Boosting cycles and Stabilization effects of Fiscal Rules

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By

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Abstract

The dynamic and the structure of the economy determine the effects of political economy shocks, fiscal and monetary policy. Based on a DSGE model and stylized facts for small open economy, we evaluate the effects of fiscal consumption tax shocks on the presence of two fiscal rules in the periods of 1990 to 2000 and 2001 to 2010. The two rules are based on: first, taxes adjust according to the debt level and government expenditures; and second, balanced budget where taxes adjust every time in order to preserve the equilibrium in the fiscal budget. Results show that after the fiscal shock hits the economy, the first fiscal rule has mayor stabilization effects on the economy than the second one, around 50%, and the GPD react greater than in the second period, 0.02%.

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Keywords: Government expenditure, fiscal rule, *pass - through, rule-of- thumb households*

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1. Introduction

During the last economic downturn governments around the world have taken extraordinary fiscal measures in order to stimulate their economies and boost the aggregate demand, limiting job losses and easing negative effects of business cycles. In this sense, one of the central issues of Policy Makers is to review the Fiscal Policy effects on the economy and how it can contribute to the growth economy in the context where it is impossible to design a correct fiscal policy that meets all possible requirements: i) achieving low borrowing cost, ii) avoiding deficit bias, iii) smoothing the economic cycle and iv) stimulating government investment.

During the nineties fiscal deficits were around -3.72%, in the period 2000 to 2010 the deficits were in the order of 2.13% and finally between 2006 to 2010 fiscal surpluses were around 2.8%. The positive environment induced increments on fiscal expenditure and poses the question about its effectiveness on the economy. Besides, we test how the economy responds against to consumption tax shock in the context of two fiscal rules.

This paper seeks to investigate, review and analyze the fiscal expenditure and consumption tax shocks effects and the stabilization properties of fiscal rules in Bolivia's. Since Bolivia doesn't have any fiscal rule; we impose to the model structure fiscal rules and simulate them using a dynamic stochastic general equilibrium (DSGE) model with the New Keynesian macroeconomic vintage for a small open economy (SOE) adding different types of shocks to assess the whole response of the economy.

In line with Kocherlacota (2010) and Galí et. al. (2007), the paper builds a DSGE model. The paper introduces consumption heterogeneity (rule – of – thumb), market imperfections, and sticky prices following the Calvo mechanism and applies different types of fiscal rules. First, as in Galí et. al. (2007), taxes are endogenous and move in response to government expenditure and debt level. In the second rule, we have a balanced budget in every period where taxes react every period in two cohorts, 1990 to 2000 and 2001 to 2010.

In particular, we modified the principal benchmark in order to find more relations that allow us explain the Bolivia's economy since it is a small dollarized open economy (SDOE). In order to simplify the external effects we use the Hybrid New Keynesian Phillips Curve. Based on Balakrishnan and López Salido (2002) we modified the production function and its factor structure so as to put in and assess the pass – through to the economy.

Monetary Policy in Bolivia doesn't have traditional instruments to shock the economy, like an interest rate rule (Taylor Rule), but we use open market operations interest rate as proxy and applied it on the rule proposed in Schmidt – Hebbel and Tapia (2002) and Caputo et. al. (2006). Interest rate not only reacts to the inflation and output deviations, but also to interest rate lags (rigidities) and changes in nominal exchange rate.

Results and simulations were reached using DYNARE routine, but first the model must be log – linearized. The calibration of deep parameters is used for Bolivia's economy was design for the two periods contemporaneous ones common in literature that help us explain the behavior in other developing economies.

The application of two fiscal rules are compared to model without a fiscal rule, so the canonical model allow us to assess the true multiplier effect of fiscal and tax shocks on fundamental macroeconomic variables for the economy.

In the nineties, fiscal shock produces an increase in total consumption in 0.5% explained by a positive increase in the rule – of – thumb households. However, a fiscal shock generates pressures on inflation through the cost channel; so, interest rate respond against fiscal pressures on inflation restrained pressures on inflation. In the first period, results show that first fiscal rule has greater stabilization properties than the second in the presence of the two shocks.

During de period 2000 – 2010, the effects of fiscal shock is greater than in the nineties, consumption and GDP reacts greater, implying that in this period the dynamics of aggregate demand responds positively to fiscal impulses, 0.02%. On the same way, the first fiscal rule stabilize the economy more than the second.

The model structure and the cohorts allow us to assess the effects of the fiscal shock on the other variables. It produces nominal exchange rate mix results and real exchange rate appreciation. On the other hand, risk premium and tax pressure increases in presence of first fiscal shock

The paper is organized as follows: section 2, reviews literature about fiscal expenditure effects and other economies experience; section 3, develop the model methodology; section 4, describes data and calibration; section 5, shows fiscal shock effects under the two fiscal rules, and finally section 6, concludes and give new future investigation guidelines

2. Literature review

Empirical evidence on the fiscal rules effects on the economy in the new macroeconomic vintage, called newkeynesian, are fewer. Valdivia and Montenegro (2008) shows that in the presence of fiscal rule, fiscal shock effect on prices are moderate, Machicado et. al (2010) evaluate the effects of public expenditure policy in Bolivia and if it is enough for economic growth - without any fiscal rule –. But the model calibration was in base of a specific year. Then, empirical papers and investigation in this way are restricted to other economies.

Traditionally, fiscal rules are designed to reduce the level of debt or at least to prevent the debt/GDP ratio increasing further in each economic cycle. In the case of EMU countries, fiscal consolidations were forced by the Maastricht Treaty and the Stability and Growth Pact, Ballabriga and Mongay (2002) or Gali and Perotti (2003). Their results confirm that before the Maastricht Treaty the primary budget balance showed little correlation with the output gap, but correlation is positive and statistically significant in the consolidation period; secondly, the response of the primary budget surplus to the lagged debt to trend GDP ratio is more than three times larger in the consolidation period than in the pre-Maastricht one.

Empirical evidence of fiscal rules are find Australia, Canada, Germany, New Zeeland, Spain, United States, European Union, table 1.

