OIL-DEPENDENT REVENUES AND MACROECONOMIC STABILITY UNDER FISCAL AND MONETARY RULES: AN ANALYSIS FOR MEXICO

Ana María Aguilar[*] *and Claudia Ramírez Bulos*[*]

In this paper we develop a small open economy macroeconomic model, and estimate it for Mexico. We incorporate the effect of oil prices on public finances. Assuming monetary policy follows an optimal policy rule, we evaluate the impact of two different fiscal policy rules: a balanced budget rule or a structural-balance rule on macroeconomic stability. We find that when the economy faces inflation or consumption shocks, both rules generate almost the same effect. However, when oil price shocks occur, higher macroeconomic stability is achieved and the monetary authority reacts less aggressively under the structural balance-rule. These results are even more relevant with the recent proposals to flexibilize the energy pricing policy in Mexico.

1 Introduction

Fiscal policy and public debt are important for monetary policy since they can influence the level of aggregate demand and interest rates and they may also affect monetary authorities' ability to control inflation. Standard economic theory suggests that fiscal policy should be countercyclical.[1] A procyclical fiscal policy translates into higher public spending and lower tax rates in good times, and viceversa. However, in practice governments seem to follow pro-cyclical fiscal policies, as some authors have already documented.[2] This feature is even more important in developing economies, particularly for commodity-rich countries, where revenues linked to commodities can be a large portion of government revenues. Hence, when commodity prices are high, sometimes linked to positive global growth perspectives, governments might have more revenues and spend more. Additionally, the fact that commodity prices are generally very volatile, overall revenues become volatile as well.[3]

Mexico, as other commodity exporter countries has faced a number of challenges derived from the management of commodities, particularly oil. In this country, public finances are significantly influenced by the movements on oil prices. In the first place, more than 30 per cent of the public sector's revenues are from oil, in the second place, energy prices are set by a rule determined by the government. This rule is supposed to act as a tax when energy prices abroad are low and as a subsidy when those prices are high. Indeed, before mid-2000s, this rule functioned as a tax, however, during the last decade energy prices have been showing an upward trend and, although they declined temporary during the 2008-09 financial crisis, recently they reached historically high levels and elevated volatility.

In this sense, it is important to reconsider the way public expenditures are determined by such a volatile source of revenues, and to re-think the appropriateness of the energy pricing rule in this new environment. Thus, in this paper we develop a small open economy macroeconomic

[*] Banco de México.

E-mail: amaguilar@banxico.org.mx, and claudia.ramirez@banxico.org.mx

The authors thank Daniel Sámano and Carlos Lever for their useful comments. MauricioTorres, José Manuel Rodríguez and Miriam González provided us with excellent research assistance.

The opinions expressed in this article are solely those of the authors and do not necessarily reflect the views of Banco de México.

[1] See Barro (1979).

[2] See Talvi and Vegh (2005), Gavin and Perotti (1997), Stein *et al.* (1999), and Lane (2003).

[3] See Céspedes and Velasco (2011).

model, and estimate it for Mexico, incorporating the effect of oil prices on public finances. Assuming monetary policy follows an optimal policy rule, we evaluate the impact of two different fiscal policy rules: a balanced budget rule or a structural-balance rule. We find that when the economy faces inflation or consumption shocks, both rules generate almost the same effect. However, when oil price shocks occur, the monetary authority reacts less aggressively and higher macroeconomic stability is achieved under the latter rule. These results are even more relevant with the recent proposals to flexibilize the energy pricing policy.[4]

It is important to mention that Mexico, like many other developing economies, has showed some convergence towards greater transparency and accountability, recognizing the benefits of the authority taking decisions under clear and transparent procedures, under a regulatory framework versus a discretionary one. In recent years, Mexico has made some important reforms. Indeed, one of the major actions taken was recognizing in the Constitution, in 1994, the autonomy of the central bank, thus generating greater monetary policy credibility.

In turn, some reforms regarding fiscal policy were put in place as well. In 2006 the Fiscal Responsibility Act was approved in which, among other things, it requires that the economic package is formulated based on medium-term projections, in particular establishing a formula for setting the price of oil to fix the budget for the next fiscal year, and does not allow the tax authorities running deficits. These reforms allowed achieving lower levels of deficit and debt, limiting and eventually eliminating the fiscal dominance situation, which allowed the monetary policy to fulfill its mission of maintaining price stability and generating greater macroeconomic stability. However there are still some vulnerabilities that prevail in the Mexican public finances and that during the recent financial crisis were present, the still high dependence of public revenues on oil revenues, and the fact that energy prices are set by a rule determined by the government, as we have mentioned.

Thus, we consider this a relevant issue for Mexican macroeconomic policies, since all sources of volatility for the macroeconomy that are not managed by the fiscal authorities might be addressed by the monetary ones. Even though the energy pricing rule may be convenient from the inflation stability perspective in the short run, since it absorbs the major part of energy prices volatility, it could imply such high costs in terms of public finances that in the medium term it might become a threat for price stability. In addition to that, the dependence of public finances on oil prices makes it very common for the government to “close” the government budget with adjustments in public prices and rates fixed by the government. This is a very important source of uncertainty for inflation (especially non-core component) and therefore inflation expectations.

The central bank has been very successful in accommodating supply shocks to inflation, specifically exchange rate fluctuations and volatility in agricultural prices. However, the Mexican economy has not yet learned to absorb, in an orderly way, energy price volatility. Therefore, this is an open issue and still a challenge from the monetary policy perspective.

Given the current environment and international conditions in the oil market, the actions undertaken in the recent past can lead to better results if the authority considers additional elements to isolate the effects of cyclical elements in the macroeconomic decisions. Thus, these matters are taken into account in this paper in which we develop a small open economy macroeconomic model for policy analysis, incorporating the effect of oil prices on public finances, in an environment in which monetary policy follows an optimal policy rule, and fiscal policy follows one of two rules: a balanced budget rule or a structural-balance rule. The purpose is to identify the effect of these different fiscal rules on the Mexican economy to various shocks and their effects on macroeconomic stability.

[4] The energy pricing policy is described later in the document.

The paper is organized as follows. In Section 2 we describe some common features of the fiscal rules that have been put in place in a number of economies. In Section 3 we present the model. In Section 4 we describe the data we used to estimate and calibrate the model. In Section 6 we analyze the two policy rules showing some exercises and Section 5 concludes.

2 Fiscal rules

During the past two decades monetary policy in many emerging economies was constrained by the high levels of public debt. Nevertheless, mainly during the 1990s many emerging countries implemented some policies that led to reduced debt levels generating a better fiscal position. Indeed many economies implemented formal fiscal rules. Three "waves" can be observed as (Schaechter *et al.*, 2012) mentions. The first one in the early and mid-1990s in part responding to bank and debt crises as well as consolidation needs to qualify for the euro area. The second one was driven largely by emerging economies in the early 2000s when many adopted rules and reformed fiscal frameworks in responses to experience with fiscal excesses, and more recently the third "wave" in response to the recent crisis. In general, the main arguments supporting the use of fiscal rules are to achieve macroeconomic stability, to support other political rules, to obtain sustainable fiscal policies, among others. Notwithstanding, in Latin America, some of the rules implemented prior to the recent crises were more effective in terms of addressing fiscal sustainability as compared to the capacity of responding to shocks, as Berganza (2012) mentions. Thus strong medium-term growth prospects, in many emerging markets' fiscal positions are still exposed to financial and external demand shocks, particularly those commodity exporters.

There have been several empirical studies regarding fiscal rules. One of the main research areas in relation to fiscal rules focuses on determining whether the rules actually restrict the government's ability to use fiscal policy to smooth business cycle fluctuations.

Bayoumi and Eichengreen (1995) use data from 1971-90 for the United States to find that the reduction in fiscal stabilizers can lead to a significant increase in aggregate output variations. In another study, Alesina and Bayoumi (1996) show that even though the tax rules are associated with less variability cyclical fiscal balance, this does not lead to increased output variability. They used data for U.S. states from 1965 to 1992 and found that there is statistically significant relationship between the actual output variability and severity states of fiscal controls. They speculate that this could occur simply because state-level stabilization might not be very important or because stronger controls limit fluctuations in the surplus that could be politically motivated and are potentially destabilizing and limiting countercyclical policies, which could lead to uncertainty in the impact on output variability.

Meanwhile, Levinson (1998) notes that Alesina and Bayoumi (1996) do not control for unobservable characteristics that may be correlated with the business cycle fluctuations and the existence of state fiscal controls. He suggests that the size of the state is correlated with the ability to affect cycle fluctuations through countercyclical fiscal policies and remarks that state tax policy matters more in large states than in small ones, thus the difference between the business cycle fluctuations in states with fiscal controls and strict controls is actually higher among large states than between small states, hence concluded that there is evidence that a strict fiscal rule as the budget balance exacerbates the business cycle fluctuations.

In turn, Galí and Perotti (2003) investigated whether the Maastricht Treaty and the Stability and Growth Pact in Europe weakened the ability of European governments to conduct a stabilizing fiscal policy. This is done by estimating fiscal rules for the discretionary budget deficit in the period 1980-2002, using data from the European countries in the monetary union and control groups of countries that are not part of the monetary union. They find that discretionary fiscal policy in EMU countries have become more counter-cyclical over time, following a trend that seems to be affecting other industrialized economies as well. In turn, there is some evidence on the pro-cyclicality of fiscal policy in Latin America (see Gavin and Perotti (1997); Kaminsky *et al.*, 2005; Daude *et al.*, 2011) which contributes to macroeconomic volatility.

In sum, after the economic crisis, some governments that already had some sort of fiscal rules in place might need to adjust them based on the lessons resultant from experiences after the crisis and some other countries will start implementing them. It is also noteworthy that in many countries fiscal rules were violated during the crisis as many governments have adopted stimulative policies. However, combining automatic responses and discretionary stimulative actions has produced some imbalances in many countries. One of the most common ways to evaluate the possible effect of certain policies in a particular economy is through the analysis of economic models that describe the dynamics of the main macroeconomic variables. In the following section, a macroeconomic model is developed in which fiscal and monetary policies interact in the context of a small open economy.

3 Model

In this section we present the model used in this paper to analyze the effect of implementing fiscal rules on macroeconomic stability. We develop a standard semistructural small open economy neokeynesian model. Even though the coefficients of the model have a theoretical background, they are presented in a reduced form.[5] In particular, the aggregate supply is modeled by a New Phillips Curve; the aggregate demand is determined by its main components: private consumption, government spending, investment, exports and imports, these equations are derived from each components' optimization process and are expressed in terms of reduced form parameters.

Additionally, the model incorporates an equation to describe the behavior for the real exchange rate and two policy rules: an optimal monetary policy rule and a fiscal rule. The design of the fiscal policy takes into account two different alternatives: a balanced budget and a structural balance.

