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Abstract

Fiscal multipliers are different across countries and according with economic circumstances. The studies about the effect of a government spending shock on output have focus their attention on the behavior of consumption. However, the crowding out of investment is also an important matter of study. In this sense, balance sheet effects play an important role in all countries and in all circumstances. The aim of this paper is to study this important issue in a small open economy that is also characterized by an important proportion of non-Ricardian agents and commodity revenues. The results show that balance sheet effects might reduce the fiscal multiplier by half. Also, that this result might be mitigated if a subsidy, financed with the income taxes revenues from a higher fiscal multiplier, is implemented. Finally, the paper also shows that a structural fiscal rule delivers less welfare losses, due to financial frictions, than other rules.

Keywords: Fiscal multipliers, fiscal policy rules, non-Ricardian households, DSGE model, financial frictions. **JEL** D91, E21, E62.

1 Introduction

Advanced and emerging economies have been affected by the worst financial crisis since the Great Depression. As a response to the crises, governments have implemented different fiscal stimulus packages. One question arising from the fiscal policy implemented is how big could be the fiscal multipliers in a world with financial frictions. To answer this question, we develop a fiscal DSGE model with balance sheet effects à la Bernanke et al. (1999) for a small open economy characterized by the presence of non-Ricardian agents. The model replicates the empirical evidence of an increase in

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consumption and the crowding out of investment due to a government spending shock. The balance sheet effects introduced in the model highlight the severity of the crowding out of private investment.

Similarly, many oil producer countries that relied on revenues from this commodity were severely affected by the drop in oil prices since 2014. Fiscal oil revenues shocks also have a different impact on investment and output depending on the severity of balance sheets effects in the economy. Colombia was one of the countries "favored" by the oil prices increases during 2004-2011. However, Colombia also was affected by the so called Dutch disease phenomenon. But all in all, fiscal revenues were high and the introduction of a fiscal rule to handle this sources of income were an important step to mitigate this phenomenon. The model presented here for this emerging market economy with oil revenues also analyzes this side of the fiscal policy.

The model is calibrated for Colombia, a small open economy. It has 7 sectors. The households sector that is divided into Ricardian and Non-Ricardian agents. The entrepreneurial sector that makes the investment decisions and faces a costly state verification problem giving rise to an external finance premium that depends on the balance sheet of the firm. The third sector is the capital producers sector that purchases consumption goods as material input, combines it with rented capital and produces new capital. The fourth sector is the retailers sector that use the wholesale output of entrepreneurs, differentiate it and set prices à la Calvo. We also model a National Agency in the labor market and the rest of the world. Finally, we have the government that conducts monetary and fiscal policy. Fiscal policy is characterized by a public sector that collects income taxes and receipts revenues from oil production. Accordingly, this last sector follows a structural fiscal rule.

In our paper we present the impact of government spending on investment if the Modigliani-Miller theorem holds, i.e. when financing decisions have no impact on real economic activity, and in the case that the theorem does not hold. We found that in the presence of financial frictions the fall in investment opportunities due to a government spending shock is exacerbated.

We also ask ourselves how to mitigate the negative impact of financial frictions on the size of fiscal multiplier. The answer is the imposition of a subsidy that compensates for the loss of efficiency of the financial system due to the financial frictions. Besides, such a subsidy would stabilize output and inflation if the monetary policy reacts strongly to inflation.

Finally, given that the Colombian economy is affected by oil prices shocks, we consider the response of macroeconomic variables to a shock of this kind with and without financial accelerator under different fiscal rules. Our results show that balance sheet effects affect more investment in the case of a commodity price shock when a pro-cyclical and a structural balanced rule are implemented. In the case of a countercyclical rule, investment does not fall as much as in the other rules. In terms of welfare, also the pro-cyclical rule is the one that present a higher impact due to financial frictions.

The reminder of this paper proceeds as follows. Section 2 is about related literature. Section 3 discusses the empirical evidence. Section 4 presents the model. Section 5 presents the calibration of the model. Section 6 presents the results and Section 7 concludes.

2 Related literature

Our results contribute to several strands of literature. First of all, our results add to the literature that examine the effect of government spending on consumption and output (see Colciago 2011; Galí et al. 2007; Monacelli and Perotti 2010) . Some of these papers are intended to replicate the effect of government spending on consumption for advanced economies, and some of them for small open economies, but as these papers do not include balance sheet effects, they tend to overestimate the impact of the fiscal multiplier as we will show in our paper. Specifically, our results add to the literature that examines the fiscal multiplier using a DSGE model enriched with financial frictions (see Sin 2016; Castro et al. 2014). These papers also are meant to replicate stylized facts for small open economies. But they do not model the role of non-Ricardian agents in these kinds of economies as we do in our study.

Our paper is also related to the strand of literature that study fiscal stimulus and crowding out effects under the presence of financial frictions (see Freedman et al. 2010; Fernández-Villaverde 2010) for advanced economies. Our contribution is to analyze the crowding effect for a developing economy.

Another related literature deals with the Dutch disease phenomenon that affected several countries around the world during 2003-2013 due to the increase in commodity prices (see Fernández and Villar, 2014; Goda and Torres, 2015; Pieschacón, 2012; Sarmiento G and López, 2016). One way to deal with this phenomenon has been the implementation of fiscal rules. Our paper is also related to the literature that examines the role of balance sheet effects of the movements of commodity prices on the macroeconomy. In the fiscal rules for government policy, for instance García-Cicco and Kawamura (2015), present a two sectors model for the Chilean economy. In our paper we add the comparison of different fiscal rules under balance sheets effects in a new-Keynesian model for the Colombian economy.

3 Empirical Evidence

The empirical evidence about the effect of a fiscal expenditure shock on consumption and investment is scan. Here we add to the empirical literature on fiscal multipliers that have found that consumption increases after a fiscal expenditure shock and that investment falls.

Following Vargas et al. (2012) we identify the government spending shock with a method that meets the criteria of no anticipation and no contemporaneous correlation with output. To do so, we define the shock as the difference between the Central Government actual primary expenditures (overall spending without interest payments on public debt) and the forecast made of this variable. Next we consider the effect of the shock in a VAR. The data is quarterly from 1999 until 2011. We use Ramey's (2011) strategy of using a fixed set of variables and rotating other variables of interest. The fix set of variables consists of the no anticipated spending shock, the log of real per capita government

spending, and the log of real per capita GDP. We then rotate each of the other variables in the VAR; consumption, hours, real wages, real exchange rate and investment.

The results are plotted in Figure 1. We normalize the impulse responses to an unanticipated government spending shock to obtain a response of government spending equal to one. In addition, we use the ratio of GDP to government spending of 6.7 during the period in order to obtain directly the implied fiscal multiplier. Studies for other countries show evidence of an increase of consumption as a response to a government spending shock (see Ravn et al. 2007; Mountford and Uhlig 2009; Monacelli and Perotti 2010; Ramey 2011). In Colombia our results show that consumption reaches a peak in the third quarter and the effect is about 1.2 per cent. This suggests that the presence of non-Ricardian agents is important in our economy. In the side of investment, there exist an important delay in the expected fall in it, but it eventually falls. Many theoretical models have this expected result explained mainly by the increase of real interest rates in the economy after a fiscal expansion. The fall is very drastic suggesting the presence of balance sheets effects. The other important result is that the long run fiscal multiplier is 3.3 at a four quarter horizon.

Figure 1 also presents the response of real wage that increases as expected by models with non-Ricardian agents like the model of Galí et al. (2007) and by models that eliminates the wealth effects on preferences like the one of Monacelli and Perotti (2010). Finally, Figure 1 plots the impulse response of real exchange rate and hours worked which do not present a definite pattern.

4 Model

The model has some characteristics of the one we developed in Gonzáles et al. (2014) and is based in Bernanke et al. (1999), from whom we take the set up of the financial frictions in the economy. The model also is developed along the lines of Galí et al. (2007) and Kumhof and Laxton (2013) modified for a small open economy. As in Galí et al. (2007), the model is characterized by the presence of non-Ricardian agents which suits very well the Colombian economy given the high proportion of credit constraint households. From Kumhof and Laxton (2013), we borrowed the way they introduce the different fiscal policy rules. Finally, the model includes an oil sector given the importance of those revenues for the government.

4.1 Households

There is a fraction Γ of Non-Ricardian households in the economy whose variables are denoted by n and a fraction $(1-\Gamma)$ of Ricardian agents whose variables are denoted by r. The utility function of households is non-separable between consumption and labor.

4.1.1 Ricardian Households

Ricardian Household, denoted by r, are indexed between Γ and 1 and have preferences of the form

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma_r} \left\{ c_{r,t} - \theta_r \frac{n_{r,t}^{1+\gamma_r}}{1+\gamma_r} \right\}^{1-\sigma_r} - \frac{1}{1-\sigma_r}$$

where $c_{r,t}$ is a consumption index and $n_{r,t}$ are hours worked. The parameter σ_r measures the intertemporal elasticity of substitution, θ_r is a scale parameter and γ_r the inverse of the Frisch elasticity. This kind of preferences were introduced by Greenwood et al. (1988) (GHH) and have the property that the wealth effect on labor supply is muted.

These households maximize utility subject to the budget constraint:

$$(1+\tau_{c,t})\, c_{r,t} + b_{r,t} + \frac{e_{t-1} p^{\star}_{t-1}}{p^c_{t-1}} b^{\star}_{r,t-1} \frac{\left(1+i^{\star}_{t-1}\right)}{\left(1+\pi^{\star}_t\right)} =$$

$$(1-\tau_{n,t})\, w_{r,t} n_{r,t} + b_{r,t-1} \left(\frac{1+i_{t-1}}{1+\pi_t} \right) + \frac{e_t p^{\star}_t}{p^c_t} b^{\star}_{r,t} + \frac{1}{1-\Gamma} \left[\xi^{\omega_r}_t + \xi^h_t + \xi^e_t \right] + T_t$$

The terms in the right hand side represent sources of income including after tax labor income, domestic nominal discount bonds issued by the entrepreneurs, foreign bonds holdings, profits from unions, intermediate firms and entrepreneurs, and lump-sum net transfers. The left hand side of the equation represents purchases in consumption including taxes, and purchases of domestic and foreign assets, where following Schmitt-Grohé and Uribe (2003), the foreign interest rate $i^{\star}_t = \bar{i}^{\star} \exp\left(\phi_b \left(\frac{e_t p^{\star}_t}{p^c_t} \frac{b^{\star}_t}{g d p_t} - \bar{b}^{\star}_r \right) \right) - 1$ depends on the country's net foreign asset position, as a percentage of GDP, $b^{\star}_t$, the real exchange rate, $\frac{e_t p^*_t}{p^c_t}$, and an exogenous risk premium shock, ϕ_b.

