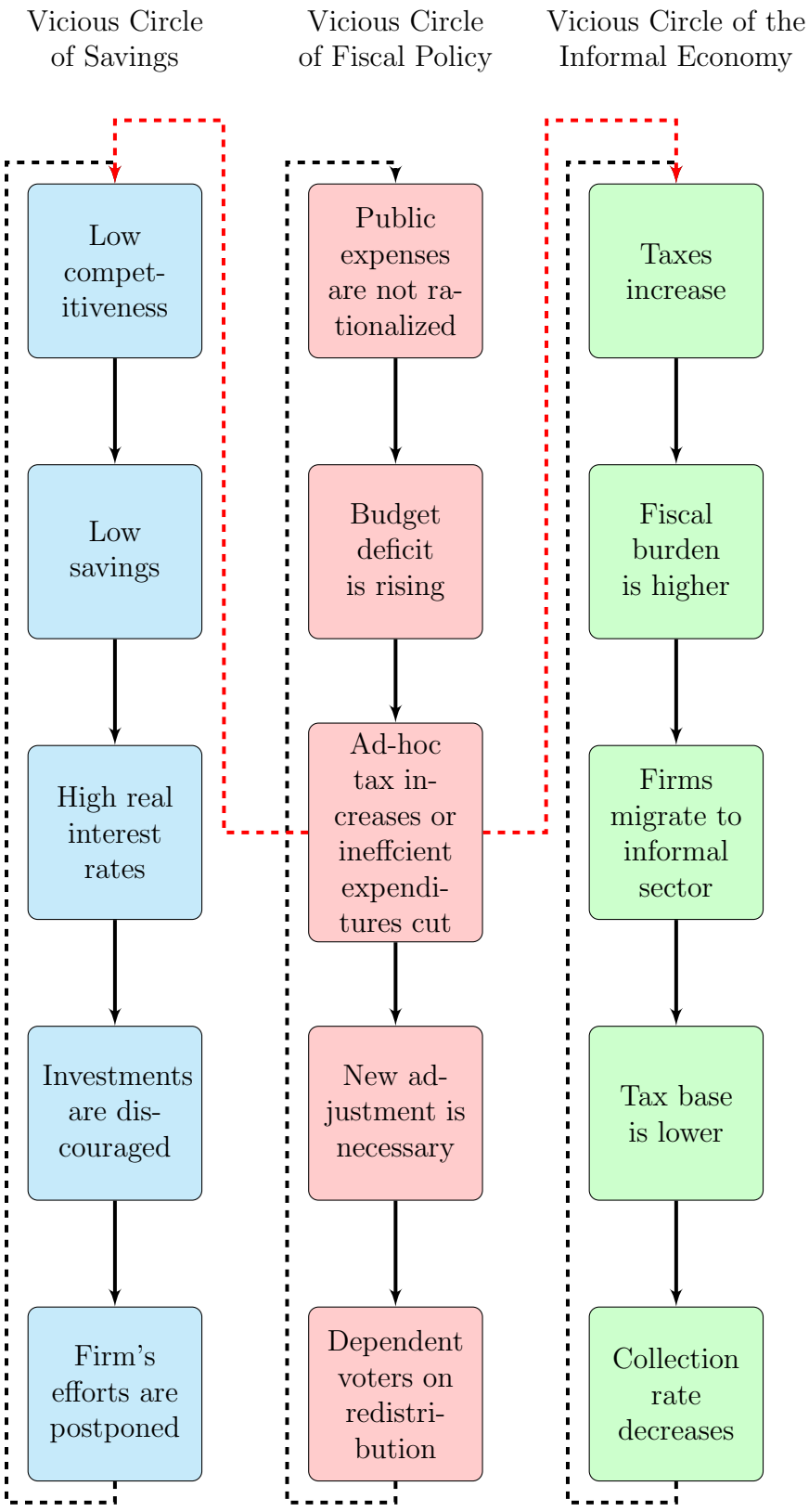
Vicious circle of the informal economy. The other negative influence resulting from the reduced capacity of the government to select expenditures is triggering the vicious circle of the informal economy. As tax pressure rises, as a result of tax increases, companies decide to migrate towards informal sector. The expansion of the informal sector leads to a reduction in the tax base and, apparently, the level of collection is reduced. With a reduced base and the need for fiscal stabilization, new tax increases are required, thus increasing the transfer of firms to the informal sector. Davis & Henrekson (2004) confirms that there is a positive relationship between the level of taxation and the informal economy, especially in developed countries, with high income levels. Chiarini, Marzano & Schneider (2013) talk about a vicious circle between fiscal pressure and evasion, but its presence in Italy is not confirmed.

In figure 5 we present the 3 vicious circles that describe all the above mention interactions through a series of flow charts.

A first attempt of modelling this problem was proposed during my bachelor degree studies: using a cointegration methodology, I've selected a set of *proxy* variables describing the dynamics of the circle and I've estimated a long run and a error correction mechanism, individually. The validation criteria was based of the sign of the estimated coefficients, their speed of adjustment to the long run relation, the link to a common variable (taxation rate) and also impulse response functions.

[5]Public projects have had a central role to play in managing investments, precisely to support structural reform, but political guidelines generally have the last word.

Figure 5: Interactions between the 3 vicious circles



Note: solid line - direct effect (within the circle), dotted line - reiteration of the circle, red line - indirect effect (outside the circle) which exacerbates the propagation mechanism.
Source: personal interpretation based on Croitoru & Târhoacă (1999), Croitoru (2014).

The outcome is that in a weak sense (not taking into account the interlinkages between the 3 circles), only the vicious circle of savings and the vicious circle of the informal economy is present. On the other hand, in a strict manner, the one imposed by the authors, we cannot confirm the presence of any vicious circle acting on the economy. Unfortunately some disadvantages are still present: lack of dynamic interactions between the three equations and large number of variables relative to the small sample (for more details see Stavre (2015)).

As mention in the introduction section we impose sign restrictions based on the theory of the authors. This approach is widely used in the literature: Peersman & Straub (2004) and Peersman & Straub (2006) analyze the effects of a technology shock on the labor market, using sign restrictions derived from the Real Business Cycle model and New Keynesian model; other examples are Uhlig (2005) for the impact of monetary policy shock on output and Mountford & Uhlig (2005) for the effects of a fiscal shock.

3 Methodology

In this section we present the theoretical model together with estimation techniques, identification schemes adopted, as well as the data used.

To meet our objective we apply the following methodology: (i) select *proxy* variables that summaries components of the vicious circles, (ii) estimate VAR model, (iii) derive sign restrictions from the theory of the authors, (iv) make structural inferences based on SVAR and (v) analyze the response of the unrestricted variables. The validation process is straightforward: check whether the response of the unrestricted variables match the ones implied by the theory of the authors. In doing so, we analyze IRF in two ways: (i) plot the dynamic response over time, along side the confidence interval to make a decision about the sign and (ii) analyze the full distribution of results for 4 quarters by comparing the median with zero.

We begin with the setup of the model. Let $Y_t = (y_{1,t} \cdots y_{n,t})'$ be a vector of endogenous variables and consider the standard VAR(p) model representation:

$$Y_t = c + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + u_t, \tag{1}$$

where u_t is a n-dimensional vector of Gaussian residuals ($u_t \sim N(0, \Psi)$ and $Eu_t u_t' = \Psi$), $c = (c_1, \cdots, c_n)'$ is a n-dimensional vector of intercepts and $A_1, \cdots, A_p$ are $n \times n$ autoregressive matrices.