This model considers the existence of oil, whose price is determined in international markets (*i.e.*, the price is exogenous to the model) and production of this natural good is owned by the government, as it is the case in Mexico.[6]

3.1 Model specification

3.1.1 Aggregate demand

The aggregate demand is defined as the sum of its different components, private consumption, private investment, government spending and the trade balance (exports and imports).[7]

The different components of aggregate demand are modeled individually with reduced form coefficients, which take into account a number of features. First, the aggregate demand in this model is an extension of the optimizing IS-LM model specification for an small open economy which incorporates an external sector, for this purpose, the model developed by McCallum and

[5] See Mc Callum and Nelson (1999).

[6] The estimation of the model for the Mexican economy is presented in the Appendix.

[7] Inventories are considered a residual.

Nelson (1999) is the main reference for this paper. Second, the equations used in this work were developed for three main purposes: i. to capture the persistence of the variables, ii. to incorporate the agents' expectations and allow them to smooth their behavior, and iii. to generate a structural relationship between variables. These main features allow for a simple model to explain the behavior of an small open economy, such as Mexico.[8] The government spending dynamics is described in more detail at the end of the section.

Private consumption

In order to capture an important feature of Mexican consumers, we assume that there is a fraction Φ of consumers who have access to financial markets, so that they can smooth consumption over time by accumulating financial assets.[9] While a fraction $(1-\Phi)$ do not have access to financial markets and consume only their disposable income each period.[10]

To model the behavior of consumers with access to financial markets, we use the specification of McCallum and Nelson (1999), where consumers' optimization process, after some manipulation, leads to the following representation:

$$c_t^{FM} = \alpha_0 + \alpha_1 c_{t-1}^{FM} + \alpha_2 E_t\left[c_{t+1}^{FM}\right] + \alpha_3\left(R_t - E_t\left[\Delta p_{t+1}\right]\right) + \upsilon_{c,t} \qquad (1)$$

In equation (1), $\alpha_3<0$, c_t^{FM} is the logarithmic deviation of consumption (Dixit Stiglitz type) of the agents with access to financial markets of the goods that the representative agent consumes in period t , taking into account consumption habits. R_t is the nominal interest rate paid for bonds in the domestic country, $E_t[\Delta p_{t+1}]$ is the expected inflation rate over the next quarter, so $R_t-E_t[\Delta p_{t+1}]$ is the real *ex ante* interest rate, and vc_t is a stochastic shock related to the agents' preference over present and future consumption, with zero mean and constant variance, $\sigma^{2},_{vc}^{FM}$.

The consumption for agents without access to financial markets, is simply modeled by:

$$c_t^{NFM} = \left(x_t - t_t^{tax}\right) + \upsilon_{c,t} \qquad (2)$$

where $x_t - t^{tax,t}$ is the log linearized disposable personal income, and $t^{tax,t}$ is the income tax.

Private investment

In the spirit of the consumption equation, it is assumed that private investment also maintains a hybrid dynamic so the behavior for present investment depends on the projects started in the past, on the expectations for future investment and on the real ex-ante interest rate, resulting in the following equation:

$$in_t = \vartheta_0 + \vartheta_1\, in_{t-1} + \vartheta_2\, E_t\left[in_{t+1}\right] + \vartheta_3\left(R_t - E_t\left[\Delta p_{t+1}\right]\right) + \upsilon_{in,t} \qquad (3)$$

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8 These components are expressed in terms of deviations from their tendency in an effort to identify in a simple fashion the transmission mechanism of the monetary and fiscal policies over the output level.

9 Following Woodruff (2006) in Mexico around 74 per cent of the population has access to financial markets, whereas 26 per cent do not have access.

10 The model equations can be derived from an infinite horizon scheme where agents choose optimal consumption and debt paths and each one of these agents produce a good with a certain level of market power.

In this equation, $\vartheta_3 < 0$, in_t is the logarithmic deviation from private investment with respect to its tendency and $R_t - E_t[\Delta p_{t+1}]$ is the real *ex ante* interest rate. υin_t is a stochastic shock related to the investors preferences over intertemporal investment, with mean zero and constant variance $\sigma^2_{\upsilon in}$.

Exports

Given the context of a small open economy, the domestic economy exports goods to a small fraction of foreign consumers and the level of exports do not affect the price level of the foreign economy. Aggregate exports in this model are positively related to the real exchange rate, $Q_t \equiv S_t P_t^* / P_t^A$, so the equation that describes exports is given by the following expression:

$$ex_t = \delta_0 + \delta_1 ex_{t-1} + \delta_2 E_t\left[ex_{t+1}\right] + \delta_3 q_t + \delta_4 x_t^{US} + \upsilon_{ex,t} \tag{4}$$

In equation (4), ex_t represents the logarithmic deviation of exports with respect to its tendency, q_t represents the real exchange rate, x_t^{US} represents the foreign country' output gap and υex_t represents a stochastic shock related to the preferences from foreign consumers towards domestic goods, with mean zero and constant variance , $\sigma^2_{\upsilon ex}$.

Imports

The domestic economy does not only consume domestic production goods, but also imported goods from abroad that can be used as production inputs. In this case, imports, im_t depend on consumers' habits with respect to consumption of foreign goods and the expectations for future imports. Imports are also affected by the real exchange rate, q_t, and by the domestic output gap as defined bellow:

$$im_t = \gamma_0 + \gamma_1\, im_{t-1} + \gamma_2\, E_t\left[im_{t+1}\right] + \gamma_3 q_t + \gamma_4 x + \upsilon_{im,t} \tag{5}$$

In this case, the term υim_t represents a stochastic shock related to domestic consumers' preferences towards foreign goods, with mean zero and constant variance, $\sigma^2_{\upsilon im}$.

Inventories

It is assumed that inventories follow an AR(1) process given by:

$$inven_t = \rho_{\upsilon e}\, inven_{t-1} + \upsilon_{invent,t} \tag{6}$$

where $\rho_{\upsilon e} < 1$ and $\upsilon inven_t$ is a stochastic shock with mean zero and constant variance $\sigma^2_{\upsilon ex}$. This variable is commonly a residual that allows the output level to be adjusted; in this case it is assumed exogenous.[11]

[11] This component is also specified as a residual in the estimations presented in the Appendix.

3.1.2 New Phillips curve

In Neo-Keynesian models, a natural way to describe aggregate supply is through a Phillips Curve, which relates the price level in an economy with its output level. Following McCallum and Nelson (1999), in order to incorporate nominal rigidities, we assume that the economy has gradual price adjustments when firms take production decisions, so the description of price dynamics is fitted properly by a Phillips Curve equation. Many studies have tried to describe inflation dynamics for several countries using backward and forward-looking components,[12] in particular, for Mexico, Ramos-Francia and Torres (2005) find that the New Neo-Keynesian Phillips Curve properly describes inflation dynamics in Mexico.

Following that specification, we use a hybrid Phillips curve to describe the inflation dynamics. Additionally, we use core inflation since it best reflects inflationary pressures as it might be considered "the structural inflation of the economy". The New Phillips curve equation is the following:

$$\pi_t^C = \alpha_1 \pi_{t-1}^C + \alpha_2 E_t\left[\pi_{t+1}^C\right] + \alpha_3 x_t + \alpha_4 \left(\Delta ner_t + \pi_t^{US}\right) + \upsilon_\pi \tag{7}$$

where core inflation π_t^C is affected by past inflation, π_{t-1}^C by the expectations for future inflation, $E_t\left[\pi_{t+1}^C\right]$ by the output gap, x_t, and since it is a small open economy, it is also affected by changes in the nominal exchange rate and foreign inflation, $\Delta ner_t + \pi_t^{US}$.

Additionally, a stochastic shock is included related to changes in inflation dynamics with the traditional features of zero mean and constant variance.

3.1.3 Real exchange rate

The real exchange rate equation used in this model considers the real interest rates parity:

$$rer_t = E_t\left[rer_{t+1}\right] + \left(r_t^{US} - r_t\right) \tag{8}$$

However, one of the main disadvantages for this equation is that the real exchange rate adjusts instantly given any imbalance producing an overshooting of its estimated value. Several proposals have been made in the literature to avoid this abrupt adjustment of the exchange rate (delayed overshooting) as described in Eichenbaum and Evans (1995).

One of the solutions proposed to this problem consists in incorporating an exchange rate lag in the interest rate parity condition. This procedure generally results statistically significant in order to explain the real exchange rate since it replicates the observed persistence in the real exchange rate dynamics generating a gradual adjustment. Under this assumption, it is implicitly supposed that the exchange rate depends on the real exchange rate in the previous period and on the expectations of the exchange rate on the following period, as presented in the following equation.

$$rer_t = c_0 rer_{t-1} + c_1\left(E_t\left[rer_{t+1}\right] + \left(r_t^{US} - r_t\right)\right) \tag{9}$$

3.1.4 Monetary policy rule

In this model, the monetary policy instrument, the short-run nominal interest rate, is obtained through an optimal rule following Söderlind (1999).

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[12] See Galí and Gertler (1999) among others.

We calculate optimal discretionary monetary policy rules for each fiscal policy rule tested. This methodology does not require us to specify the form of the optimal instrument, since it is a function of all the values of the state-vector of the model.

In order to calculate this optimal policy rule we assume that the monetary authority minimizes a standard loss function. Hence, we define the loss function L as:

$$L = E_t \left\{ \sum_{j=0}^{\infty} \varphi^j \left[\left(\alpha_\pi \left(\pi_{t+j} - \pi^* \right)^2 + \alpha_x x_{t+j}^2 + \alpha_i \left(i_{t+j} - i_{t+j-1} \right)^2 \right) \right] \right\} \tag{10}$$

s.t. the structure of the economy (*inflation*, *aggregate demand*, *real exchange rate*)

In this loss functions, α_π, α_x and α_i represent the relative importance of output and inflation gaps as well as interest rate smoothing, and we assume that the authority assigns the same weight to the three of them.[13]

3.1.5 *Fiscal policy rule*

In this model, government spending not only is considered part of the aggregate demand, but it is also subject to fiscal rules that determine how fiscal adjustments should be done by the authority given exogenous shocks.

We assume that the budget constraint for the government is the following:

$$B_t = G_t - T_t + \left(R_{t-1} + \Psi \left(\exp\left(B_{t-1} - b \right) - 1 \right) \right) B_{t-1} \tag{11}$$

where B_t is the real level of government indebtedness, b represents the debt level in the stationary state, G_t represents real government spending, T_t represents public revenues, R_{t-1} is one plus real interest rate $(1+r_t)$ and $(R_{t-1} + \Psi \exp(B_{t-1} - b) - 1)$ is the cost of debt.[14] In this expression, $\Psi>0$, is the interest rate elasticity given changes in debt levels, the cost is defined this way because the price of debt is sensitive to the level of outstanding debt.

Additionally it is supposed the existence of a commodity, oil, sold abroad with production rights owned by the government, so the revenues from this sale are entirely for the government.

Therefore, public revenue has two main components tax revenues on the one hand, and oil revenues on the other.

Total revenues are described as:

$$T_t = \varphi_1 \, \tau \, Y_t + \left(1 - \varphi_1\right) P_t^{oil} Y_t^{oil} \tag{12}$$

where φ_1 is the share of tax revenues, τ is the tax rate, $(1 - \varphi_1)$ is the share of oil revenues, P_t^{oil} is the price of oil in period t and Y_t^{oil} is oil production in period t.