Table 1
International Fiscal Rules

Australia: A Charter for Budget Honesty requires the government to 'spell out its objectives and targets', but is not enforced.
Canada: There are no legislated rules, but the government had a 'balanced budget or better' policy from 1998.
Germany: The Domestic Stability Pact contains a version of the UK's golden rule, requiring that the budget deficit does not exceed investment. It is not enforced.
New Zealand: A non-binding rule that debt and net worth be maintained at a 'prudent' level and operating surpluses be run over a 'reasonable' period of time. The government of the day sets its own numerical targets, without enforcement.
Spain: The 2004 Fiscal Stability Law requires that accounts at all levels of government show a surplus.
United States: From 1990 to 2002, the Budget Enforcement Act required that legislated changes to revenues or mandatory spending programmes be budget neutral over a five year time-frame.
European Union: The Stability and Growth Pact requires EU members to aim for a debt-to-GDP ratio of 60 per cent and keep annual deficits below 3 per cent of GDP, or face an 'excessive deficit procedure' with the potential for fines to be levied for the repeated breach of the rules. However, the 3 per cent target can be avoided in exceptional circumstances', the definition of which was substantially widened in 2004 after several countries breached it without real sanction. A number of countries, like Italy and Belgium, have never come close to meeting the 60 per cent debt ratio.

Source: Murray and Wilkes (2009)

The negative response of the consumption against an increase in government spending is insufficient; this result can be obtained in Ricardian RBC models or as in the neoclassic model predictions, Christiano and Eichenbaum (2002), and Fatás and Mihov (2001, FM).

Therefore most of the evidence is concentrated in VAR models. Blanchard and Perotti (2002, BP) and FM (2001) found that, against to neoclassical models, in response to a fiscal expenditure shock consumption increases, but in different degrees. Besides, investment doesn't have a unique response: in the first case, investment falls in great magnitude; and, in the second one, investment increases insignificantly.

Using United States quarterly data Galí et al (2007) shows when an increase in government spending is significantly it produces a persistent increase in output and at the same time a persistent increase in consumption[2], working hours and real wage increases; and in the short run investment falls but in the medium it improves, but not significantly, finally deficit increases.

Mountford y Uhlig (2004), Burnside et al (2003) find that in response to a fiscal shock, consumption responses weakly and not significantly. Additionally, Alesina and Ardagna (1998) show that during periods of fiscal consolidation, forecast of the neoclassical model were good; so, fiscal spending reduction yields positive movements in consumption and output.

3. Model Methodology

The model is based on Gali et. al. (2007), we model a small open economy (SOE) in order to introduce the Bolivia's economy characteristics.

3.1 Households

Newkeynesian models with rule – of – thumb households, includes myopic or lack of credit, it helps us to explain positive movements in total consumption against business cycle models with full ricardian agents or neoclassical models. Rule – of – thumb households only consume the product of their work, they have fear to save (asset accumulation) and ignore intertemporal consumption. On the other hand, ricardian households or optimizers have assets and access to the capital market and receive benefits of the firms.

The coexistence of these two types of agent allows us to explain the positive movement of total consumption in response to a fiscal shock.

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[2] This output is explained because of the introductions of rule – of – thumb consumers in the canonical structure of the model

3.1.1 Ricardian households

They have a utility function subject to a budget constraint and response to their own characteristics. Following Galí et. al. (2007) we can introduce investment at last.

$$E_0 \sum_{t=0}^{\infty} \beta^t U\left(C_t^o, N_t^o\right) \quad (1)$$

According to Andrés and Doménech (2005), and García and Restrepo (2007) the budget constrain can be:

$$P_t\left(\left(1+\tau_t^c\right)C_t^o + I_t^o\right) + R_t^{-1} B_{t+1}^o + S_t\left(\Phi\left(\frac{S_t B_t^*}{P_t Y_t}\right) R_t^*\right)^{-1} B_{t+1}^{o*} =$$
$$P_t\left(1-\tau_t^N\right) W_t N_t^o + P_t\left(1-\tau_t^K\right) Z_t K_t^o + B_t^o + S_t B_t^{o*} + \left(1-\tau_t^D\right) D_t^o - P_t T_t^o \quad (2)$$

Capital law of motion with adjustment cost is:

$$K_{t+1}^o = \left(1-\delta\right) K_t^o + \phi\left(\frac{I_t^o}{K_t^o}\right) K_t^o \quad (3)$$

Where tax structure: $\tau_t^c, \tau_t^N, \tau_t^K, \tau_t^D$, are tax rates to consumption, labor income, capital return and dividends. Domestic and foreign debt, or assets, are B_t^o, B_t^{o*}. Nominal Exchange rate is S_t and country risk premium is $\Phi\left(\frac{S_t B_t^*}{P_t Y_t}\right)$. Dividends are D_t^o, and the domestic and the foreign interest rate are R_t, R_t^*. Real price of factors are W_t, Z_t. Labor and Capital are N_t^o, K_t^o and P_t is the price level. Finally, T_t^o is defined as lump sum taxes (or transfers if it is negative) paid by Ricardian consumers.

Furthermore, capital law of motion must be $\phi'(\ ) > 0$, $\phi''(\ ) \leq 0$ with $\phi'(\delta) = 1$, and adjustment cost function in steady state are equal to capital depreciation rate, $\phi(\delta) = \delta$.

The utility function takes a separable one:

$$U\left(\bullet\right) = \frac{\upsilon_t^c C_t^{1-\sigma}}{1-\sigma} - \frac{\upsilon_t^N N_t^{1+\varphi}}{1+\varphi}$$

υ_t^c, υ_t^N are idiosyncratic shocks of preference that hits consumption and labor. The taxation effect on Ricardian households can be seen in the Euler equation that is shocked by preference shocks.

Optimality conditions are:

$$1= \beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}\left(R_t\frac{P_t}{P_{t+1}}\right)\right) \tag{4}$$

$$1=\beta E_t\left(\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{S_{t+1}}{S_t}\left(\Phi\left(\frac{S_t B_t^*}{P_t Y_t}\right)R_t^*\right)\frac{P_t}{P_{t+1}}\right)\right) \tag{5}$$

The Euler equation is:

$$C_t^{o^{-\sigma}} =\beta E_t\left(C_{t+1}^{o^{-\sigma}} R_t\left(\frac{P_t}{P_{t+1}}\right)\left(\frac{1+\tau_t^c}{1+\tau_{t+1}^c}\right)\left(\frac{\upsilon_{t+1}^c}{\upsilon_t^c}\right)\right) \tag{6}$$

Capital shadow price, Tobin's Q, is given by:

$$Q_t = \frac{1}{\phi'(\bullet)}$$

$$Q_t = \beta\left(\frac{\lambda_{t+1}}{\lambda_t}\left(Z_{t+1}\left(1-\tau_{t+1}^K\right)+Q_{t+1}\left(\left(1-\delta\right)+\phi\left(\frac{I_{t+1}^o}{K_{t+1}^o}\right)-\phi'\left(\frac{I_{t+1}^o}{K_{t+1}^o}\right)\frac{I_{t+1}^o}{K_{t+1}^o}\right)\right)\right) \tag{7}$$

Moreover, we have two options for the labor market structure: first, a competitive labor market where each household choose labor supply given the market wage and; second, wages can be fixed by unions[3]. Then, in the last case, wages can be determined by households.

