Policy mix in a small open emerging economy with commodity prices

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Abstract

The article analyzes the interaction between monetary and fiscal policy in Mexico. We use a semi-structural model for a small open economy, calibrated for Mexico using data from 2001 to 2017. The fiscal policy block models the fiscal deficit depending on the output, an endogenous sovereign risk premium, a state-owned oil company and the dynamics of public debt with domestic and foreign components. A fiscal rule is assumed whereby the deficit has an upper bound. The monetary policy follows a Taylor rule to respond to both the fiscal and exogenous blocks. We study independently and qualitatively the effects of each shock on the economy. We thus show that the risk premium channel transmits fiscal shocks into the monetary block, calling for the central bank to stabilize inflation. Whereas the monetary shocks affect the fiscal block mainly through the interest rate influencing the debt service, leading to a fiscal response in order to stabilize deficit.

Keywords: small open economy, emerging economy, policy mix, oil prices, commodity prices, risk premium.

JEL Classification: C61, C68, E17, E47, E52, E62, E63, F41, H62, H63.

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1 Introduction

Lately, during the Global Financial Crisis (GFC), and more recently, for the Covid-19 crisis, negative commodity prices shocks have considerably affected the global economy and even more so emerging market economies that export commodities. Furthermore, given the stronger integration of emerging market economies with global financial markets, the global cyclical conditions and interest rates in advanced economies play a key role on both domestic fiscal and monetary policy. We analyze those consequences through the lens of a small open emerging economy that is exporting goods and commodities, and determine what would be the response of both fiscal and monetary policy makers to different shocks in order to maintain the budget balanced and the inflation stable, respectively.

Mexico is a typical small open emerging-market economy and has a strong economic component linked to oil prices since Mexico's government owns PEMEX, the main firm allowed to extract and exploit oil in Mexico. In 2019, total exports of Mexican economy represent almost 40% of GDP among which 77% of exports are aimed at the US economy, and 16,4% of total exports are commodities. As for the fiscal accounts, oil revenue from PEMEX between 1990 and 2019 represents almost 6% of GDP, and 28% of total government revenue.[1] After the Great Financial Crisis and the Covid-19 crisis, the public revenues and debt linked to oil industry have been negatively affected due to the international prices of oil registering a considerable drop, and to the downgrade of PEMEX's debt rating, which in turn negatively impacts the country risk premium, measured with the EMBI-G index constructed by JP Morgan.[2]

Note that the impact of oil price shocks on domestic inflation has declined over time due mostly to a better conduct of monetary policy in most advanced and emerging countries (Choi et al. 2018). However, Filis and Chatziantoniou (2014) stress that financial markets are more sensible to an increase in oil price when those markets are newly established or when they are less liquid. Those characteristics also apply for Mexico since in comparison to advanced economies, the Mexican financial market (Bolsa Mexicana de Valores) remains small and vulnerable to external shocks, and needs further instruments to increase its liquidity and efficiency (Skelton 2011). In existing DSGE models, oil prices enter as a mere supply shock, hence a boom in the oil sector constrains factor markets and crowds out non-oil activity, corresponding to the phenomenon of the so-called Dutch disease. However Bergholt (2014) and Bergholt et al. (2019) introduce a DSGE model that allows demand shocks driven by oil prices, depending of the structure of the economy. This type of model also generates a real appreciation of local currency for positive oil-price shocks due to the gains in terms of trade, and generates a boost in non-oil activity. In our analysis, we consider oil-price shocks as a demand shock that better corresponds to Mexican economic structure because the oil-price shock is similar to a government spending shock, constituting an oil-specific demand shock (Killian 2009, Stevens 2015, Bergholt et al. 2019). One issue in many models reproducing the effects of oil-price shocks on the macroeconomic activity is that they can only analyze a positive oil-price shock, assuming a negative oil price shocks leads to asymmetric consequences (Bergholt 2014). The model we use allows for considering an oil price shock being a demand shock that incorporates endogenous sovereign risk premium proxied by the EMBI-G that allows to model positive as negative oil-price shocks.

The oil-price shock by affecting the Consumer Price Index (CPI) and public revenues has consequences

[1] See the Timely Public Finances Statistics, Ministry of Finance, April 2020.

[2] As a measure of sovereign risk premium in this model for Mexico, we use the EMBI-G spread (Emerging Market Bond Index Global elaborated by JP Morgan) that should reflect the fiscal performance. This particular index reflects the stock of debt including PEMEX's debt. Furthermore it is commonly used in the literature, measures the sovereign default risk and is constructed as excess promised returns on the US treasury, including Brady bonds, loans, and dollar-denominated Eurobonds with a face value of at least $500 million.

on both monetary and fiscal policy. Those consequences raise the question of finding the most efficient policy mix. As largely debated in the literature, there exists two possible combinations of policy mix (Leeper 1991, 2016), one where the active monetary policy targets inflation by moving nominal interest rate more than one for one with inflation, while the passive fiscal policy manages tax collecting moving positively alongside with government debt, in order to cover real debt service and total debt. A second possible combination for policy mix is when the central bank sets its nominal interest rate in a passive way responding to inflation less than one-for-one to avoid that interest payments of public debt do not destabilize debt, whereas the fiscal policy does not make taxes responsive to state of government indebtedness.