This model can be estimated using classic frequentist techniques via Ordinary Least Squares (OLS) estimator. It is convenient to re-write the model in equation (1) as a system of multivariate regressions:

$$\underbrace{Y}_{T\times n} = \underbrace{X}_{T\times k}\underbrace{B}_{k\times n} + \underbrace{U}_{T\times n}, \tag{2}$$

where $Y = (Y_1, \cdots, Y_T)'$, $X = (X_1, \cdots, X_T)'$ with $X_t = (Y_{t-1}', \cdots, Y_{t-p}', 1)$, $U = (u_1, \cdots, u_T)'$ and $B = (A_1, \cdots, A_p, c)'$ is the $k \times n$ matrix containing all

coefficients and $k = np + 1$. OLS estimator and the computed estimate for the covariance matrix are given by:

$$\begin{aligned} \tilde{B} &= (X'X)^{-1}XY \\ \tilde{\Psi} &= \frac{1}{T-k-1}(\tilde{U}'\tilde{U}) \end{aligned} \tag{3}$$

The most important shortcoming of OLS estimator when applied to VAR models is dimensionality: in large systems the estimator becomes bias. To tackle this problem we resort to Bayesian estimation. In this alternative approach our prior believes can be incorporated in estimation and standard Bayesian VAR (BVAR) techniques builds on the assumption that all the equations are "centered" around a random walk with drift[6] and that coefficients can be shrink, this is what Litterman (1985) refers to as Minnesota prior and the generalization is given by a Normal Inverted Wishart prior:

$$vec(B)|\Psi \sim N(vec(B_0), \Psi \otimes \Omega_0) \quad \text{and} \quad \Psi \sim iW(S_0, \alpha_0) \tag{4}$$

where B_0, Ω_0, S_0 and α_0 are chosen so that prior believes and variances of B and expectations of Ψ are equal to those implied by the Minnesota prior.

The disadvantages of using Minnesota prior is that we cannot estimate large BVAR models, no prior covariance is assumed among the VAR coefficients and with this kind of structure is very difficult to work, especially when dealing with unit root processes[7]. To tackle with this shortcomings, in what follows we are going to impose the previous prior by means of dummy observations construction as in Bańbura, Giannone & Reichlin (2008). We start by adding T_d dummy observations Y_d and X_d to the system in equation (2) and impose the Normal Inverted Wishart prior with:

$$B_0 = (X_d X_d')X_d' Y_d \quad \Omega_0 = (X_d X_d')^{-1} \quad S_0 = (Y_d - X_d B_0)'(Y_d - X_d B_0) \quad \alpha_0 = T_d - k$$

For matching Minnesota moments, the dummy variables have the following structure:

$$Y_d = \begin{pmatrix} diag(\delta_1\sigma_1, \cdots, \delta_n\sigma_n)/\lambda \\ 0_{n(p-1)\times n} \\ \cdots \\ diag(\sigma_1, \cdots, \sigma_n) \\ \cdots \\ 0_{1\times n} \end{pmatrix} \quad X_d = \begin{pmatrix} J_p \otimes diag(\sigma_1, \cdots, \sigma_n)/\lambda & 0_{np\times 1} \\ \cdots & \cdots \\ 0_{n\times np} & 0_{n\times 1} \\ \cdots & \cdots \\ 0_{1\times np} & \epsilon \end{pmatrix} \tag{5}$$

where $J_p = diag(1, 2, \cdots, p)$, $\delta_1, \cdots, \delta_n$ are prior means for each coefficients, λ is a hyperparameter that control for the overall tightness of the prior around the random walk process[8] and $\sigma_1, \cdots, \sigma_n$ are scaling parameters and are approximated with the variance of the univariate process of each variable in the VAR model. Y_d imposes prior beliefs on the autoregressive coefficients, the first block of X_d are priors for the covariance matrix, while the second block is an uninformative prior

[6] More precisely an AR(1) process: $Y_t = c + Y_{t-1} + u_t$.

[7] For a comprehensive survey on the literature of prior used for BVARs see Dieppe, Legrand & Roye (2016).

[8] Set $\lambda = 0$ then the posterior equals the prior and data has no influence on the estimates and for $\lambda = \infty$ posterior coincides with OLS estimates.

for the intercept (if ϵ is set to very small values). Augmenting the model in equation (2) with the dummies in equation (5) we get:

$$\underbrace{Y_*}_{T_*\times n} = \underbrace{X_*}_{T_*\times k}\underbrace{B}_{k\times n} + \underbrace{U_*}_{T_*\times n}, \tag{6}$$

with the following mapping:

$$T_* = T + T_d, \quad Y_* = (Y', Y_d')' \quad X_* = (X', X_d') \quad U_* = (U', U_d')$$

and the final posterior is given by:

$$vec(B)|\Psi, Y \sim N(vec(\tilde{B}, \Psi \otimes (X_*'X_*)^{-1}) \quad \text{and} \quad \Psi|Y \sim iW(\tilde{\Sigma}, T_d + 2 + T - k) \tag{7}$$

with $\tilde{B} = (X_*'X_*)^{-1}X_*'Y_*$ and $\tilde{\Sigma} = (Y_* - X_*\tilde{B})'(Y_* - X_*\tilde{B})$. The last step is to resort to Gibbs sampler in order to get the estimated values.

In order to gauge on the effects of the three vicious circles on the Romanian economy we need to identify this shock through an SVAR model. Consider the reduced form representation in equation (1) and re-write in AR(1) representation:

$$Y_t = B \cdot Y_{t-1} + u_t \quad \text{with} \quad u_t \sim N(0, \Sigma_u) \tag{8}$$

In equation (8) the residuals are correlated, which reflect contemporaneous relation between variables. In order to disentangle shocks by economic meaning we need for the innovations to be uncorrelated. With this in mind we need a structural representation of our economy:

$$\mathbf{A} \cdot Y_t = B \cdot Y_{t-1} + e_t \quad \text{with} \quad e_t \sim N(0, I) \tag{9}$$

Matrix $\mathbf{A}$ contain all contemporaneous effects. We cannot estimate directly this model, but if we multiply equation (9) with $\mathbf{A}^{-1}$

$$\mathbf{A}^{-1} \cdot \mathbf{A} \cdot Y_t = \mathbf{A}^{-1} \cdot B \cdot Y_{t-1} + \mathbf{A}^{-1} \cdot e_t \Rightarrow Y_t = F \cdot Y_{t-1} + u_t \tag{10}$$

we get a reduced form, which we can now estimate. Combining this observation with equation (8) and (9) we have:

$$\begin{aligned} F &= \mathbf{A}^{-1} \cdot B \\ u_t &= \mathbf{A}^{-1} \cdot e_t \\ \Sigma_u = \mathbf{A}^{-1} \cdot I \cdot \mathbf{A}^{-1'} &= \mathbf{A}^{-1} \cdot \mathbf{A}^{-1'} \end{aligned} \tag{11}$$

Identification is achieved is we can pin down matrix $\mathbf{A}^{-1}$. The most basic identification scheme is to assume a recursive chain, hence Choleski factorization allows identification, if P is a lower triangular matrix since:

$$\Sigma_u = \mathbf{A}^{-1} \cdot \mathbf{A}^{-1'} = P' \cdot P \tag{12}$$

After identification is achieved we analyze the impulse response function (IRF): how a variable would respond if a structural shock is applied. Previous restrictions are know as "short run" restrictions. An alternative approach is to use sign restrictions on the response of variables to various shocks, derived from economic theory (e.g. a monetary policy shocks *must* have a negative impact on inflation).