Therefore, labor supply is influenced not only by taxes on consumption and work, but also is affected by preference of idiosyncratic shocks.

$$N_t^{o^{\varphi}} C_t^{o^{\sigma}} = W_t\frac{\left(1-\tau_t^N\right)}{\left(1+\tau_t^c\right)}\frac{\upsilon_t^c}{\upsilon_t^N} \tag{8}$$

[3] Bénassy (2002) ch 5.

3.1.2 *Rule – of – Thumb households*

This type of households only receives income labor for their work. So, not only they consume all of their labor income, but also they don't save. Additionally, they don't have access to the capital markets.

They have a utility function:

$$U\left(C_t^r, N_t^r\right) \tag{9}$$

Subject to:

$$P_t\left(1+\tau_t^c\right)C_t^r = P_t\left(1-\tau_t^N\right)W_t N_t^r \tag{10}$$

3.2 Demand goods

In order to find the good market equilibrium we need to differentiate domestic and foreign consume. Following Gali and Monacelli (2005), consumption takes a CES form.

$$C_t = \left((1-\alpha)^{\frac{1}{\eta^c}} \left(C_{H,t}\right)^{\frac{\eta^c-1}{\eta^c}} + \alpha^{\frac{1}{\eta^c}} \left(C_{F,t}\right)^{\frac{\eta^c-1}{\eta^c}} \right)^{\frac{\eta^c}{\eta^c-1}} \tag{11}$$

Where $C_{H,t}$, $C_{F,t}$ are consumption of domestic and foreign goods[4] and take a CES form and the Dixit – Stiglitz aggregators of imported and domestic goods are:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta^c} C_t \tag{12}$$

$$C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta^c} C_t \tag{13}$$

and we imposed that the aggregate price level is given by:

[4] We didn't take into account imported goods because we use the New Keynesian Phillips Curve, and put imported goods in the production function and it takes the CES form. So, effects of imported prices affect directly to the NKPC.

$$P_t = \left((1-\alpha)(P_{H,t})^{1-\eta^c} + \alpha (P_{F,t})^{1-\eta^c} \right)^{\frac{1}{1-\eta^c}} \quad (14)$$

So, when $P_{F,t} = P_{H,t}$, α is the proportion for domestic goods given the imported goods. α is the natural open index.

3.3 Aggregation

Aggregation is as follows: Total consumption is the sum of Ricardian households and rule – of – thumb. The total number of hours worked is the same as total consumption and λ is the share of rule – of – thumb.

$$C_t = \lambda C_t^r + (1-\lambda) C_t^o \quad (15)$$

$$N_t = \lambda N_t^r + (1-\lambda) N_t^o \quad (16)$$

Since only Ricardian consumers have access to the capital market, investment and capital stock market are given by:

$$I_t = (1-\lambda) I_t^o \quad (17)$$

$$K_t = (1-\lambda) K_t^o \quad (18)$$

Domestic and foreign assets, including fiscal debt B_t^{G*} are given by:

$$B_t = (1-\lambda) B_t^o \quad (19)$$

$$B_t^* = B_t^{G*} + (1-\lambda) B_t^{o*} \quad (20)$$

3.4 Firms

There exists a continuum set of competitive monopolistic firms. All of them produce only intermediate goods; but production factors are competitive. In particular, final goods are produced by constant return technology (CES production function).

$$Y_t = \left(\int_0^1 Y_t(j)^{\frac{\varepsilon_p - 1}{\varepsilon_p}} dj \right)^{\frac{\varepsilon_p}{\varepsilon_p - 1}} \quad (21)$$

$Y_t(j)$ is the quantity of intermediate goods used as input. So, intermediate goods demand is given by Dixit – Stiglitz aggregator:

$$Y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon_p} Y_t \tag{22}$$

And prices are given by:

$$P_t = \left(\int_0^1 P_t(j)^{1-\varepsilon_p}\, dj\right)^{\frac{1}{1-\varepsilon_p}} \tag{23}$$

3.4.1 Intermediate Goods

We assume a continuum set of monopolistic firms. In order to put the pass- through in the price equation, HNKPC, we use imported price goods as input. Our production function takes a CES form with M and N as inputs.

$$Y_t(j) = A_t\left(\alpha_M M(j)_t^{\frac{\sigma_S-1}{\sigma_S}} + \alpha_N N(j)_t^{\frac{\sigma_S-1}{\sigma_S}}\right)^{\frac{\sigma_S}{\sigma_S-1}} \tag{24}$$

A_t is the technology and technology shock act through this, and σ_s is the elasticity of substitution between imported goods and work. Both of them are greater than zero. Intermediate imported goods are $M(j)_t$ [5].

Given that the real price of factors P_t^M and W_t, the equilibrium through a minimization cost is:

$$\frac{W_t}{P_t^M} = \frac{\alpha}{1-\alpha}\left(\frac{M(j)_t}{N(j)_t}\right)^{\frac{1}{\sigma_s}} \tag{25}$$

Marginal cost is given by:

$$MC = (1-\alpha)^{\frac{2\sigma_S-1}{\sigma_S}}\left(P_t^M\right)^{1-\sigma_S} + (\alpha)^{\frac{2\sigma_S-1}{\sigma_S}}\left(W_t\right)^{1-\sigma_S} \tag{26}$$

[5] Intermediate firms' aggregation also takes a CES form.

3.1.5 Price setting

Following Calvo (1983), (1-θ) is the fraction of firms that reset its price optimally each period believing that the price chosen will be optimally t periods ahead. While a fraction θ keep their prices unchanged. Based on Galí and Gertler (1999), we can put in the optimal price a fraction of firms that reset their prices forward – looking, (1-ω). At the same time, a fraction ω set prices backward – looking. This set of firms reset their prices based on the optimal price and inflation in t-1.

$$Max\sum_{k=0}^{\infty}\theta^{k}E_{t}\left\{\Lambda_{t,t+k}\left(P_{t}^{f*}(j)Y_{t+k}(j)-\Psi_{t+k}\left(Y_{t+k}(j)\right)\right)\right\} \tag{27}$$

Subject to

$$Y_{t+k}(j)=\left(\frac{P_{t}^{f*}(j)}{P_{t+k}}\right)^{-\varepsilon_{p}}Y_{t+k} \tag{29}$$

The cost function is $\Psi_{t+k}\left(Y_{t+k}(j)\right)$ and P_{t}^{f*} must satisfy the first order condition:

$$\sum_{k=0}^{\infty}\theta^{k}E_{t}\left\{\Lambda_{t,t+k}Y_{t+k}\left(P_{t}^{f*}(j)-\mu\ \varphi_{t+k}(j)\right)\right\}=0 \tag{30}$$