4.1.2 Non-Ricardian Households

Non-Ricardian Households, denoted by n, are indexed between 0 and Γ and solve a similar problem, but they are assumed to have no access to financial markets. Therefore, they consume period by period all their labor income and the transfers received from the government. They seek to maximize their lifetime utility

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma_n} \left\{ c_{n,t} - \theta_n \frac{n_{n,t}^{1+\gamma_n}}{1+\gamma_n} \right\}^{1-\sigma_n} - \frac{1}{1-\sigma_n}$$

subject to the budget constraint

$$(1+\tau_{c,t})\, c_{n,t} = (1-\tau_{n,t})\, w_{n,t} n_{n,t} + \frac{1}{\Gamma}\xi_t^{\omega_n} + T_t$$

4.2 Domestic and imported consumption

It is assumed that the composition of the consumption bundle is identical for both types of households. The consumption bundle takes the form

$$c_t = \left[(1-\alpha_c)^{\frac{1}{\eta_c}} \left(c_t^h\right)^{\frac{\eta_c-1}{\eta_c}} + \alpha_c^{\frac{1}{\eta_c}} \left(c_t^f\right)^{\frac{\eta_c-1}{\eta_c}}\right]^{\frac{\eta_c}{\eta_c-1}} \quad (1)$$

where c_t is a CES index that includes domestic and foreign goods, with parameter α_c determining the degree of openness and η_c the elasticity of substitution between domestic and imported goods. The lagrange multiplier, p_t^c, denotes the consumption price index that normalizes every price index of the economy

$$p_t^c = \left[(1-\alpha_c)\left(p_t^h\right)^{1-\eta_c} + \alpha_c \left(p_t^f\right)^{1-\eta_c}\right]^{\frac{1}{1-\eta_c}}$$

4.3 Labor Agencies, Unions and Wage setting

In order to introduce nominal rigidities in wages and to facilitate the aggregation, we use the set up that we developed in Gonzáles et al. (2014). The set up is as follows: Ricardian and non-Ricardian households sell labor to specific Ricardian and non-Ricardian unions respectively that differentiates it. Since they produce differentiated labor, these unions have monopolistic power. After buying labor from the households, the differentiated labor is sold to Ricardian and non-Ricardian agencies in perfect competition that "pack" the labor into composites of Ricardian and non-Ricardian labor respectively. Finally, both types of "packed" labor are bought by a national agency that aggregates them into a final composite to be sold to intermediate good firms.

4.3.1 Labor Agencies

As mentioned before, there are three types of labor agencies: Non-Ricardian, Ricardian and aggregate labor agency. The first two are identical and are designed to buy the differenciated labor from Ricardian, $u_{n,t}$, and non-Ricardian, $u_{r,t}$, unions to aggregate into Ricardian and non-Ricardian indexes. The national labor agency aggregates Ricardian and non-Ricardian labor "packed" by specific labor agencies and sells it to intermediate good firms subject to a CES aggregator

$$n_t = \left[(1-\alpha_h)^{\frac{1}{\eta_h}}\left(u_{n,t}\right)^{\frac{\eta_h-1}{\eta_h}} + \alpha_h^{\frac{1}{\eta_h}}\left(u_{r,t}\right)^{\frac{\eta_h-1}{\eta_h}}\right]^{\frac{\eta_h}{\eta_h-1}} \tag{2}$$

so that the demand for "packed" Ricardian and non-Ricardian labor are given by

$$u_{n,t} = (1-\alpha_h)\left(\frac{v_{n,t}}{v_t}\right)^{-\eta_h} n_t \tag{3}$$

$$u_{r,t} = \alpha_h\left(\frac{v_{r,t}}{v_t}\right)^{-\eta_h} n_t \tag{4}$$

with the lagrange multiplier equal to v_t

$$\frac{v_t}{p_t^c} = \left[(1-\alpha_h)\left(\frac{v_{n,t}}{p_t^c}\right)^{1-\eta_h} + \alpha_h\left(\frac{v_{r,t}}{p_t^c}\right)^{1-\eta_h}\right]^{\frac{1}{1-\eta_h}}$$

where $\frac{v_t}{p_t^c}$ stands for the real wage paid by the intermediate good firms as shown below.

Non-Ricardian labor agency demands labor from union j given the aggregate labor agency's demand and the aggregation function

$$u_{n,t} = \left[\int_0^1 \left(u_{n,j,t}\right)^{\frac{\theta^{\omega_n}-1}{\theta^{\omega_n}}} dj\right]^{\frac{\theta^{\omega_n}}{\theta^{\omega_n}-1}}$$

Thus, the demand for labor from union j is given by

$$u_{n,j,t} = \left(\frac{v_{n,j,t}}{v_{n,t}}\right)^{-\theta^{\omega_n}} u_{n,t} \tag{5}$$

where $u_{n,t}$ is the labor demanded by the national agency in Eq.3. The corresponding wage index is

$$v_{n,t} = \left[\int_0^1 \left(v_{n,j,t}^{1-\theta^{\omega_n}}\right) dj\right]^{\frac{1}{1-\theta^{\omega_n}}}$$

Aggregating over unions, we obtain

$$\Gamma n_{n,t} = \Upsilon_t^{\omega_n} u_{n,t} \tag{6}$$

where $\Upsilon_t^{\omega_n} \equiv \int_0^1 \left(\frac{v_{n,j,t}}{v_{n,t}}\right)^{-\theta^{\omega_n}} dj$ and $\Gamma n_{n,t}$ corresponds to the aggregate labor supplied by non-Ricardian households.

In the same way, there is a Ricardian Labor Agency that solves a similar problem with respect

to the labor supplied by Ricardian labor Unions.

4.3.2 Labor Unions

There is a continuum of unions $j \in [0,1]$ that buy labor from non-Ricardian Households at $w_{n,t}$ and sell it to the non-Ricardian labor agency at $v_{n,j,t}$. They have monopolistic power and can set $v_{n,j,t}$ optimally with probability $(1-\varepsilon^{\omega_n})$ each period. Between re-optimization periods we allow the nominal wage to be adjusted according to the following indexation rule

$$v_{n,j,t+i} = v_{n,j,t+i-1}\left(1+\pi^c_{t+i-1}\right) = v_{n,j,t}\prod_{s=1}^{i}\left(1+\pi^c_{t+s-1}\right)$$

Every union j maximizes benefits subject to this indexation rule and the demand from the non-Ricardian labor agency given by Eq.5.

As for labor agencies, the Ricardian unions solve a similar problem to that of non-Ricardian unions.

4.4 Entrepreneurs

Entrepreneurs purchase capital in each period, k_t and use it in combination with hired labor, n_t to produce the wholesale output good in the economy, y^h_t. They use a constant-return-to-scale technology:

$$y^h_t = A_t k^{\alpha}_{t-1} n^{1-\alpha}_t \tag{7}$$

where A_t is an exogenous technology shock.

The entrepreneurs choose k_t and n_t to maximize profits subject to the production technology.

The resulting real marginal cost is:

$$\varphi_t = \frac{1}{A_t}\left(\frac{r^k_t}{\alpha}\right)^{\alpha}\left(\frac{\frac{v_t}{p^c_t}}{1-\alpha}\right)^{(1-\alpha)}$$

Where r^k_t represents the rental rate of capital.

We now consider the capital acquisition decision. The entrepreneur finances their purchases of capital partly with his or her own net worth available at the end of period t, N_t and partly by issuing nominal bonds, b_{t+1}. The capital financing is divided between net worth and debt as follows:

$$q_t k_{t+1} = N_{t+1} + b_{t+1} \tag{8}$$

where q_t corresponds to the relative price of a unit of capital which varies depending of the

capital producing technology. The entrepreneurs' demand for capital is determined by comparing the expected marginal return to holding capital with its expected marginal financial cost. The expected gross return to holding a unit of capital from t to $t+1$ $E_t f_{t+1}$ is defined as:

$$E_t f_{t+1} = E_t \left[\frac{(1-\tau_{k,t}) r_t^k + (1-\delta) q_{t+1}}{q_t} \right] \tag{9}$$

Where $\tau_{k,t}$ represents government tax on capital and the parameter δ the capital depreciation rate. The second term is the capital gain enjoyed by the entrepreneurs.

On the other hand, following Bernanke et al. (1999), the balance sheets effects that affect investment are given by a financial friction. In their set up, there is a costly state-verification problem that limits the entrepreneurs to freely borrow from lenders. The financial cost condition for purchasing capital is the main feature of this model. According to Bernanke et al. (1999), lenders must pay a fixed "auditing cost" if they wish to observe the borrower's realized returns. This auditing cost is interpreted as the cost of bankruptcy or default. Additional costs (the premium) over riskless interest rate r_{t+1} are imposed on borrowers if they demand external funds. The default risk depends on the degree to which the entrepreneurs depend on external funds, debt, and this leads to a relationship between two important ratios: the ratio of $E_t f_{t+1}$ to r_{t+1} and the ratio of net worth to assets, as follows

$$E_t f_{t+1} = E_t \left[r_{t+1} \left(\frac{q_t k_{t+1}}{N_{t+1}} \right)^{\psi} \right] \tag{10}$$

When the ratio of internal funds is low the default risk is high and in this case the cost of borrowing rises.