For details see Uhlig (2005). A problem with Choleski factorization is that the decomposition in equation (12) is not unique since we can use any orthogonal matrix S (with the property that $S'S = I$) and write:

$$\Sigma_u = P' \cdot P = P' \cdot I \cdot P = P' \cdot S' \cdot S \cdot P = R' \cdot R \tag{13}$$

This new matrix is no longer lower triangular, but the information contain in Σ_u is not altered, in this case, depending on the numbers of random draws, we get the same number of possible decompositions of the covariance matrix. To be ensure that our random matrix is *good* we verified it against a set of sign restrictions with economic meaning (imposed *a priori*). To obtain the IRFs we must proceed with the next algorithm (Blake & Mumtaz (2012)):

1. Estimate the reduced-form VAR and obtain F and Σ_u
2. Compute $P' = chol(\Sigma_u)$.
3. Draw a random orthogonal matrix S.
4. Compute $A^{-1} = R = P'S'$.
5. Compute the impulse response associated with $R(= A^{-1})$.
6. Are the sign restrictions satisfied?
   (a) Yes $\Rightarrow$ store the impulse response.
   (b) No $\Rightarrow$ discard the impulse response.
7. Repeat 3-6 until we obtain N replications.
8. Report mean or median and confidence interval (in general 16th and 84th percentiles).

Proxy variables are required for the model. For the vicious circle of savings we need a measure for competitiveness, the most ovious one is to use real effective exchange rate (REER)[9]. We combine savings and investment in the form of private sector balance (SNG) and use real interest rate for loans contracted by firms (RFIN). For the next vicious circle (fiscal policy) we need a variable that captures the *majority of voters that are dependent on redistributions*; we decided to make use of capital expenditures and total transfers. These two variables show the orientation of the budget (towards productive expenses or inefficient schemes); to summarize them we make a ratio of them and they denote a *discretionary measure* (DISCR). A proxy variable to capture the *ad-hoc tax increases* (i.e.: tax burden) is implicit taxation rate (ITR). This measure is used to compare different effective average tax burden levied on different types of income sources. Alongside the previous 2 variables we include the government budget balance (SBG).

The last challenge arises from the approximation of the vicious circle of the informal economy. For this we calculate a measure of informal economy sector (IES). Davidescu & Dell'Anno (2016) provide a comprehensive set of alternative measure conducted on the Romanian market (MIMIC approach, labor approach etc.). There results are fairly robust to different specifications and with this in mind we choose to implement the simpler approach, namely the currency demand model, since we don't want to draw attention from the main objective [10]. We have 2 constructed

[9]REER based on labor cost or prices may tend to show conflicting signals, but both are relevant for the dynamics of export (Claire & Francesco (2015)). They also suggest using a non-price factors (e.g. product quality, industry specialization, efficiency of sales networks etc) in the form of absolute and relative total factor productivity, constructed in a similar manner as REER.

[10]We must keep in mind that our primary concern are the 3 vicious circles.

variables (i.e.: level of taxation and size of informal economy). In order to keep the methodology as simple as possible we present the details in dedicated appendices. In appendix B and C we present the complete process used to obtain overall ITR and IES.

The final step is to derive sign restrictions used for the identification schemes. From diagram 5 we can obtain the set of restrictions for our variables. We do not have in hand a theoretical model, but we have the expected sign of the variables and can used them as prior information to pin down the structural shocks. As a consequence, each of this shocks are interpreted as *shocks triggering* the appearance of the vicious circles. In table 1, 2 and 3 we highlight the restrictions used. For scheme S1 we have a basic set of restrictions derived from the authors theory, moving to scheme S2 we add restrictions for the shock triggering the vicious circle of the informal economy and lastly add more restrictions for every shock, in order to better identify them. Also, when implementing the sign restrictions we are *agnostic* with respect to time horizon (i.e. we restrict the sign for 0 periods, thus data can freely inform the variables response).

After the model is identified we are going to analyze the response of the unrestricted variables and compared it with the theoretical expected sign (e.g. for the shock triggering the vicious circle of savings, for identification scheme S1, we are going to look at all the variables except SNG, REER, RFIN; next the other shock and so on and so forth). We are aware that we do not have an benchmark study to compare our results (under an empirical approach). For that we resort to robustness analysis, to ensure that our results remain a fact: use alternative identifications schemes and specify REER under 2 alternative deflators: consumer price index (CPI) and unit labor cost (ULC).

Table 1: Sign restrictions (scheme S1)

	SBG	SNG	REER	RFIN	DISCR	IES	ITR
VC of savings		↓	↑	↑			
VC of fiscal policy	↓				↓		↑
VC of the informal economy						↑	

Table 2: Sign restrictions (scheme S2)

	SBG	SNG	REER	RFIN	DISCR	IES	ITR
VC of savings		↓	↑	↑			
VC of fiscal policy	↓				↓		↑
VC of the informal economy		↓				↑	↑

Table 3: Sign restrictions (scheme S3)

	SBG	SNG	REER	RFIN	DISCR	IES	ITR
VC of savings		↓	↑	↑			↑
VC of fiscal policy	↓		↑		↓		↑
VC of the informal economy		↓	↑			↑	↑

Note: VC — shock triggering vicious circle.

Data spans the period 2000Q1-2016Q4, we include 4 lags for the VAR model, according to information criteria. Data source is National Bank of Romania (NBR), National Institute of Statistics (NIS) and EUROSTAT. We stop with the simulations at 50000 replications due to the computation burden[11]. All computations were done in MATLAB® 2017a[12].

The main tools of our empirical assessment are Impulse Response Functions (IRF), Forecast Error Variance Decomposition (FEVD) and Historical Decomposition (HD).

4 Results

In this section we present the main findings of our empirical work: IRFs, FEVDs and HDs, including robustness switches. Due to page limitation we present only the relevant results. We start by comparing the response of the unrestricted variables to the shocks triggering the vicious circles. In what follows we analyze the model that includes the measure of competitiveness (i.e. RERR) based on the CPI deflator and is identify using scheme S1.

For the shock triggering the vicious circle of savings we get the expected sign for discretionary measure and for informal economy sector, while the other 2 remaining don't validate: the response of government budget is positive and significant for almost 10 periods, while ITR has a huge hike in the first 5 quarters; suggesting maybe the implementation lag that fiscal policy usually encounters.

From the most unrestricted shock of this scheme (the one fueling the appearance of informal economy) result are even: 3 variables have the expected sign (public budget, REER, discretionary variable) and the remaining do not validate; also none has statistical relevance and for REER and ITR the adjustment process (return to zero) is very slow.