Where $\mu=\frac{\varepsilon_{p}}{\varepsilon_{p}-1}$ is the gross *mark – up* when inflation is zero in steady state and nominal marginal cost is given by $\varphi_{t+k}(\bullet)=\Psi_{t+k}^{'}(\bullet)$. Furthermore, factor discount is given by:

$$\Lambda_{t,t+k}=\beta^{k}E_{t}\left(\frac{C_{t+1}^{o^{-\sigma}}}{C_{t}^{o^{-\sigma}}}\left(\frac{P_{t}}{P_{t+1}}\right)\left(\frac{1+\tau_{t}^{c}}{1+\tau_{t+1}^{c}}\right)\left(\frac{\upsilon_{t+1}^{c}}{\upsilon_{t}^{c}}\right)\right) \tag{31}$$

In steady state we can get $\Lambda_{t,t+k}=\beta^{k}$. Moreover, to complete the dynamic price we must use the following equation.

$$P_{t}=\theta P_{t-1}+(1-\theta)P_{t}^{*} \tag{32}$$

$$P_{t}^{*}=(1-\omega)P_{t}^{f*}+\omega P_{t}^{b*} \tag{33}$$

$$P_{t}^{b*}=P_{t-1}^{*}+\pi_{t-1} \tag{34}$$

3.5 Monetary Policy

Since Bolivia doesn't have common policy instruments, monetary interest rate rule, we can model monetary policy by Taylor Rule and taking care of exchange rate and output. This type of rule was used by Schmith – Hebbel and Tapia (2002) and Caputo et. al. (2006)

$$i_t = \psi_i i_{t-1} + (1-\psi_i)(\psi_\pi \pi_t + \psi_y y_t + \psi_{\Delta s} \Delta s_t) + \upsilon_t^m \quad (35)$$

We use open market operations interest rate as proxy, i_t is the interest rate, that is a monetary policy tool, ψ_π and ψ_y are responses of the monetary authority to deviations of inflation and GPD growth of their natural level. $\psi_{\Delta s}$ shows response to nominal exchange rate deviations.

3.6 Fiscal Policy

Government budget constraint and taxes revenues are given by:

$$P_t G_t = \tau_t^c P_t C_t + \tau_t^N P_t N_t + (1-\lambda)\tau_t^D D_t^o + R_t^{-1} B_{t+1} + S_t \left(\Phi\left(\frac{S_t B_t^*}{P_t Y_t}\right) R_t^* \right)^{-1} B_{t+1}^{G*} - B_t - S_t B_t^{G*} \quad (36)$$

$$\tau_t^{N,D}\left(P_t Y_t - P_t I_t + \left(P_t^F - S_t P_t^{F*}\right) Y_t^F\right) \quad (37)$$

3.6.1 Fiscal Rules

Galí et. al. (2007) proposed a fiscal rule where taxes revenues are equal to government expenses. Let's define $g_t = \frac{G_t - G}{Y}$, $t_t = \frac{T_t - T}{Y}$ and bonds as $b_t = \frac{\left(\frac{B_t}{P_{t-1}}\right) - \frac{B}{P}}{Y}$. So, according to this rule, taxes adjust whenever debt or spending change.

Fiscal rules applied are a generalization of García and Restrepo (2007).

$$\tau_t^c P_t C_t + \tau_t \left(P_t Y_t - P_t I_t + \left(P_t^F - S_t P_t^{F*}\right) Y_t^F\right) = \phi_b B_t + \phi_g P_t G_t \tag{38}$$

Allowing $\phi_g = 1$ and $\phi_b = 0$, the government budget constraint is in equilibrium, and in order to hold it taxes must adjust in every period.

$$\tau_t^c P_t C_t + \tau_t \left(P_t Y_t - P_t I_t + \left(P_t^F - S_t P_t^{F*}\right) Y_t^F\right) = \phi_g P_t G_t \tag{39}$$

3.7 Market clearing condition

Market clearing conditions are given by:

$$N_t = \int_0^1 N_t(j)dj \tag{40}$$

$$M_t = \int_0^1 M_t(j)dj \tag{41}$$

$$Y_t = C_t + I_t + G_t + XN_t \tag{42}$$

And equilibrium in the economy is given by:

$$P_t\left(C_t + I_t + G_t\right) = P_t Y_t + P_t^F Y_t^F - S_t P_t^{F*} Y_t^F + S_t \left(\Phi\left(\frac{S_t B_t^*}{P_t Y_t}\right) R_t^*\right)^{-1} B_{t+1}^* - S_t B_t^* \tag{43}$$

3.8 Closing the model

In order to close the model we must use the following equations:

Real exchange rate

$$RER_t = \frac{S_t P_t^{F*}}{P_t} \tag{44}$$

Interest rate

$$inom_t = r_t + \pi_{t+1} \tag{45}$$

Uncovered interest parity

$$r_t - \pi_{t+1} = r_t^* + s_{t+1} - s_t \tag{46}$$

3.9 Stochastic exogenous process

Many shocks hit the economy:

Preference shocks

$$\upsilon_t^c = \rho^c \upsilon_{t-1}^c + \varepsilon_t^c \tag{47}$$

$$\upsilon_t^N = \rho^N \upsilon_{t-1}^N + \varepsilon_t^N \tag{48}$$

Technology shocks

$$a_t = \rho^a a_{t-1} + \varepsilon_t^a \tag{49}$$

Monetary shocks

$$\upsilon_t^m = \rho^m \upsilon_{t-1}^m + \varepsilon_t^m \tag{50}$$

Fiscal spending shocks

$$g_t = \rho^g g_{t-1} + \varepsilon_t^g \tag{51}$$

Foreign interest rate shocks

$$r_t^* = \rho^{r*} r_{t-1}^* + \varepsilon_t^{r*} \tag{52}$$

Foreign prices shocks

$$p_t^{F*} = \rho^{p^{F*}} p_{t-1}^{F*} + \varepsilon_t^{p^{F*}} \tag{53}$$

Where ρ^i represent shocks persistence ε_t^i and follows a normal distribution with zero mean and variance $\sigma_{i,t}^2$, $i = \upsilon^c, \upsilon^N, a, \upsilon^m, g, r^*, p^{F*}$ and innovations are not correlated.

4. Data and calibration

We use the following series: consumption, GDP, investment, fiscal spending, net exports, tax rate, real remuneration, total population working, Bolivian real interest rate, open market operations interest rate, nominal and real exchange rate, inflation, domestic and external debt; and foreign interest rate.