The sovereign default literature in emerging economies supports that default is extremely likely to happen if both policies are active in the sense of Leeper (1991, 2016). That is, the monetary authority implements an inflation target and the tax policy stays exogenous (Uribe 2006). However, in emerging economies, the predicted level of government debt at which the sovereign default can occur is much lower than the debt level at which sovereign risk premium is observed in developed countries (Bi 2012). Furthermore, for emerging market economies, the lower level of productivity not only reduces tax revenues, leading to higher levels of public borrowing, but also shifts down the state-dependent distribution of fiscal limits. The latter raises the default probability even if the debt stock remained at the same level the same. In short, a higher stock of debt, along with the lower distributions of fiscal limits, pushes up the sovereign borrowing cost, which worsens the government budget. Such a mechanism can yield a higher risk premium during a recession.

Therefore, there ought to be an even deeper need of coordination between fiscal and monetary policy in emerging economies. The effect of public spending on aggregate output depends on three idiosyncratic elements: first, the responsiveness of risk premia to changes in public indebtedness; second, the length of time during which monetary policy is expected to be constrained if fiscal policy is active; and finally, the sensitivity of tax revenue to economic activity (Corsetti et al. 2013). As a matter of fact, the sensibility of risk premium to variations of debt is shown to be higher in emerging economies exporting commodities, as well as the sensitivity of tax revenue to economic activity due to the volatility of oil prices. Countries with large fiscal imbalances present the feature that fiscal policy may affect exchange rates through the risk premium channel (Giorgianni 1997). Indeed, without fiscal discipline in a context of high public debt, with a short-average maturity, the concerns about sovereign debt sustainability significantly increase the risk premium, if the latter is assumed to reflect the performance of fiscal policy (Bi 2012).

Additionally, the conduct of monetary policy can radically worsen the public finance stance. Several studies, including Blanchard (2004), Favero and Giavazzi (2004), show the role of debt dynamics on the performance of inflation targeting. These studies imply that, after a sovereign risk-premium shock, the risk-premium channel could actually further modify the price level in the economy when the central bank follows a tight monetary policy depending on the fiscal response (Bi 2012, Corsetti et al. 2013). On one hand, without any credible fiscal contraction, a tighter monetary policy associated with higher real interest rates would increase the debt service burden and could actually lead to capital outflows, due to a flight to quality, and eventually to a depreciation of the domestic currency by increasing the sovereign risk premium, assuming for risk averse investors (Aktas et al. 2010). On the other hand, in the presence of a credible fiscal contraction, the risk-premium channel manifests itself by a lower risk carried by home-currency denominated assets, which increase their demand and finally could appreciate domestic currency (Giorgianni 1997). A higher sovereign risk premium that leads to a credible fiscal contraction in an economy with a large stock of public debt may produce two consequences. First, the fiscal contraction reduces the amount of public debt being held by domestic and foreign investors. Second, it lowers uncertainty about future taxation, making the economy less sensitive to external shocks. According to Corsetti et al. (2011, 2013), the risk-premium channel reduces the fiscal multiplier because it dampens aggregate demand through the fiscal tightening in the absence of any credible fiscal response.

Our model contributes to the literature by showing the interaction between fiscal and monetary policy for a small open emerging market economy exporting commodities, when addressing each one's objectives and their effect on the main macroeconomic variables using data from Mexico. This paper confirms the results of the monetary policy literature when oil-price shocks hit the economy as well as premium risk or exchange rate shocks when monetary policy acts counter-cyclically. We further add to this literature by considering the interaction between different transmission channels belonging to both fiscal and monetary blocks that eventually impact activity and inflation. In our model, the behavior of risk premium contributes to the risk premium channel literature: an exogenous increase in the risk premium, derived for example from a higher level of uncertainty in the conduct of public policies, leads to a reduction in public spending and an increase of the policy interest rate. In particular, the increase in the risk premium leads to a depreciation of the exchange rate and, consequently, an increase in inflation. It translates into a drop in economic activity, since uncertainty inhibits private investment, and therefore a fall in tax revenues. The latter implies an increase in the public debt service. Finally, we perform an optimal policy analysis in order to find the best coordination between monetary and fiscal policy makers.

The main results derived from our model describe the conduct of policy making that helps the economy to go back to the steady state in the event of supply and demand shocks affecting both fiscal and monetary blocks. For the whole paper, we assume that the fiscal policy always remains passive in the sense of Leeper (1991, 2016), meaning that the fiscal policy aims to have a balanced public finances even in the event of shocks. Maintaining this hypothesis, we first find that after a positive shock on risk premium, or a depreciation of the domestic currency, the central bank has to increase the interest rate to stabilize inflationary pressures. Another result is that after a positive shock of public primary spending, a shock deteriorating fiscal position, or an increase in oil prices, the central bank should raise its interest rate to face inflationary pressures. When comparing the scenarios for finding the optimal policy mix, we find that the best response to simultaneous shocks of oil-price, economic activity and risk premium, would be a counter-cyclical coordinated monetary and fiscal response. This policy mix smooths adverse effects on economic activity, while inflation barely deviates from its target relative to other scenarios.

The rest of the paper is organized as follows. Section 2 analyzes the recent evolution of fiscal policy in Mexico and sovereign risk. Section 3 explains the model structure and its main characteristics. Section 4 presents Impulse-Response functions that illustrate the model mechanisms and analyze interactions between both policies. Section 5 concludes and describes the future working agenda.

2 An outlook at the recent evolution of fiscal policy in Mexico

Since GFC, and more recently, through the Covid-19 crisis, the Mexican economy has been negatively affected by a number of simultaneous shocks. These shocks especially have impacted public finance in Mexico. In the following, we describe the current fiscal stance in Mexico as it holds some country-specific arrangements.