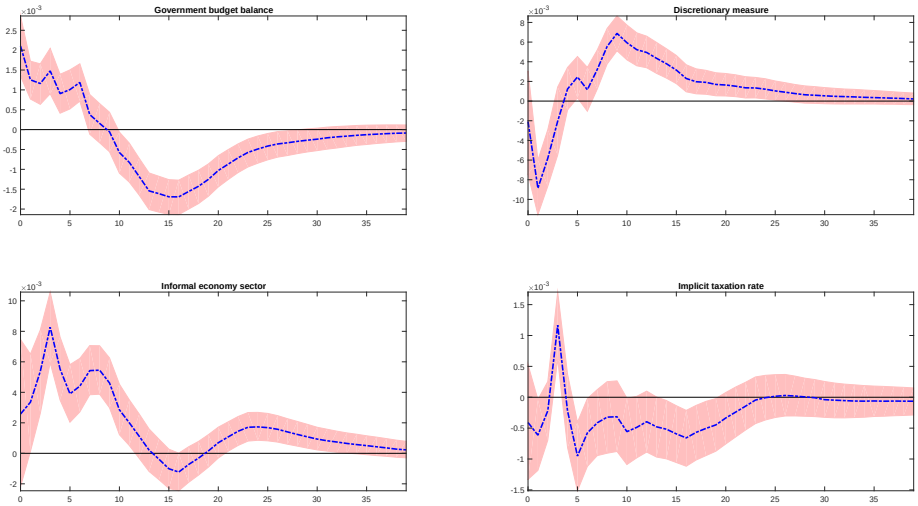
The shock that is intended to be the catalyst of the three vicious circle, namely the shock driving the vicious behavior of fiscal policy has only one sign that confirms the theory of the authors (the rise of real interest rate). For private sector balance we have a relevant and positive response and informal economy in reduced by a huge portion (compared to the later adjustment). Real effective exchange rate initially benefits from the triggering of the vicious circle of fiscal policy, but within a year suffers a huge loss in price competitiveness (this may describe the short term benefits of a fiscal policy). All results are presented in figure 6. When moving to more restrictive identifications schemes (S2 and S3), remarks tend to remain constant: the unrestricted variables preserve their sign when switching to other schemes. This consistency suggest that our results are robust. Complete set of results are presented in appendix D (figure 12 and 13).

[11] Given that we have to run the algorithm six times (3 alternative identification schemes and 2 REER measures), the total elapsed time was close to 5 days.

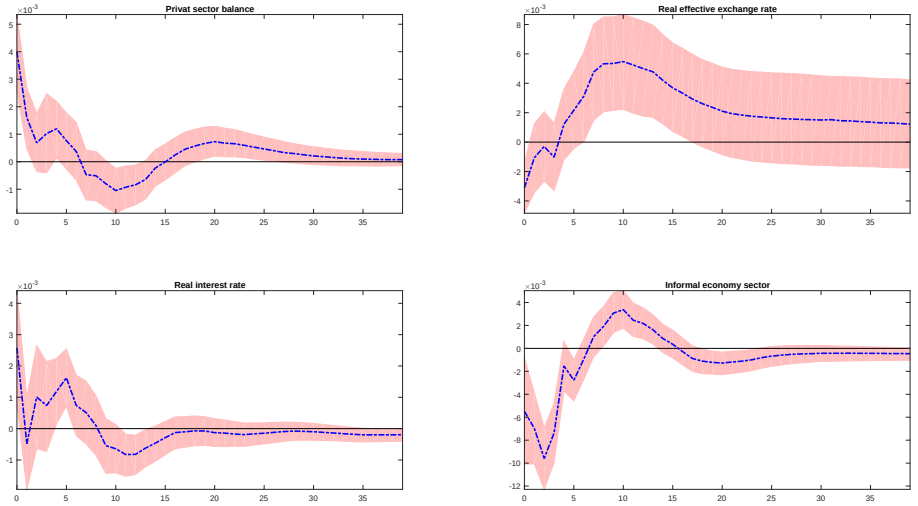
[12] We build on the scripts available on Haroon Muntaz's and Ambrogio Cesa-Bianchi's personal website.

Figure 6: Response of unrestricted variables (identification scheme S1)

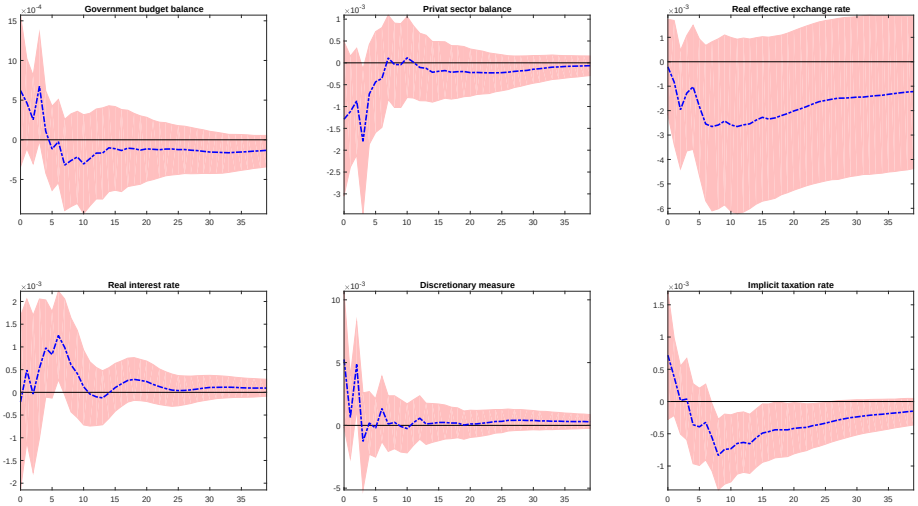
(a) Shock triggering the vicious circle of savings



(b) Shock triggering the vicious circle of fiscal policy



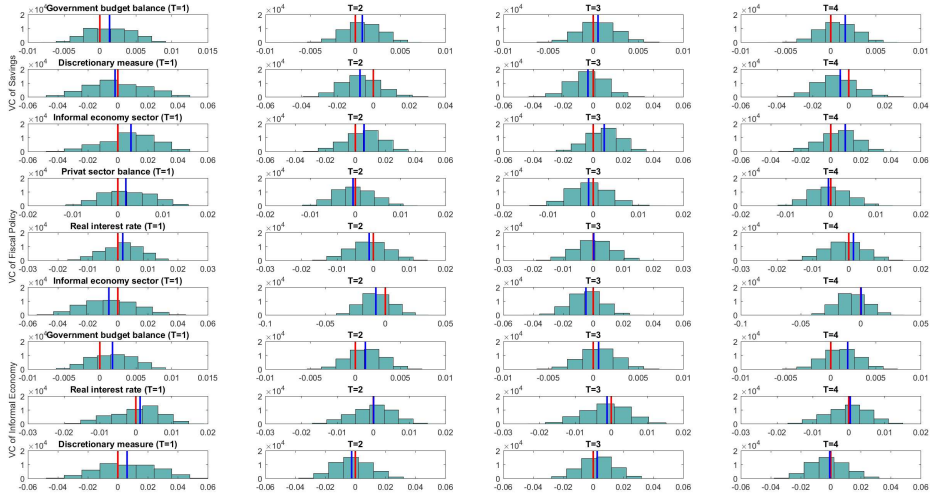
(c) Shock triggering the vicious circle of the informal economy



Source: own computations.

As an additional measure to verify the correctness of the responses of variables to the structural shocks, we also analyze detailed distribution of each variables, over a horizon of 4 quarters. In figure 7 we plot the entire distribution of results, the median and zero benchmark line. A response is valid if the median is situated over/ below the zero line and respect the theoretic sign. We present the results only for identification scheme S3 (since the other 2 where similar).

