Impulse on the Aggregate Demand in Bolivia through the coordination of the Monetary and Fiscal Policy in crisis time1

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Impulse on the Aggregate Demand in Bolivia through the coordination of the Monetary and Fiscal Policy in crisis time[1]

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SUMMARY

At the end of 2014, the Bolivian economy, despite facing negative external shocks (falling oil prices), registered a high economic growth in the region of Latin America. Monetary policy was aimed at keeping the government bond rate close to zero and raising liquidity levels in the economy (monetary policy expansive). On the part of the government, the two main sources of income of the nonfinancial public sector (SPNF) are: i) tax revenues and ii) the sale of hydrocarbons (gas), at that time Bolivia's fiscal policy was countercyclical To the behavior of the Latin American Product (increases in fiscal expenditure in infrastructure). These antecedents, aid to the interest of the study of the coordination of the economic policy in Bolivia. The structure of a Dynamic Stochastic General Equilibrium Model (DSGE) helps us to understand the transmission channels of shocks (in Taylor rule, Phillips curve and public investment) and how the monetary and fiscal policy reacts to these shocks.

JEL classification: E42, E58, E62, E63

Key Words: Bayesian Estimation, Monetary Policy, Fiscal Policy, Dynamic Stochastic General Equilibrium Model (DSGE).

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INTRODUCTION

This paper intends to understand the behavior of monetary and fiscal policy in Bolivia and its effect on the behavior of certain variables aggregated in the short and medium term, through a Dynamic Stochastic General Equilibrium Model (DSGE).

Since the end of 2012 until July 2014, the position of the Central Bank of Bolivia maintained a contractive position to prevent inflationary effects, however from mid-2014 the orientation of monetary policy changed to be expansive due to the slowdown in global activity economic growth in recent years and lower oil prices.

The position of fiscal policy in recent years in Bolivia plays a favorable role for the Bolivian economy. The result of the nonfinancial public sector (SPNF) until the mid-2000s is a deficit, reporting a deficit of 1,735.86 million Bs (2005), but since 2006 the fiscal result of the SPNF reports a surplus, to despite this, in fiscal year 2014 the fiscal balance again reported a deficit of -7,669.18 million Bolivians, this is due to the fact that the fiscal sector received lower revenues from the sale of hydrocarbons to the foreign market (the capture of revenues from the sale of gas in the last Quarter of 2014 decreased because the price of oil decreased, consequently by contracts the price of gas also fell).

Despite the different external shocks to the Bolivian economy, it is important to quantify the effects of the monetary policy instruments (interest rate) and to highlight the fiscal policy position (public investment) on consumption and investment, the results of the document suggest positive effects on Bolivia's economic growth, despite lower revenues from the non-financial public sector, stability was achieved at the price level, and finally incentives for investment during the period of analysis (2001 - 2016).

LITERATURE REVIEW

The interaction or coordination of monetary and fiscal policy is important for the macroeconomic stability of a country. Because the results of the coordination are reflected in a desirable price stability within the central bank's inflation targets and the economic growth stimulated by a fiscal expenditure for infrastructure (capital spending).

On the other hand, monetary policy impacts on the behavior of the interest rates of an economy, the observed inflation and the inflationary expectations of the economic agents, these events have direct effects on fiscal variables (for example the sustainability of debt that contracts in the public sector). On the other hand, fiscal policy also affects monetary policy instruments. Leeper (1991) shows that the government budget constraint imposes several restrictions on fiscal and monetary variables, this fiscal theory of the price level (FTPL), indicates that the Present value of the budget determines the equilibrium of the price level.

Hanif and Farooq (2008), classify several reasons why coordination between fiscal and monetary policy is necessary:

• Establish objectives of consistent and mutually aligned domestic monetary and fiscal measures towards stable non-inflationary growth.
• Facilitate the effective implementation of previous decisions taken to achieve the established objectives of monetary and fiscal policy by exchanging information and conducting targeted consultations in that direction.
• Influencing monetary and fiscal policy to adopt sustainable policies.

Leeper E. (1990). Studies the behavior of fiscal and monetary policy through a stochastic model, imposes a fiscal rule in relation to the fiscal collection and its reaction to the debt by the government and inserts the reaction of the nominal interest rate against changes in inflation. The result found in the research suggests that changes in fiscal behavior (determination of optimal debt) determine how monetary shocks affect the price level.

Baxter M. and King B. (1993). Analyzing fiscal spending in a context of general equilibrium with price flexibility, the results indicate that permanent changes in government spending have important effects on economic activity, when these expenses are financed with lump sum taxes.

Blanchard O. and Perotti (2002). They use a Vector Autoregressive (VAR) model, to quantify the response of the product and the consumption to the fiscal expense shocks, the result is positive in both variables, however the investment reaction is opposite.

García C. and Restrepo (2007). They evaluate the effect of a fiscal expenditure shock, the results reveal positive changes in consumption and output, but the real exchange rate decreases and has an impact contrary to investment (by an interest rate hike). The research also concludes that the fiscal rule helps to reduce product volatility compared to the balanced budget rule against natural resource price shocks.

García C., Restrepo and Tanner (2011). They analyze the fiscal rule for the Chilean economy, subject to commodity price changes (copper and molybdenum prices). Through a Dynamic Stochastic General Equilibrium Model (DSGE), they conclude that positive shocks in the price of copper generate a transmission to fiscal spending and increase the aggregate consumption of the economy and the product, but the investment is negatively affected.

Valdivia D. and Montenegro M. (2008). They explain two fiscal rules for Bolivia in a Dynamic Stochastic General Equilibrium Model (DSGE). The first where taxes react according to the level of debt and level of expenditure, second a balanced budget (zero debt) and taxes react to keep the budget balanced. The result of both rules is: a) an increase in the price of factors, b) in response to the increase in factor prices, which have a negative effect on inflation (produce higher inflation), the central bank reacts by raising rates of interest c) There is a devaluation of the nominal exchange rate and a slight appreciation of the real exchange rate; d) exports of the economy are guided by the movement of the real exchange rate, and finally e) the level of country risk increases.