During the GFC, the Mexican economy was affected by a contraction in output and consequently, a fall in public revenue. Additionally, since 2014, the international prices of oil registered a considerable drop combined with a downward trend in PEMEX oil production, which has led to a sharp reduction in oil-based public revenues. Given these elements, the fiscal authority was allowed to temporally widen the public deficit, under the clauses of the Fiscal Responsibility Law in 2014. In the following years, the fiscal consolidation process was postponed, causing greater public deficits and therefore a higher total debt-to-GDP ratio. Negative oil-price shocks gradually led to a deterioration in the terms of trade as oil-price shocks corresponds in Mexican economy to demand shocks, since negative oil price shocks decrease government's revenue, representing a negative government spending shock (Stevens 2015).

The decline in terms of trade contributed to a domestic currency depreciation since the end of 2014. This currency depreciation has been essentially caused by the oil-prices drop from 2014 on, especially the end of "the commodity supercycle". In this context, the current account deficit in terms of GDP deepened due to a reduction in oil exports. To sum up, in addition to a sharp domestic currency depreciation, the evolution of public spending and income has led a significant increase in the stock of public debt, from 32.9 to 44.9% GDP between 2008 and 2018. In April 2019 the government reoriented PEMEX's objectives to help the company facing structural challenges such as oil prices volatility and re-orientating production goals.[3] In particular, the current PEMEX Business Plan entails changes for the fiscal policy in the short term. The Business Plan in 2019 forecasts that direct taxes paid by the firm eventually show an upward trajectory given the production increase. On the other hand, despite the tax reform implemented in 2014, tax-to-GDP revenues have decreased, while also decreasing its share in total revenues. Indeed, oil revenue between 2015 to 2019 represents around 4% GDP, whereas between 2005 and 2014 oil revenues represented around 7.5% GDP. As a consequence of the slowdown in tax revenues, the government has tapped resources from the Budgetary Income Stabilization Fund (BISF). The BISF is a fiscal buffer in Mexico, that operates as a counter-cyclical mechanism allowing fiscal compensation when public revenues are lower in order to reach the fiscal objective given by the Law of Federation's Revenue.[4]

In addition, there has been an increase in the Mexican sovereign risk premium, even above other emerging market economies peers. This can lead to a negative effect on activity and a depreciation of the exchange rate.

Yet, since 2016, the Ministry of Finance carries out fiscal consolidation. In 2017 the government obtained a primary surplus of 0.4 percent of GDP for the first time since 2008. In 2018, the government reached its deficit target of 2.5% of GDP, being measured by the Public Sector Borrowing Requirements (PSBR).

However, in 2019, the fiscal target was not reached, if one excludes the use of the BISF. The IMF warned of a slight deviation from that target in 2019, due to a weaker income. Although, the IMF already points out to the need to take additional measures to increase income or reduce spending, in order to avoid generating additional fiscal gaps for 2020. Thus, in late 2019, the foreseen deficit was of 0.5 to 1.5% of GDP for 2020-2024.[5] Furthermore, in the medium term, the deficit should reach a debt of 55% GDP.

A foreign interest rate shock, added to a negative both oil prices and a tax shock result in generating more volatility and therefore high uncertainty for the Mexican economy and public finance outlook for 2020. These numerous shocks pose the challenges for the fiscal policy to attain a reasonable deficit and level of public debt, and raise the question of which monetary policy should be conducted to minimize the impact of those shocks on the exchange rate, inflation and activity, while fiscal policy aims at maintaining sustainability of debt.

[3]For a detailed description, see the "PEMEX Business Plan" Box in the April - June 2019 Banco de Mexico Quarterly Report, pp. 42-45.

[4]The Budgetary Revenue Stabilization Fund is not explicitly included in the model but can be introduced in the form of a positive shock to public spending. This tool was originally created in 2001 for compensating losses in public revenues from oil activity, due to the volatility of oil prices.

[5] See Article IV-Consultation Report for Mexico, IMF 2019.

Indeed, if the primary deficit deteriorates, the PSBR increase. The latter raises the sovereign risk, and consequently yields a depreciation of the exchange rate. In particular, an increase in the interest rate accommodates the higher inflation derived from the initial expansion of activity and the depreciation of the exchange rate.

3 Monetary and fiscal macroeconomic model

Our model is constructed upon two main blocks, the fiscal block (subsection 3.1) and the monetary block (subsection 3.2). We first solve the fiscal block independently, we then insert the output into the monetary block, and obtain the monetary policy response to fiscal decisions. This strategy corresponds to the fact that the central bank is goal-independent in our model (Debelle and Fischer 1994 among others).[6]

3.1 Fiscal Block

The fiscal block has been built upon the public finances framework in Mexico. That is, the public revenue mostly depends on income tax, oil tax, corporate tax and others types of tax. This fiscal block follows a VAR structure for most of its equations. Each VAR equation has been calibrated, and using data from 2001 to 2017. One strong assumption, that conditions the return to steady state, is that the fiscal budget must be balanced. In the fiscal block, US and international markets are ruled by a law of motion following an AR(1) process.[7]

We decided for a matter of simplicity to then express all variables as deflated ratios of the GDP, following:

$$a_t = \hat{a}_t / (p_t x_t) \tag{1}$$

where the matrix of variables a_t that are in the the fiscal block are deflated using the consumer price index measure (p_t) and expressed as a ratio to the GDP (x_t). Hence, all the following equations are expressed in levels of nominal GDP.