Figure 7: Distribution of IRFs (identification scheme S3)



Note: Red line is the zero benchmark; blue line is the median; *VC* — shock triggering vicious circle; T stands for period (e.g. T=1 is the first quarter after the shock took place).
Source: own computations.

The assessment presented above remain unchanged. As an overview across different schemes and definition for variables, we get that 4 out of 10 unrestricted variables have the expected sign derived from the theory of the authors. In these conditions we cannot point with the conclusions in the same directions as the authors, hence the three vicious circles are not present in our economy (at least as specify in their paper).

In table 4, a forecast error decomposition exercise is presented — each response of the variable, over a specific horizon, is explain by certain contribution of a specific shock; all structural shocks sum up to 100%. Figures are based on identification scheme S3 (the other 2 show similar patterns) over 5, 10 and 40 quarters horizon.

Table 4: FEVD — identification scheme S3

Variable	Shocks	5Q	10Q	40Q
SBG	Savings	13.9%	13.7%	15.1%
	Fiscal	11.1%	11.1%	12.4%
	Informal	15.0%	15.1%	16.0%
	Others	60.1%	60.1%	56.5%
SNG	Savings	17.2%	18.7%	18.7%
	Fiscal	11.2%	11.4%	12.8%
	Informal	22.0%	21.7%	19.6%
	Others	49.5%	48.2%	48.9%
REER	Savings	19.4%	21.7%	19.5%
	Fiscal	14.6%	17.6%	20.4%
	Informal	13.5%	13.4%	13.3%
	Others	52.5%	47.3%	46.8%
RFIN	Savings	10.6%	11.1%	12.7%
	Fiscal	13.2%	13.6%	14.3%
	Informal	13.7%	13.8%	14.6%
	Others	62.4%	61.5%	58.4%
DISCR	Savings	13.3%	13.4%	14.8%
	Fiscal	13.8%	14.5%	15.0%
	Informal	13.8%	13.7%	14.6%
	Others	59.1%	58.4%	55.6%
IES	Savings	15.3%	16.0%	16.6%
	Fiscal	12.9%	12.8%	13.8%
	Informal	20.8%	21.1%	19.8%
	Others	50.9%	50.1%	49.8%
ITR	Savings	12.0%	12.2%	13.0%
	Fiscal	10.8%	12.3%	16.1%
	Informal	14.1%	13.8%	13.4%
	Others	63.1%	61.7%	57.5%

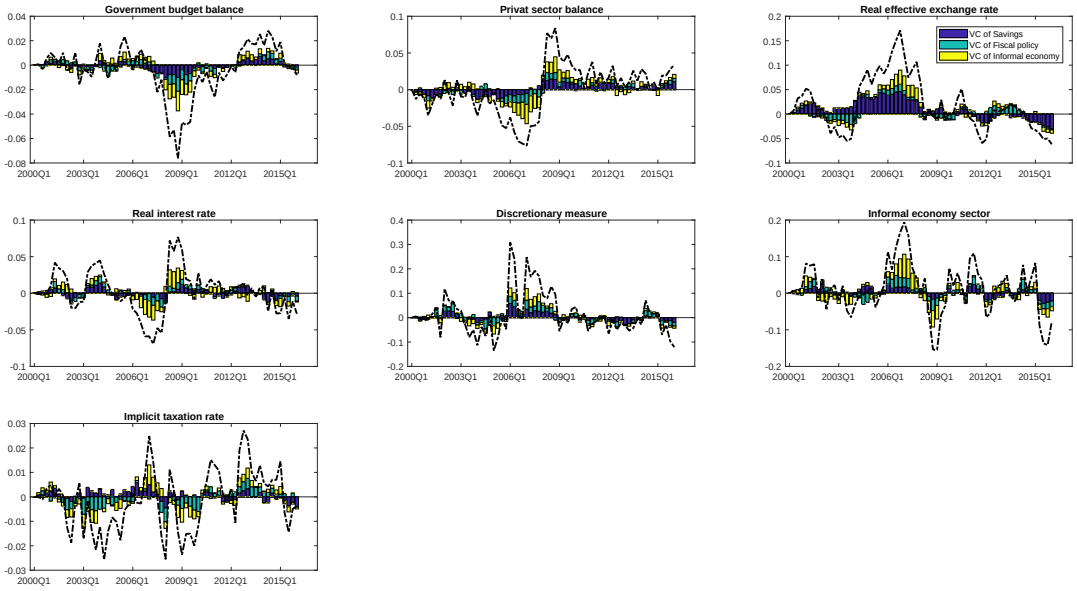
Note: Others refer to the cumulative value of the remaining 4 unidentified shocks.

When adding the three shocks we get o combine marginal contribution of 43% for 5 quarters horizon, while for the entire horizon of 10 years it slightly increases to 47%. The contributions of shocks is roughly equal across different identifications scheme: for the shock triggering the vicious circle of savings the impact range is 14.6% - 15.8%, the next shock (*fiscal*) the values are 12.5% - 15% and for the last shock considered the interval is wider, but also decreasing when moving to distant horizons (16.1% - 15.9%). While is impact dissipates over time, the shock triggering the appearence of the vicious circle of informal economy remains the most important.

The last tool in our empirical analysis is the historical decomposition exercise: each variable is presented as deviation from baseline and is decompose in structural shocks derived from the SVAR model. In figure 8 we plot only the three shocks triggering the appearance of the vicious circles.

The shock triggering the vicious circle of savings had the most prominent impact on the real effective exchange rate (alongside the shock responsible for the informal economy) and on the government budget balance (especially in 2009). The size of the informal economy was in second stage affected by the fiscal policy conduit (the own shock has the higher effect). Real interest rate was mainly driven by the shock triggering the informal economy circle.

Figure 8: Historical decomposition (identification scheme S3)



Note: VC — shock triggering vicious circle; results are presented as deviation from baseline.
Source: own computations.

Also, as emphasized in the previous remarks, the most important structural shock obtain from the FEVD exercise (informal economy) is present in all variables with relative important contributions. There are also some variables that have been equally affected by the three shocks, although in small size, but the remaining 4 unidentified shocks explain most of the recorded deviations.

Our last comment is with respect to the robustness analysis: when switching to the real effective exchange rate measured by the unit labor cost deflator results (IRF, FEVD or HD, across all 3 identification schemes) do not register significant changes, thus we only mention them here[13].

[13]Complete set of results are available upon request.

5 Final remarks

Throughout this paper we intended to develop a validation process for testing the three vicious circles that (presumably) act on the Romanian economy, as described by Croitoru & Târhoacă (1997) and Croitoru (2015). We build an SVAR model using *proxy* variables to capture the interactions between the circles and impose sign restrictions derived from the aforementioned papers and analyze the response of the variables using different identifications schemes and definitions of variables.

All in all, our results do not harmonized with the theory of the authors. As an overview we get that 4 out of 10 unrestricted variables have the expected sign. Thus we cannot confirm the presence of these circles in our economy (at least with the current methodology — a dose of conservatism must be maintained when treating this finding as a final result).

The competitiveness of the Romanian economy has improve over time, real labor costs and total factor productivity are supportive for future growth. Nowadays, the current account is manageable, but recent developments indicates that the public budget has started a new process of taking away the savings that the private sector has strive to conserve.

Policy implications are pretty straight forward. Although the three circles have not been confirmed, the recommendation for policy makers is valid: awareness of a vicious circle acting on the economy is the first step in eliminating the component that generates perturbation in the transmission mechanism.