Finally, net worth evolves as following

$$N_{t+1} = \nu \left[f_t q_{t-1} k_t - r_t \left(\frac{q_{t-1} k_t}{N_t} \right)^{\psi} (q_{t-1} k_t - N_t) \right] \tag{11}$$

The first term in the right hand side represents the ex-post return of capital and the second term the ex-ante cost of borrowing, where υ is the share of equity held by entrepreneurs at $t-1$ who are still in business at t. Entrepreneurs that exit the market transfer the remaining profits to Ricardian households.

4.5 Capital Producers

Capital producers purchase consumption goods as material input, x_t, and combine it with rented capital, k_t, to produce new capital. Following Dib and Christensen (2008), we assume that capital producers are subject to quadratic capital adjustment costs. Their optimization problem, in real terms, consist of choosing the quantity of investment to maximize profits, so that

$$\max_{x_t} \left[q_t x_t - x_t - \frac{\kappa}{2} \left(\frac{x_t}{k_t} - \delta \right) k_t \right] \tag{12}$$

The first order condition is

$$q_t - \frac{\kappa}{2} \left(\frac{x_t}{k_t} - \delta \right) = 0 \tag{13}$$

The aggregate capital stock evolves according to:

$$k_{t+1} = x_t + (1 - \delta) k_t \tag{14}$$

4.6 Domestic and imported investment

As for consumption, the investment bundle x_t aggregates domestic and foreign investment according to the next function:

$$x_t = \left[(1 - \alpha_x)^{\frac{1}{\eta_x}} \left(x_t^h \right)^{\frac{\eta_x - 1}{\eta_x}} + \alpha_x^{\frac{1}{\eta_x}} \left(x_t^f \right)^{\frac{\eta_x - 1}{\eta_x}} \right]^{\frac{\eta_x}{\eta_x - 1}} \tag{15}$$

with its corresponding price index.

4.7 Retailers

We assume that entrepreneurs sell all their output to retailers. Retailers then sell differentiated output goods to households, capital producers, and the government sector. Given that their output is differentiated, retailers have the monopolistic power to set prices of these final output goods. These firms are assumed to set nominal prices according to the stochastic time dependent rule proposed by Calvo (1983). Each firm resets its price with probability $1 - \varepsilon^h$ each period, independently of the time elapsed since the last adjustment, setting price p_z^h. In absence of re-optimization, the firm follows an updating rule

$$p_{z,t+i}^h = p_{z,t+i-1}^h \left(1 + \pi_{t-1}^h \right) = p_{z,t}^h \prod_{s=1}^{i} \left(1 + \pi_{t+s-1}^h \right)$$

The problem of the firm z is to pick $p_{z,t}^h$ to maximize the discounted sum of expected profits when the firm adjust prices once:

$$maxE \sum (\beta \varepsilon^h)^i \frac{\lambda_{t+i} \xi_{z,t+i}^h}{P_{t+i}^h}$$

subject to the demand function variety z

$$y_{z,t}^h = \left(\frac{p_{z,t}^h}{p_t^h} \right)^{-\theta^h} y_t^h$$

where

$$\xi_{z,t+i}^h = \left[p_{z,t}^h \prod_{s=1}^{i} \left(1 + \pi_{t+s-1}^h\right) - \varphi_{t+i} \right] y_{z,t+i}^h$$

4.8 Government

4.8.1 Monetary Policy

Monetary policy follows a conventional simple policy rule where interest rate is set by the Central Bank according with

$$i_t = \bar{i} \left(\frac{\pi_{t+1}^c}{\overline{\pi}} \right)^{\rho_\pi} \epsilon_{i,t} \tag{16}$$

where long-run interest rate is $\bar{i}$, the inflation target is $\overline{\pi}$ and the feed-back parameter is ρ_π.

4.8.2 Fiscal Policy

The government purchases both domestic and foreign goods. These purchases are assumed to have null effect on private utility or productivity. Again, the government bundle of goods G_t is a CES aggregator of domestic and imported government purchased goods:

$$G_t = \left[(1-\alpha_G)^{\frac{1}{\eta_G}} \left(G_t^h\right)^{\frac{\eta_G - 1}{\eta_G}} + \alpha_G^{\frac{1}{\eta_G}} \left(G_t^f\right)^{\frac{\eta_G - 1}{\eta_G}} \right]^{\frac{\eta_G}{\eta_G - 1}}, \tag{17}$$

also with its corresponding price index.

In addition, the government taxes consumption, labor income and capital, transfers resources to Non-Ricardian and Ricardian households and has access to international debt markets. The government budget constraint takes the following form:

$$b_{g,t}^\star = \left[\left(\frac{1 + i_{t-1}^\star}{1 + \pi_t^\star} \right) \frac{e_{t-1} p_{t-1}^\star}{p_{t-1}^c} b_{g,t-1}^\star - s_t \right] \left(\frac{e_t p_t^\star}{p_t^c} \right)^{-1} \tag{18}$$

$$s_t = \tau_t + \omega \frac{p_t^m}{p_t^c} y_t^m - \frac{p_t^G}{p_t^c} G_t - T_t \tag{19}$$

where s_t is the primary surplus and τ_t denotes the total tax revenues, the second term in the right hand side is oil revenues from government, $g_t \equiv \frac{p_t^G}{p_t^c}\frac{G_t}{gdp_t}$ is the government spending as a percentage of GDP, and T_t lump-sum net transfers. The international price of oil $p_t^{m\star}$ is assumed to follow an exogenous autorregresive process, implying a domestic oil price $p_t^m = \frac{e_t p_t^\star}{p_t^c} p_t^{m\star}$; in the same way, oil production y_t^m is assumed to be exogenous. ω denotes the share of oil production that the government owns, so that a fraction ω of oil revenues accrues to the government, whereas the remaining share of oil revenues goes to foreign companies.

Total tax revenues correspond to collected taxes on consumption, capital and labor income.

$$\tau_t = \tau_{n,t}\frac{v_t}{p_t^c} n_t + \tau_{k,t} r_t^k k_t + \tau_{c,t} c_t \tag{20}$$

Government surplus gs_t is defined as:

$$gs_t = -b_{g,t}^\star \left(\frac{e_t p_t^\star}{p_t^c}\right) + b_{g,t-1}^\star \left(\frac{e_{t-1} p_{t-1}^\star}{p_{t-1}^c}\right)\left(\frac{1}{1+\pi_t^\star}\right), \tag{21}$$

which equals the primary surplus and net interest payments on government debt.

The share of government expenditure to real GDP of the economy, g_t, is assumed to follow an exogenous and autorregresive process:

$$g_t = (1-\rho_G)\,\overline{g} + \rho_G g_{t-1} + \epsilon_{G,t}, \tag{22}$$

where $\overline{g}$ is the long run government share and ρ_G captures the persistence of the process.

Similarly, tax rates on wages, consumption, holdings of capital and the investment subsidy are allowed to vary according to:

$$\tau_{c,t} = (1-\rho_{\tau_c})\,\overline{\tau}_c + \rho_{\tau_c}\tau_{c,t-1} + \epsilon_{\tau_c,t} \tag{23}$$

$$\tau_{n,t} = (1-\rho_{\tau_n})\,\overline{\tau}_n + \rho_{\tau_n}\tau_{n,t-1} + \epsilon_{\tau_n,t} \tag{24}$$

$$\tau_{k,t} = (1-\rho_{\tau_k})\,\overline{\tau}_k + \rho_{\tau_k}\tau k_{,t-1} + \epsilon_{\tau_k,t} \tag{25}$$

where $\bar{\tau}_n$, $\bar{\tau}_k$, and $\bar{\tau}_c$ are long-run tax rates, ρ_{τ_n}, ρ_{τ_k}, and ρ_{τ_c} represent persistency and ϵ_{τ_n}, ϵ_{τ_k},and ϵ_{τ_c} are *i.i.d.* white noise shocks.

The final component of fiscal policy is the policy rule that is explained in the next section.

4.9 Fiscal Policy Rules

The fiscal policy rule of the government takes the form of

$$\frac{gs_t}{gdp_t} = \overline{gs}^{rat} + d_{tax}\left(\frac{\tau_t}{gdp_t} - \frac{\overline{\tau}}{\overline{gdp}}\right) + d_m\left(\omega\left(\frac{p_t^m}{p_t^c}\frac{y_t^m}{gdp_t} - \frac{\overline{p}^m}{\overline{p^c}}\frac{\overline{y}^m}{\overline{gdp}}\right)\right) + d_{debt}\left(\frac{b_{g,t}^\star}{gdp_t} - \frac{\overline{b}}{\overline{gdp}}\right)$$

where $\overline{gs}^{rat}$ is a structural surplus target. A fiscal rule similar to this was introduced in Colombia in July 2011 with a structural surplus target of -2.3% for the year 2014. The remaining items correspond to cyclical adjustments according to excess tax revenue, excess revenue from mining sector and an additional debt gap variable.

A strict Balanced Budget Rule (BBR) corresponds to parameter values of $d_{tax} = d_m = d_{debt} = 0$. This kind of rules are highly procyclical because it calls for higher spending in a boom. An alternative rule introduced in countries like Chile, (see Céspedes et al. 2012) and Norway (see Pieschacón, 2012) to avoid problems such as the Dutch disease phenomenon is a Structural Surplus Rule (SSR) where the it ties government spending to structural/permanent government revenues. This is the case of parameter values of $d_{tax} = d_m = 1$ and $d_{debt} = 0$. In this rule, excess revenues from oil or tax revenue are saved in form of reduced debt or increased assets. According to Céspedes et al. (2012), in the case of Chile "the idea was to acknowledge that public debt was at a level higher that was considered appropriate for a small open economy that faced exogenous credit constraint shocks and a given potential future pension liabilities". The structural surplus target, $\overline{gs}^{rat}$, is exogenous. As pointed out by Kumhof and Laxton (2013), this rule has at least two important implications. First, it has the ability to stabilize long-run debt. Equation 21 shows that a SSR anchors the long-run debt to GDP ratio, $\bar{b_g}^{rat} = -\frac{\bar{gs}^{rat}}{4}\left(\frac{\bar{\pi g}}{\bar{\pi g}-1}\right)\left(\frac{ep^\star}{p^c}\right)^{-1}$, which in the case of Colombia with a nominal growth rate $\bar{\pi g}$ of 5 percent and surplus target of -2.3 percent of GDP would imply a long-run debt to GDP ratio of about 12 percent compared to the actual 30 percent level. The second implication is related to the business cycle stabilization and volatility of fiscal instruments. We will discuss this aspect in the results of the simulations of the model.