Government spending may follow two different behaviors depending on the fiscal rule in turn.

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13 See Appendix for more details about the optimal policy rule.

14 This expression incorporates an adjustment cost following Schmitt-Grohe and Uribe (2001), so the debt is not undetermined, given the fact that R_t is greater than one so debt is not stationary. Assuming such adjustment cost, we can ensure stationarity by supposing that $(R_{t-1}+\Psi\exp(B_{t-1}-b)-1)$ is less than one.

Balanced Budget Rule:

In this case, the government meets the balanced budget restriction but there exists the possibility of issuing debt, so government spending adjusts in the following way:[15]

$$G_t = T_t - \left(R_{t-1} + \Psi\left(\exp\left(B_{t-1} - b\right) - 1\right)\right) B_{t-1} \tag{13}$$

With the balanced-budget rule (BB), the government can spend only what it receives from tax and oil revenues minus the debt service, constant over time. However, after an increase in output, tax revenues increase allowing for a higher spending level while meeting the rule. In the same way, after a decrease in output, government spending must be reduced in order to meet the rule. The same behavior for government spending is observed after changes in oil revenues. Therefore this rule is pro-cyclical.

Structural Balance Rule:

In the same spirit as in Galí and Perotti (2003) the structural fiscal deficit or structural balance (SB), attempts to factor out cyclical components from the actual budget balance. In general, the actual balance reflects both cyclical and structural factors that might over- or underadjust budget developments by the government but separating cyclical from structural factors might help diminish these overadjustments.[16]

Assume that the balance is represented as follows:

$$BA_t = T_t - G_t - \left(R_{t-1} + \Psi\left(\exp\left(B_{t-1} - b\right) - 1\right)\right) B_{t-1} \tag{14}$$

$$B_{st} = BA_t - \tilde{T}_t = T_t - \tilde{T}_t - G_t - \left(R_{t-1} + \Psi\left(\exp\left(B_{t-1} - b\right) - 1\right)\right) B_{t-1} \tag{15}$$

being $\tilde{T}_t = \varphi_1 \tau \left[Y_t - Y_{ref}\right] + \left(1 - \varphi_1\right)\left[P_t^{oil} - P_{ref}^{oil}\right] Y_t^{oil}$. In this case Y_{ref} is defined as potential output level and P_{ref}^{oil} as a price reference for oil.[17]

The structural balance rule used in this paper is based on the rule currently followed by Chile and takes into account the model described by Medina and Soto (2007) for this Latin American economy when defining the structural balance rule.[18]

While following this type of rule, a shift in oil price causes an increase in the level of cyclical revenues since the gap for oil price with respect to its reference level increases, and so the structural deficit level diminishes. In order to maintain the structural deficit level unchanged, government spending should decrease to compensate for this effect. The same is true when output level deviates from its potential level, after an increase in output, cyclical revenues increase with the same effect on the structural deficit. In this way, fiscal policy does not overadjust over the cycle.

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15 Under the balanced budget rule it is possible to isolate the effect of monetary policy on fiscal behavior; while for a positive level of debt, monetary policy actions through interest rate affect the cost of debt.

16 See Fiess (2004).

17 The oil reference price for Mexico is determined as a weighted average of observed prices and futures, as described in the Fiscal Responsibility Act.

18 Given the log-linearized structure of the model, the structural balance level as a fiscal policy rule becomes irrelevant. Constant levels in this type of models do not affect the result since variables are expressed in terms of deviations from the steady state.

Equations (11) to (15) are expressed in levels, however, in order to be incorporated in the model and maintain the same structure as the rest of the equations in the model it is necessary to log-linearize them. In this case, the equations are expressed in the following way:

Budget constraint: $$b_t = s_1 g_t + s_2 b_{t-1} + s_3 r_{t-1} - s_4 t_t \tag{16}$$

Public revenues: $$t_t = q_1 x_t + q_2 \left(p_t^{oil} + x_t^{oil} \right) \tag{17}$$

Balanced Budget Rule: $$g_t = n_1 x_t + n_2 p_t^{oil} + n_3 x_t^{oil} - n_4 b_{t-1} - n_5 r_{t-1} \tag{18}$$

Structural Balance Rule: $$g_t = j_1 x_t^{ref} + j_2 p_{ref}^{oil} + j_3 x_t^{oil} - j_4 b_{t-1} - j_5 r_{t-1} - j_6 \left(bas_t + x_t \right) \tag{19}$$

Variables b_t , g_t , t_t , p_t^{oil} , p_{ref}^{oil} , x_t^{oil} and x_t , x_t^{ref} are logarithmic deviations of real debt, government spending, oil price, oil production and output level, respectively; r_t is the short-run real interest rate.[19]

We assumed that non-core inflation, oil price gap, oil production gap and inventories follow an AR(1) process.

The output gap is computed as the weighted sum of its components' gaps, and the foreign variables follows an autoregressive vector.

Foreign Variables:

$$\pi_t^{US} = \phi_0 + \phi_1 \pi_{t-1}^{US} + \phi_2 \pi_{t-2}^{US} + \phi_3 x_{t-1}^{US} + \phi_4 x_{t-2}^{US} + \phi_5 i_{t-1}^{US} + \phi_6 i_{t-2}^{US} + v_t^{\pi US} \tag{20}$$

$$x_t^{US} = k_0 + k_1 \pi_{t-1}^{US} + k_2 \pi_{t-2}^{US} + k_3 x_{t-1}^{US} + k_4 x_{t-2}^{US} + k_5 i_{t-1}^{US} + k_6 i_{t-2}^{US} + v_t^{\pi US} \tag{21}$$

$$i_t^{US} = \chi_0 + \chi_1 \pi_{t-1}^{US} + \chi_2 \pi_{t-2}^{US} + \chi_3 x_{t-1}^{US} + \chi_4 x_{t-2}^{US} + \chi_5 i_{t-1}^{US} + \chi_6 i_{t-2}^{US} + v_t^{\pi US} \tag{22}$$

4 Data

In this section we describe the data used for the analysis. The relevant variables regarding the Mexican economy are: private consumption, government spending, investment, exports, imports, real debt, nominal and real exchange rates. For Mexico and the U.S., the variables of interest are inflation, nominal and real interest rates, output gap and the crude oil price. Our sample ranges from the first quarter of 2002 to the third quarter of 2012. We decided to use this sample since variables such as inflation started to be stationary in Mexico since then (Capistran *et al.*, 2008). For Mexico, quarterly data of GDP components: private consumption, government spending, investment, trade balance, was used to estimate gaps for each of these variables. Each gap is defined as the percentage deviation (logarithmic difference) between the level of each variable and its trend, calculated using the Hodrick-Prescott filter. Monthly core and non-core inflation were transformed into quarterly data. The source of all data is INEGI. Inflation target, prior to 2004, was calculated by a quarterly lineal interpolation of inflation targets established by Banco de México in its Annual Inflation Reports. Since 2004 it corresponds to the current 3 per cent target established by Banco de México. Nominal exchange rate refers to FIX exchange rate in pesos per dollar and real exchange rate corresponds to an index (base 1990=100). The periodicity of these series is daily so we calculated the quarterly average and expressed them in

[19] The parameters s,q,n and j are define after log-linearizing the model, and are presented in Appendix 1.

logarithms. Regarding nominal interest rate, it corresponds to 91-days CETES yield. Real interest rate was estimated from the nominal interest rate and 12 months inflation expectation. The source of this data is Banco de México.

With respect to U.S variables, CPI was extracted from the Bureau of Labor Statistics. Nominal interest rate corresponds to 3-month Treasury bills secondary market rate, which was provided by the Federal Reserve. Real interest rate was calculated using the nominal interest rate and 12 months inflation expectation, published by Michigan University (Survey Research Center). As in the case of Mexican variables, we transformed them into quarterly data. The source of output gap data is Haver Analytics and the crude oil price was provided by Bloomberg.

In order to analyze the dynamics of the Mexican business cycle, we estimated the volatility of GDP and its components, measured as the standard deviation, and the cross correlation between GDP and the rest of the variables. First we analyze the performance of these variables across the entire sample and then we divide it into two subsamples: the first one ranges from the first quarter of 2002 to the last quarter of 2007, just before the international financial crisis started; and the second one goes from the first quarter of 2008 to the third quarter of 2012.

In Table 1 we report the results for the entire sample. As we can observe from column seven, all the components of GDP, except public consumption are highly pro-cyclical, being private consumption and imports the components with higher correlation with the GDP gap. Regarding private consumption, we can also see from the second column that in contrast with what the consumption theory would suggest, consumption is more volatile than output. Nevertheless, this result is consistent with previous studies of business cycles in emerging economies, such as Mexico, Torres (2000) and Cuadra (2008). The volatility in private consumption suggests that consumption smoothing across the cycle is very limited, which can be due to the existence of credit constrains or to the cyclical component of the cost of external credit, as mentioned in Cuadra (2008). In Table 1 we reported the results for the entire sample.

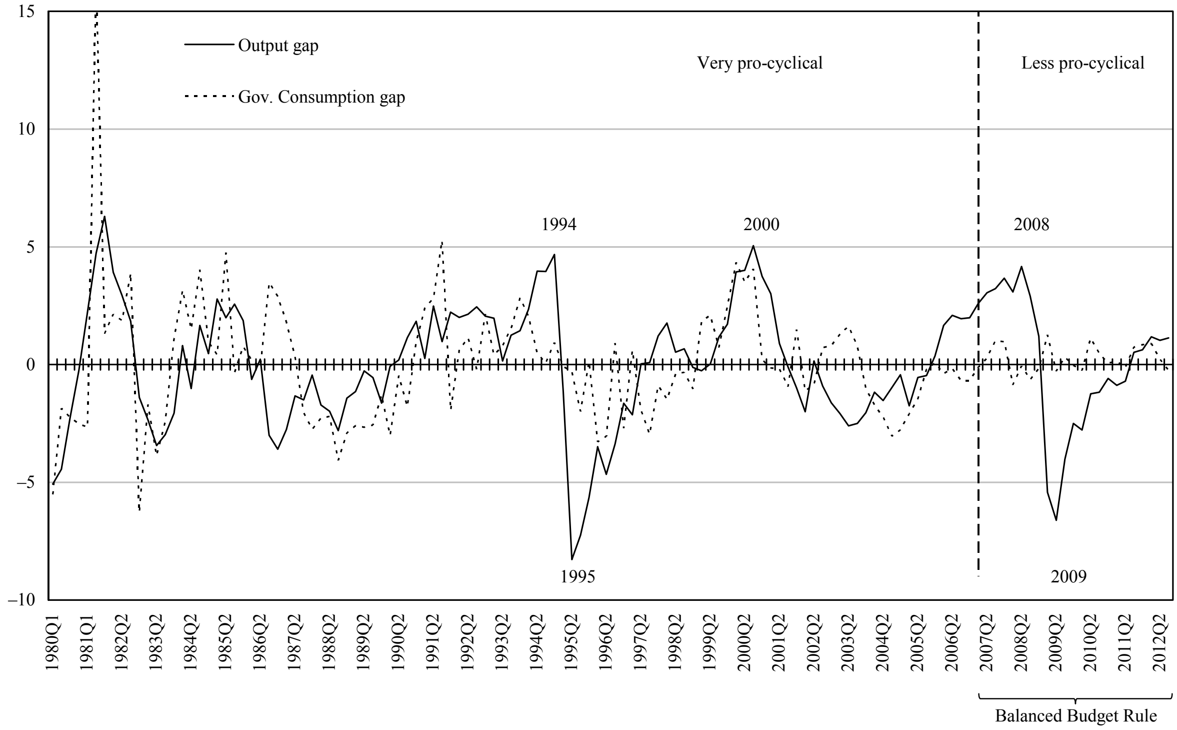
Cyclical components of investment, exports and imports exhibit great volatility across the cycle. Looking to the relative volatility, which is defined as the ratio of the standard deviation of each variable to the standard deviation of GDP, we can see that these variables are twice as volatile as the output. If we compare our results with similar analysis using different samples, we can see that the volatility reported for investment and imports in our data is lower than the one reported using a bigger sample. Cuadra (2008) found that from 1980 to 2006 investment was four times more volatile than the output and imports were six times more volatile. Our results are consistent with empirical data showing important decreases in volatility of investment and imports through time.