The public revenue τ_t is constituted by the sum of main taxes in México:

$$\tau_t = \tau_t^{tax} + \tau_t^{oil} + \tau_t^{ab} + \tau_t^{others} \tag{2}$$

where τ_t^{tax} being the revenue from income tax, τ_t^{oil} the revenue from oil-sector taxes and royalties, τ_t^{ab} the revenue generated by government agencies and private firms, and τ_t^{others} is composed of other types of revenue.[8] τ_t^{ab} and τ_t^{others} follow AR (1) processes for simplicity.

The income tax τ_t^{tax} is a fixed proportion of aggregate domestic output x_t and its current level depends on past one:

[6] Banco de Mexico is independent since April 1994. The CB independence can be decomposed into two components, *i.e.*, the goal independence and the instrument independence. The guarantee of being goal-independent is given by a CB that is free from political pressures when defining its policy objectives and preferences. Goal independence can be designed by meeting several criteria such as the mandate period for the governor and the board superior to five years , the fact that the governor or/and the board are not appointed by the government, the non-approval of the government for monetary policy formulation,...(Balls and Stansbury 2018) The instrument independence can be observed by the way the central bank freely adjusts its policy tools while targeting its goals.

[7] The international variables do not follow a VAR since all variables are depending only on its past value and a white noise shock.

[8] Oil revenue depends on the oil prices in US dollars p_t^{oil}, such as $\tau_t^{oil} = \left(p_t^{oil} FX_t\right) X_t^{oil}$, where the nominal exchange rate FX_t expresses the value of one unit of foreign currency (here US dollars) against domestic currency (Mexican peso here) defined by $FX_t = s_t - s_{t-1} + \left(\pi_t - \pi_t^{US}\right)$, where s_t the real exchange rate, π_t represents the domestic inflation, π_t^{US} the US inflation. The quantity of oil extracted from the production platform x_t^{oil} follows an AR (1) process:$x_t^{oil} = \varphi x_{t-1}^{oil} + \varepsilon_t^{X^{oil}}$.

$$\tau_t^{tax} = \upsilon_1 x_t + \varepsilon_t^{tax}, \tag{3}$$

with υ_1 representing the average share of income collected by the government, and ε_t^{tax} an exogenous shock to the income tax.[9]

We henceforth consider the oil revenues as:

$$\tau_t^{oil} = \lambda_1 wti_t + \lambda_2 x_t^{oil} + \lambda_3 s_t + \varepsilon_t^{oil} \tag{4}$$

where wti_t represents the price of US oil WTI barrels, x_t^{oil} the domestic oil production, s_t the real exchange rate. An increase in s_t corresponds to a currency depreciation, and conversely, if s_t reaches negative values, then domestic currency is appreciating. Finally, ε_t^{oil} an exogenous shock to the oil revenue. Parameters in (4) implicitly capture the complex tax structure through which PEMEX contributes to public revenue.[10]

Since we analyze an emerging-market small open economy, we take into account the fact that the government debt b_t is divided into its domestic b_t^d, and foreign b_t^f components.

$$b_t = b_t^d + b_t^f, \tag{5}$$

where domestic debt corresponds to

$$b_t^d = \kappa_1 b_{t-1}^d + \kappa_2 psbr_t + \varepsilon_t^{B^d}, \tag{6}$$

with $psbr_t$ represent the Public Sector Borrowing Requirements (PSBR), κ_1 the persistence degree of the domestic debt and κ_2 the proportion of the PSBR financed with domestic debt. The shock $\varepsilon_t^{B^d}$ is exogenous. An increase in PSBR implies a deterioration of the expanded public balance.

$$b_t^f = \mu_1 b_{t-1}^f + \mu_2 s_t + \mu_3 psbr_t + \varepsilon_t^{B^f}, \tag{7}$$

with μ_1 is the the lag coefficient for the foreign debt, μ_2 measures the sensitivity of the foreign debt to real exchange rate, μ_3 the sensitivity of foreign debt to Public Sector Borrowing Requirements, and $\varepsilon_t^{B^f}$ an exogenous shocks to foreign debt.

Thus, by considering the definitions of domestic and foreign debt, public debt, b_t, is :

$$b_t = \kappa_1 b_{t-1}^d + \mu_1 b_{t-1}^f + (\mu_3 + \kappa_2) psbr_t + \mu_2 s_t + \varepsilon_t^{B^d} + \varepsilon_t^{B^f}. \tag{8}$$

The PSBR is the widest measure of the public deficit and embodies the primary deficit d_t, and the public sector financial cost FC_t defined below in (12), or also called debt service.

$$psbr_t = d_t + FC_t + \varepsilon_t^{PSBR}. \tag{9}$$

The primary deficit can be defined as the difference between primary public spending g_t and public revenue from tax collection τ_t given by (2) :

$$d_t = g_t - \tau_t, \tag{10}$$

[9] All exogenous shocks are assumed to follow a Normal law of mean zero. The variances are different for each shock, and are driven from Bayesian estimations.

[10] ???Note that Mexico has been a net oil-importer since 2014, for instance in 2019, Mexico has a deficit of 21 000 millions of dollars in oil (See the INEGI-Press Release 23/20 from January 2020).

where the primary public spending g_t depends on:

$$g_t = \psi_1 g_{t-1} - (1-\psi_1)\,\psi_2 psbr_t + \varepsilon_t^g, \tag{11}$$

where ε_t^g represents an exogenous shock to primary spending.

The fiscal rule aims to stabilize the PSBR at its equilibrium level. We assume the government seeks to smooth variations in public spending, since any adjustment becomes costly due to the regulations surrounding the Federation's Expenditure Budget. Thus, the government will gradually stabilize its accounts.