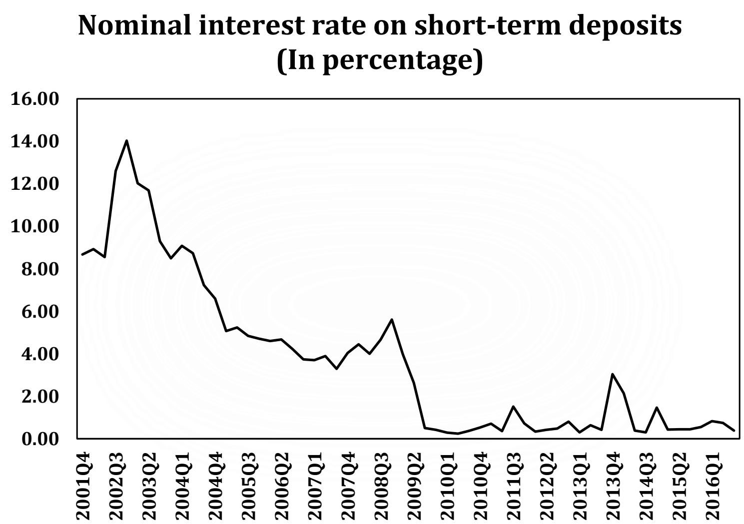
Machicado G. and Estrada P. (2012). They point out that fiscal policy in the Bolivian economy (current expenditure), is not capable of generating growth rates in output, must be accompanied by efficient capital expenditure (infrastructure) and productivity increases in economic sectors, Research is carried out through a Dynamic Stochastic General Equilibrium Model (DSGE), with price flexibility.

Valdivia J. (2016). Develops a Dynamic Stochastic General Equilibrium Model (DSGE) for Bolivia to evaluate fiscal policy between the years 2000 and 2014 the results indicate that the fiscal expenditure to be dependent on the evolution of the international price of the oil tanker shows that shocks of the commodity price (oil) is able to explain a part of GDP expansion as well as imports and the interest rate. In addition, the results indicate that the real exchange rate depreciates because of the oil price shock.

DESCRIPTION OF DATA

Monetary policy

In the direction of an expansionary monetary policy in the last two years, high levels of liquidity were observed from August 2014 onwards accompanied by bond rates close to zero, stimulating the credit of the financial system, and obtaining an effect on the real aggregate variables (Investment and consumption), maintaining one of the region's highest economic growth rates (Latin America)



Fiscal policy

Fiscal policy has a decisive influence on the determination of economic reality, since it directly affects aggregate variables and the level of aggregate demand in an economy. In addition, in conjunction with monetary policy and exchange rate policy, it also influences balance of payments, debt levels, interest rates, inflation and economic growth. "Often the internal and external macroeconomic imbalances can be attributed to a fiscal imbalance that the respective policy has not been able to correct"[4]

In addition, fiscal policy is generally associated with the changes induced by fiscal expenditure on the product (fiscal multiplier) and how it can affect economic growth, in addition to other variables.

The description of the different components the total expenditure incurred by the central government helps to identify the fiscal multiplier, therefore the disaggregation of the expenditures of the nonfinancial public sector (SPNF) is divided into: i) capital expenditure and ii) current expenditure .

The capital expenditure refers to the acquisition of fixed capital and this in turn is destined to:

- The construction and improvement of roads, bridges and works of public improvement such as irrigation system, pavement or asphalt of roads of communication.
- Purchase of fixed assets comprising resources for the acquisition of buildings, land, productive properties, production machinery and equipment, transport and traction equipment, among others.
- Social investment, which represents the operating expenses of the health, education, social management and citizen security and basic sanitation sectors.

Current expenditure is broken down into:

I) Personal Services Expenses consisting of expenses for compensation (payment of salaries to teachers, doctors and FF.AA), payment of retirees and beneficiaries[5] (bonuses created in the policy of redistribution of income).

II) Expenditure on Goods and Services that considers the operational expenditures of the General Government (Sub-National Central Administration) and Public Companies.

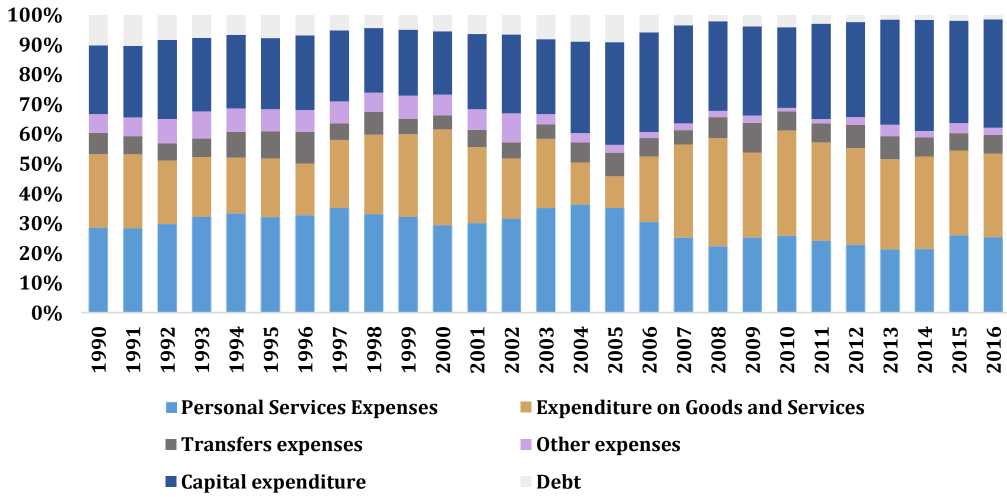
[4] Enzo Croce, Mercedes Da Costa and V. Hugo Juan Ramón; "Financial Programming Methods and Application - International Monetary Fund, 2002"

[5] See Fiscal Dossier 2012.

III) Transfers expenses that include transfers made to the private sector and different sectors of the population such as conditioned transfers[6] such as the Bono Juancito Pinto and Juana Azurduy, and unconditional transfers such as Renta Dignidad .

In addition, there are two other accounts that are: iv) other expenses and v) expenses for the payment of the total debt (this composes the internal and external debt).

Participation of the components of public expenditure of the NFPS
(In percentage)



MODEL

The model proposed seeks to describe the interaction between monetary and fiscal policy, in addition to showing the multiplier of public investment. The proposed model was made through a Dynamic Stochastic General Equilibrium Model (DSGE) with rigidities in prices according to Galí[7], in addition it was estimated some parameters of the model with Bayesian econometrics to obtain greater robustness. The effects on certain variables of the model will be explained and described in the results section and the explanation of the parameters estimated in the section of estimation methodology.

[6] Conditional transfers are granted in exchange for conditions targeting an example, such as the Juana Azurduy Bonus seeks to reduce maternal infant mortality and chronic malnutrition rate in children under two years of age and the Juancito Pinto Bonus seeks to reduce the rate of drop out.

[7] Galí, Jordi 2008 "Monetary Policy, Inflation, and the Business Cycle; An Introduction to the New Keynesian Framework, "ch. 5.