Regarding the cyclical component of public consumption, we can see in Table 1 and Figure 1 that it shows low absolute and relative volatility. One possible explanation to this fact is the prevailing fiscal rule in Mexico. As we mentioned before, in order to increase the transparency and reduce the discretionary component in public spending, in 2006 was approved the Federal Budget and Fiscal Responsibility Law which forces the government to have an equilibrium in public finances at all time. This is also consistent with the low correlation of public spending with GDP.

With respect to the real interest rate, we observed that during the period of our study it exhibited low volatility. Moreover, as we can see from column four to twelve, cross correlation of this variable with GDP suggest that real interest rate reacts with some lag to fluctuations in output, although when we looked into the subsamples it exhibited different dynamics before and after the crisis.

Figure 1

GDP and Government Consumption
(cycle components)



Comparing our two subsamples (Table 2 and Table 3), we can observe that after the financial crisis volatility in all the variables increased. Nevertheless the dynamics of the relative volatility were different across variables. In the case of consumption, even though it showed a considerable increase in volatility, relative volatility remains almost unchanged, and since the crisis consumption became more correlated with GDP. For investment, we observed that in the second period absolutevariance increased but its relative volatility decreased. As we mentioned before, this performance is consistent with an important reduction of the volatility of the cyclical component of investment. The same consideration applies to the component of exports.

Regarding the relation between real interest rate and output cycles we can observe that it changes significantly between our two subsamples. This difference is mainly due to the fact that the central bank maintained interest rates unchanged for several years after the crisis and inflation was stable as well.

4.1 Oil

For several decades, the Mexican economy has been characterized for the high dependence of public revenues to oil revenues. This situation has been considered one of the major issues of public finances in Mexico.[20] Evenmore, in recent years the production of oil in Mexico has been beneath the average of 1990-2012, as we can see in Figure 2, the barrels of crude oil extracted per

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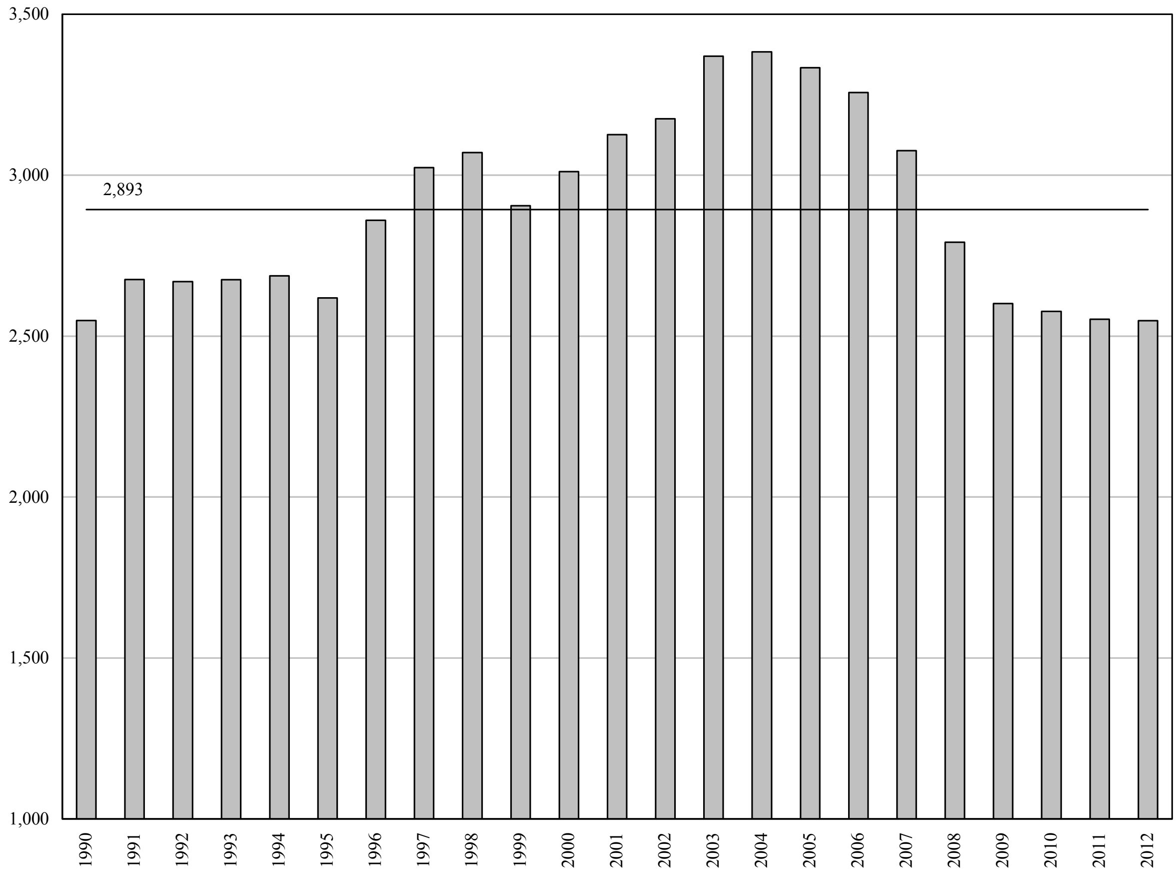
20 Some credit rating agencies have explicitly mentioned this factor as one of the most important obstacles to upgrade the Mexican debt.

Figure 2

Mexican Crude Oil Production
(barrels per day)



day reached its maximum level in 2004 and since then total production has been decreasing. At the same time, we have observed an increasing volatility of international oil prices (Figure 3). In particular, the price of the Mexican crude oil has grown more than 260 per cent since 2000, with higher volatility through 2007 and 2008 due to the international financial crisis, where we observed a sudden decrease.

The combined effect of changes in these two variables has been reflected in particular in public finances. In Mexico, more than a third of total public revenues come from oil (Figure 2), making revenues quite vulnerable to the dynamics of the situation in international markets.

Since the early seventies, the development of oil prices has been driven mainly by the interaction between supply and demand. Changes in oil supply by OPEP were very relevant factors behind the significant changes in oil prices in the seventies.

However, the sharp increase in oil demand, especially from emerging countries in recent years has been a crucial factor behind the dynamics of international oil prices, of course together with supply policies applied by some producing countries. Looking ahead, it is likely that imbalances between oil supply and demand will continue to be relevant as oil supply could be limited by physical factors and by reducing investments, while demand, especially from emerging economies could continue to grow, as mentioned by ECB (2010).

Table 1

Summary Statistics
(period: 2002Q1-2012Q3)

Variable x	**Sigma (x)**	**Sigma (x)/ Sigma (GDP)**	**Correlation of GDP with**								
			x(*t*–4)	**x(*t*–3)**	**x(*t*–2)**	**x(*t*–1)**	**x(*t*)**	**x(*t*+1)**	**x(*t*+2)**	**x(*t*+3)**	**x(*t*+4)**
Output	2.39	1.00	0.19	0.36	0.58	0.82	1.00	0.82	0.58	0.36	0.19
Private Consumption	2.73	1.15	0.16	0.34	0.59	0.83	0.97	0.81	0.62	0.40	0.24
Public Consumption	1.08	0.45	–0.03	0.01	0.02	–0.06	–0.01	0.06	0.09	0.16	0.15
Investment	5.19	2.18	0.00	0.15	0.38	0.63	0.85	0.85	0.80	0.70	0.56
Exports	6.29	2.64	0.31	0.44	0.63	0.83	0.89	0.67	0.37	0.10	–0.07
Imports	7.13	2.99	0.15	0.31	0.56	0.81	0.92	0.76	0.51	0.27	0.10
Real Interest Rate	1.65	0.69	0.11	0.13	0.16	0.24	0.32	0.44	0.45	0.40	0.26

* It corresponds to the gap of each variable, except for real interest rate.

Table 2

Summary Statistics*
(period: 2002Q1-2012Q4)

Variable x	Sigma (x)	Sigma (x)/ Sigma (GDP)	Correlation of GDP with								
			x(*t*–4)	x(*t*–3)	x(*t*–2)	x(*t*–1)	x(*t*)	x(*t*+1)	x(*t*+2)	x(*t*+3)	x(*t*+4)
Output	2.00	1.00	0.46	0.60	0.72	0.82	1.00	0.82	0.72	0.60	0.46
Private consumption	2.26	1.13	0.47	0.61	0.74	0.83	0.96	0.80	0.76	0.58	0.45
Public consumption	1.30	0.65	–0.16	–0.09	–0.01	0.06	0.19	0.25	0.27	0.36	0.43
Investment	4.58	2.28	0.48	0.65	0.76	0.82	0.97	0.80	0.73	0.62	0.45
Exports	5.46	2.72	0.57	0.64	0.73	0.82	0.95	0.76	0.63	0.47	0.34
Imports	5.97	2.98	0.48	0.59	0.73	0.84	0.99	0.83	0.73	0.58	0.46
Real interest rate	1.10	0.55	0.51	0.42	0.34	0.27	0.25	0.26	0.21	0.15	0.00

Table 3

Summary Statistics*
(period: 2008Q1-2012Q3)

Variable x	Sigma (x)	Sigma (x)/ Sigma (GDP)	Correlation of GDP with								
			x(*t*–4)	x(*t*–3)	x(*t*–2)	x(*t*–1)	x(*t*)	x(*t*+1)	x(*t*+2)	x(*t*+3)	x(*t*+4)
Output	2.82	1.00	–0.30	–0.09	0.27	0.72	1.00	0.72	0.27	–0.09	–0.30
Private consumption	3.22	1.14	–0.38	–0.12	0.28	0.73	0.98	0.69	0.27	–0.05	–0.24
Public consumption	0.58	0.21	0.29	0.18	0.07	–0.27	–0.30	–0.08	–0.07	0.07	–0.11
Investment	6.00	2.12	–0.56	–0.41	–0.04	0.42	0.79	0.80	0.59	0.37	0.16
Exports	7.21	2.55	–0.18	–0.01	0.33	0.73	0.85	0.52	–0.01	–0.44	–0.60
Imports	8.46	3.00	–0.34	–0.15	0.24	0.70	0.87	0.59	0.11	–0.30	–0.48
Real interest rate	1.44	0.51	–0.67	–0.52	–0.29	0.05	0.39	0.60	0.62	0.48	0.26

* It corresponds to the gap of each variable, except for real interest rate.