Furthermore, we assume that only a fraction of the spending is exercised productively g_t^p, where the productive public spending is defined as $g_t^p = \omega_1 g_t$. This productive spending is then reflected into the monetary block via the IS equation (14). The productive public spending is constituted by investment public spending, in opposition to consumption public spending. Following Chu et al. (2018), we assume that public spending is 90% productive, the last 10% of public spending being dedicated to public consumption.[11] Such a spending introduces the idea that there exists a positive feedback between the tax rate, the productive capacity of the economy and tax revenue, a concept pioneered by Baxter and King (1993), then further developed by Kamiguchi and Tamai (2011, 2012) among others.

An exogenous increase in tax revenues reduces the primary deficit, which allows reducing the PSBR. Higher public revenues yields a higher public spending, which stimulates economic activity, but ultimately translates into inflationary pressures. Meanwhile, a lower PSBR reduces the country risk, which appreciates the exchange rate.

In this model, the fiscal rule works through the primary spending (g_t). The fiscal rule aims to stabilize the PSBR at its equilibrium level. In turn, it is assumed that the government seeks to smooth changes in spending, as adjustments are costly, given the regulations surrounding the Federation's Expenditure Budget. Thus, the government will gradually stabilize its accounts.

The debt service, measured by public sector financing costs, FC_t depends on the primary deficit d_t, the domestic and foreign real interest rates respectively ($r_t = i_t - \pi_t$ and $r_t^{US} = i_t^{US} - \pi_t^{US}$),, and the risk premium (Υ_t) defined below in (13).

$$FC_t = \phi_1 FC_{t-1} + (1-\phi_1)\left(\phi_2 i_t - \phi_3 \pi_t + \phi_4 i_t^{US} - \phi_5 \pi_t^{US} + \phi_6 d_t + \phi_7 \Upsilon_t\right) + \varepsilon_t^{FC}. \tag{12}$$

The risk premium depends on its own lag (Υ_{t-1}), the public revenues issued from oil production and the level of the deficit ($psbr_t$).

$$\Upsilon_t = \xi_1 \Upsilon_{t-1} + \xi_2 \mathbb{E}\left(\Upsilon_{t+1}\right) + \xi_3 psbr_t + \varepsilon_t^{\Upsilon}. \tag{13}$$

As an index of risk premium, following the literature, we use the EMBI-G built by JP Morgan that is assumed to represent fiscal performance. Our approach entails caveats. Indeed, other factors can also explain EMBI-G spreads movements. For instance, Calvo (2003) shows that domestic factors could be irrelevant in explaining the EMBI-G spreads, since the main determinant of this spread is the foreign investors appetite for risk. Additionally, the evolution of EMBI-G is highly sensitive to political news. Moreover, the bonds that form the EMBI-G spread typically have long maturities that do not necessarily reflect the government's fiscal flow position. Consequently, EMBI-G spreads reflect not only the fiscal performance but also external

[11] The productive government spending constitutes the sum of expenditure on education, health, defense, housing, economic affairs and general public services expenditure, while non-productive expenditure consists of expenditure on public order and safety, recreation and social protection.

factors and political news. Therefore, the changes in the EMBI-G spreads cannot be viewed as being derived solely from fiscal fundamentals. Finally, EMBI-G spreads are weighted averages that are not based on a structural model (Aktas et al. 2010).

The fiscal block works as follows, given a negative oil price shock (for a positive oil price shock, we obtain a symmetric negative result). A decrease in oil revenues yields lower total revenues of the public sector, which increases the primary deficit and the PSBR. Lower revenues reduce public spending and, therefore, decrease economic activity, which translates into a deflationary trend. Simultaneously, the PSBR increase raises the country risk, which depreciates the exchange rate. To adjust for deflationary trend generated by a lower economic activity (despite the depreciation of the exchange rate), the interest rate decreases. Public spending increases little by little as the effect of this oil-price shock dissipate. Of course, this example is conditioned on the set-up of the monetary block, which we address in the following subsection 3.2.

One caveat of our approach in the fiscal block is to consider that oil-price shocks have symmetric effects whether they are positive or negative. However, in the literature, there is no consensus about the necessity of introducing asymmetric effects of oil-price shocks.

Another caveat is that an increase in tax will have, in the end, a positive effect on aggregate activity through a mechanical increase in public spending. This tax increase could also discourage workers from working more hours, or from paying their taxes and leave the formal sector, a key feature present in emerging economies, especially for LATAM.[12]

3.2 Monetary Block

The monetary block follows a DSGE-VAR structure (DelNegro and Schorfheide 2006) being based on the IS equation, Phillips curve, and the Uncovered Interest Rate Parity (UIP) condition.

The IS curve describes the output gap x_t:

$$x_t = \alpha_1 x_{t-1} + \alpha_2 \mathbb{E}_t(x_{t+1}) - \alpha_3 r_t + \alpha_4 s_t + \alpha_5 g_t^p - \alpha_6 \tau_t - \alpha_7 \Upsilon_t + \alpha_8 x_t^{US} + \varepsilon_t^x. \tag{14}$$

The output gap evolves according to its own lagged value x_{t-1} and forward-looking component x_{t+1}. It also depends on the real exchange rate s_t, the US output gap x_t^{US}, and fiscal block's variables such as primary spending that is productively used g_t^p, government revenue τ_t, and the risk premium Υ_t. Finally, demand shocks hit the economy under the form of an exogenous shock ε_t^x.

The variables g_t^p, τ_t and Υ_t connect the fiscal block to the monetary block. The parameters α_5 and α_6 measure the direct impact of fiscal policy on the activity, as such α_5 may be interpreted as the positive public spending effect on activity (Keynesian multiplier) whereas a too high α_6 could offset public spending's positive consequences for activity and would correspond to Ricardian equivalence. An increase in the risk premium Υ_t yields negative effects for activity.