We also have to take into account future redevelopment and better ways to improve the underlying paper, in this respect we propose to: (i) search for new variables, (ii) build a structural model and (iii) use an optimal rate to gauge the point at which the tax burden induces disequilibrium for firms.

Lastly we have faith that this paper will encourage future research with *domestic considerations* as the main driver.

6 References

Bańbura, M, Giannone, D & Reichlin, L 2008, 'Large Bayesian VARs', ECB Working Paper Series, no. 966.

Blake, A & Mumtaz, H 2012, 'Applied Bayesian econometrics for central bankers', CCBS Technical Handbook No. 4.

Cagan, Philip, 1958. The Demand for Currency Relative to Total Money Supply. The Journal of Political Economy, 66, 303–29.

Chiarini, B, Marzano, E & Schneider, F 2013, 'Tax rates and tax evasion: an empirical analysis of the long-run aspects in Italy', European Journal of Law and Economics, vol 35, no. 2, pp. 273-293.

Christiane, N & Isabel, V 2008, 'Fiscal policies, the current account and ricardian equivalence', ECB Working Papers, no. 935.

Claire, G & Francesco, Z 2015, 'Exploring price and non-price determinants of trade flows in the largest euro-area countries', ECB Working Papers, no. 1789.

Croitoru, L & Târhoacă, C 1999, 'Fiscal Policy in Romania', RCEP Working Papers, no. 14.

Croitoru, L 2015, 'Cercul Vicios al Politicii Fiscale', Studii BNR.

Davis, SJ & Henrekson, M 2004, 'Tax Effects on Work Activity, Industry Mix and Shadow Economy Size: Evidence from Rich-Country Comparisons', NBER Working Papers, no. 10509.

Davidescu, A & Dell'Anno, R 2016, 'What is the size of the shadow economy in romania? A comparison of different estimation approaches', SIEP 2016.

Dieppe, A, Legrand, R & Roye, BV 2016, 'The BEAR toolbox', ECB Working Papers Series, no. 1934.

Litterman, RB 1985, 'Forecasting with Bayesian Vector Autoregressions - Five Years of Experience', Federal Reserve Bank of Minneapolis Working Paper, no. 274.

Mountford, A. & H. Uhlig (2005), "What are the Effects of Fiscal Policy Shocks", Discussion Paper 2005-039, SFB 649, Humboldt-Universitat, Berlin.

Peersman, G & Straub, R 2004, 'Technology Shocks and Robust Sign Restrictions in a Euro Area SVAR', ECB Working Papers, no. 373.

Peersman, G & Straub, R 2006, 'Putting the New Keynesian Model to a Test', IMF Working Papers, no. 135.

Schwab, K & Sala-i-Martín, X 2016, 'The Global Competitiveness Report', World Economic Forum, Geneva.

Stavre, IG 2015, 'Testarea celor 3 cercuri vicioase ale economiei românești: o abordare VAR–VEC', Colecția de working papers ABC-ul Lumii Financiare, no. 3.

Tanzi, Vito, 1983. The Underground Economy in the United States: Annual Estimates, 1930-80. International Monetary Fund Staff Papers 30, 283–305.

Taxation Trends, 2017, 'Taxation Trends in the European Union (Technical appendix of the document, section F)'.

Uhlig, H 2005, 'What are the effects of monetary olicy on output? Result from an agnostic identification procedure', Journal of Monetary Economics, no. 52, pp. 381-419.

A Data

In this section we described and present the data used in estimation.

Government budget balance. Difference between government total revenue and government total expenditure (normalized over GDP). Source: EUROSTAT.

Privat sector balance. The variable is constructed by substracting government budget balance from current account (normalized over GDP). Source: EUROSTAT.

Real effective exchange rate. Deflator: consumer price indices (CPI) and unit labour costs in the total economy (ULC), both for 37 trading partners (index: 2005=100). A rise is equivalent to a loss of competitiveness. Source: EUROSTAT.

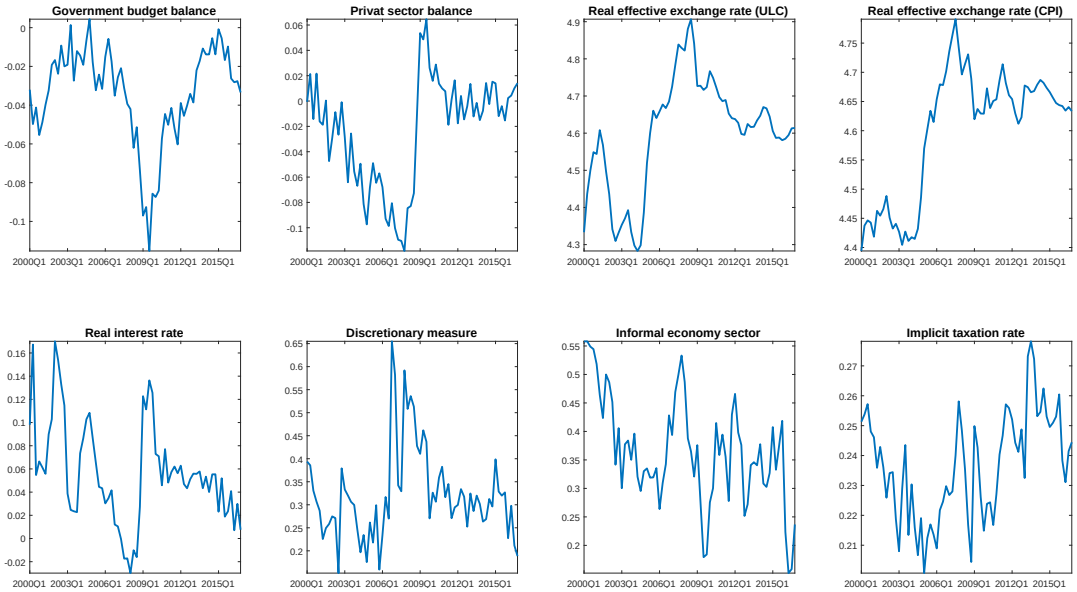
Real interest rate. Interest rate for loans contracted by non-financial corporations (outstanding), adjusted for inflation (based on GDP deflator). Source: NBR, NIS.

Discretionary measure. The variable is constructed as a ratio between capital expenditures (gross capital formation) and total transfers (social benefits, capital transfers and other transfers — all payable) of the government. Source: EUROSTAT.

Informal economy sector. Constructed variable — see appendix C. Source: NBR, NIS, EUROSTAT.

Implicit taxation rate. Constructed variable — see appendix B. Source: EUROSTAT.

Figure 9: Variables used in estimation



Source: NBR, NIS, EUROSTAT, own computation.