Finally, a countercyclical fiscal rule is implemented in the case that $d_{tax} > 1$ which calls for higher tax rate (or lower spending) in a boom. This rule would represent strong automatic stabilizers, such as progressive taxation or countercyclical transfers, for example unemployment insurance (Kumhof and Laxton, 2013).

In order to achieve objective of the targeting rule the fiscal authority has five instruments, three taxes $\tau_{c,t}$, $\tau_{n,t}$ and $\tau_{k,t}$, and two spending items T_t and G_t. The default instrument for our baseline results is transfers T_t. In this case, the fiscal rule is given by:

$$\left(\frac{T_t}{gdp_t} - \frac{\overline{T}}{\overline{gdp}}\right) = (1-d_{tax})\left(\frac{\tau_t}{gdp_t} - \frac{\overline{\tau}}{\overline{gdp}}\right) + (1-d_m)\left(\omega\left(\frac{p_t^m}{p_t^c}\frac{y_t^m}{gdp_t} - \frac{\overline{p}^m}{\overline{p^c}}\frac{\overline{y}^m}{\overline{gdp}}\right)\right) - d_{debt}\left(\frac{b_{g,t}^\star}{gdp_t} - \frac{\overline{b}}{\overline{gdp}}\right) \tag{26}$$

where the overlined variables denote their steady state values, so that the fiscal rule activates when

the variables of interest of the government deviate from their steady state values and $\overline{T}$ has been set to satisfy the structural surplus budget.

4.10 Rest of the world

Foreign demand of home produced goods $c_t^{h\star}$ is given by

$$c_t^{h\star} = \left(\frac{p_t^h}{p_t^c} \left(\frac{e_t p_t^c}{p_t^\star} \right)^{-1} \right)^{-\mu} c_t^\star \tag{27}$$

where the parameter μ represents the price elasticity of exports.

4.11 Equilibrium and Aggregation

Foreign and domestic debt

$$b_t = (1-\Gamma)\, b_{r,t} \tag{28}$$

$$b_t^\star = (1-\Gamma)\, b_{r,t}^\star + b_{g,t}^\star \tag{29}$$

Aggregate consumption

$$c_t = \Gamma c_{n,t} + (1-\Gamma)\, c_{r,t} \tag{30}$$

Domestic uses of product

$$y_t^h = c_t^h + x_t^h + G_t^h + c_t^{h*} \tag{31}$$

Finally real GDP is

$$gdp = \frac{p_t^h}{p_t^c} y_t^h + \frac{p_t^m}{p_t^c} y_t^m \tag{32}$$

4.12 Aggregate Welfare

Making use of the cashless limit assumption, the period utility of representative n household at time t is given by

$$u_t^n = \frac{1}{1-\sigma_n} \left\{ c_{n,t} - \theta_n \frac{n_{n,t}^{1+\gamma_n}}{1+\gamma_n} \right\}^{1-\sigma_n} - \frac{1}{1-\sigma_n}$$

The expectation of welfare is

$$W_t^n = u_t^n + \beta W_{t+1}^n \tag{33}$$

In order to have a metric for the welfare gain if Colombia could switch from the Balanced Budget kind of Rule that follows until now to a Structural Balanced Rule like the one in Chile or Norway, we compute the welfare gain Ω^n as:

$$\Omega^n = 100\left(1 - \exp\left(\beta - 1\right)\left(EW_t^{n,fisc} - EW_t^{n,BBR}\right)\right)$$

where $EW_t^{n,fisc}$ is the expectation on welfare under a given combination of fiscal rule parameters and $EW_t^{n,BBR}$ is the expectation of welfare under the baseline combination, the BBR. We use second order approximation of the first order conditions of the model and the utility functions to compute welfare.

Finally, we quantify aggregate welfare by way of population-weighted average of welfare gains:

$$\Omega = (1 - \Gamma)\Omega^r + \Gamma\Omega^n \tag{34}$$

5 CALIBRATION

The calibration of the model is made for the Colombian economy as in Gonzáles et al. (2014). The additional parameter to be calibrated corresponds to the inverse of the elasticity of the external finance premium to leverage. In our simulations for the model with financial accelerator this parameter was set in 0.05 according to the estimates by López et al. (2009). The other parameters were calibrated as in Gonzáles et al. (2014). The elasticity of substitution η_c and η_x are fixed at 0.9 and 0.5 according with estimates by González et al. (2011). The parameters θ_j for $j = n$, r are set to 4, consistent with steady state hours worked. In addition, α_c, α_x and α_G are 0.13 that correspond to the imports to GDP ratio. We also calibrated the Calvo price probability, ε^h, in 0.7 according with estimates for Colombia by Bejarano (2005) which is also in line with estimates for the United States by Smets and Wouters (2007). The Calvo wage probability was calibrated in 0.4 for Ricardian agents in line with estimates for Colombia by Bonaldi et al. (2011), and we assumed a low wage rigidity for the non-Ricardian agents. The long-run values $\overline{\tau}$ are in line with estimates by Fergusson (2003) and Hamann et al. (2011). The depreciation rate, δ, is 0.035 to be consistent with the long-run ratio of investment to GDP, implying a 14% annual depreciation rate. The long-run ratio of government expenditure to GDP $\overline{g}$ is 0.15 according with the data. The parameter ω is consistent with the government's share on total mining sector dividends, which corresponds to the share of government in state firm Ecopetrol. For the parameter Γ, share of non-Ricardian agents in the Colombian economy, we use a Superfinanciera (the banking supervision agency in Colombia) dataset recorded by

each bank in the 341 form about saving accounts as a percentage of the population in working age reported by DANE (the Colombian statistics department): 80%. This parameter value is similar also to the one estimated for the Chilean economy by Corbo and Schmidt-Hebbel (1991). The elasticity of substitution among varieties of intermediate goods, θ^h, is calibrated in 6 which implies a steady-state mark-up of 20 per cent, a common value used in the literature. The investment cost parameter, κ, is set at 0.5 as estimated by López et al. (2009) for the Colombian economy. The elasticity of country risk premium with respect to net foreign debt, ϕ_b, is set equal to 0.0024, which as pointed out by Gertler et al. (2007) should be small enough so that the friction in the capital market does not alter the high frequency model dynamics but nonetheless makes net foreign indebtedness revert to trend. The elasticity of output to capital, α, is set to 0.3 to be consistent with the labor income share. The inverse of Frisch elasticity was calibrated in 0.5 according with Prada and Rojas (2009). The subjective discount factor β is set to 0.99, implying a steady state interest rate of 4%. The relative risk aversion coefficient, σ_r, was set at 2.0 according with estimates by López (2001). We fix the steady state world interest rate at 3 per cent per annum. The steady state foreign and domestic inflation rates are set at 3 per cent per annum. Table 1 summarizes the parameters and their description.

6 RESULTS

6.1 Fiscal multiplier and balance sheet effects

In this section we illustrate the different fiscal multipliers: with and without financial accelerator. As we described in section 3 in the VAR, the fiscal multiplier is between 0.4% and 2.0%.

In Figure 2, we present the effects of a government spending shock on different macroeconomic variables before taking into account balance sheet effects. The baseline fiscal rule that we use in this simulations corresponds to the Budget Balanced Rule that is the one that has been in place in Colombia. The results are close to upper bound of the empirical evidence of the VAR presented in section 3. Given that the economy is described in the model in a framework with the presence of non-Ricardian agents and GHH preferences, total consumption increases. Both Ricardian and non-Ricardian consumption increases given the fiscal stimulus. Non-Ricardian households consume all the transfers from government, while the consumption of Ricardian households is stimulated because the wealth effect is not present in their preferences. The result is an increase in total consumption that also matches the upper bound of the response in the data.

This increase in consumption results in a rise in output that causes inflation also to increase. In an inflation targeting regime, the monetary authority reacts raising nominal interest rates. As mentioned in the description of the model, the price of capital is the discounted value of dividends. As the real interest rates rise, the price of capital falls. Accordingly, as the investment is explained by the q-theory of investment this also drops. This would be the final result in an environment where the Modigliani-Miller theorem holds. However, the fall in investment in this case is too low (-0.1%)

compared with the empirical responses presented in the VAR (-1.0%).

How the fall in investment is affected when we consider balance sheet effects? In Figure 3, we present the results. In a model with balance sheet effects on investment, that is, with financial accelerator, when the price of capital drops there is an additional effect in the economy: the net worth of entrepreneurs also falls. When the net worth decreases, collateral values are lower and the external finance premium to borrowers increases. The increase in the external finance premium causes investment to fall even farther as a result of the financial accelerator mechanism. Consequently, the crowding out effect of government spending is higher than in a world without balance sheet effects. The effect of government spending in output is therefore lower and we can observe a lower fiscal multiplier effect. The parameter ψ was calibrated to replicate the lower bound of 0.4 of the fiscal multiplier observed in the VAR in section 3. This result is also in line with estimates by Vargas et al. (2012).

When we compare this results with the ones of Freedman et al. (2010), we can contrast the fiscal multiplier with financial accelerator for an advanced economy like the United States, where there is a high proportion of Ricardian agents (3/4 of population) and an emerging economy with a proportion of non-Ricardian agents with 80% of the population.

Finally, the government expenditure shock induces a real exchange rate appreciation and an increase in hours worked which matches the results of the VAR.

6.2 A subsidy on external finance premium to borrowers.

As described earlier, the outcome in an economy with important financial frictions is that there is a wedge between the lending and the risk free interest rate. One policy that has been implemented in order to reduce this wedge has been to introduce subsidies to ameliorate the fall in investment. In Colombia, for instance, in the social interest housing sector, subsidies on interest rates to borrowers have been implemented. Also in the rural sector, FINAGRO provides this kind of subsidies to farmers in the production of certain type of crops.