Households

A function of constant risk aversion (CRRA) will be assumed, where $C_t = consumption\ and\ h_t = labor\ supply$ therefore the functional form of $u(c_t h_t)$ is:

$$Max\ E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{\phi_t^c C_t^{1-\vartheta} - 1}{1-\vartheta} - \frac{\phi_t^w h_t^{1+v} - 1}{1+v} \right]$$

s.t.:

$$p_t C_t + \frac{B_{t-1}^T}{R_t} + I_t^{priv} + m_t = Z_t + W_t h_t \phi_t^w + B_{t+1}^T + g_t^{Tr} + I_t^{pub} + m_{t-1}$$

Households are the owners of capital for this reason they obtain a profit $Z_t$that the companies pay them, in addition they receive a wage W_t, the real balance term m_t and finally receive income from loans B_{t+1}^T. In addition, the representative agent is benefited by spending on transfers g_t^{Tr} and public investment I_t^{pub}.

As households own capital, they are the same ones that generate private investment I_t^{priv}, which is inserted into I_t^T total investment.

Firms

In the model there are representative types of firms: (i) firms producing and (ii) intermediate firms, given the type of production function of the goods a decreasing demand for each type of intermediate enterprise, which generates some power over The price of goods and intermediate firms behave under the market of monopolistic competition (the other firms take the price as given). This implies that there is no instantaneous adjustment in each period of prices.

Producing firms

For the modeling of the production, the expression of a firm represents the competitiveness with a production function of Constant Substitution Elasticity (CES), the firms use as a factor of production exclusively the work. The function of benefits is given by:

$$\underset{\{Y_t(j)\}}{Max} \quad p_t Y_t - \int_0^1 p_t(j) Y_t(j)\ dj$$

s.t.:

$$Y_t = \left\{ \int_0^1 [Y_t(j)]^{\frac{\varepsilon-1}{\varepsilon}} \, dj \right\}^{\frac{\varepsilon}{\varepsilon-1}}$$

Intermediary firms

It assumes an intermediate producer of goods with a function with constant returns to scale at work:

$$\underset{\{h_t(j), K_t^T(j)\}}{Min} \quad W_t h(j) + Z_t K_t^T(j)$$

s.a.:

$$Y_t = f[h_t(j), K_t^T(j)]$$

As it is assumed that prices do not adjust instantaneously in each period, there is a probability of "$1-\theta$" with which prices can be adjusted. This means that the representative firm has a probability θ of market power over the prices to not change. In this way, the dynamic problem for the signature will be:

$$\underset{\{p_t(j)\}}{Max} \; E_t \sum_{t=0}^{\infty} \Omega_{t,t+i} \theta^i \{p_t(j) Y_{t+i}(j) - \varphi_{t+i} Y_{t+i}(j)\}$$

s.t.:

$$Y_t(j) = \left[\frac{p_t^*}{p_t(j)}\right]^{\varepsilon} Y_t$$

The aggregation of prices with inertia, has a behavior described by:

$$\pi_t^{1-\varepsilon} = \theta + (1-\theta)\left[\frac{p_t^*}{p_{t-1}}\right]^{1-\varepsilon}$$

$$p_t = p_t^* + \pi_{t-1}$$

Where $\pi_t = \frac{p_t}{p_{t-1}}$, is inflation and p_t^* is the price that firms re-optimize in each period, steady state with zero inflation and assuming $p_{t-1} = p_t^* = p_t$, $for\ all$ "t", the linear log approximation is:

$$\widetilde{\pi_t} = (1-\theta)(\widetilde{p_t^*} - \widetilde{p_{t-1}})$$

Solving the maximization problem yields the new Keynesian hybrid Phillips curve

$$p_t(j) = \frac{\mu E_t \sum_{i=0}^{\infty}\left[(\beta\theta)^i cmg_{t+i} \emptyset_t C_{t+i}^{-\vartheta} Y_{t+i} p_{t+i}^{\varepsilon}\right]}{E_t \sum_{i=0}^{\infty}\left[(\beta\theta)^i p_{t+i}^{\varepsilon-1} Y_{t+i} C_{t+i}^{-\vartheta}\right]}$$

Log - linearizing the previous expression we obtain:

$$\widetilde{\pi_t} = \gamma\widetilde{\pi_{t-1}} + \beta\widetilde{\pi_{t+1}} + \lambda^{\pi}\widetilde{Y}_t + \emptyset_t^{\pi}$$

The parameter $\lambda^{\pi} = (1-\theta)(1-\theta\beta)/\theta$ which measures the degree of rigidity in prices. From the process of cost minimization we obtain the real marginal cost (MC_t) represented by:

$$MC_t = \frac{1}{A_t}\left[W_t^{1-\alpha}\, Z_t^{T^{\alpha}}\right]$$

Thus the demands of factors are derived from the first-order condition:

$$\frac{Z_t}{W_t} = \frac{h_t}{K_t^T}$$

Production Function

All the firms have a differentiated product, but they have the same technology represented by a Cobb-Douglas production function that includes public investment (I_t^{pub}), in addition to the total capital of the economy and the labor demand ($K_t^T, h_t^{1-\alpha}$):

$$Y_t(j) \equiv f\left(A_t, h_t, k_t, I_t^{pub}\right) = A_t K_t^{T^{\alpha}}(j) h_t^{1-\alpha}(j) (I_t^{pub})^{\alpha^{pub}}$$

In addition, a closure equation was added by identity of national accounts assuming a closed economy:

$$Y_t = C_t + I_t^T + G_t^T$$

I_t^T represents the total investment in the economy which is the sum of the investment of the private sector and the public sector. G_t^T is the total expenditure of the SPNF.

The total capital stock K_t^T is described by the law of typical capital movement, but at the same time there are two additional laws of capital movement, private capital K_t^{priv} and the public K_t^{pub}, the aggregation will also be given by two types of investment I_t^{priv} and I_t^{pub}.

$$K_{t+1}^T = (1-\delta^T)K_t^T + I_t^T$$

$$K_{t+1}^{pub} = \left(1-\delta^{pub}\right)K_t^{pub} + I_t^{pub}\phi_t^{I^{pub}}$$

$$K_{t+1}^{priv} = \left(1-\delta^{priv}\right)K_t^{priv} + I_t^{priv}\phi_t^{I^{priv}}$$

For the aggregation of K_t^T and I_t^T it will be assumed that the weights (parameters) in the capital stock and the investment will be the same $\varrho^{Kpub} = \varrho^{Ipub}$ and $\varrho^{Kpriv} = \varrho^{Ipriv}$

$$K_t^T = \varrho^{Kpub}K_t^{pub} + \varrho^{Kpriv}K_t^{priv}$$

$$I_t^T = \varrho^{Ipub}I_t^{pub} + \varrho^{Ipriv}I_t^{priv}$$

Fiscal policy

It is considered a government which is represented by an intertemporal restriction that is fulfilled all the periods, where the taxes and the total debt are those that finance the governmental expense.

$$T_t + B_t^T + m_t = G_t^T + I_{t-1}^{pub} + B_{t-1}^T R_{t-1} + m_{t-1}$$

T_t are the taxes that the government obtains at each moment of time, B_t^T is the total debt (it is decomposed between internal and external debt), perceived by the government. On the other hand, total expenditures G_t^T represent the total of the NFPS, in addition it incurs disbursements by public investment or capital expenditure I_{t-1}^{pub} in infrastructure, $B_{t-1}^T R_{t-1}$ is the payment of the debt contracted plus interest, finally m_t represents as in Leeper (1991) the real balances.