Log – linearization technique requires all variables must be log – deviations from steady state[6], so it's necessary use some steady state measure[7], but there is not theory that supports the steady state, e.g. GDP, should be a moving average weighted, which is HP's outcome. In this sense, all variables are hit by shocks and it produces changes in business trend – cycles, therefore, high frequency band pass filter proposed by Christiano & Fitzgerald (1999), which is unvaried method, allow us to incorporate business cycles and isolate short or long run movements privileging business cycles defined by the researcher.

Alternatively, we can use the Nadaraya – Watson non – parametric filter. So, if we understand seasonality as systematic movement, no necessary regular, produced in the year, Hylleberg (1992); the problem is, how to treat it? First, there is a group of economists that believe that seasonality must be eliminated; second, another group point out that seasonality is known by economic agents and they will make their decisions according to these; consequently, it should be an error to eliminate seasonality in an economic research.

In this sense, to isolate seasonality components, we have a lot of methods and procedures and it performs depend on what we are looking for: a) an effortless filter which use regression with dummy variables; b)Box – Jenkins (1976) difference seasonality filter; c) ARIMA X-11 and X-12 filter; d) TRAMO/SEAT filter.

[6] In dynamic stochastic general equilibrium models we must understand that it refers to the natural level where there is no market frictions

[7] Hodrick y Prescott filter is generally accepted

Based on Bianchi (1997), we applied ARIMA X-12 which discomposes series under an additive background. Trend – cycle component can be obtained using ARIMA X-12, so we can apply a kind of filter like HP to get the cycle and long run trend.

Steady states of variables and calibrated parameters are listed in tables 1 and 2. The following steady states are obtained using Christiano Fitz Gerald filter: C/Y, I/Y, G/Y, X/Y, M/Y, G/C, P^f/P, Y^f/Y, RER, N, W, inflation and tax pressure. Country risk premium is calibrated using Corp *Banca* Group average qualification to Bolivia. At the same time, consumption, labor and capital taxes are taking from Bolivian tax structure.

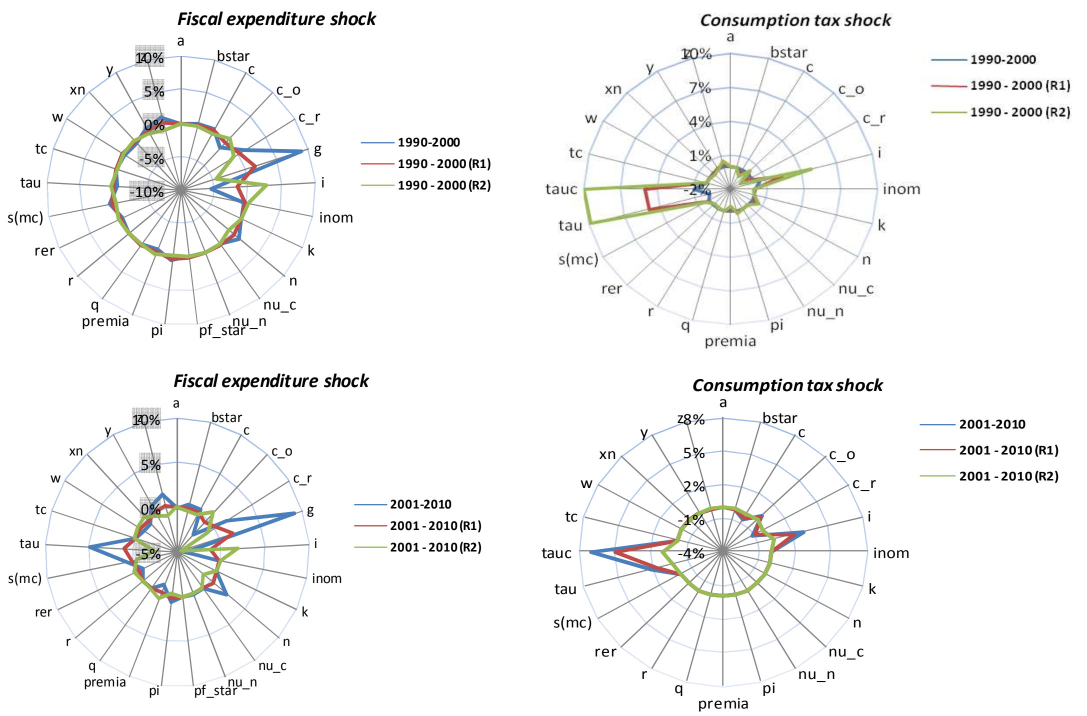
Hybrid New Keynesian Phillips Curve parameters are obtained from Valdivia (2008) taking care of contemporaneous pass – through similar to other papers for Bolivia, before 2005. Moreover, Taylor rule, which takes the responses of the Central Bank to variations of nominal exchange rate, is estimated by General Method of Moments (GMM). Results of the GMM procedure gave us consistency when the Central Bank is worried about exchange rate movements, in our case crawling – peg system.

Nominal interest rate calibration is based on the Central Bank of Bolivia Monetary Report (January, 2008). Besides, Bolivia population structure of Ricardian households and rule – of – thumb households are taking of National Statistical Institute household's surveys. The last parameters are standard in economic literature

5. Effects of fiscal shocks

Results are showed between the two periods, figure 1. In the subsequent figures are showed the impulse response functions, the stochastic movement are explained by the presence of different shocks and their correlations. The first, 1990 - 2000, shows the effects of fiscal and consumption tax shocks. GDP, consumption, investment and current account responds much more in the presence of the first fiscal rule 0.12%, 0.23% and -0.19%, respectively; additionally prices increases 0.25%. In the second period, 2001 – 2010, the fiscal policies multiplier effect are greater than in the first one, GDP is 0.02% greater, and the distributional effects inside consumption in favor of rule-of-thumb household is better through and increase in fiscal revenue, tax pressure. These results are explained by the realization of fiscal surpluses since 2006. This result reinforces the driving force and multiplier and the effect of fiscal policy on the fundamentals. In the presence of the first fiscal rule, the multiplier effect of fiscal policy has distributional effects, especially on households.

Figure 1
Effects of fiscal shocks between periods
(Response in t=0)



Fiscal rules reduce exogenous shocks effect on the economy. Figure N° 2, shows how fiscal shock hits the economy and how the model reacts without fiscal rules. In this case, domestic debt, foreign debt, total consumption, rule – of –thumb households, ricardian households, investment, capital, nominal interest rate, labor, Tobin's Q, inflation, country risk premium, real interest rate, real exchange rate, marginal cost, tax pressure, nominal exchange rate, wages, net exports, capital price and output (GDP) reacts.