The increase in the inefficiency of the financial system is modeled as a shock to the external finance premium that increases even more the wedge between the lending and the risk free interest rate, holding constant firm balance-sheet positions. Figure 4 shows the response of output and inflation to an exogenous 100-basis-point rise in the external finance premium under two scenarios: one with a monetary authority that is accommodative fighting inflation and one when it is aggressive against it. In the case of an aggressive monetary policy, the output and inflation volatility is much lower than in the case of an accommodative policy. In the opposite case of a subsidy that closes the gap between the lending and risk free rate, the result is also macroeconomic stabilization if monetary policy is aggressive.

The later opens the question of how aggressive the monetary policy should be? We answer this

question with a welfare analysis in terms of an optimized utility function as described at the end of Section 3. The results are presented in Table 2 and Figure 5.

In Table 2 we present the two cases, an accommodative monetary policy rule where ρ_π equals 2 and an aggressive policy rule where ρ_π equals 6. We can observe that the more aggresive the monetary policy is the better results in terms of welfare it achieves.

In Figure 5 we vary ρ_π between 1.5 and 15 and compute welfare gains. The result is that the optimal response of monetary authority, if the inefficiencies in the financial sector are larger, would be a feedback coefficient, ρ_π, around 6 where the welfare gains reach an asymptote. This means that a Central Bank relatively conservative would ameliorate welfare losses derived from the financial frictions. The baseline fiscal rule that we use in this exercise is the Structural Balance Rule as in the previous results.

6.3 Oil prices shock and balance sheet effects under different fiscal rules.

Now we turn to analyze the effects of an oil price shock on several macro variables under the presence of balance sheet effects. We compare the results under different alternatives of fiscal rules. What the government does with the proceedings from oil depends on its fiscal policy rule. In Figure 6 we plot the impulse responses of macroeconomic variables to oil price shock of 1% for alternative fiscal policy rules. The fiscal instrument used for the comparisons is transfers T_t , while tax rates and government spending are kept constant.

The first scenario is the procyclical fiscal policy (BBR), $d_{tax} = d_{debt} = d_m = 0$, in which the government responds to the additional oil revenue by increasing transfers to households, thus allowing them to increase consumption. However, the increase in consumption is lower under balance sheets effects. The effects of the financial frictions in the economy are more evident for the case of inflation, price of capital and investment. With and without financial accelerator inflation rate rises inducing a response of the monetary authority that increases interest rates to cool down the economy. As consequence, the price of capital decreases and it falls even harder in the financial accelerator case because it is the expected discounted dividends that are lower when output is lower. As consequence, there is a strong crowding out in investment. Hours worked increase in tandem with consumption, so the results in terms of welfare have to be analyzed as we will do later in this section.

The second rule is the structural surplus fiscal rule (SSR), $d_{tax} = d_m = 1, d_{debt} = 0$. In this case, the government holds transfers relatively unchanged as it receive more proceedings from oil. This smooth the business cycle with more macroeconomic stability. Output and consumption increase but in lower amount returning faster to their steady state values that under the BBR. In this case, output increases but half the magnitude that in the case of the BBR. However, it does not fall later and its convergence is smoother than in the other two rules. We observe a similar behavior in consumption and total hours. Without a financial accelerator effect, inflation is lower than in

the BBR, the monetary authority response to the oil shock boom is lower and, as result, the price of capital does not fall with the following increase in investment. However, if balance sheet effects are taken into account, there is a crowding out in investment that falls. As explained before, this rule was implemented in Colombia since 2011 with the goal of saving proceedings from oil revenues from the government during a boom to be used in the case of a decline in oil revenues. That is, the rule is intended for stabilize the business cycle. Compared to the BBR the boom does not cause overinvestment originated in possible bubbles coming from capital inflows. Finally, as in the previous case, we observe that hours worked and consumption move together. There is an increase in consumption, but also workers have to work harder. The final result in terms of welfare will be presented later.

With respec to the countercyclical rule, CCR, which implies lowering transfers to households, results in the worse scenario in terms of household´s consumption in both cases with and without financial accelerator. However, the results for investment are the opposite. Given that inflation rate is significantly low with the drop in output, interest rates are low and the price of capital and investment rises almost in the same proportion with and without financial accelerator. Nonetheless, hours worked are very low in the absence of balance sheet effects causing more output volatility.

Now we describe briefly the welfare results of the use of the three fiscal rules. In Figure 7 we show the welfare gain for the different rules with and without financial accelerator in the case of an oil price shock. It is noticeable that the rule that delivers more welfare losses because of the presence of balance sheet effects is the procyclical BBR.

Finally, it is also of interest to analyze whether the welfare gains are the same for the two subgroups of agents. Figure 8 also plots the welfare gain for each group of agents. There, we observe that the SSR is particularly welfare improving in the case of the non-Ricardian households, with a welfare gain of 2%, while in the case of Ricardian agents the welfare gain is almost negligible. The intuition behind this result is that in the case of the non-Ricardian households, a structural fiscal policy rule, SSR, helps to improve welfare because the government smooth consumption of non-Ricardian households when faced with an exogenous shock to oil revenues. In the case of Ricardian agents, they smooth consumption and the fiscal policy does not improve their welfare. Therefore, the presence of non-Ricardian households in the economy justifies the use of a structural fiscal rule that plays the role of a stabilizer.

7 Final Remarks

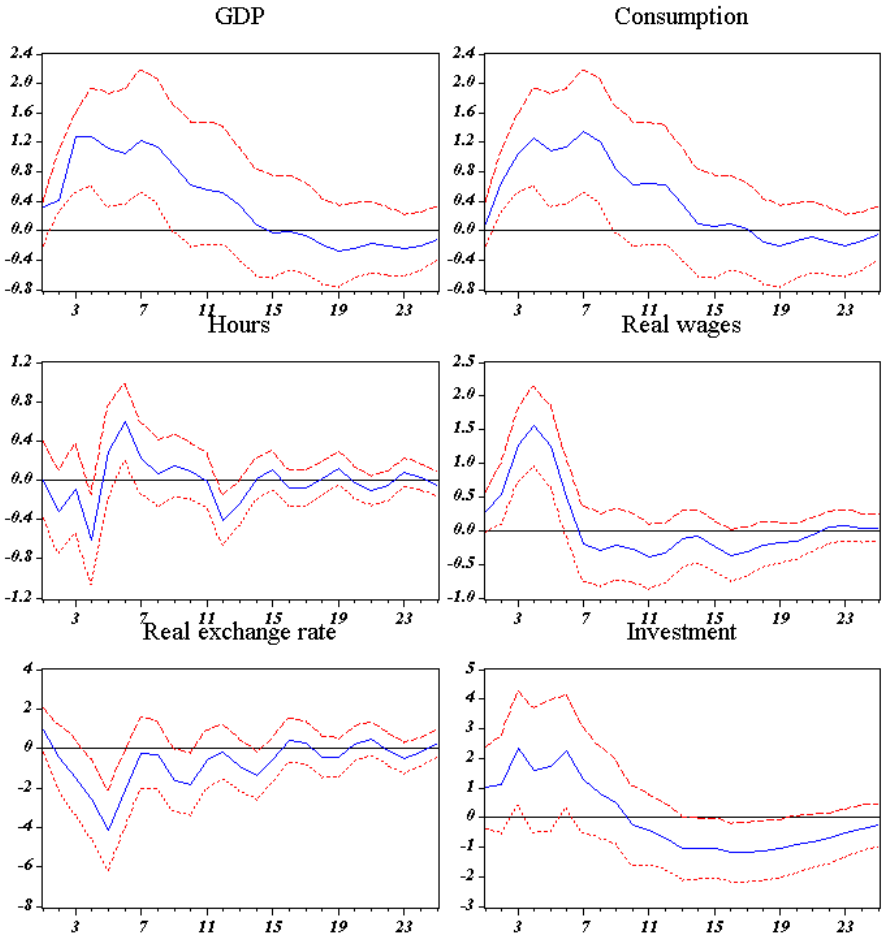
This paper highlighted the importance that balance sheet effects have over investment, consumption and output. The important role of asset prices on net worth of firms and housing investment has a multiplier effect that reinforces the crowding out of investment and deteriorates the increase in consumption and output almost by half. This result might explain why some empirical studies about

fiscal multipliers find a small response of output due to a fiscal stimulus.

Our results suggest that the inefficiency in the financial system, that vary across countries, might be compensated with the introduction of some kind of subsidy that reduces the gap between the lending and the risk free rate. The way of financing this subsidy would be by the increased income taxes that would result from the higher output as a consequence of the government spending shock. This is a practice that has been implemented in some countries and in some sectors such as the housing sector in Colombia. The result has been a lower decrease in investment in the face of an adverse external finance premium.

With respect to the implementation of a fiscal rule in a country like Colombia, the results support previous results about the kind of rule that stabilized the business cycle: a Structural Balance Rule. In terms of welfare the results with this rule are not very strong as in the case of a procyclical or a contracyclical fiscal rule.

Fig. 1: VAR Impulse-Response to a Government Spending Shock.