The decomposition of G_t^T is associated to different types of expenditure for the case of Bolivia was decomposed G_t^T in:

$$G_t^T = \varrho^{g^{SP}} g_t^{SP} + \varrho^{g^{BS}} g_t^{BS} + \varrho^{g^{TR}} g_t^{TR} + \varrho^{g^{OG}} g_t^{OG} + \varrho^{I^{pub}} I_t^{pub}$$

This decomposition proves that G_t^T will be explained by g_t^{SP} (expenditure on personal services), g_t^{BS}((expenditure on goods of service), g_t^{TR} (spending on transfers), g_t^{OG}other expenses and I_t^{pub} Public investment or capital expenditure). This specification is made to describe the behavior of the SPNF in Bolivia and each variable described is explained in the section "Data description".

The parameters $\varrho^{g^{SP}}, \varrho^{g^{BS}}, \varrho^{g^{TR}}, \varrho^{g^{OG}}, \varrho^{I^{pub}}$ are the average weights (deep parameters) within the sample used for Bayesian estimation.

In addition, two fiscal rules were inserted:

$$T_t = \rho^{B^{int}} * B_{t-1}^{int} + \gamma^{T\_Yint} * Y_{t-1} + \phi_t^{T\_Bint}$$

$$T_t = \rho^{B^{ext}} * B_{t-1}^{ext} + \gamma^{T\_Yext} * Y_{t-1} + \phi_t^{T\_Bext}$$

To measure the reaction of the tax collection in relation to the internal debt (B_t^{int}) and the external debt (B_t^{ext}) and in addition to the behavior of the product cycle Y_t .

Monetary policy

The central bank sets the nominal interest rate according to the following Taylor rule:

$$R_t = (R_{t-1})^{\rho^R} \left[\left(\frac{\pi_t}{\pi^*}\right)^{\varphi^\pi} \left(\frac{y_t}{y^*}\right)^{\varphi^y} \right]^{1-\rho^R} \phi_t^R$$

Where R_t is the nominal interest rate, π^* is the steady-state inflation, y_t represents the product and y^* is the steady-state value. Central banks do not react immediately to changes in the inflation rate and the product, so inertia is introduced into the Taylor rule R_{t-1}, a monetary policy shock ϕ_t^R is added.

Closing Equations

The Euler equation and the decision equation between work and leisure are obtained from the maximization problem of households:

$$\beta E_t \left\{ \left(\frac{\phi_t^c c_t}{\phi_{t+1}^c c_{t+1}} \right)^{\vartheta} (1 + i_t) \frac{p_t}{p_{t+1}} \right\} = 1$$

$$h_t^v c_t^{\vartheta} = W_t \phi_t^W$$

The price aggregation is described by:

$$p_t = \left\{ \int_0^1 [p_t(j)]^{1-\varepsilon} \, dj \right\}$$

The total debt is explained by the internal and external debt, so their average weights ϱ^{Bint} and ϱ^{Bext} Bext guarantee the degree of participation of both debts within the behavior of total debt:

$$B_t^T = \varrho^{Bint} B_t^{int} + \varrho^{Bext} B_t^{ext}$$

On the other hand, the weights by type of expenditure have the following closing identities

$$\varrho^{g^{SP}} = \frac{g_t^{SP}}{G_t^T}, \varrho^{g^{BS}} = \frac{g_t^{BS}}{G_t^T}, \varrho^{g^{TR}} = \frac{g_t^{TR}}{G_t^T}, \varrho^{g^{OG}} = \frac{g_t^{OG}}{G_t^T}$$

Some of the self-regressive AR (1) processes that were not previously described, which describe the dynamics of the model and have effects on the whole system are:

$\phi_t^c = \rho^C \phi_{t-1}^c + \varepsilon_t^C$	Shocks of demand (preferences in consumption)
$\phi_t^W = \rho^W \phi_{t-1}^W + \varepsilon_t^W$	Demand shocks (preferences in labor supply)
$\phi_t^\pi = \rho^\pi \phi_{t-1}^\pi + \varepsilon_t^\pi$	Shocks on the Phillips curve (cost push inflation)
$\phi_t^R = \rho^R \phi_{t-1}^R + \varepsilon_t^R$	Shocks in the monetary policy rule (interest rate)
$\phi_t^{I^{priv}} = \rho^{I^{priv}} \phi_{t-1}^{I^{priv}} + \varepsilon_t^{I^{priv}}$	Shocks in private investment
$\phi_t^{I^{pub}} = \rho^{I^{pub}} \phi_{t-1}^{I^{pub}} + \varepsilon_t^{I^{pub}}$	Shocks in public investment
$A_t = \rho^A g_t^A + \varepsilon_t^A$	Shocks in the technological process
$\phi_t^{T\_Bint} = \rho^{T\_Bint} \phi_{t-1}^{T\_Bint} + \varepsilon_t^{T\_Bint}$	Shock in Tax Rule TAX - Internal Debt

$$\phi_t^{T\_Bext} = \rho^{T\_Bext}\phi_{t-1}^{T\_Bext} + \varepsilon_t^{T\_Bext} \quad \text{Shock in Tax Rule TAX - External Debt}$$

$$m_t = \rho^m m_{t-1} + \varepsilon_t^m \quad \text{Shocks in real balances (demand for money)}$$

Where $\varepsilon_t^{T\_Bint}, \varepsilon_t^{T\_Bext}, \varepsilon_t^C, \varepsilon_t^W, \varepsilon_t^\pi, \varepsilon_t^R, \varepsilon_t^{I^{priv}}, \varepsilon_t^{I^{pub}}, \varepsilon_t^{g^{SP}}, \varepsilon_t^{g^{BS}}, \varepsilon_t^{g^{TR}}, \varepsilon_t^{g^{OG}}, \varepsilon_t^A$ are the stochastic processes i.i.d. $N(0, \vartheta^2)$.

ESTIMATION METHODOLOGY

The model parameters were evaluated using an econometric methodology from the Bayesian point of view to measure the effect of the shocks previously presented in the observed variables. The Bayesian econometric approach brings much more information to decisions under uncertainty, unlike classical "frequentist" econometrics, this approach considers different types of information often subjective, which may have on the parameters to be estimated before taking into account the data. The Bayesian estimation can be seen as a bridge between the calibration and the estimation by maximum likelihood (MV).