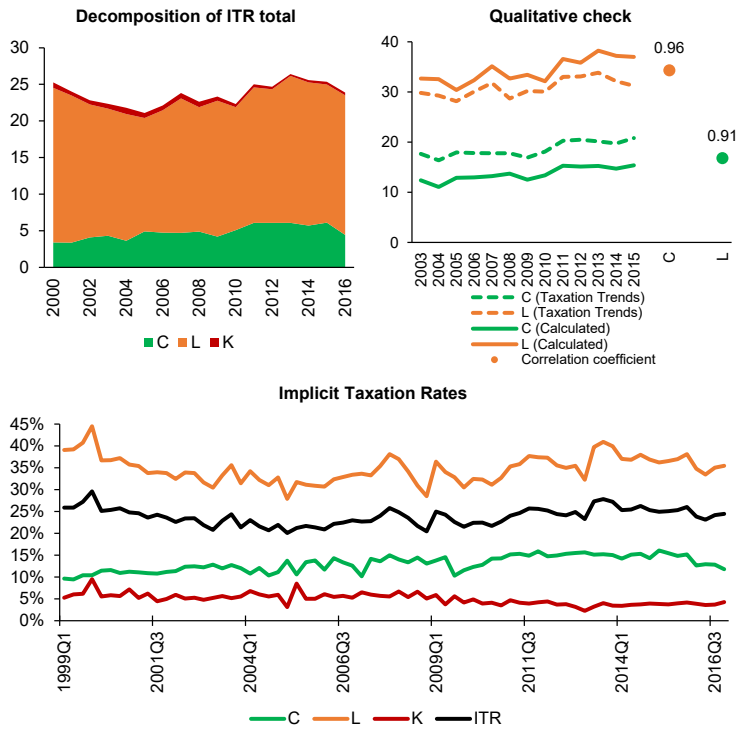
B Implicit Taxation Rate

In this section we described the process used to obtain Implicit Taxation Rate (ITR), using the methodology described in Taxation Trends (2017).

The general concept of ITR is to identify all eligible taxes for an category (e.g. consumption) and a suitable denominator (i.e. potential tax base), such that the ratio between the aforementioned series produces the desire estimation of the tax rate. Main data source is the information from national accounts[14]. After computing the 3 individuals rates (for consumption — C, labor — L and capital — K), overall ITR is constructed as a weighted average, where weights are obtain from the relative contribution of individual taxes to total revenue of the government.

We aggregated and compared our results with the annual values provided by Taxation Trends report (only for consumption and labor). For ITR_C we have lower values (with 4.91 pp), while for ITR_L higher (3.45 pp). Although our figures are slightly different, when calculating the correlation coefficients for both component we have over 90%. Taking this into account, we have a very reasonable proxy for taxation and can compute the overall ITR (see figure 10).

Figure 10: Results for Implicit Taxation Rate



Note: ITR stands for overall ITR, while C/ L/ K are the subcomponents defining consumption/ labor/ capital.
Source: EUROSTAT, Taxation Trends (2017); own computations.

[14]The main challenge is that ITRs are computed using a more refined database at annual frequency, but our current need is for quarterly frequency.

C Informal Economy Sector

In this section we described and present the derivation of the informal economy size, using the currency demand model. This type of monetary model builds on the work of Cagan (1958) and Tanzi (1983). In short, demand for currency is dependent on a set of factors: economic activity, taxation level, interest rate; the first 2 are expected to have a positive impact, while the last variables captures a opportunity cost and the expected sign is negative. Once we have a measure for level of currency, we can ignore the *illegal* factor (i.e. taxation) and thus obtain the supplement of currency.

Following Davidescu & Del Negro (2016) we estimate a Vector Error Correction Model (VECM) using the following variables: real currency (nominal currency in circulation deflated with the GDP deflator) — CR, real GDP — Y, inflation (HICP based) — P, tax revenues (over GDP) — T, nominal interest rate (term deposits) — I and employment rate — E. All variables are specified as $ln(1+x)$, with the exception of currency and real GDP who are tranformed as simple $ln(x)$. Estimation period is 2000-2016 (quarterly frequency), source of data: NIS, NBR, EUROSTAT. Information criteria indicates the usage of 3 lags and Johansen cointegration test suggest at least one cointegration vector.

Once parameters are obtain through OLS estimation we get an estimated value for currency ($\widehat{CR}$), next the tax variable (T_t) and inflation (P_t) are set to minimum level[15] and the model is solved to extract the level of currency without tax burden ($\widehat{CR}_{NT}$). Subtract the previous 2 variables and the *additional* currency reflects the part generated by underground economy. The last step to obtain informal GDP (Y_i) is to make a ratio of shadow currency (C_i) and official currency (C_f), correct the estimates for the fact that income elasticity (i.e. $\beta = 1.17$) is not unitary and to multiply with official GDP level (Y_f)[16]. The final value obtained is normalized over GDP.

In table 5 and figure 11 we present the results for the long-run equation from the VECM estimation. Model has good statistical properties: with exception of interest rate, all estimated parameters have the expected sign and are significant. Fitted values are within the confidence interval and residuals are not correlated or heteroskedastic.

From the historical decomposition exercise, demand for currency experience a sudden rise in 2007 due to a higher tax development and in recent years was mainly driven by rise in employment and economic activity, while in 2016 we distinguish negative contribution from taxes.

[15]The taxes over GDP ratio are fixed at 30%, which translates to the value of 0.2624 and inflation at a conservative 0%.

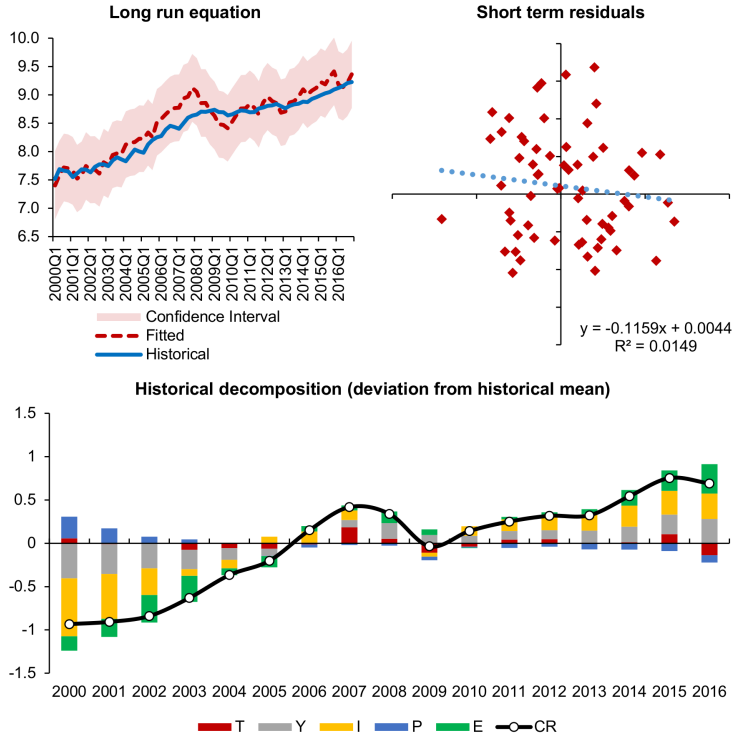
[16]Defined as $Y_i = (\frac{C_i}{C_f})^{\beta^{-1}} \cdot Y_f$.

Table 5: Long run equation results

Parameter	Value
Y	1.17 (***)
P	11.64 ( )
T	10.75 (***)
I	-3.04 (***)
E	11.56 (***)
Intercept	-11.65 (***)
Statistics	
R^2 adj	46%
LM test	0.91
White test	0.35

Note: ***, **, * denote statistically significant at 1%, 5% and 10%.
H_0 (LM test): no serial correlation at lag order 5 (similar results for inferior lags).
H_0 (White test): no heteroskedasticity.
Source: own computations.