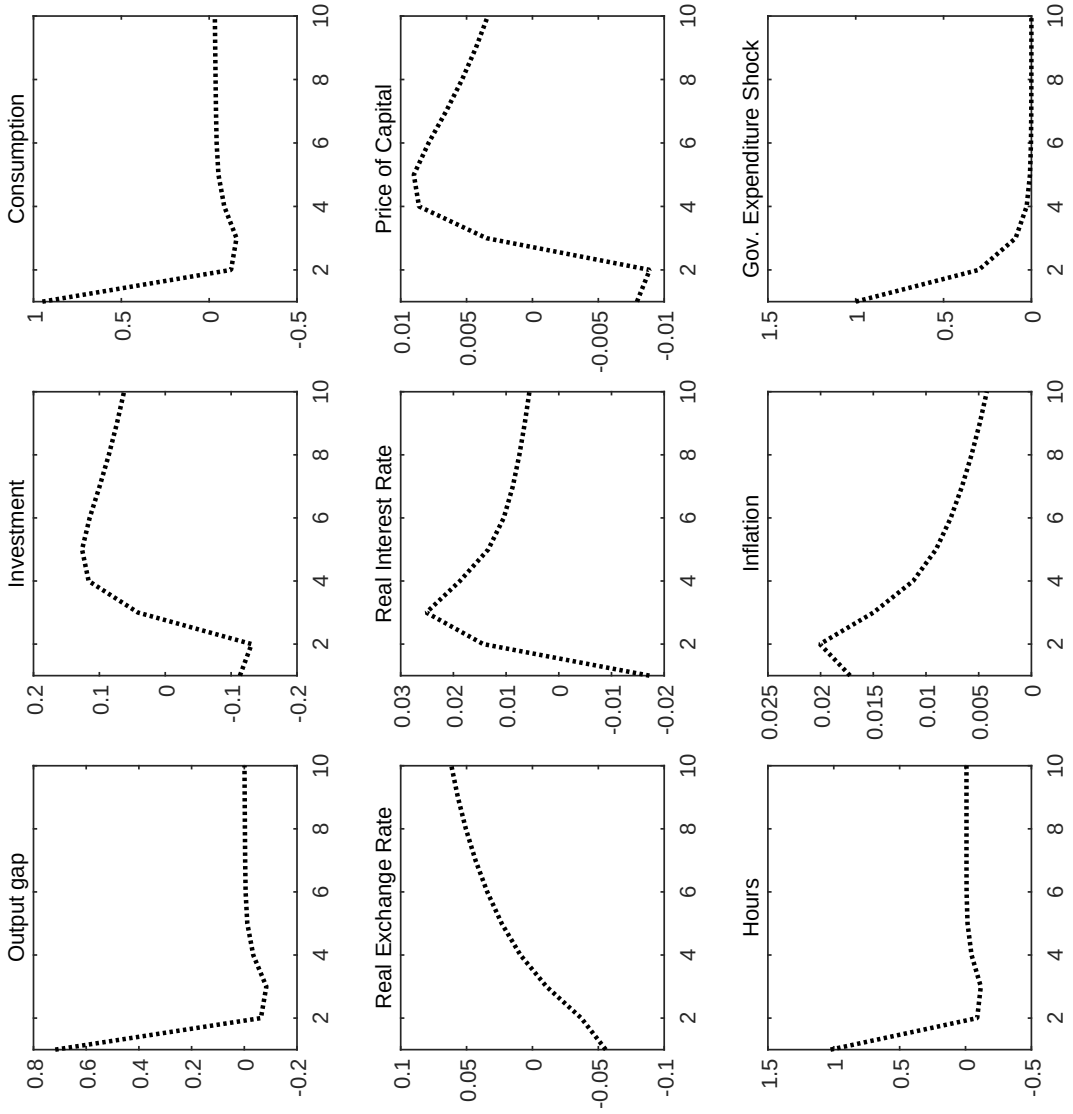


Fig. 2: Impulse-Response: Government Expenditure Shock

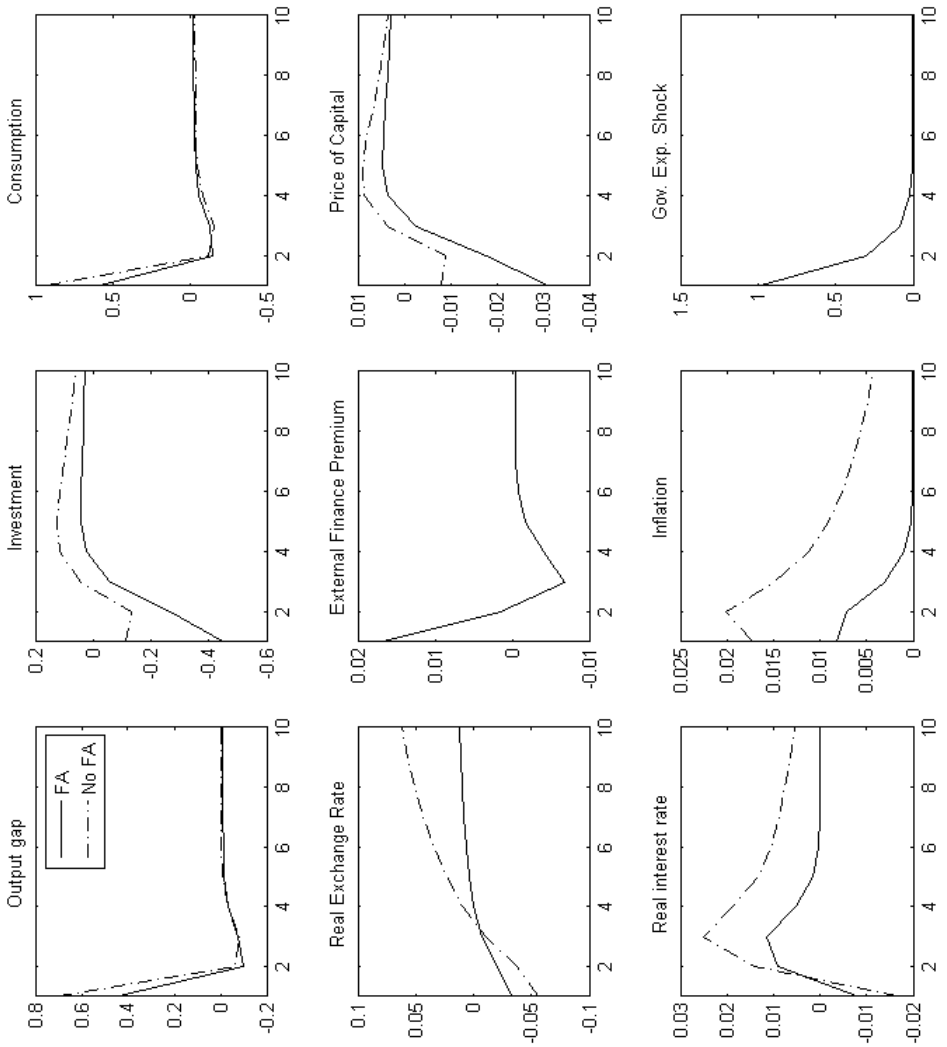


Fig. 3: Impulse-Responses: Government Expenditure Shock with and without Balance Sheet Effects

Fig. 4: Efficiency deterioration of the Financial System: Financial Premium Shock

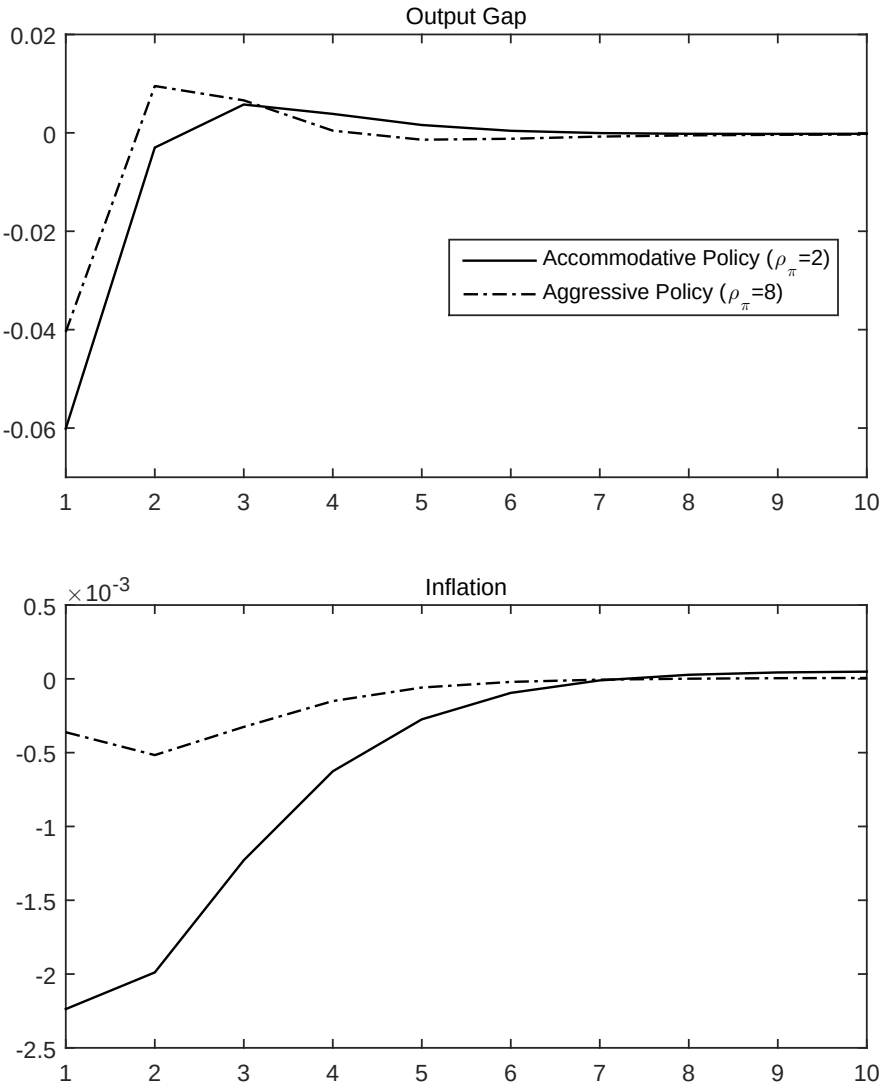
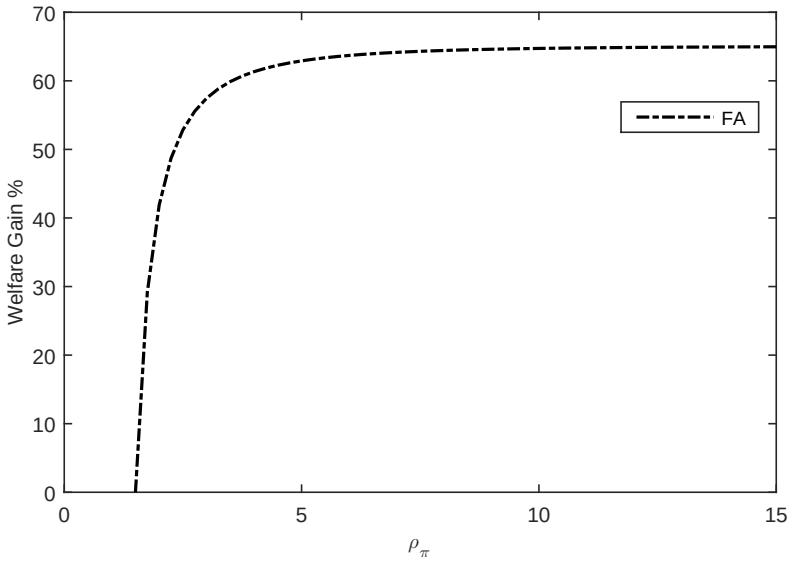