The estimated model was spiced with reference to Fernández-Villaverde and Rubio-Ramírez, 2004; Smets and Wouter, 2007. The estimation is based on a plausibility function generated by the solution of the log-linearized version of the model. Prior distributions of the parameters of interest are used to provide additional information in the estimation. The whole set of linearized equations form a system of linear equations of rational expectations, which can be written as follows:

$$\Gamma_0(\vartheta)\, \mathrm{z}_t = \Gamma_1(\vartheta)\, \mathrm{z}_{t-1} + \Gamma_2(\vartheta)\, \varepsilon_t + \Gamma_3(\vartheta)\, \Theta_t$$

Where z_t is a vector containing the model variables expressed as logarithmic deviations from their steady states, ε_t is a vector containing white noise from the exogenous shocks of the model, and Θ_t is a vector containing the rational expectations of the prediction errors. The matrices Γ_1 are non-linear functions of the structural parameters contained in the vector ϑ. The vector z_t contains the endogenous variables of the model and the exogenous shocks: $\varepsilon_t^C, \varepsilon_t^W, \varepsilon_t^\pi, \varepsilon_t^R, \varepsilon_t^{I^{priv}}, \varepsilon_t^{I^{pub}}, \varepsilon_t^{T\_Bext}, \varepsilon_t^{T\_Bint}, \varepsilon_t^A$ The solution to this system can be expressed as follows:

$$\mathrm{z}_t = \Omega_z(\vartheta)\, \mathrm{z}_{t-1} + \Omega_\varepsilon(\vartheta)\, \varepsilon_t + \Gamma_3(\vartheta)\, \Theta_t$$

Where Ω_z and Ω_ε are functions of the structural parameters. In addition, y_t it is a vector of the observed variables, which is related to the variables in the model through a measurement equation:

$$\mathrm{y}_t = H\mathrm{z}_t$$

H is a matrix that selects elements of z_t, and y_t includes the following observed variables (the sample comprises from 2001Q4 - 2016Q3):

$$\mathrm{y}_t = [Y_t, C_t, I_t^T, G_t^T, K_t^T, K_t^{pub}, K_t^{priv}, I_t^{pub}, I_t^{priv}, B_t^T, B_t^{int}, B_t^{ext}, R_t, T_t, \pi_t]$$

These equations correspond to the state-space form represented by y_t. If we assume that the white noise, ε_t is normally distributed, and using the Kalman filter we can calculate the conditional likelihood function for the structural parameters. Let $p(\vartheta)$ be the density function prior to the structural parameters and $L\,(\vartheta/Y^T)$, where $Y^T = \{y_1, y_T\}$ contains the observed variables. The posterior density function of the parameters is calculated using the Bayes theorem:

$$p\,(\vartheta/Y^T) = \frac{L\,(\vartheta/Y^T)\,p(\vartheta)}{f L\,(\vartheta/Y^T)\,p(\vartheta)d\vartheta}$$

Since the conditional likelihood function has no analytic expressions, it was approximated using numerical methods based on the Metropolis-Hastings algorithm. The estimates were obtained with Dynare program.

Prios and Results

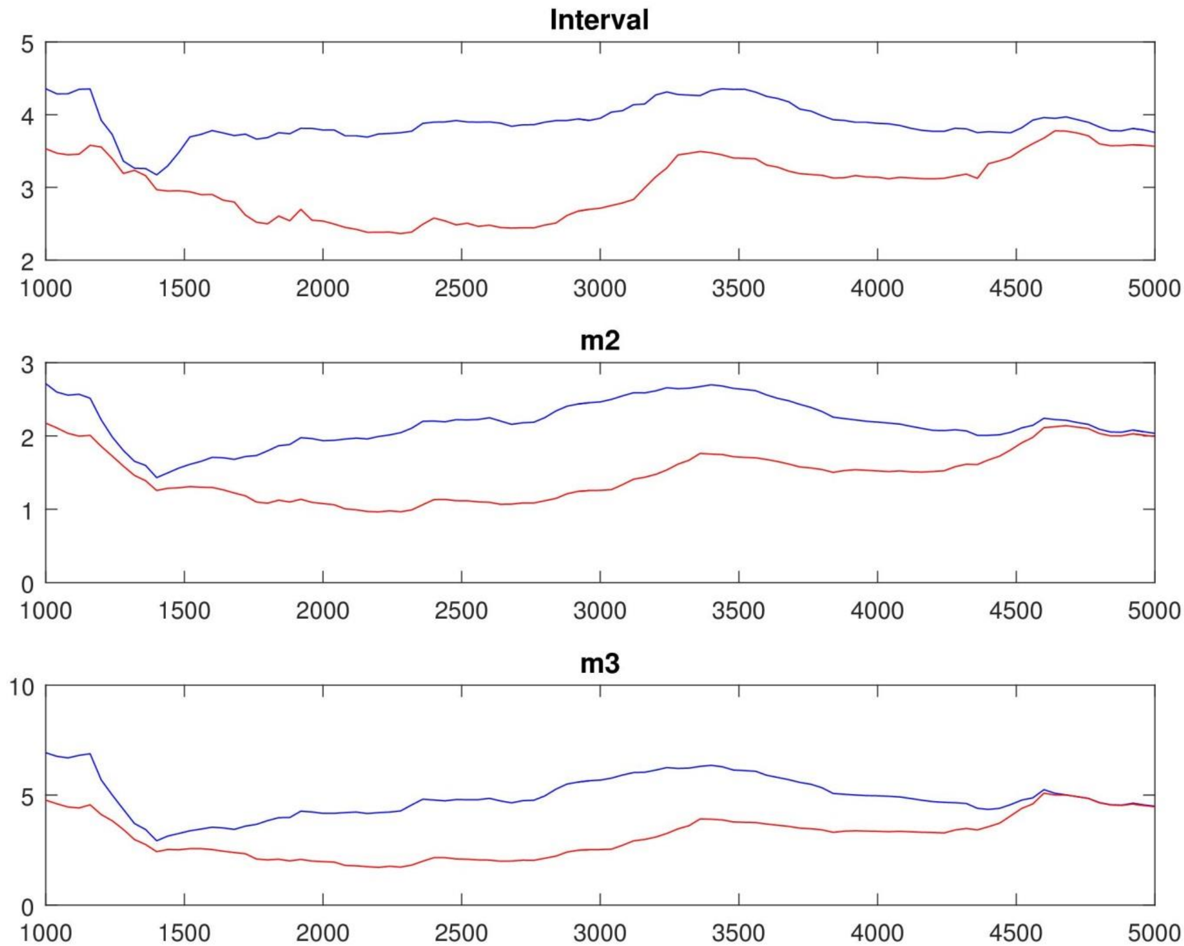
The following tables present the prior values of the parameters and shocks, which are in line with the international literature that incorporates beliefs about possible traits of prior density and behavior of variables (Smets and Wouters, 2002 - 2007; Pesenti, 2003).