Figure 3

International Market Price
(US $)

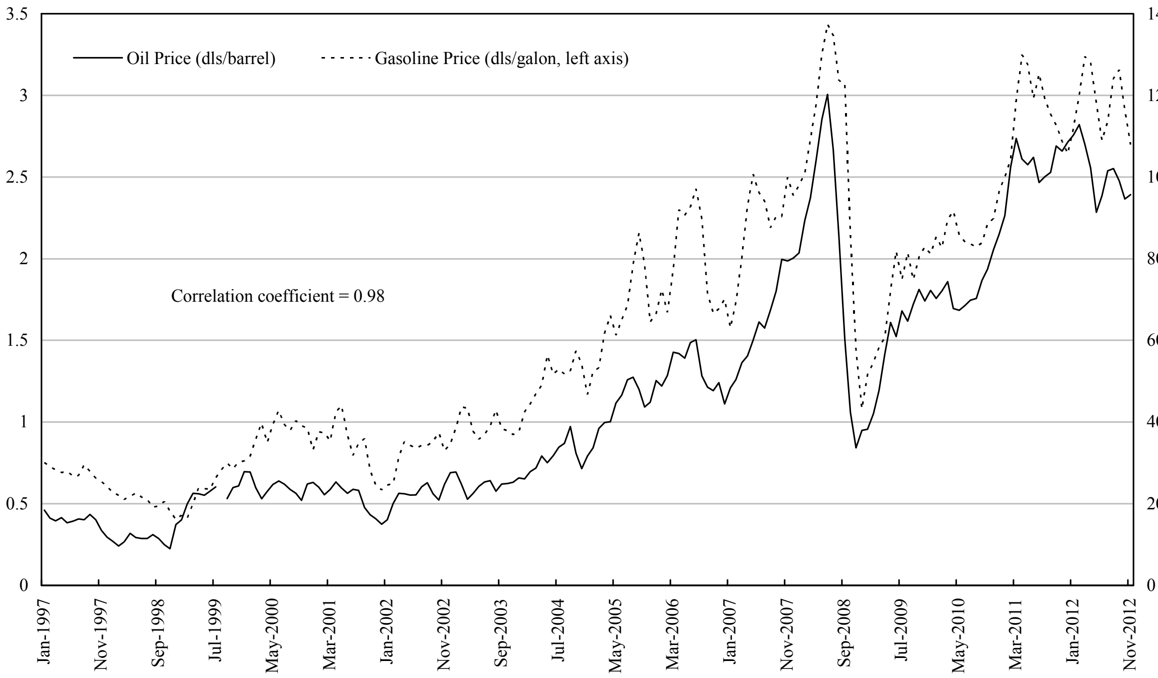
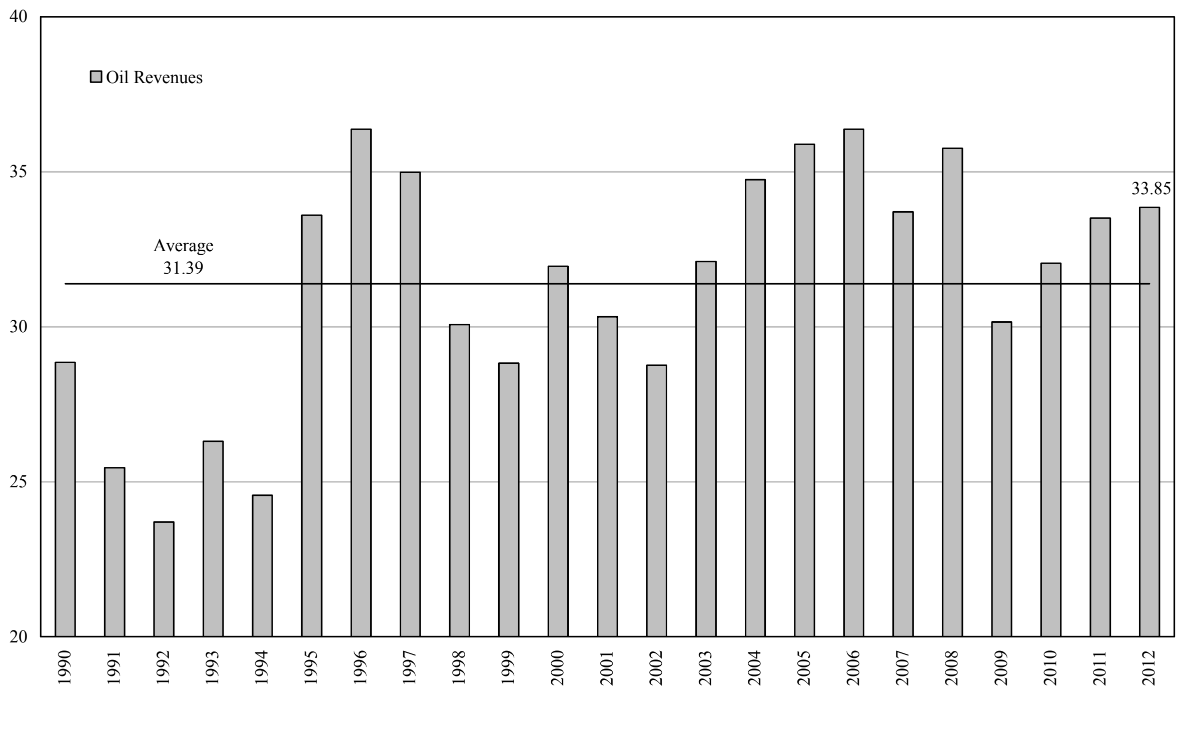


Figure 4

Oil Revenues
(percent of total revenues)



Under these circumstances it is harder for the government to plan future public spending. Moreover, even though in Mexico public finances have been sound and macroeconomic stability has improved, there is still room for reducing the dependence of public revenues to oil revenues. The prevailing fiscal rule has allowed the government expenditure to reduce its volatility, however the balanced budget rule currently in place is still a procyclical fiscal policy rule.

4.1.1 Oil prices and inflation

One important feature of the Mexican price structure is that fuel prices are set by the government, hence volatility in oil prices has not been transmitted to CPI inflation in any direction. Until the second half of 2000s, gasoline prices in Mexico were higher than international gasoline prices, however, given the abrupt increase in oil prices in the last years this situation has changed. As a response, in the last years the government has been announcing gradual increases in gasoline prices in order to close the gap between domestic and international prices. In this context, it has been discussed the possibility of flexibilizing gasoline prices, or at least adjust them to be consistent with international gasoline prices. We have discussed the potential vulnerabilities of public finances to oil prices volatility, however, if this adjustment in inflation occurs the effects of volatility in oil prices will not only affect public finances but inflation as well.[21] Under these circumstances, the monetary policy might need to respond more aggressively.

5 Exercises

In this section we perform a macroeconomic evaluation of both fiscal rules allowing the monetary policy to optimally adjust its policy under both fiscal scenarios. Next we present some impulse-response functions in order to illustrate the functioning of the model.

5.1 Evaluation of policy rules

In this subsection we use the model presented in the previous section and the loss function described above to evaluate the two fiscal alternatives presented before. We set the “loss function” in order to compare the two different policy rules. In particular, we are interested in evaluating whether the optimal monetary policy instrument in combination with a SB rule achieve a better outcome than an optimal monetary policy rule in combination with a traditional BB rule.

To assess the performance of the different rules we simulated stochastic shocks for 1000 periods allowing the optimal monetary policy rule for each case to adjust endogenously. We repeat this 3000 times obtaining the average standard deviations across repetitions. The results from the simulations are reported in Table 4. As we can observe, under the SB rule, standard deviations of the main macroeconomic variables in the model are lower than under the BB rule. In particular, the output gap and headline inflation show lower volatility under the former one. Under the BB rule headline inflation is around 2.2 per cent more volatile than under the SB rule. In turn, the output gap is 6.4 per cent more volatile. This is in line with a more stable government spending, which is 75 per cent less volatile under the SB rule as compared to the BB rule. Regarding the monetary policy instrument, it is 2.4 per cent less volatile under the SB rule, generating less aggressive responses from the monetary authority under the SB rule.

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[21] Gasoline prices’ weight on inflation is around 4.2.

Table 4

Evaluation of Standard Deviations and Loss Functions Under Different Fiscal Rules

	Structural Balance Rule	**Balanced Budget**
Loss function	239.16	270.4
Headline inflation	1.655	1.693
Output gap	14.48	15.47
Consumption	4.16	4.18
Government spending	3.99	16.31
Investment	19.16	19.33
Real exchange rate	1.72	1.75
Nominal interest rate	5.18	5.31
Real interest rate	4.62	4.75

5.2 *Impulse-response functions*

In this section we present the functioning of the model under the two different fiscal policy alternatives presented in the previous sections, using impulse-response functions. In order to see the main channels through which the model functions we present 3 shocks. The first one is a traditional "cost-push" shock, the second one is an aggregate demand shock. Finally we analyze an oil price shock.

First of all we show how the economy responds to a typical "cost-push" shock (inflation shock). A one standard deviation increase in the non-core inflation leads to an increase in headline inflation (Figure 5), which forces the central bank to raise interest rates to counteract the effect. This increase in the interest rate leads to a fall in private consumption of agents who have access to the financial markets, investment, and indirectly, in exports due to the appreciation of the exchange rate. By reducing economic activity when the interest rate increases, consumers who do not have access to financial markets are affected since their disposable income reduces and therefore their level of consumption. At the same time tax revenues fall and spending under the various rules also decreases, although in different magnitudes. As expected, government consumption fluctuates more with the balanced budget rule than with the structural balance rule. For the former case, since the shock generates lower tax revenues, the government reduces its spending as the output gap decreases. Additionally, spending has to fall more because the government must meet its debt payment duties still complying with a zero deficit rule. Finally, under a structural balance rule, since government spending reacts to changes in the level of the "reference output" and not to current changes in the output level, the fall in spending is much lower.