Fig. 5: Total Welfare Gains: Financial Premium Shock under a SSR fiscal rule



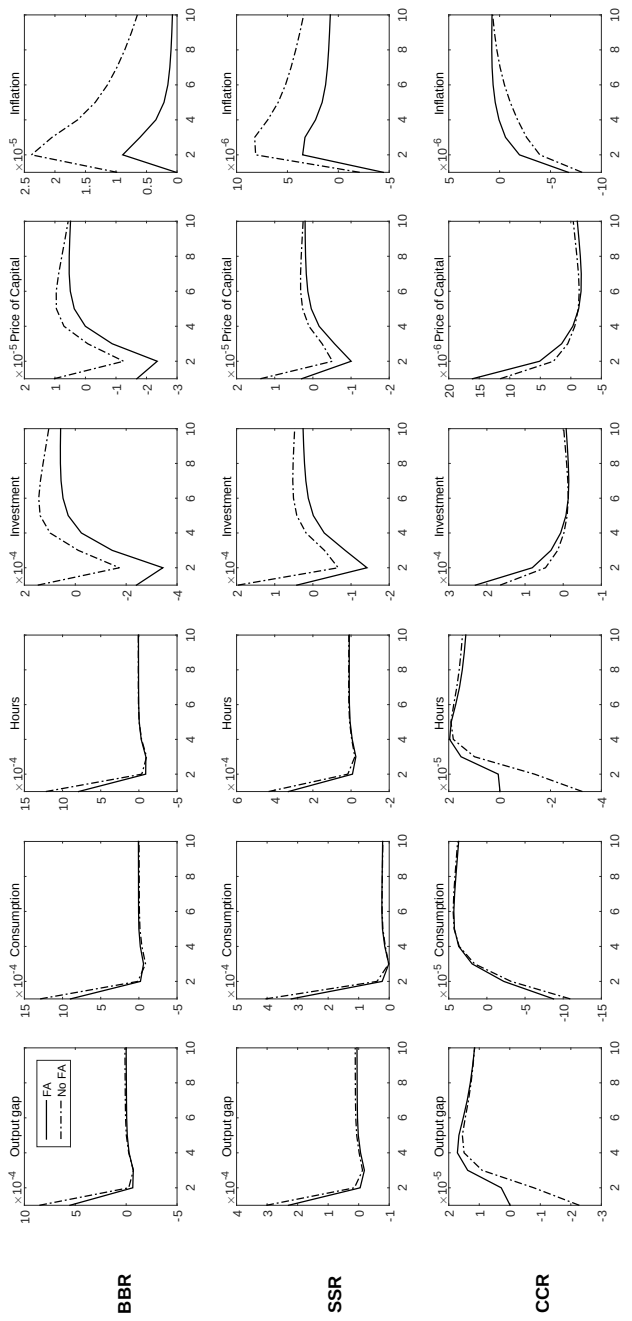
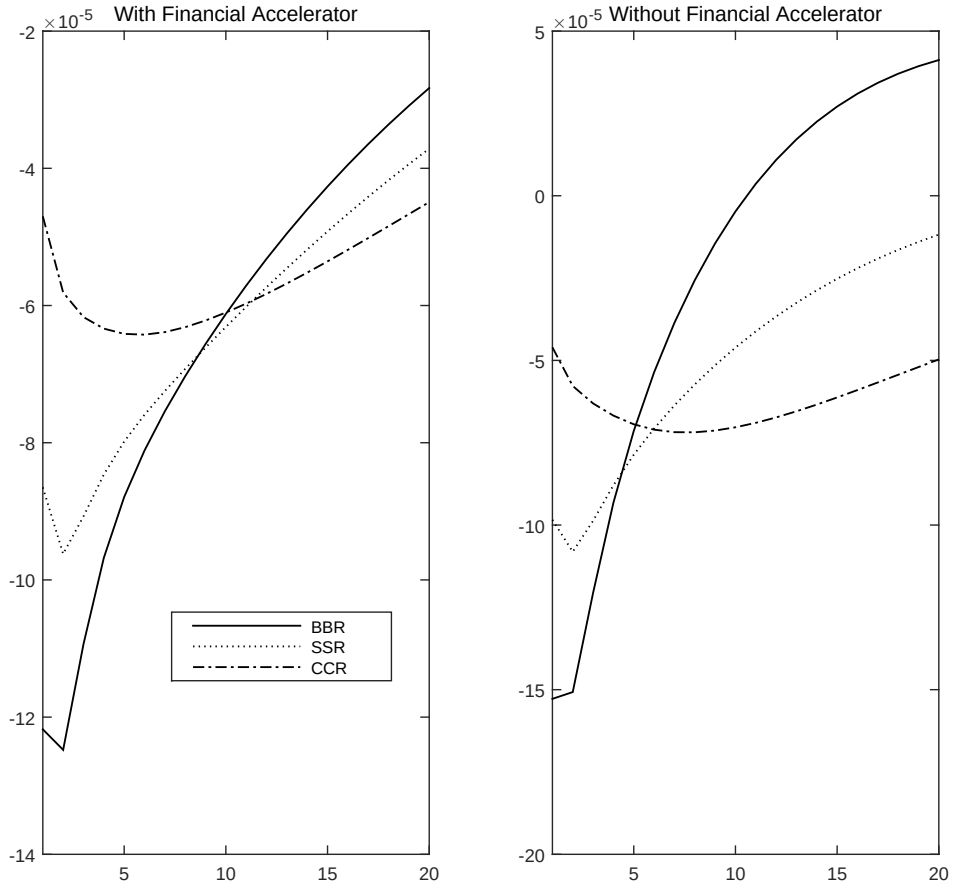


Fig. 6: Mining Prices Shock under different fiscal rules

(a) Mining Prices Shock under different fiscal rules



(b) Mining Prices Shock under different fiscal rules: Real exchange rate

Fig. 7: Welfare Gains under different fiscal rules

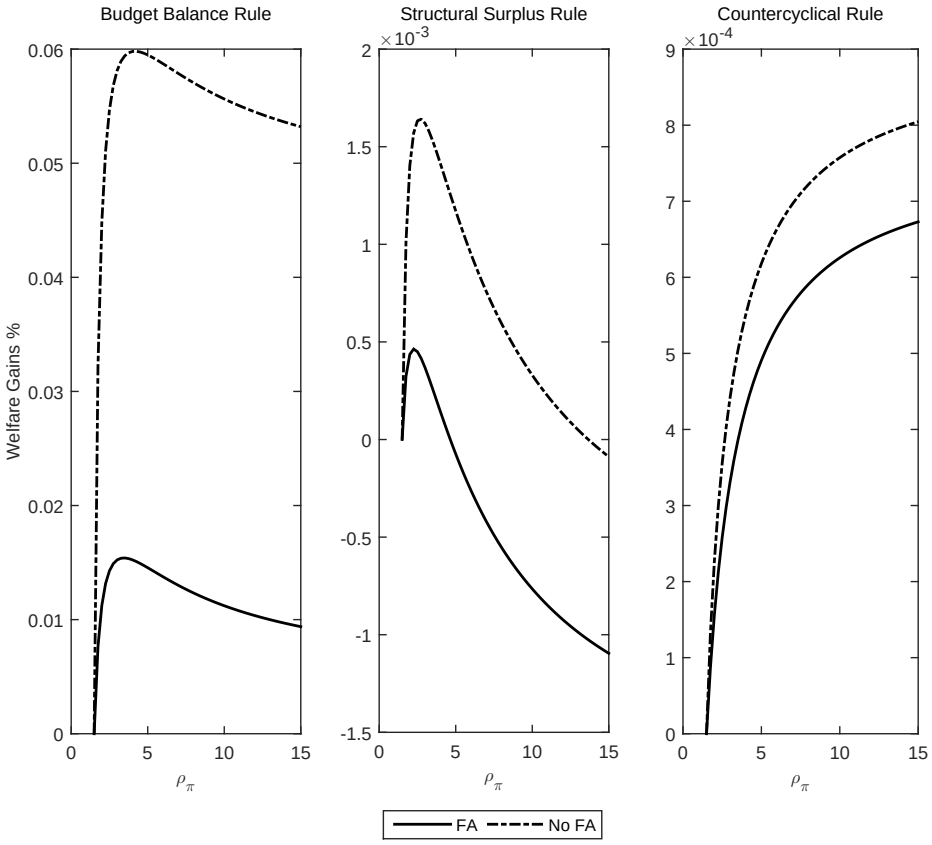
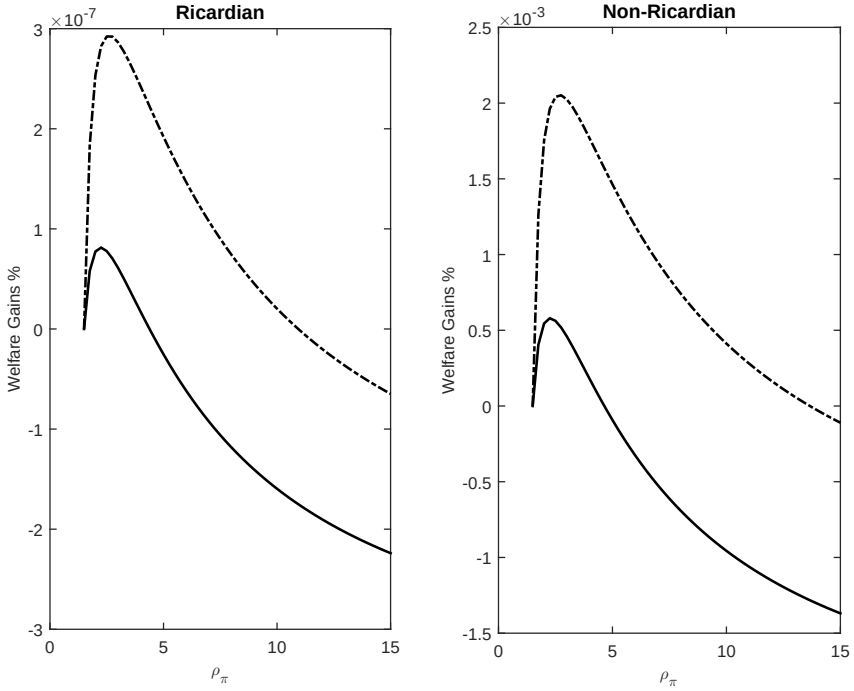