Prior and posterior distribution

Parameters	Distribution	Prior Mean	S.D.	Post Mean	10%	90%
ϑ	norm	1.5	0.37	1.4723	1.4596	1.4919
β	beta	0.99	0.002	0.9905	0.9904	0.9906
α	beta	0.35	0.02	0.3406	0.3396	0.3414
α^{pub}	beta	0.35	0.02	0.3296	0.3293	0.33
θ	norm	0.4	0.1	0.4564	0.4538	0.4592
γ	norm	0.4	0.1	0.4499	0.4472	0.4519
ρ^R	beta	0.75	0.1	0.6775	0.6763	0.6787
φ^y	norm	0.12	0.05	0.1316	0.1295	0.1337
φ^π	norm	1.5	0.25	1.482	1.4788	1.484
ρ^A	beta	0.5	0.1	0.5212	0.5167	0.5265
$\rho^{B^{int}}$	norm	1.5	0.1	1.5582	1.5556	1.5598
$\rho^{B^{ext}}$	norm	1.5	0.1	1.4694	1.4636	1.4765
γ^{T_Yint}	norm	1	0.1	0.9806	0.9782	0.9828
γ^{T_Yext}	norm	1	0.1	1.0209	1.019	1.0238
ρ^m	beta	0.5	0.1	0.5517	0.5507	0.5526
ρ^R	beta	0.5	0.1	0.4921	0.4899	0.4953
$\rho^{I^{priv}}$	beta	0.5	0.1	0.5115	0.5086	0.5169
$\rho^{I^{pub}}$	beta	0.5	0.1	0.523	0.5208	0.525
ρ^π	beta	0.5	0.1	0.5424	0.5371	0.5458
ρ^W	beta	0.5	0.1	0.5226	0.5196	0.5247
ρ^C	beta	0.5	0.1	0.4626	0.4602	0.4647
ρ^{T_Bext}	beta	0.5	0.1	0.4912	0.4896	0.4933
ρ^{T_Bint}	beta	0.5	0.1	0.5523	0.5485	0.5549
ε_t^A	invg	0.01	Inf	0.0052	0.0025	0.0081
ε_t^R	invg	0.01	Inf	1.7839	1.6144	1.877
$\varepsilon_t^{I^{priv}}$	invg	0.01	Inf	1.2785	1.2093	1.3523
$\varepsilon_t^{I^{pub}}$	invg	0.01	Inf	0.3241	0.2534	0.3718
ε_t^π	invg	0.01	Inf	0.0077	0.0022	0.0136
ε_t^W	invg	0.01	Inf	3.9161	3.8665	3.9733
ε_t^C	invg	0.01	Inf	3.643	3.489	3.7678
$\varepsilon_t^{T\_Bint}$	invg	0.01	Inf	0.0062	0.0029	0.0087
$\varepsilon_t^{T\_Bext}$	invg	0.01	Inf	1.4172	1.3513	1.5059
ε_t^m	invg	0.01	Inf	0.0076	0.0032	0.0125

On the other hand, the convergence of the Monte Carlo Markov Chain (MCMC) is satisfactory. The multivariate analysis of the parameters of the model converges towards its stability, this result indicates that they are statistically significant.

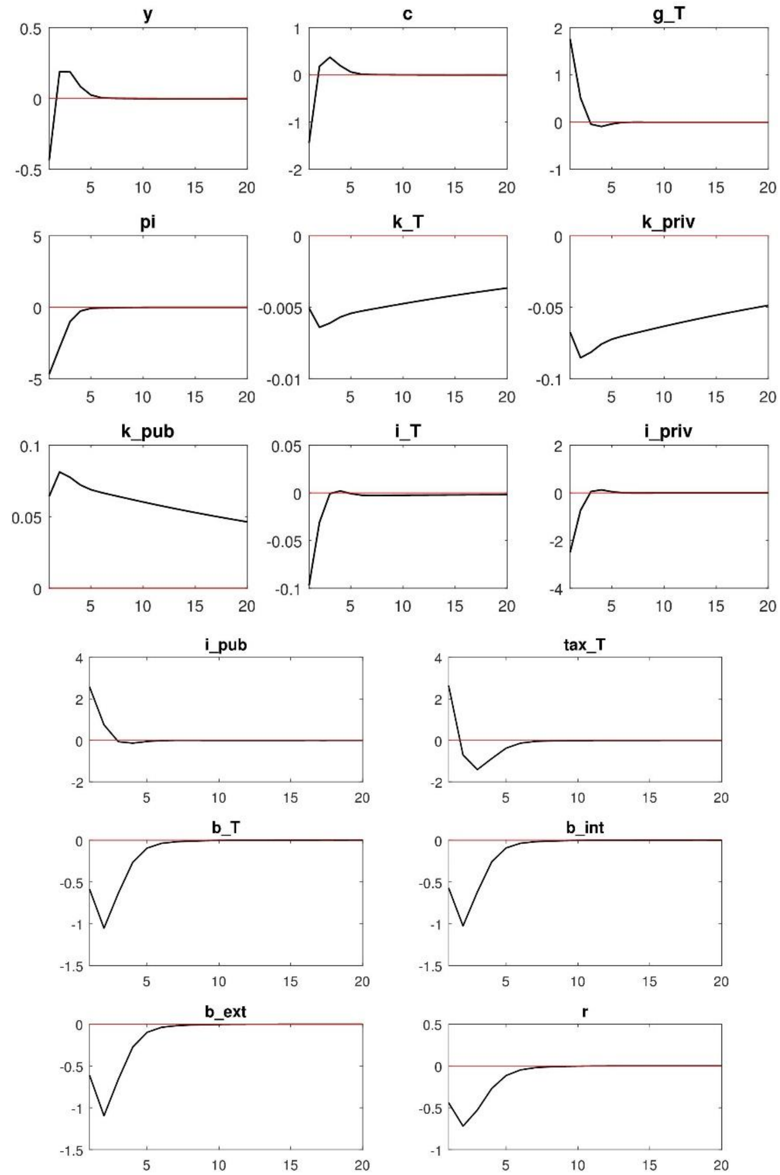
Monte Carlo Markov Chain Convergence



RESULTS

The results found in response to positive shocks in the interest rate indicate a monetary policy against cyclical. By the ratio described in the Euler equation, the product decreases by 0.43% and consumption by 1.44%, to contain the inflationary outbreaks inflation falls by 4.69 basis points (b.p.), the results go in the line as. The total and private investment response is contractive (-0.097% and -2.49%, respectively), an effect described in the typical IS-LM model. Public investment in spite of increases in the interest rate continues to maintain an expansive character in the economy.