Next, we present a scenario where consumption is subject to a positive shock. When the economy faces this type of shock, as seen in Figure 6, it generates demand pressures that drive the gap to a level above its equilibrium, which in turn generates inflationary pressures that are transmitted through the Phillips curve, making the monetary authority to increase the nominal interest rate so that the real interest rate rises enough to counteract the effect. By increasing the

Figure 5

IRF.s Non-core Inflation Shock

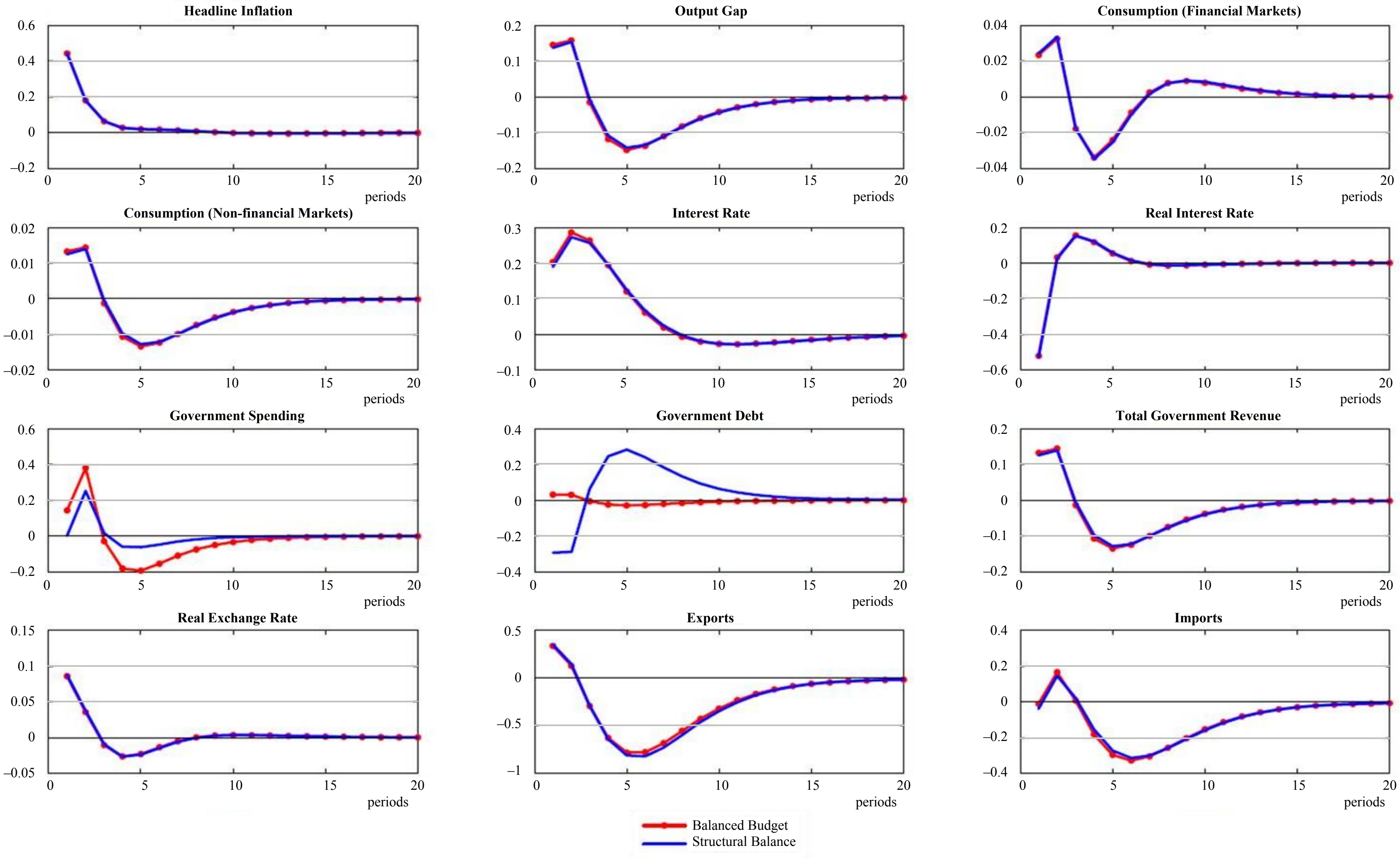


Figure 6

IRF.s Consumption Shock

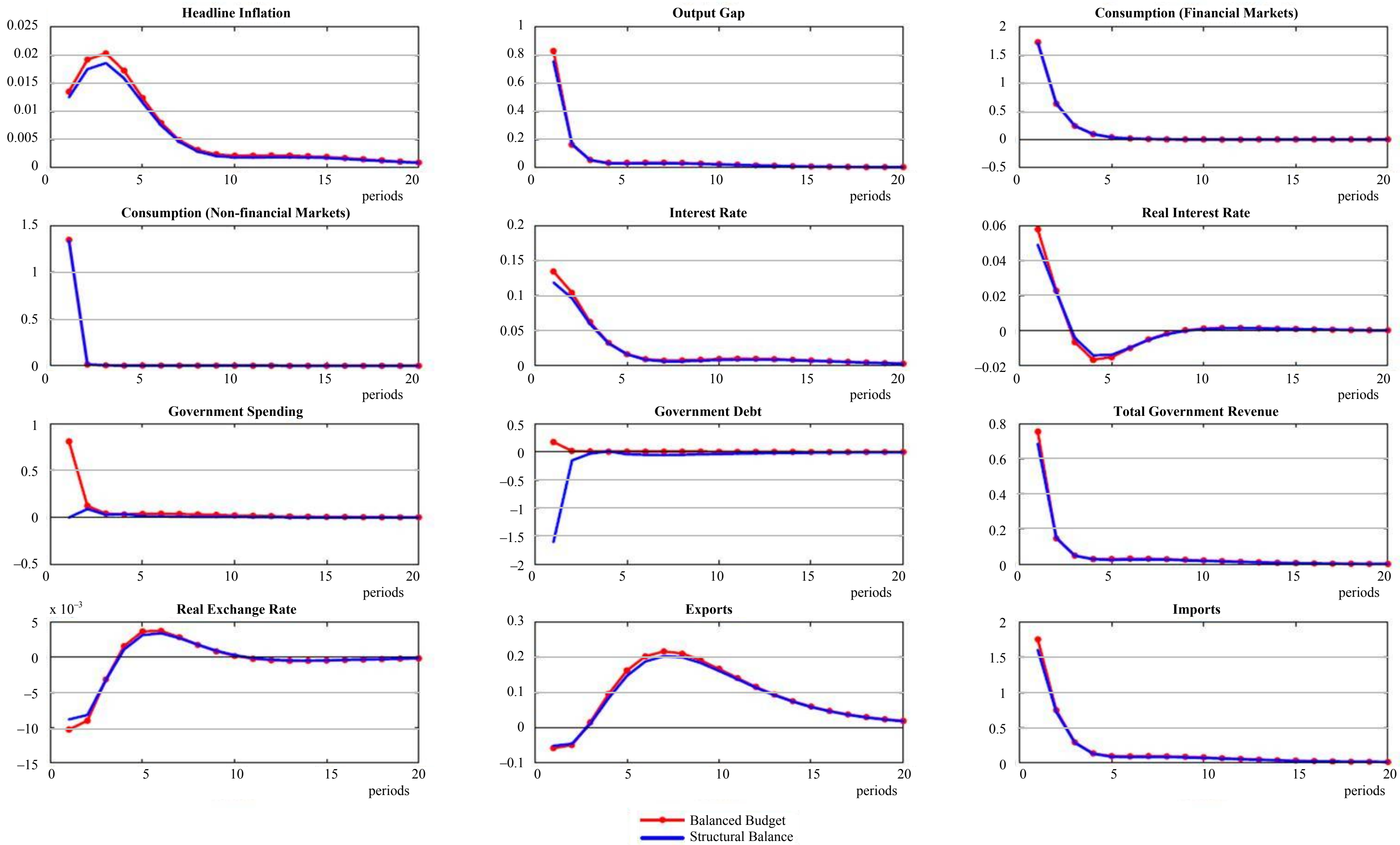


Figure 7

IRF.s Oil Price Shock

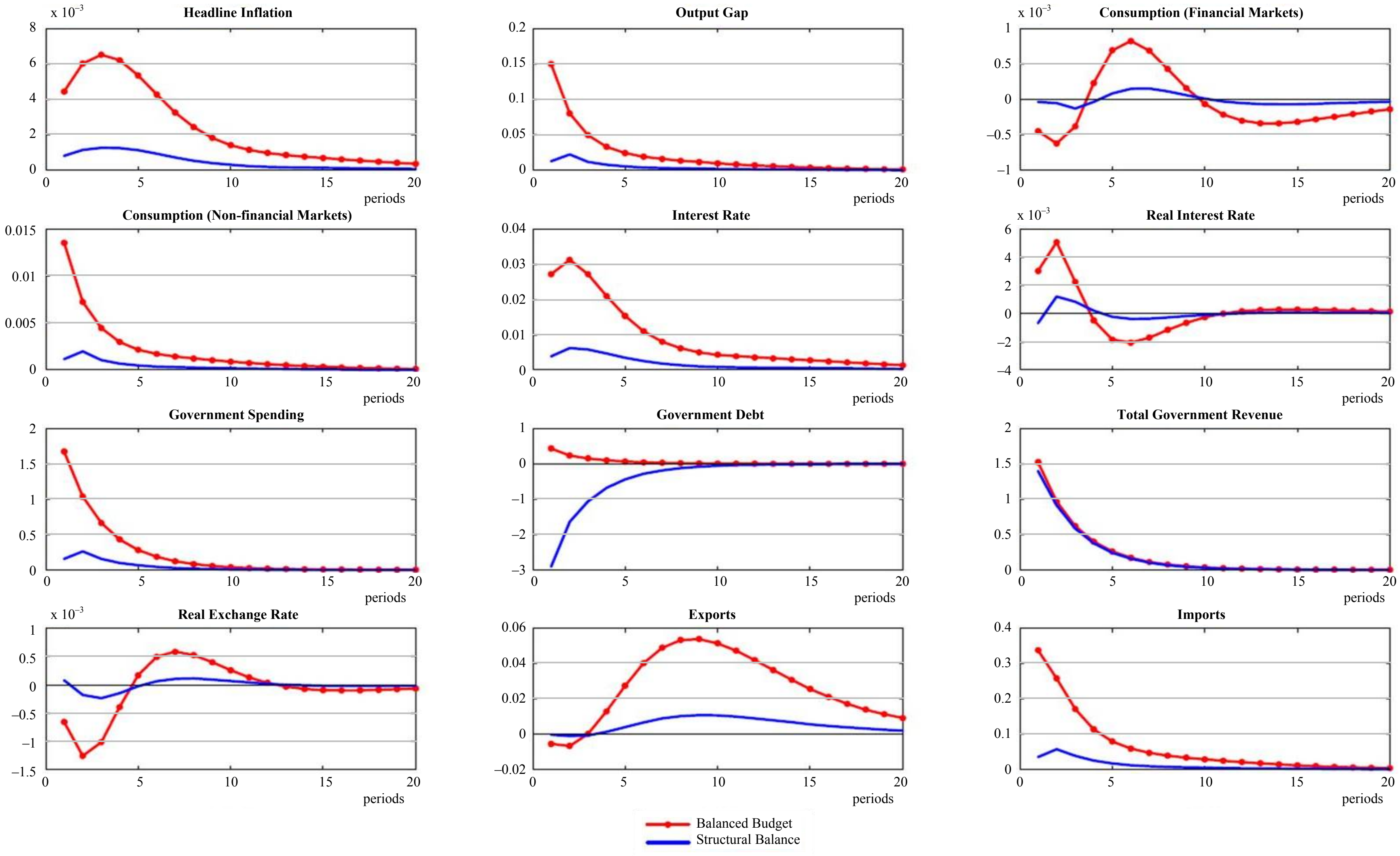
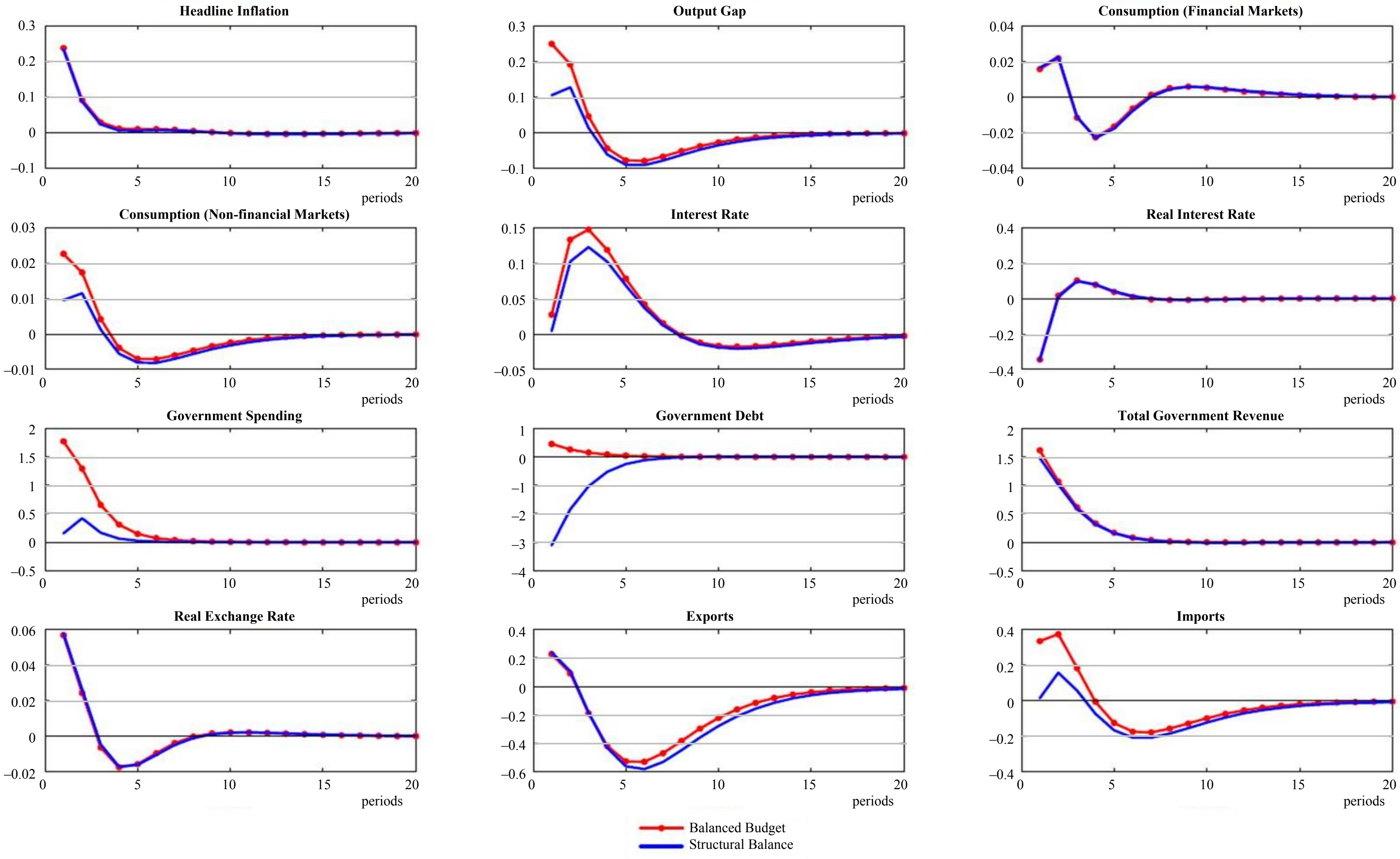


Figure 8

Increase of Gasoline Prices and Inflation



output gap, tax revenues increase as well, so the government can spend more, but spending behavior will also depend on the type of rule followed by the tax authority. In the case of a zero deficit, as revenues increase, the government can spend more and still meet the rule. In addition, the increase in interest rates by the central bank to reduce inflation, generates an increase in the financial cost of the government and a fall in investment, consumption and, therefore, the output gap that feeds back the effect on spending through tax revenues. Additionally it generates an appreciation of the exchange rate, causing an increase in imports and a decline in exports. Finally, the effect on spending under a structural balance rule maintains the same spirit as the former rule but generating much smoother movements in government spending because it only reacts to changes in the "reference output", and a change in consumption today affects it minimally.

Finally, Figure 7 shows the response of the different variables of the model to an increase in oil prices, but not in inflation since movements in oil prices are not transmitted to movements in fuel prices under the rule determined by the government.[22] This shock´s immediate effect is reflected in the increased government revenue due to higher oil revenues, however the reaction of government spending depends on the type of rule that is being followed.[23] In general, due to the increase in government revenue, demand pressures are generated. The central bank has to act to contain these pressures and increases the interest rate on the short-term, which affects both inflation and the exchange rate so that inflation begins to decline and the increase in the real interest rate generates an appreciation of the real exchange rate, increasing imports and decreasing exports. Consumers and investors, meanwhile, know that given the increase in oil prices the government will have more money to spend, hence the output gap will increase, but also know that the monetary authority will react to these pressures by tightening the interest rate to offset this effect on inflation. For this reason, consumption, is affected at the time of the shock and gradually adjusts during the following periods after the shock. Considering the balanced budget rule, given an increase of oil revenues, the government can increase its spending and still comply the fiscal rule. This in turn generates a fiscal policy that exacerbates the effect of the increase in the price of oil with high volatility. In the case of the structural balance rule, government spending only reacts to changes in the "reference price" of oil, so an increase in oil prices generate minor effects on the output gap and therefore on inflation, which leads monetary policy to increase the interest rate in a lower magnitude compared to the balanced budget rule and therefore the effects on the exchange rate, consumption and investment, are lower as well.

5.3 Oil prices shocks

In Mexico, as already mentioned, movements in oil prices are not transmitted to movements in fuel prices since the government fix these prices every year resulting in a very limited impact on inflation. However, one of the main purposes of the government in recent years has been to close the gap between domestic and international fuel prices. This modification will imply that oil price volatility will not only affect government revenues volatility but also inflation volatility.

It is important to mention that the current rule followed by the government to fix fuel prices is a very regressive subsidy that distorts the relative prices of inputs and therefore generates inefficient allocation of resources. Even though from the inflation stability perspective, the energy prices rule may be convenient in the short run since it absorbs the major part of energy prices volatility, it could imply such high costs in terms of public finances that in the medium term it

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22 Note that this assumption will be modified in the following excercise.

23 In Mexico, the increase in oil prices affects government revenues by extracting more surplus to the rest of world, since the sale of crude oil to other countries does not directly affect domestic consumers.

might be a threat for price stability. Considering the situation described above we compare the two fiscal policy rules considered in this analysis allowing oil price shocks to affect not only government revenues but also inflation.