If we consider positive shocks in all exogenous variables, we can expect that variables are hit by the fiscal shock and other shocks; they generate movements that produce oscillations in impulse responses functions. For that reason, once the fiscal expenditure shock hit the economy, the model structure, with lags, allows oscillations in variables due to they are hit by other shocks.

In the whole period, we can observe that fiscal spending shock has positive effect over total consumption, as a consequence of agent's structure, figure N° 1. As we expected, rule – of – thumb households reacts in a positive manner explained, 0.38%, by an increase in the real interest which reduces Ricardian household's consumption, -0.26%. GDP increases, 0.13%, inflation increase, 0.19%, through the firms channel cost.

The multiplier effect of fiscal spending shock is reflected in new levels of foreign debt, it increases in 11%, which has effects on variables taking in the model. As a consequence of increases in price of factors, labor supply increases, 0.35%, explained by hand – to – mouth households. On the other hand, there is a nominal appreciation of exchange rate, 0.01%, as an effect of inflation increases greater than interest rate increase. At the same time, since price increases are greater than nominal exchange rate depreciation, it turns out a weaker real exchange rate appreciation, 0.21%; so net exports are affected negatively, 0.21%, but over the time it recovers to its natural level and is led by exchange rate movement.

Shadow price of capital, Tobin's Q, falls as a consequence of negative effect of fiscal spending shock, 0.0019%. This result is consequence of increases in prices that are greater than increases in real interest rate and capital price. Moreover, country risk premium falls in 0.23%, and foreign debt increase is greater than output and inflation increases. Finally, since output increases, pressure tax is pushed up by output movements, 0.53%.

Figure N° 1, also shows how the model reacts to the second fiscal rule, when only taxes act, and how it helps to reduce the effect the fiscal spending shocks. In this case, since the economy is hit by fiscal expenditure shock, it reduces the tax pressure, 1.06% and the economy decrease approximately 0.36%.

Impulse response structure is the same as the first fiscal rule, but magnitudes are different. The most relevant results are: a) the increase of total consumption is greater than the first one; b) since the increase in factor prices is greater than the first one, marginal cost is higher and pass – through to inflation increases are more than in the first case; c) since inflation increases, the Central Bank responses aggressively through increases nominal interest rate, so investment contraction is higher than depreciation in nominal exchange rate in order to moderate inflation imported.

Finally, in the case of Bolivia we need to know, what of the two fiscal rules have more stabilizing effects against to a fiscal spending shock? In figure N° 1, we compare results obtained above with a canonical model that doesn't have a fiscal rule.

In all outcomes obtained above, the first fiscal rule, when taxes act against to new external debt in order to generate more fiscal spending, has more stabilizing effects. In particular, the effect of fiscal spending shock on inflation is moderated around 50% of the total effect.

Despite of the fiscal shock effects on output is sacrificed, and all variables which are influenced by it. In terms of welfare, the result obtained above is preferable because rule-of-thumb households are better and the fiscal policy applied success in terms of distributional effects

6. Conclusions

We developed a canonical model according to new macroeconomic vintage called new Keynesian models with imperfect competition in the determinacy of inflation.

Based on dynamic stochastic general equilibrium model, we looked for to compare the fundamentals performance when they are shock by fiscal shocks in two periods 1990 – 2000 and 2001 - 2010. We used two types of fiscal rules: first, taxes adjust according to debt level and government spending, therefore debt plays a central role; second, a budget balanced – zero debt – where taxes adjust every time in order to keep equilibrium.

Consequently, after computing and simulating our three models, two of them with different fiscal rules and one without fiscal rule, our results can be summarized as follows: a) an increase in GPD, 0.02%, greater than in the first period, an increase in consumption of rule – of – thumb households, 0.1%; b) since marginal cost increased, through HNKPC, inflation raises more than expected, and Central Bank must react through raising the monetary policy interest rate leading investment to diminish in the short run, -1.06%, so as to reduce inflation pressures, 0.25% to 0.19%.

Finally, the most important result is how the first fiscal rule has more stabilizing effects over the fundamentals and overall in the model than the second one when we consider a budget balanced getting zero debt level, in the two periods analyzed. Inflation reduces around 50% as a consequence of applying the fiscal rule.

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Table N° 2

Steady States

	C_Y	G_Y	I_Y	M_Y	X_Y	TCR	PF_P	yf_y	tau_c	g_c	t_y
1990-2000	0,7672	0,1340	0,1707	0,2784	0,2051	0,9541	0,4596	1,9410	0,1564	0,1750	0,1197
2001-2010	0,6736	0,1509	0,1490	0,3070	0,3360	1,0104	0,5627	1,8495	0,2976	0,2249	0,1961

Table N° 3

Basic Parameters

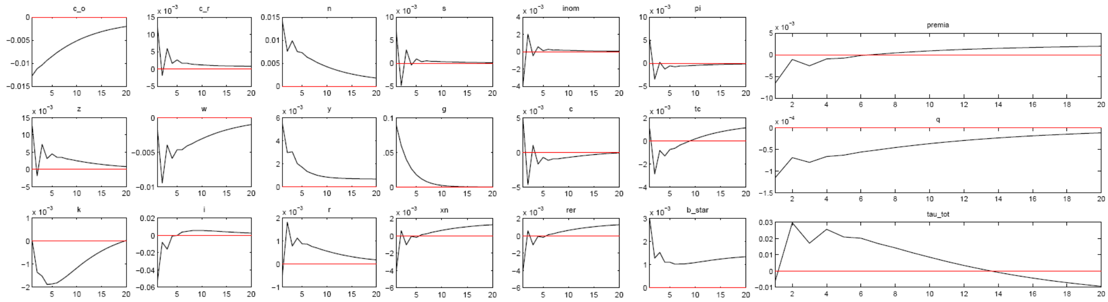
σ Risk aversion coefficient	2
τ^c consumption tax rate	20%
τ^n Labor tax rate	13%
τ^k Capital tax rate	40%
λ Weight of rule – of – thumb households	0.7
φ Marginal elasticity of labor disutility	1.7
υ^c Consumption idiosyncratic shock in ss	1
υ^n Labor idiosyncratic shock in ss	1
δ Depreciation rate	0.25
η Investment elasticity to Q	1
Π Inflation in ss	2.18% - 1.14%
η^x RER elasticity exports	1
α Capital share in CES production function	0.61
ξ^f HNKPC forward parameter	0.4966
ξ^b HNKPC backward parameter	0.4581
λ_π HNKPC marginal cost parameter	0.4852
χ_{mc} HNKPC foreign *pass-through*	0.4278
σ_s CES Substitution elasticity	2
ψ_i Taylor rule inertial interest rate component	0.84 – 0.91
ψ_π Taylor rule inflation component	2.14 – 3.42
ψ_y Taylor rule output component	0.023 – 0.046
ψ_s Taylor rule nominal Exchange rate variation comp	8.94 – 6.13