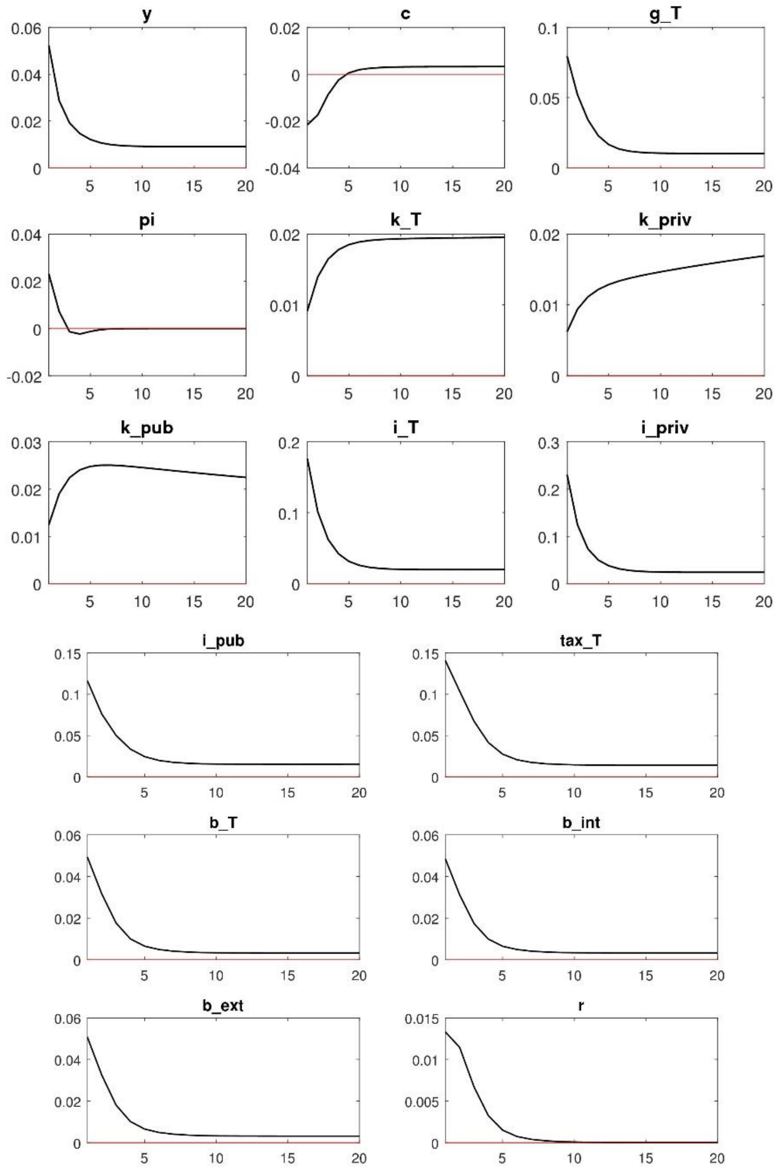
Functions Impulse Response to shocks in the Interest Rate



The response by the product to shocks in public investment has an expansive nature of 0.05%[8], the consumption reaction is contractive (-0.02%), due to Ricardian equivalence (the agents internalize that the capital expenditure will be financed via taxes In the future), there are inflationary effects of 2.02 b.p. On the other hand, the behavior of the stock of total capital, private and public to this shock is persistent in time. To counteract the inflationary effects of public investment, the monetary authority must react with the increase in the interest rate by 0.013 b.p.

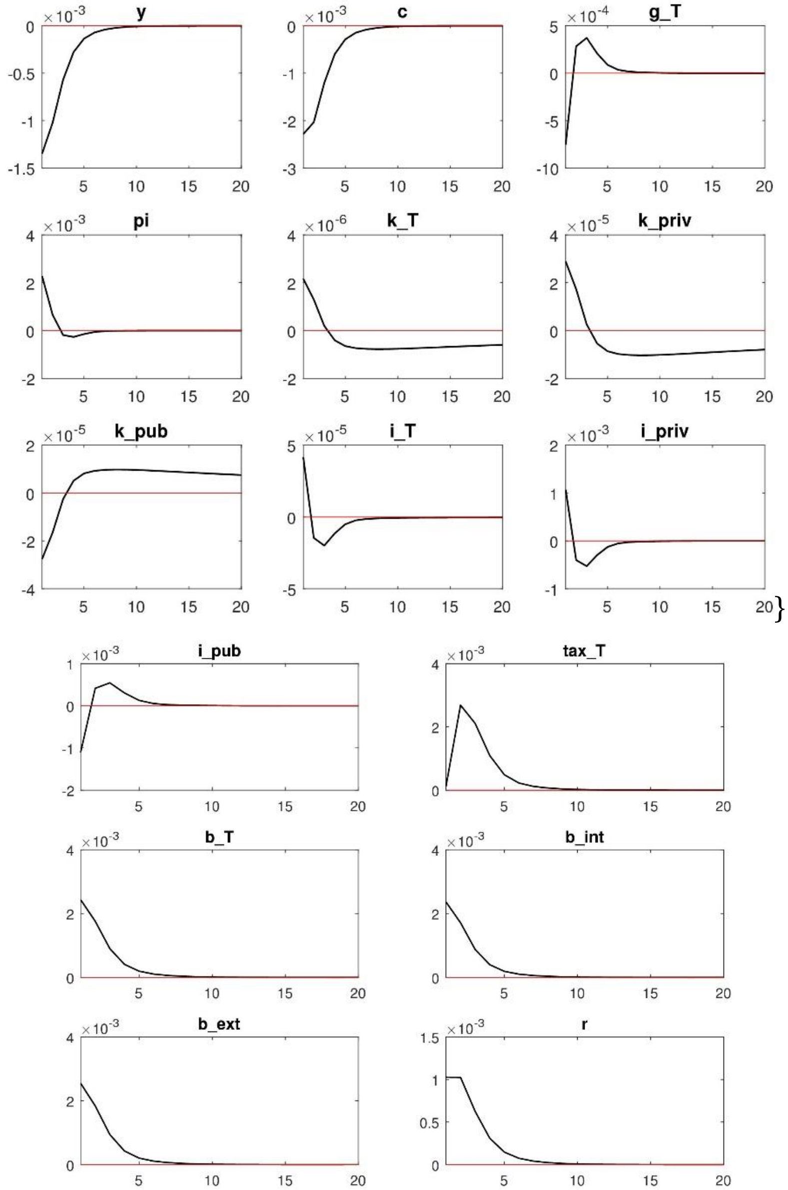
[8] This result is consistent, since the fiscal multiplier between 2001q1 - 2016q3 is 0.57

Functions Impulse Response to shocks in Public Investment



The effect of shock on the Phillips curve hybrid (cost push inflation) generates a decrease of the product and the consumption (-0.0013 and -0.0023 respectively). Total inflation rises by 0.002 b.p Private investment responds positively to changes in the price level (0.001%). Finally the public sector responds in a contrary way to avoid more inflationary effects and the monetary authority raises the interest rate by 0.001 b.p.