Fig. 8: Total Welfare Gains: Oil Price Shock



Tab. 1: Parameter Values

Parameter	Value	Description
β	0.99	Intertemporal discount factor
Γ	0.8	Share of Non-Ricardian on total population
γ_j	0.5	Inverse of Frisch elasticity
θ_j	4	Labor supply scale parameter
σ_j	2.0	Intertemporal elasiticity of substitution
α_c	0.13	Share of imported goods on total consumption
η_c	0.9	Elasticity of subst. between domestic and foreign goods
α_x	0.13	Share of imported goods on total investment
η_x	0.5	Elasticity of subst.between domestic and foreign goods
α_G	0.13	Share of imported goods on total government expenditure
η_G	0.5	Elasticity of subst.between domestic and foreign goods
δ	0.035	Depreciation rate
κ	0.5	Investment costs
α_h	0.5	Share of Non-Ricardian labor on total supply
η_h	0.99	Elast. of subst.between Non-Ricardian and Ricardian labor
ω	0.5	Government's share on total mining sector benefits
θ^{ω_j}	6	Elast. of subst. between intermediary union labors for intermediary producers
ε^{ω_n}	0.01	Probability of non-Ricardian unions not to optimize wage
ε^{ω_r}	0.4	Probability of Ricardian unions not to optimize wage
α	0.3	Share of capital on total production
θ^h	6	Elast. of subst. between intermediary goods on final production
ε^h	0.7	Probability of firms not to optimize price
μ	0.4	Exports elasticity
ϕ_b	0.3	Elasticity of country risk premium.
$\bar{gs}$	-0.025	Surplus target
$\bar{\pi}$	1.03	Long-run domestic inflation
$\bar{\pi}^\star$	1.03	Long-run foreign inflation
$\bar{b}^\star$	0.3	Long-run debt-GDP ratio
$\bar{i}^\star$	1.0176	Long-run foreign nominal interest rate (quarterly)
$\bar{i}$	1.0176	Long-run nominal interest rate (quarterly)
$\bar{g}$	0.15	Mean of government expenditure to GDP shock
$\bar{\tau_c}$	0.08	Mean of consumption tax shock
$\bar{\tau_k}$	0.10	Mean of capital tax shock
$\bar{\tau_n}$	0.17	Mean of labor tax shock
$\bar{f}$	$1.0148/\bar{\pi}$	Mean of cost of financing
ν	$1/f$	Share of equity held by entrepreneurs at t-1 who are still in business at t
ψ	0.05	Inverse of the elasticity of the external finance premium to leverage

Tab. 2: Welfare Gains under a SSR fiscal rule and different reactions of monetary policy to inflation

Monetary Policy reaction to inflation	ρ_π	Mean		
		Ricardian	Non-Ricardian	Total
Accommodative	2	0,0119469	52,365389	41,894701
Aggressive	6	0,0252772	79,621010	63,7018641

References

Bejarano, J. A. (2005). Estimación estructural y análisis de la curva de phillips neokeynesiana para colombia. *Ensayos sobre Política Económica*, 23(48):63–116.

Bernanke, B., Gertler, M., and Gilchrist, S. (1999). *The Financial Accelerator in a Quantitative Business Cycle Framework*, volume 1 of *Handbook of Macroeconomics*, chapter 21, pages 1341–1393. Handbook of Macroeconomics.

Bonaldi, P., González, A., and Rodríguez, D. (2011). Importancia de las rigideces nominales y reales en colombia: un enfoque de equilibrio general dinámico y estocástico. *Ensayos sobre Política Económica*, 29(66):48–78.

Calvo, G. A. (1983). Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3):383–398.

Castro, G. L. D., Mourinho-Félix, R., Júlio, P., and Maria, J. R. (2014). Fiscal multipliers in a small euro area economy: How big can they get in crisis times? CEFAGE-UE Working Papers 14/7, Banco de Portugal.

Colciago, A. (2011). Rule of thumb consumers meet sticky wages. *Journal of Money, Credit and Banking*, 43:325–353.

Corbo, V. and Schmidt-Hebbel, K. (1991). Public policies and saving in developing countries. Policy Research Working Paper Series 574, The World Bank.

Céspedes, L. F., Fornero, J., and Galí, J. (2012). Non-ricardian aspects of fiscal policy in chile. Working Papers Central Bank of Chile 663, Central Bank of Chile.

Dib, A. and Christensen, I. (2008). The financial accelerator in an estimated new keynesian model. *Review of Economic Dynamics*, 11(1):155–178.

Fergusson, L. (2003). Tributación, crecimiento y bienestar: El caso colombiano(1970-1999). Documentos CEDE 003662, Universidad de los Andes- CEDE.

Fernández, C. and Villar, L. (2014). Bonanzas temporales de recursos y producción manufacturera: una perspectiva global. *Monetaria (CEMLA)*, 36(2):177–232.

Fernández-Villaverde, J. (2010). Fiscal policy in a model with financial frictions. *American Economic Review: Papers and Proceedings*, 100:35–40.

Freedman, C., Kumhof, M., Laxton, D., Muir, D., and Mursula, S. (2010). Global effect of fiscal stimulus during the crisis. *Journal of Monetary Economics*, 57:506–526.

Galí, J., López-Salido, J. D., and Vallés, J. (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1):227–270.

García-Cicco, J. and Kawamura, E. (2015). Dealing with the Dutch disease: Fiscal rules and macroprudential policies. *Journal of International Money and Finance*, 55:205–239.

Gertler, M., Gilchrist, S., and Natalucci, F. (2007). External constraints on monetary policy and the financial accelerator. *Journal of Money, Credit and Banking*, 39(2-3):295–330.

Goda, T. and Torres, A. (2015). Flujos de capital, recursos naturales y enfermedad holandesa: el caso colombiano. *Ensayos sobre Política Económica*, 33(78):197–206.

Gonzáles, A., López, M., Rodríguez, N., and Téllez, S. (2014). Fiscal policy in a small open economy with oil sector. *Revista Desarrollo y Sociedad*, 73:33–69.

González, A., Mahadeva, L., Prada, J. D., and Rodríguez, D. (2011). Policy analysis tool applied to colombian needs: Patacon model description. *Ensayos sobre Política Económica*, 29(66):222–245.

Greenwood, J., Hercowitz, Z., and Huffman, G. W. (1988). Investment, capacity utilization, and the real business cycle. *American Economic Review*, 78(3):402–17.

Hamann, F., Lozano, I., and Mejía, L. F. (2011). Sobre el impacto macroeconómico de los beneficios tributarios al capital. Borradores de Economia 668, Banco de la Republica de Colombia.

Kumhof, M. and Laxton, D. (2013). Simple fiscal policy rules for small open economies. *Journal of International Economics*, 91(1):113–127.

López, M. (2001). Seigniorage and the welfare cost of inflation in colombia. *Ensayos sobre Política Económica*, 19(39):114–131.

López, M., Prada, J. D., and Rodríguez, N. (2009). Evidence for a financial accelerator in a small open economy, and implications for monetary policy. *Ensayos sobre Política Económica*, 27(60):12–45.

Monacelli, T. and Perotti, R. (2010). Fiscal policy, the real exchange rate and traded goods. *Economic Journal*, 120(544):437–461.

Mountford, A. and Uhlig, H. (2009). What are the effects of fiscal policy shocks? *Journal of Applied Econometrics*, 24(6):960–992.

Pieschacón, A. (2012). The value of fiscal discipline for oil-exporting countries. *Journal of Monetary Economics*, 59(3):250–268.

Prada, J. D. and Rojas, L. E. (2009). La elasticidad de frisch y la transmisión de la política monetaria en colombia. Borradores de Economia 555, Banco de la Republica de Colombia.

Ramey, V. A. (2011). Identifying government spending shocks: It's all in the timing. *The Quarterly Journal of Economics*, 126(1):1–50.

Ravn, M. O., Schmitt-Grohé, S., and Uribe, M. (2007). Explaining the effects of government spending shocks on consumption and the real exchange rate. NBER Working Papers 13328, National Bureau of Economic Research, Inc.

Sarmiento G, E. and López, M. (2016). Dutch disease exchange rate incidence over profits of traded and non-traded goods. *Forthcoming Monetaria (CEMLA)*, 38(1).

Schmitt-Grohé, S. and Uribe, M. (2003). Closing small open economy models. *Journal of International Economics*, 61(1):163–185.

Sin, J. (2016). The fiscal multiplier in a small open economy: The role of liquidity frictions. IMF Workig Paper 16/138, International Monetary Fund.

Smets, F. and Wouters, R. (2007). Shocks and frictions in US business cycles: A bayesian DSGE approach. *American Economic Review*, 97(3):586–606.

Vargas, H., Gonzalez, A., and Lozano, I. (2012). Macroeconomic effects of structural fiscal policy changes in colombia. In Bank for International Settlements, editor, *Fiscal policy, public debt and monetary policy in emerging market economies*, volume 67 of *BIS Papers chapters*, pages 119–160. Bank for International Settlements.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