Figure N° 2

Fiscal Shock Impulse Responses

No Rule

1990-2000



2001-2010

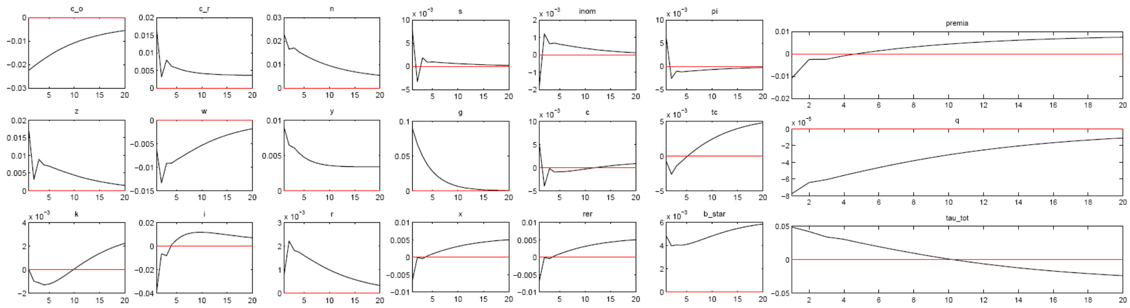
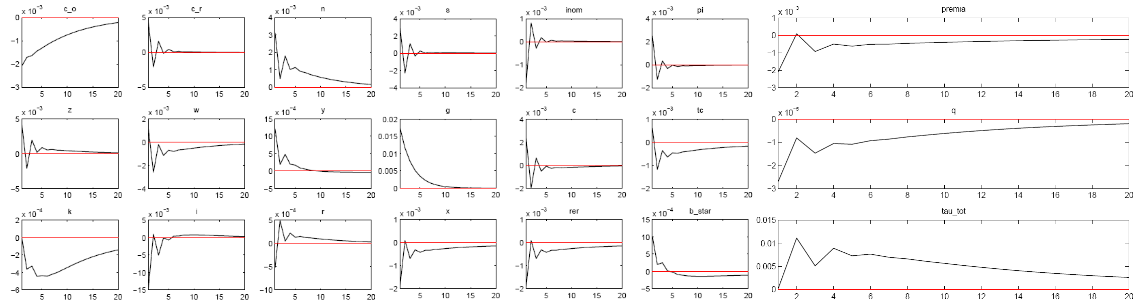


Figure N° 3

Fiscal Shock Impulse Responses

Rule 2

1990-2000



2001-2010

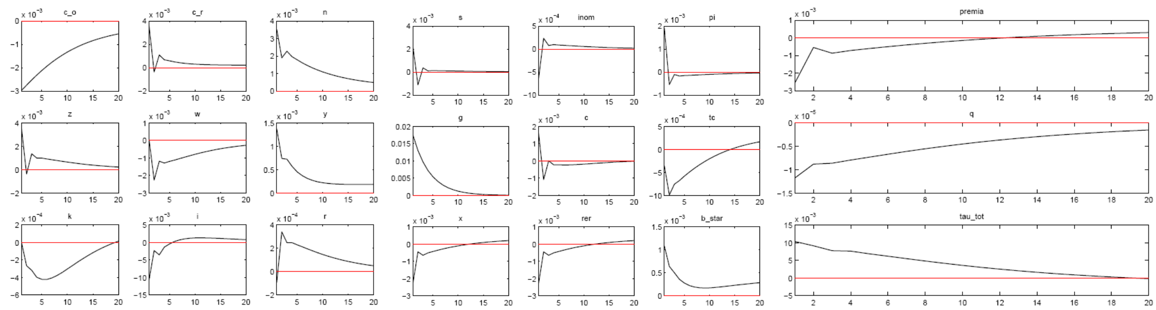
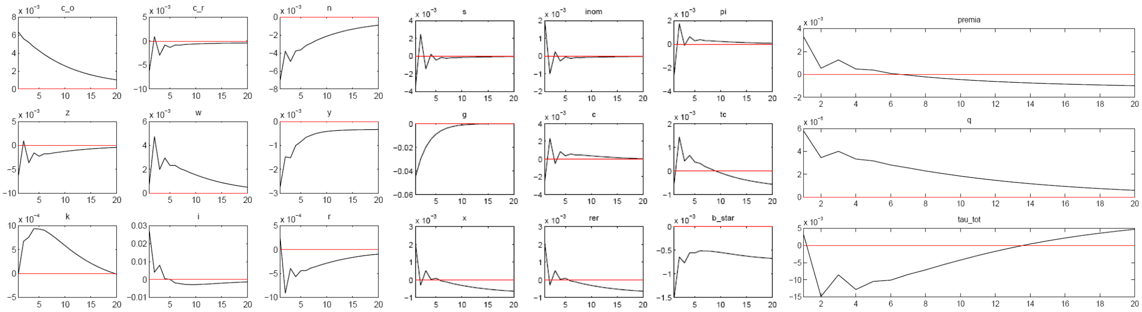


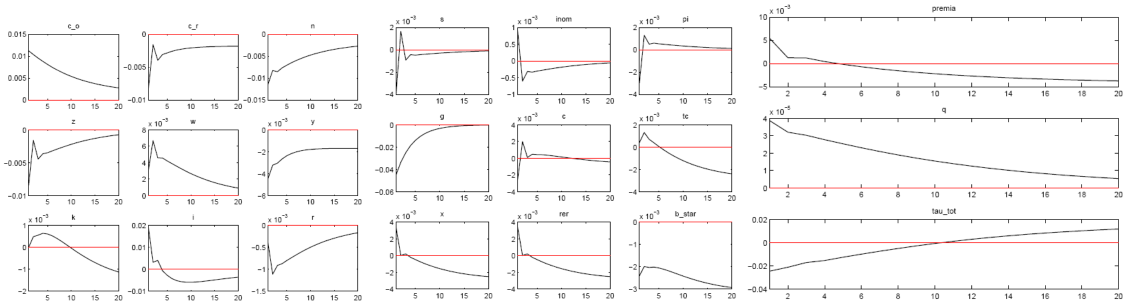
Figure N° 4
Fiscal Shock Impulse Responses

Rule 2

1990-2000



2001-2010



R1 rule 1, R2 rule 2 and "C" represent the canonical model without rule

Appendix A

Log – linearized Model

Log- linearized model solution around the steady state is:

Ricardian and rule-of-thumb households:

$$c_t^o = c_{t+1}^o - \frac{1}{\sigma}\left[r_t - \hat{\pi}_{t+1} + \upsilon_{t+1}^c - \upsilon_t^c - \left(\frac{\tau^c}{1+\tau^c}\right)\Delta\hat{\tau}_{t+1}^c \right]$$

$$c_t^r = w_t - n_t - \left(\frac{\tau^N}{1-\tau^N}\right)\hat{\tau}_t^N - \left(\frac{\tau^c}{1+\tau^c}\right)\hat{\tau}_t^c$$

Aggregation of consumption:

$$c_t = \lambda c_t^r + (1-\lambda)c_t^o$$

Labor supply:

$$w_t = \left(\frac{\tau^N}{1-\tau^N}\right)\hat{\tau}_t^N + \left(\frac{\tau^c}{1-\tau^N}\right)\frac{N^{\varphi}C^{o\sigma}}{W\ \upsilon^c / \upsilon^N}\hat{\tau}_t^c + \upsilon_t^N - \upsilon_t^c + \varphi n_t + \sigma c_t^o$$

Interest rate and investment return are given by:

$$r_t = \left(\frac{R+\delta}{1+R}\right) z_{t+1}$$

$$q_t = \left(\frac{1-\delta}{1+R} + \left(\frac{\eta-1}{1+R}\right)\delta\Pi\right) q_{t+1} + (1-\tau^k)\left(\frac{R+\delta}{1+R}\right)\Pi\, z_{t+1} - \left(\frac{R+\delta}{1+R}\right)\Pi\,\tau^k\,\hat{\tau}_{t+1}^k$$
$$- \left((1-\tau^k)\left(\frac{R+\delta}{1+R}\right) + \left(\frac{1-\delta}{1+R}\right)\right)\Pi\left(r_t - \hat{\pi}_{t+1}\right)$$

Capital law of movement:

$$k_{t+1} = (1-\delta)k_t + \delta i_t$$

Equilibrium:

$$y_t = \frac{C}{Y}c_t + \frac{I}{Y}i_t + \frac{G}{Y}g_t + \frac{XN}{Y}xn_t$$

Labor, investment, capital and debt aggregation are given by:

$$n_t = \lambda n_t^r + (1-\lambda)n_t^o$$
$$i_t = i_t^o$$
$$k_t = k_t^o$$
$$b_t = b_t^o$$
$$b_t^* = b_t^{G^*}(1-\lambda)b_t^{o^*}$$

The economy constraint:

$$\Phi b_t^* = \frac{1}{R^*}b_{t+1}^* + y_t - \frac{C}{Y}c_t - \frac{I}{Y}i_t - \frac{G}{Y}g_t + \frac{P^F}{P}\frac{Y^F}{Y}p_t^F + \left(\frac{P^F}{P} - RER\right)\frac{Y^F}{Y}y_t^F$$
$$- RER\frac{Y^F}{Y}rer_t - \left(\frac{P^F}{P}\frac{Y^F}{Y} + \left(\frac{1}{R^*} - \Phi\right)\right)p_t + \left(\frac{1}{R^*} - \Phi\right)s_t - \frac{1}{R^*}\hat{\phi}_t$$

Country risk premium:

$$\hat{\phi}_t = s_t - p_t + b_t^* - y_t$$

Foreign production function

$$y_t^F = \rho^{yf} y_{t-1}^F + \varepsilon_t^{yf}$$

Exports:

$$x_t = \eta^x rer_t + c_t^*$$

Real Exchange rate:

$$rer_t = s_t + p_t^{F^*} - p_t$$

Labor and consumption shocks:

$$\upsilon_t^c = \rho^c \upsilon_{t-1}^c + \varepsilon_t^c$$

$$\upsilon_t^N = \rho^N \upsilon_{t-1}^N + \varepsilon_t^N$$

Technological shock

$$a_t = \rho^a a_{t-1} + \varepsilon_t^a$$

Monetary shock

$$\upsilon_t^m = \rho^m \upsilon_{t-1}^m + \varepsilon_t^m$$

Fiscal shock

$$g_t = \rho^g g_{t-1} + \varepsilon_t^g$$

Foreign interest rate shock

$$r_t^* = \rho^{r^*} r_{t-1}^* + \varepsilon_t^{r^*}$$

Foreign prices shock

$$p_t^{F^*} = \rho^{p^{F^*}} p_{t-1}^{F^*} + \varepsilon_t^{p^{F^*}}$$

Taxes shock

$$\tau_t^c = \rho^{\tau^c} \tau_{t-1}^c + \varepsilon_t^{\tau^c}$$

$$\tau_t^k = \rho^{\tau^k} \tau_{t-1}^k + \varepsilon_t^{\tau^k}$$

$$\tau_t^N = \rho^{\tau^N} \tau_{t-1}^N + \varepsilon_t^{\tau^N}$$

Firm's decisions

$$n_t - m_t = p_t^m - w_t$$

Production function is given by

$$y_t = a_t + \alpha m_t + (1-\alpha) n_t$$

The Hybrid New Keynesian Phillips Curve

$$\pi_t = \xi^f \pi_{t+1} + \xi^b \pi_{t-1} + \lambda_\pi mc_t + \rho\left(p_t^{F^*} + s_t + w_t\right)$$

Marginal Costs are given by

$$mc_t = (1-\chi_{mc})(\sigma_s - 1) w_t + \chi_{mc}(\sigma_s - 1) p_t^m - a_t$$

Monetary policy rule

$$inom_t = \psi_i inom_{t-1} + (1-\psi_i)(\psi_\pi \pi_t + \psi_y y_t + \psi_{\Delta s} \Delta s_t) + \upsilon_t^m$$

Fisher's equation

$$inom_t = r_t + \pi_{t+1}$$

Uncovered interest parity

$$r_t - \pi_{t+1} = r_t^* + s_{t+1} - s_t$$

Fiscal Rule 1

$$\tau^c(\hat{\tau}_t^c + c_t)\frac{\tau}{C}\hat{\tau}_t = \phi_b \frac{b}{C} b_t + \phi_g \frac{G}{C} g_t$$

$$\frac{\tau}{Y}\hat{\tau}_t = y_t + \frac{I}{Y} i_t + \frac{P^F}{P}\frac{Y^F}{Y}\left(p_t^F - p_t + y_t^F\right) - RER\frac{Y^F}{Y}\left(rer_t + y_t^F\right)$$

Fiscal Rule 2

$$\tau^c(\hat{\tau}_t^c + c_t)\frac{\tau}{C}\hat{\tau}_t = \phi_g \frac{G}{C} g_t$$