In order to calibrate the effect of the oil price shock over inflation, we calculate how an increase in oil prices can affect inflation. We consider the price that the public pays for gasoline, and compare it with the price at which the oil company buys gasoline abroad adding other costs such as transportation costs, taxes, fees, etc. Which under perfect competition should be the price that consumers should be paying.[24] Once we obtain the price that consumers should be paying instead of the fixed price set by the government we calculate the average increase that inflation should have had if the adjustment takes place, considering the weight of gasoline prices on the CPI.[25]

In order to see the potential effect of an increase of oil prices not only in oil revenues, but also in inflation, we run impulse-response functions with both shocks, calibrated as abovementioned. As we can observe in Figure 8, the dynamics of the variables is very much the same as in the previous shocks, but we can see that the monetary policy authorities have to react increasing the interest rate more under the BB rule than under the SB rule. This situation has some costs in terms of the output gap, which is more volatile under the BB rule. It is important to mention that this shock is not considering indirect effects of increasing gasoline prices, but only the direct effect on inflation. If we consider that gasoline prices have impact on other goods and services, then the effect might be higher over inflation, hence the reaction of the monetary authority should be higher as well.

6 Conclusions

In Mexico, more than 30 per cent of the public sector's revenues are from oil revenues. Moreover, energy prices are set by a rule determined by the government. This rule is supposed to act as a tax when energy prices abroad are low and as a subsidy when those prices are high. Indeed, before mid-2000s, this rule functioned as a tax, however, during the last decade energy prices have been showing an upward trend and, although they decline temporary during the 2008-09 financial crisis, recently they reached historical high levels and elevated volatility.

In this sense, it is important to reconsider the way public expenditures are determined by such a volatile source of revenues, and also to re-think how appropriate the energy prices' rule in this new environment is. In this paper we examine this fiscal situation and its interaction with the monetary policy. Mexico, as other commodity exporter countries have faced a number of challenges derived from the management of commodities. In this context, Mexico has showed some convergence towards greater transparency and accountability, recognizing the benefits of the authority taking decisions under clear and transparent procedures, *i.e.* under a regulatory framework versus a discretionary one, in recent years, the country has made some important reforms.

These reforms allowed achieving lower levels of deficit and debt, limiting and eventually eliminating the fiscal dominance situation, which allowed the monetary policy to fulfill its mission of maintaining price stability and generating greater macroeconomic stability. However there are still some vulnerabilities that prevail in the Mexican public finances and that during the recent

[24] We consider the retail gasoline price published by the national oil company (PEMEX), transportation and other costs from the figures published by Ministry of Finance, and producer costs are obtained from the Gulf Coast Gasoline Midgrade Wholesale prices.

[25] The average increase that gasoline prices should have reflected with respect to international gasoline prices is 43 per cent. Considering this increment in gasoline prices, the incidence of this increase would be 156 percentage points.

financial crisis were present, the still high dependence of public revenues on oil revenues, and secondly, the fact that energy prices are set by a rule determined by the government, as we have mentioned.

Thus, we consider this a relevant issue for Mexican macroeconomic policies since all sources of volatility for the macro economy that are not managed by the fiscal authorities might be addressed by the monetary ones. Even though from the inflation stability perspective, the energy prices rule may be convenient in the short run since it absorbs the major part of energy prices volatility, in the medium term it could imply such high costs in terms of public finances, income distribution, since the tax is regressive and it might be a threat for price stability. In addition to that, the dependence of public finances on oil prices makes it very common for the government to "close" the government budget with adjustments in public prices and rates fixed by the government. This is a very important source of uncertainty for inflation (especially non-core component) and therefore inflation expectations. Even though in this paper we only focus on the short term costs over inflation, future work should take into account the trade-offs of these policy changes in terms of social welfare, income distribution, among other topics since this are extremely relevant for the Mexican public policies.