The Phillips Curve describes the deviations of inflation from the central bank objective as:

$$\pi_t = \beta_1 \pi_{t-1} + (1 - \beta_1) \mathbb{E}_t (\pi_{t+1}) + \beta_2 x_{t-1} + \beta_3 s_t + \varepsilon_t^\pi. \tag{15}$$

Current inflation π_t is based on inflation backward looking components, due to the observation of inflation persistence as widely supported by literature (Cogley and Sbordone 2008, Furher 2010 among others). Current inflation is also strongly conditioned by inflation expectations, therefore the coefficient β_1 matches

[12] The labor market including formal and informal sectors is not here modeled but constitutes a possible extension for this fiscal block.

the degree to which the economy is backward looking. Furthermore we represent current inflation depending on past output gap since the output gap is observed with a lag of one quarter, as Gerlach and Smets (1999) and Walsh (2003) point out among others. Current inflation also moves according to the real exchange rate s_t, in the sense that a depreciation of domestic currency unambiguously leads to inflationary pressures, and the exogenous shock ε_t^{π} represents cost-push shocks to the domestic economy.

The real exchange rate evolution is described by the UIP condition:

$$s_t = (1-\gamma_1)\, s_{t-1} + \gamma_1 \mathbb{E}_t\left(s_{t+1}\right) - \gamma_2 r_t + \gamma_3 r_t^{US} + \gamma_4 \Upsilon_t + \varepsilon_t^s, \tag{16}$$

where real exchange rate s_t moves with its own lagged and forward-looking s_{t+1} value weighted by γ_1, the domestic and foreign real interest rates (r_t and r_t^{US}, respectively), the risk premium component Υ_t determined endogenously by equation (13), and an exogenous exchange-rate shock ε_t^s.

To close the monetary block, the central bank determines a Taylor Rule that defines the determinants of the policy interest rate i_t:

$$i_t = \rho_\pi i_{t-1} + \delta_1 \pi_t^g + \delta_2 x_t + \varepsilon_t^i, \tag{17}$$

where the inflation gap π_t^g is given by the expected inflation gap and the current level of inflation:

$$\pi_t^g = \rho_{\pi^g} \mathbb{E}_t\left(\pi_{t+1}^g\right) + \pi_t. \tag{18}$$

The inflation gap is defined by the difference between current inflation and the central bank objective. Here the central bank sets policy rate i_t according to the past value of the policy interest rate i_{t-1}, but also to domestic inflation gap π_t^g, output gap x_t, and to a monetary policy exogenous shock ε_t^i. Given that the monetary policy is conducted with a time lag, the Taylor rule entails a forward looking component of inflation.

The adjustment for higher inflation requires an increase in the monetary policy interest rate, while the deterioration in the public balance caused by a higher interest rate, measured by the PSBR in (9) and reflected in IS curve (14), stabilizes with a contraction of public spending.

We chose in this monetary block to introduce persistence in inflation, output-gap and the exchange rate through the introduction of a lag corresponding variables in (14)-(16) to better match observed data. This simple technique is widely used in the literature. An alternative more realistic manner to reproduce persistence in the model is to take into account private agents' expectations being slightly backward looking, by using survey data for instance (Milani 2009, Ormeño and Molnar 2015, Trehan 2015). This approach could be easily implemented for advanced economies, but not for emerging economies, because of the scarcity to this type of data.

4 Impulse Response Functions

Emerging market economies are more exposed to periods of global risk aversion given the importance of capital flows and commodities to either public finances or GDP, and financial stability. Given the constraints faced by emerging market economies (less counter-cyclical fiscal policies possibilities, existence of external debt...), the responses the fiscal and monetary institutions can implement are weaker, resulting in a relatively larger increase in their risks premiums. While the ability of economic policies to mitigate supply and demand shocks are well known, it is unclear what would be the best policy response in the face of different type of shocks hitting the Mexican economy.

This section illustrates the interaction between fiscal and monetary policy, taking account each block's specificity. Therefore, in the next subsection 4.1, for simplicity, we first present the model mechanisms for independent shocks occurring one at a time. The following subsection 4.2. discusses further possible extensions of the model to strengthen the analysis robustness.

4.1 Model mechanisms

For the fiscal block, corresponding to Figure 1, we choose to study the effects of a positive public spending shock, of a negative shock increasing risk premium, of a negative oil-price shock. Those shocks are defined as a temporary deviation from steady state.

For the monetary block, corresponding to Figure 2, we examine the effects of a depreciation shock of the real exchange rate and a monetary policy shock, increasing policy interest rate.