Figure 11: Informal economy estimation results

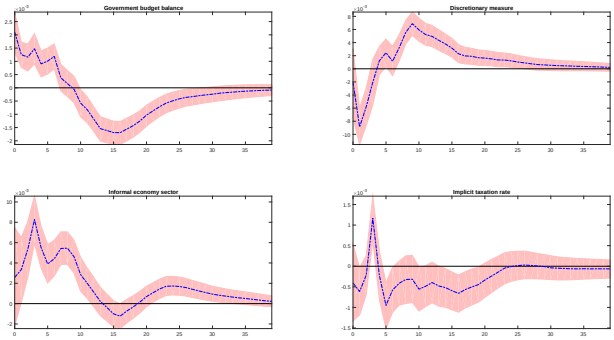


Source: NIS, EUROSTAT; own computations.

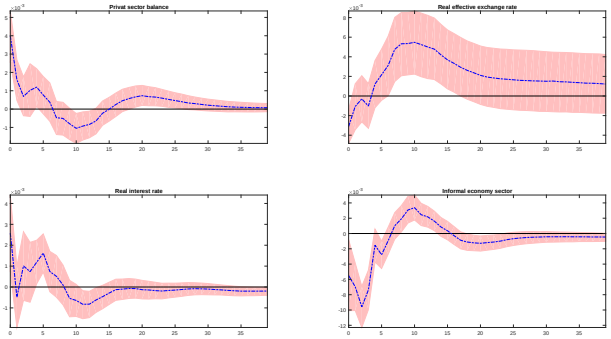
D Detailed results

Figure 12: Response of unrestricted variables (identification scheme S2)

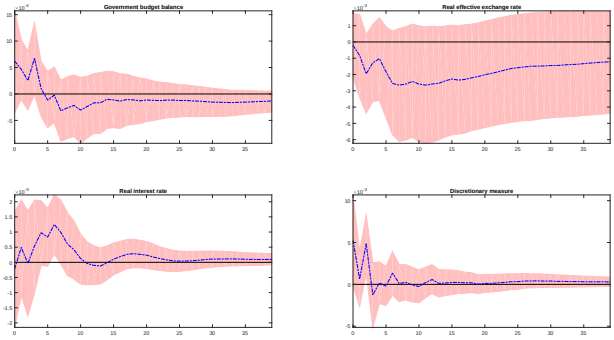
(a) Shock triggering the vicious circle of savings



(b) Shock triggering the vicious circle of fiscal policy



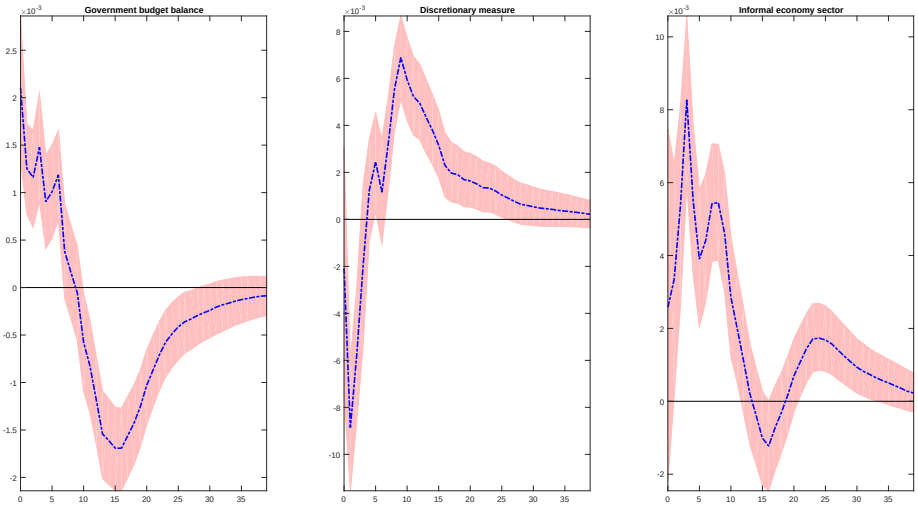
(c) Shock triggering the vicious circle of the informal economy



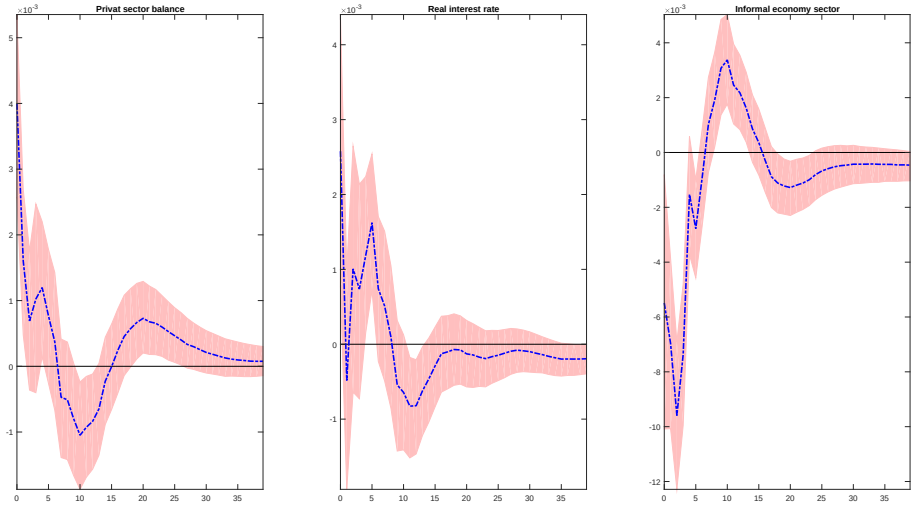
Source: own computations.

Figure 13: Response of unrestricted variables (identification scheme S3)

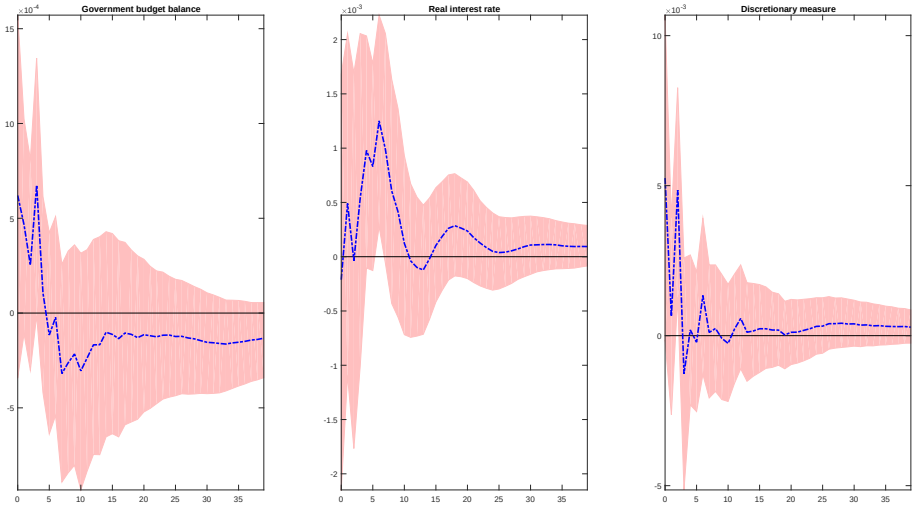
(a) Shock triggering the vicious circle of savings



(b) Shock triggering the vicious circle of fiscal policy



(c) Shock triggering the vicious circle of the informal economy



Source: own computations.