The central bank has been very successful in accommodating supply shocks to inflation, specifically exchange rate fluctuations and volatility in agricultural prices. However, the Mexican economy has not yet learned to absorb, in an orderly way, energy prices volatility. Therefore, this is an open issue and still a challenge from the monetary policy perspective.

Given the current environment and international conditions in the oil market, the actions undertaken in the recent past can lead to better results if the authority considers additional elements to isolate the effects of cyclical elements in the macroeconomic decisions. Thus, these matters are taken into account in this paper in which we develop a macroeconomic model for policy analysis, incorporating the effect of oil prices on public finances of a small open economy, in an environment in which monetary policy follows an optimal policy rule, and fiscal policy follows one of two rules: a balanced budget rule or a structural balance budget rule. We found that in general, when the economy faces domestic and external shocks, higher macroeconomic stability is achieved under the Structural Balance Budget Rule than under the Balanced Budget rule, currently in place. Furthermore, when the economy faces an oil price shock, the structural balance rule generates the monetary authority to react less aggressively than under a balanced budget rule. The resulting higher stability under structural balance rule is even more important under the potential scenario where government stops fixing fuel prices, which in the medium term will generate less distortions and better resource allocations, even though in the short term might generate inflation volatility thus a more aggresive fiscal rule might be necessary.

APPENDIX 1
VARIABLES AND ESTIMATIONS

In this section we present the estimation outputs for the different equations described in the document. We estimated most equations from 2002Q1to 2012Q2 using GMM; however, variables following AR processes were estimated using OLS. Each component of the Aggregate demand was estimated in terms of gaps. The results are the following.

New Phillips Curve

The specification of core inflation is a hybrid Phillips curve. Note that in order to fulfill the dynamic homogeneity property, *i.e.* nominal variables do not affect real variables in the long term, it is necessary that the sum of the coefficients of the nominal variables equal one, therefore $a_1+a_2+a_4=1$. The resulting estimation is:

$$\pi_t^C = 0.520\,\pi_{t-1}^C + 0.475\,E_t\left[\pi_{t+1}^s\right] + 0.009\,x_t + 0.005\left(\Delta e_t + \pi_t^*\right)$$

(0.066) (0.004) (0.003)

*Generalized Method of Moments. Instrument specification: π_{t-2}^C to π_{t-4}^C, π_t to π_{t-1}, Δe_t to Δe_{t-3} and π_t^* to π_{t-4}^*.
Standard deviation in parenthesis. *p*-value of *J* is 0.964.

In this case, the signs on the regression coefficients make sense with those suggested by the economic theory.

Real exchange rate equation

Real exchange rate is defined according to Interest Rate Parity condition plus one lag of the exchange rate in order to smooth the performance of this variable. The resulting estimation is:

$$rert_t = 0.487\,rert_{t-1} + 0.513\,E_t\left[\left[rert_{t+1}\right] - 0.453\,r_{t-1} + \frac{1}{400}\left(r_t^* - r_t\right)\right]$$

(0.055)

*Generalized Method of Moments. Instrument specification: rer_{t-1}, r_{t-1} and r_{t-3}^*.
Standard deviation in parenthesis. *p*-value of *J* is 0.412.

Private consumption

The private consumption with access to the financial market specification is the following:

$$C_t^{FM} = 0.272\,C_{t-1}^{FM} + 0.811\,E_t\left[C_{t+1}^{FM}\right] - 0.075\,r_{t-1}$$

(0.127) (0.128) (0.040)

*Generalized Method of Moments. Instrument specification: C_{t-1}^{FM} to C_{t-3}^{FM}, i_{t-3} to i_{t-4} and π_{t-1}^{ε} to π_{t-2}^{ε}.
Standard deviation in parenthesis. *p*-value of *J* is 0.857.

Investment

The specification of the investment, as well as the other components of aggregate demand, is in terms of gaps.

$$in_t = \underset{(0.964)}{1.744} + \underset{(0.071)}{0.552}\, in_{t-1} + \underset{(0.078)}{0.473}\, E_t\,[in_{t+1}] - \underset{(0.259)}{0.453}\, r_{t-1} + \underset{(0.122)}{0.228}\, x^*$$

*Generalized Method of Moments. Instrument specification: in_{t-1} to in_{t-4}, i_{t-3} to i_{t-4}, π^e_{t-1} to π^e_{t-3} and x^*_{t-2} to x^*_{t-4}.
Standard deviation in parenthesis. p-value of J is 0.722.

Exports

$$ex_t = \underset{(0.025)}{0.492}\, ex_{t-1} + \underset{(0.028)}{0.513}\, E_t\,[ex_{t+1}] + \underset{(3.737)}{6.34}\, rer_t - \underset{(0.028)}{0.056}\, x^*_{t-1}$$

*Generalized Method of Moments. Instrument specification: ex_{t-1} to ex_{t-4}, rer_t to rer_{t-4}, x^*_{t-2} to x^*_{t-4} and $dlic_t$ to $dlic_{t-4}$.
Standard deviation in parenthesis. p-value of J is 0.853.

Imports

$$im_t = \underset{(0.037)}{33.479} + \underset{(0.037)}{0.198}\, im_{t-1} + \underset{(0.033)}{0.207}\, E_t\,[im_{t+1}] - \underset{(2.705)}{7.481}\, q_t + \underset{(0.148)}{1.881}\, x_t$$

*Generalized Method of Moments. Instrument specification: im_{t-4}, x_t to x_{t-4}, rer_t to rer_{t-3}, x^*_{t-3} to x^*_{t-4} and π^{imp}_{t-2} to π^{imp}_{t-4}.
Standard deviation in parenthesis. p-value of J is 0.764.

The model assumes that changes in inventories, non-core inflation, oil prices and oil production are exogenous variables that follow a first order autoregressive process. Furthermore it is assumed that foreign variables, real interest rate, inflation and output gap for the foreign country, r^*, π^* and x^* respectively are generated from a second order autoregressive vector.

Estimates for these variables are the following.

Changes in inventories

The specification of changes in inventories is modeled as a residual. It is calculated estimating the output gap as the dependent variable and the weighted sum of the gaps of the components of GDP as independent variables. The weights used for this sum are the Historical Great Ratios of GDP components to total GDP. The resulting residuals from this estimate are divided by the average weight of inventory changes and then the following autoregressive process is estimated:

$$inven_t = \underset{(0.138)}{0.286}\, inven_{t-1} + \mu_{ex}$$

* Least Squares Method. R^2=0.082.
Standard deviation in parenthesis.

Non-core inflation

Non-core inflation is modeled by an autoregressive process of order one and the resulting estimation is:

$$\pi_t^{NC} = 0.524\,\pi_{t-1}^{NC} + \mu_{\pi_t}^{NS}$$

$$(0.138)$$

*Least Squares Method. R^2=0-0.762
Standard deviation in parenthesis.

Oil price gap

The oil price gap is modeled as an autoregressive process of order 1:

$$P\ oil_t = \ 0.643\ P\ oil_{t-1} + \mu_{ppet_t}$$

$$(0.156)$$

*Least Squares Method. R^2=0.428.
Standard deviation in parenthesis.

Oil production

In the case of oil production gap, it is modeled as an autoregressive process of order 1 as well:

$$Y\ oil_t = \ 0.814\ Y\ oil_{t-1} + \mu_{xpet_t}$$

$$(0.073)$$

*Least Squares Method. R^2=0.66.
Standard deviation in parenthesis.

The parameters that were not estimated, were calibrated from historical averages for Mexico, as in the case of the weights of the output gap, where each weigh represents the historical ratio of the component as a proportion of GDP and of the parameters describing fiscal variables, as summarized in Appendix 2.

APPENDIX 2
HISTORICAL AVERAGES AND CALIBRATED VALUES

After log-linearizing the model, the parameters *s*, *q*, *n* and *j* are defined as follows:

s_1	$\frac{\bar{G}}{\bar{B}}$	s_3	$\bar{R}$
s_2	$R+2\Psi\exp(B-b)-\Psi$	s_4	$\frac{\bar{T}}{\bar{B}}$
q_1	$\frac{\varphi_1 \tau \bar{Y}}{\bar{T}}$		
q_2	$\frac{(1-\varphi_1)\overline{Y\,oil\,P\,oil}}{\bar{T}}$		
h_1	$\frac{\bar{T}}{\bar{G}}$		
n_1	$\frac{\varphi_1 \tau \bar{Y}}{\bar{G}}$	n_4	
n_2	$\frac{(1-\varphi_1)Y\,oil\,P\,poil}{\bar{G}}$	n_5	$\frac{\bar{R}\bar{B}}{\bar{G}}$
n_3	$\frac{(1-\varphi_1)\overline{Y\,oil\,P\,oil}}{\bar{G}}$		
j_1	$\frac{2\varphi_1 \tau \bar{Y} - \bar{B}\bar{A}\bar{S}}{\bar{G}}$	j_4	
j_2	$\frac{2(1-\varphi_1)\overline{Y\,oil\,P\,oil}}{\bar{G}}$	j_5	$\frac{\bar{R}\bar{B}}{\bar{G}}$
j_3	$\frac{(1-\varphi_1)\frac{\bar{G}}{Y\,oil\,P\,oil}}{\bar{G}}$	j_6	$\frac{\bar{B}\bar{A}\bar{S}}{\bar{T}}$

Table 5

Historical Averages and Calibrated Values

$\frac{\bar{G}}{\bar{B}}$	2.389	$\frac{\bar{T}}{\bar{G}}$	0.98
$R+2\Psi\exp(B-b)-\Psi$	0.041	$\frac{\bar{R}\bar{B}}{\bar{G}}$	0.435
$\bar{R}$	1.04	τ	0.14
φ_1	0.7	$\frac{\bar{B}\bar{A}\bar{S}}{\bar{T}}$	0.002
$\frac{\overline{Y_{perPpet}}}{\bar{G}}$	0.33	$\frac{\bar{Y}}{\bar{G}}$	10
$\frac{\bar{T}}{\bar{B}}$	2.339		

Table 6

Historical Ratios

$\frac{\bar{C}}{\bar{Y}}$	ω_c	67
$\frac{\overline{IN}}{\bar{Y}}$	ω_{in}	20
$\frac{\bar{G}}{\bar{Y}}$	ω_g	13
$\frac{\overline{Ex}}{\bar{Y}}$	ω_{ex}	19
$\frac{\overline{Im}}{\bar{Y}}$	ω_{im}	20
$\frac{\overline{Vex}}{\bar{Y}}$	ω_{vex}	1

APPENDIX 3
OPTIMAL POLICY RULES

The monetary policy rules were calculated following Söderlind (1999). The policy maker loss function is 10 and it reflects its interest in the target economic variables as well as a preference for a stable interest rate. The instrument of the monetary policy authority is the nominal interest rate. The policy maker picks the interest rate such that it optimizes its loss function under discretion. This means that the policy maker optimizes every period considering the process by which the agents form their expectations as given. Something worth noting is that the optimal monetary rule is different between the BB model and SB model.

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