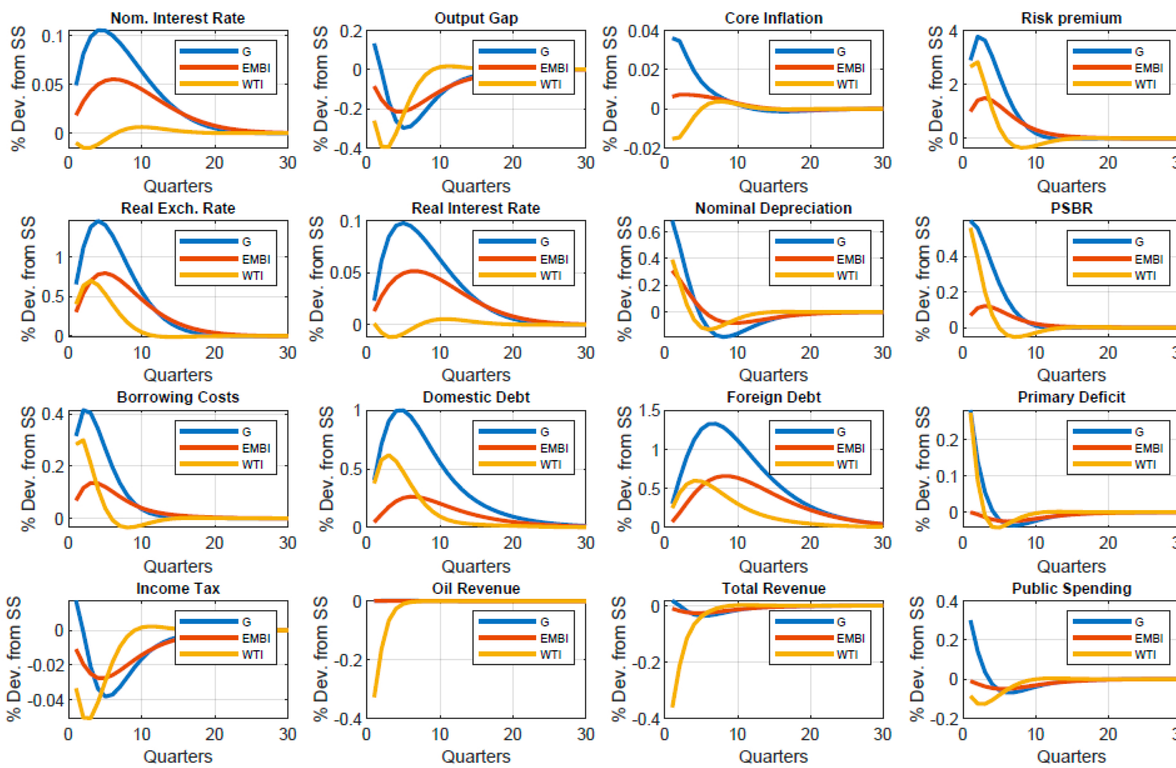

Figure 1: Public spending (G), risk premium (EMBI), and oil-price (WTI) shocks.

4.1.1 Public Spending

A positive public spending shock increases demand at the cost of worsening both the primary deficit and the PSBR. The higher level of debt-to-GDP ratio (from the expansion of primary deficit via public spending) increases country risk premium and, due to risk aversion, the nominal exchange rate depreciates. Inflationary pressures are driven by the depreciation of the nominal exchange rate and the increase in the output gap. Monetary authority increases short-term nominal interest rate in order to keep inflation expectations anchored and stabilize output gap. Even if the tax collection increases temporarily, the government faces higher borrowing cost. Thus, in order to stabilize debt, public spending should decrease inducing future primarily surpluses.

4.1.2 Risk Premium

A negative shock that increases risk premium translates into a negative demand and supply shock. On one hand, the spike in risk premium discourages private investment, which in turn, weakens economic activity. On the other hand, risk aversion induces a nominal exchange rate depreciation that increases inflation due to higher import goods prices. Public debt worsens due to an increase in the public borrowing costs from abroad, together with the nominal exchange rate depreciation and a lower tax collection. To achieve fiscal target, public spending should decrease so that primary surplus could be reached. Finally, the central bank increases short-term nominal interest rate to keep inflation expectations anchored.

4.1.3 Oil Price

As we mentioned above, given the role of PEMEX in Mexican public finances, we model an oil price shock so it the latter affects government budget constraint and thus, can be interpreted as a demand shock.

A decrease in oil prices affects the emerging market economy through different channels. The first transmission channel goes through the fiscal block, since oil-price shock diminishes revenues and therefore affects the risk premium. The depreciation of the exchange rate is a consequence of the increase in the risk. First, given that oil represents a wide share of commodities exports in emerging economies, the negative shock worsens terms of trade which, in turn, depreciate the real exchange rate. Second, it lowers oil revenues through oil tax collection. Therefore, primary deficit widens, increasing country risk premium. Fiscal policy reaction should be restrictive, contracting economic activity. Finally, inflation decreases, since the effect of lower public revenues, and a widen slack of aggregated demand, more than compensates the inflationary effect of the currency depreciation. Central bank reacts reducing short-term nominal interest rate to better keep inflation expectations anchored, and stabilizing output gap.