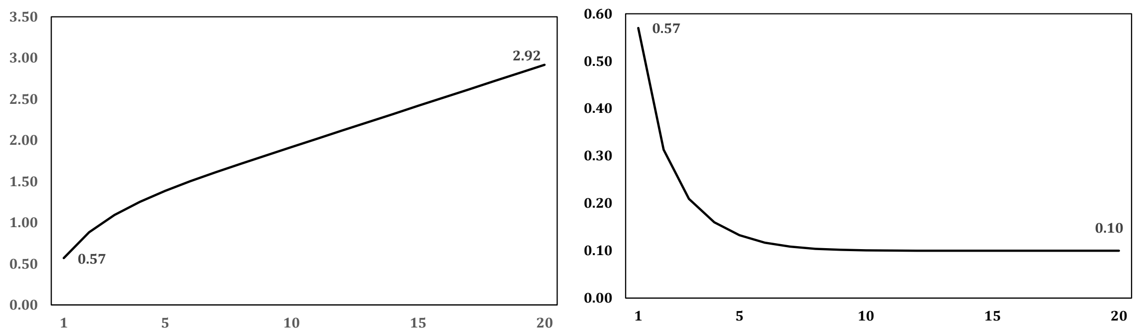
Functions Impulse Response to shocks in inflation (cost push inflation)



Elaboration: Own

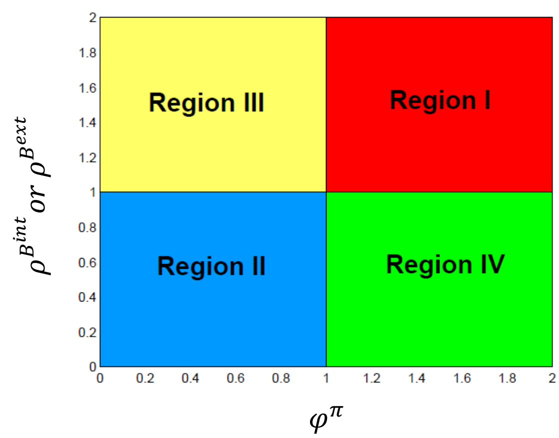
In relation to the calculation of the tax multiplier this can be observed cumulatively in the following graph, this indicates that the first quarter the GDP responds in 0.57 to the variation of the fiscal expense, this is concretized for the twelfth quarter taking a value of 2.92. In line with Cogan (2010), the effect of the fiscal multiplier over time may fade (within two years and four quarters the effect of the multiplier reaches 0.1 "increase of the product in the face of changes in public investment").

Cumulative fiscal multiplier and evolution of fiscal multiplier over time



COORDINATION OF MONETARY POLICY AND FISCAL POLICY IN REGIMES, TO LEEPER

Leeper (1991), indicates the existence of fiscal and / or monetary dominance through the values of certain parameters. In the Taylor rule for the planned model the parameter is φ^{π}, in the fiscal rules raised the parameters are $\rho^{B^{int}}$ and $\rho^{B^{ext}}$. The values that can assume these parameters determine the existence of domination of monetary or fiscal policy, which establishes the objectives of inflation in the economy.



Source: Todd B. Walker

Region I Active monetary policy and passive fiscal $\varphi^{\pi} > 1$ and $\rho^{B^{int}}$ or $\rho^{B^{ext}} > 1$.

Region II Passive monetary policy and active fiscal policy $\varphi^{\pi} < 1$ and $\rho^{B^{int}}$ or $\rho^{B^{ext}} < 1$

Region III Passive monetary policy and passive fiscal policy $\varphi^{\pi} < 1$ and $\rho^{B^{int}}$ or $\rho^{B^{ext}} > 1$

Region IV Active monetary policy and active fiscal policy $\varphi^{\pi} > 1$ and $\rho^{B^{int}}$ or $\rho^{B^{ext}} < 1$

According to the Bayesian estimate, the value of $\varphi^{\pi} = 1.482$, $\rho^{B^{int}} = 1.55\ and\ \ to\ \rho^{B^{ext}} = 1.46$, indicates that the Bolivian economy between 2001q1 and 2016q3 was in the Regime of monetary dominance (Region I) and it was the monetary policy which established the objectives of the price level.

CONCLUSIONS

In the present research, a DSGE with Bayesian estimation techniques was used to study the effects of monetary policy coordination, fiscal shocks in public investment have an expansive repercussion on output, but there are also inflationary effects on the expectations of Agents and the reaction of the monetary authorities is the increase of the interest rate. This result is contrasted in other researches such as Valdivia and Montenegro (2008), Colonel and Gaur M. (2015) and Garcia C., Restrepo J. E. and Tanner E. (2011).

The coordination of fiscal - monetary policy is evidenced in the impulse response functions of cost push inflation, given that for exogenous inflationary effects, the monetary authorities' response is to raise the interest rate and by the fiscal policy with maintaining a public investment Contractive to avoid even greater inflationary effects. It is also evident from the Bayesian estimation that Bolivia between 2001q1 - 2016q3, is between a regime of monetary dominance to the Leeper (1991).

In conclusion, due to cyclical monetary policy and an expansive fiscal policy, Bolivia's economic growth is one of the largest in South America, despite the adverse external market risks for small economies (falling commodity prices). The coordination of economic policy plays an important role in the objectives of stabilizing the price level and economic growth.

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APPENDIX

Deep Parameters

$\frac{G_t^T}{Y_t}$ =	0.11	$\varrho^{g^{SP}}$ =	0.27	ϱ^{Bext}=	0.63
$\frac{C_t}{Y_t}$=	0.71	$\varrho^{g^{BS}}$ =	0.24	ϱ^{Bint}=	0.37
$\frac{I_t^{pub}}{Y_t}$=	0.09	$\varrho^{g^{TR}}$=	0.06	ϱ^{Ipriv}=	0.53
$\frac{I_t^{priv}}{Y_t}$=	0.08	$\varrho^{g^{OG}}$=	0.05	ϱ^{Ipub}=	0.48
$\frac{I_t^T}{Y_t}$=	0.17	$\varrho^{I^{pub}}$=	0.26		

Smoothed shocks