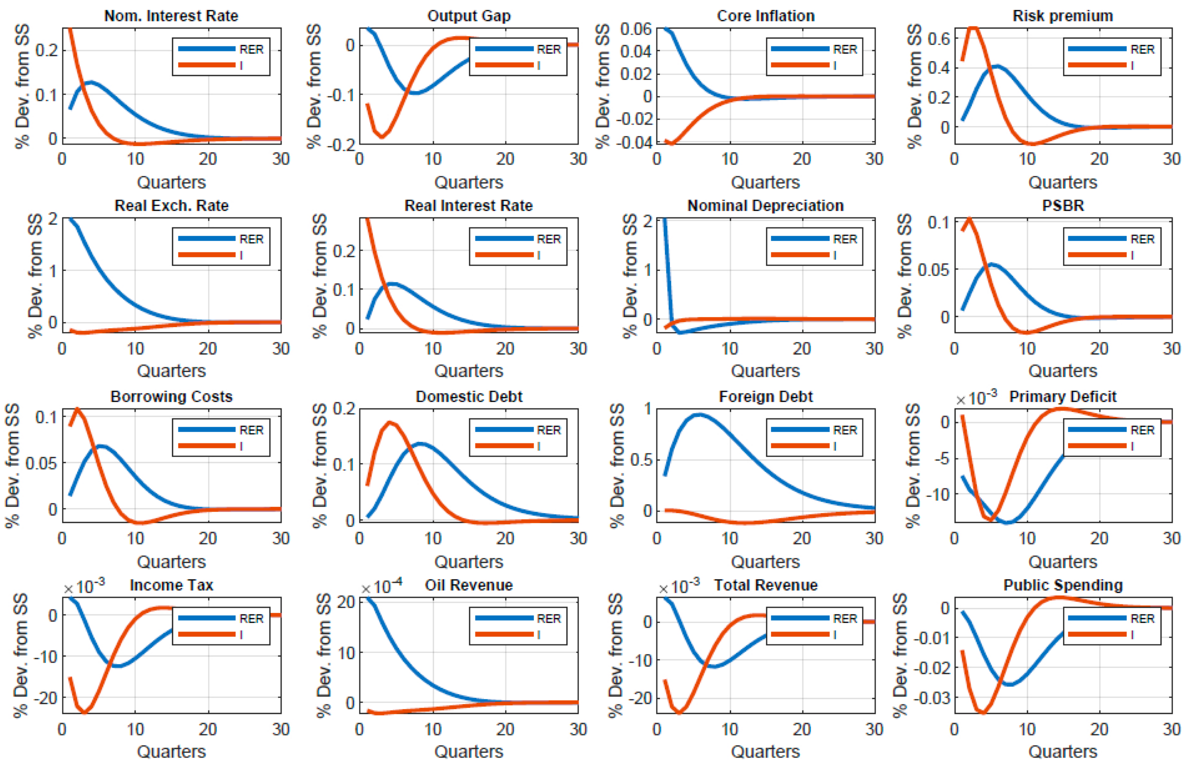

Figure 2: Real exchange rate depreciation (RER) and monetary policy (I) shocks

4.1.4 Real exchange rate depreciation

A real exchange rate depreciation stimulates aggregate demand due to an increase in net exports. Additionally, the shock requires a nominal exchange rate depreciation. The latter increases both inflation and inflation expectations. Monetary policy tightens to accommodate the shock. The latter increases PSBR. It is worth mentioning that even when nominal exchange rate depreciation increases oil tax collection, it also expands foreign currency issued obligations, therefore foreign public debt's service, and worsens overall PSBR and risk premium. Therefore, government spending decreases to achieve the fiscal target.

4.1.5 Monetary Policy Shock

An unexpected rise in the short-term nominal interest rate increases yield in domestic-currency-denominated assets, which in turn, through the uncovered interest rate parity appreciates the exchange rate. Therefore, tighter monetary conditions reduce both output gap and inflationary pressures. The latter reduces tax collection and increases borrowing costs which worsen public deficit, through higher PSBR, and increase risk premium. Fiscal authority decreases public spending inducing a reduction in the deficit to accommodate this shock. Note that, if the economy is in steady state, monetary policy shocks affect fiscal policy stance, suggesting the importance of coordinated policies.

4.2 Discussion

A plausible extension of this model would be to perform a Bayesian estimation for the Mexican economy, in order to confirm the mechanisms observed through the IRFs, and to increase the robustness of the model when identifying the transmission mechanisms.

Moreover, it would allow us to identify the exogenous shocks that are driving the business cycle. A further step to this analysis would be to assess the performance of different monetary and fiscal policies that both aim to accommodate those shocks. Indeed, in the literature, it is standard to choose a set of control variables to maximize a social welfare function and compare their performances. However, this analysis requires an explicit formulation of the objective function and the constraints that the social planner faces. While not all models have these characteristics such as the Real Business Cycle models (RBCs), it is possible to use a function that allows a similar policy evaluation. In this context, loss functions represent the simplest and most commonly used way to deal with target functions (Cecchetti, 2000). Such kind of functions usually contains the square of the differences between the actual and desired value of each target variable multiplied by an associated weight (Pearce, 1986). While the literature on which variables and weights are best for social welfare is broad and controversial, we aim at presenting an analysis in which we would consider deviations of the output gap and inflation, equally weighted, as a benchmark. This equal weight would allow us to equally compare both fiscal and monetary policies, by not putting a preference on stabilizing inflation (higher weight on central bank's preferences) nor on stabilizing output gap (higher weight on active government's preferences). Finally, we want to consider a scenario in which we calibrate public spending and monetary shocks so that they minimize the loss function. It may imply a stronger counter-cyclical coordination given the tradeoffs that each institution face. We would perform this analysis to observe what would be the optimal behavior of both institutions for each type of shock.

5 Conclusion

The model we presented in this article allows to analyze the effect of fiscal policy actions on different variables relevant to monetary policy, applied to Mexico taking into account the country's specificities. The results show the different channels where fiscal policy and monetary policy interact: the risk premium, the debt service, the exchange rate, the aggregate demand variation from public spending, level of public debt and inflation.

A direct application of the model is its ability to analyze the consequences of different adverse shocks to a small open emerging-market economy that is exporting commodities in terms of policy mix, when the central bank is independent.

Monetary policy actions have implications for public finances mainly through the channels of the debt service, the exchange rate, the negative relation between interest rate and aggregate demand, and the risk premium and inflation. We also find a classical result of Ricardian equivalence, where an increase in primary spending has only a temporary positive effect on economic activity, since the fiscal rule is binding, and fiscal policy then adjusts its spending yielding a drop in activity.

Further possible extension would be to perform forecasts and shock decomposition analysis.

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