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Good Luck or Good Policy? An Analysis of the Effects of Oil Revenue and Fiscal Policy Shocks: The Case of Ecuador

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Abstract

This paper proposes a framework to estimate the effects of exogenous fiscal policy and oil revenue shocks on the macroeconomic activity of price-taking oil producers. We apply the methodology to Ecuador, using a structural vector autoregressive model estimated with Bayesian methods. Specifically, we investigate the effectiveness of taxes, government consumption spending, government investment spending, and oil revenues on economic activity. The results show that expansive fiscal policy either through taxes or government investment has positive effects on output. However, contrary to most studies in the literature, consumption spending does not seem to have a significant effect. We also find that oil revenue shocks are a key transmission channel that significantly affects all the variables in the model, evidencing the vulnerability of the Ecuadorian economy to fluctuations of oil revenues. In particular, oil revenue shocks have been the most important driving force to move output above or below trend historically.

JEL classifications: C32, E32, E62, Q33, Q43
Keywords: Fiscal policy, Fiscal multipliers, Oil revenues, Structural VAR, Bayesian estimation

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1 Introduction

How does one evaluate the macroeconomic effects of fiscal policy in price-taking, oil-exporting countries once the effects of oil revenue fluctuations have been taken into account? In this paper, we obtain the effects of fiscal policy and oil revenue shocks using a structural vector autoregressive model estimated with Bayesian methods (BVAR from here on) and identified through sign restrictions. We apply the methodology to the case of Ecuador. This methodology can be implemented to evaluate the effects of fiscal policy in countries with oil-exporting features similar to Ecuador such as Brunei, Egypt, Kazakhstan, and Turkmenistan, among others.[1]

Since Ecuador dollarized its economy in 2000, fiscal policy became the main economic policy tool to stimulate aggregate demand as well as to counteract the effects of external shocks and natural disasters. This situation became more apparent when a new government focused on government spending came into power in 2007. In fact, government spending increased from an average 22 percent of gross domestic product (GDP) during the 2000-07 period to 38 percent during the 2008-18 period. Despite this important increase, we know very little about the effects of fiscal policy on the Ecuadorian economic activity. This paper attempts to fill this gap and provide evidence on the macroeconomic effects of fiscal policy in Ecuador after controlling for the effects of oil price shocks which, at the same time, can give insights to other countries in similar situations.

The research about the effects of fiscal policy on the macroeconomy for Ecuador has been based on alternative identification schemes and is not conclusive. For instance, Pacheco (2006) identifies fiscal policy shocks using vector autoregressions (VARs) and a Cholesky factorization. The main finding is that tax revenues and government spending do not have a significant effect on output. Carrillo (2015) proposes an eight-variable VAR that includes direct and indirect tax revenues and GDP and all its components; the identification is carried out with long-term restrictions following Blanchard and Quah (1989). The results show that government spending and direct tax revenues do not have a significant effect on economic activity. Even though indirect tax revenues have a negative effect on GDP, it is only significant during the first quarter.

The previously mentioned studies do not take into account the effects that oil revenue fluctuations could have on government spending and output. Guerrero and Trivino (2004) analyze how sensitive the Ecuadorian economy and its fiscal policy are when faced with changes in international oil prices. Using a structural vector autoregressive (SVAR) model, the authors find that an increase in oil prices lead to an increase in GDP and fiscal revenues. Gavilanes (2009) proposed a VAR to analyze the effects of an oil price shock on GDP, government spending, and inflation. The results indicate that an increase in oil prices causes an increase in inflation and government spending, but a decline in GDP.

However, the previous studies for Ecuador do not discriminate between tax and oil

[1] In the case of Ecuador, on average, oil exports accounted for 45 percent of total exports while oil revenues contributed 28 percent to the government's revenues during the 2000-18 period. As a result, the government budget and the economy in general have been particularly vulnerable to sudden positive or negative perturbations in oil prices.

revenues nor between government consumption and investment. In those regards, the present study contributes to the literature in three ways. First, we obtain the effects of fiscal policy (tax revenues and spending) and oil revenue shocks on output and then calculate their multipliers. This analysis will help clarify the extent of the effects of fiscal policy beyond the effects of oil price fluctuations. Second, we discriminate between consumption and capital spending, because the latter is most influenced by oil price shocks (see Sadeghi Emamgholi, 2017, for a panel VAR analysis that discriminates between consumption and capital spending and that includes Ecuador). Third, we perform policy simulations that include: (i) a deficit-financed tax cut, (ii) a deficit-financed investment spending expansion, (iii) an oil-financed investment spending expansion, (iv) an investment spending expansion financed with taxes, (v) a balanced-budget consumption spending expansion, and (vi) an oil revenue shock fully saved. All of these experiments obtain the implied trajectories of fiscal variables and output.

Pieschacón (2012) argues that the main empirical challenge to analyze the effects of oil price shocks on a particular economy is the fact that many of the oil exporters have market power and are able to influence the international price of oil. This is not the case for Ecuador because the country is a price taker in the international oil market. Hence, the identification of the oil revenue shock is straightforward and we take advantage of this situation.

Our findings suggest that a tax revenue shock that increases tax collections triggers a decline in output, while an increase in government consumption does not significantly affect output. Our results further suggest that government investment has a positive effect on economic activity that is larger than that of government consumption. However, a positive shock in oil revenues has the largest positive effect on output as well as a significant effect on all the fiscal variables, evidencing how vulnerable the Ecuadorian economy is to oil price fluctuations.

Regarding the policy simulations, out of the six previously described, the scenario that appears to be the best for stimulating the economy is oil-financed investment spending. This policy, in which capital spending is increased by increases in oil revenues, leads to significant increases in output as well as all of the fiscal variables. Similarly, we find that an oil shock that increases oil revenues, which are not spent on investment but are fully saved, increases output (because it includes the oil-producing sector) as well as tax revenues and government consumption. Additionally, estimates of the fiscal multipliers confirm our findings, indicating that fiscal policies through oil revenues deliver the highest effects on GDP. In particular, the discounted multipliers based on basic fiscal policy shocks indicate that the government investment multiplier leads to estimates lower than the estimates for government consumption, but the uncertainty around those multipliers is too high to reach a definite conclusion.

Finally, we perform a historical shock decomposition and find that oil revenue shocks have been the major driving force of GDP deviations from its trend, confirming that output growth (decline) dynamics have mostly been the result of good (bad) luck in the case of Ecuador.

The paper is organized as follows. Section 2 reviews the empirical literature on the effects of oil price and fiscal policy shocks. Section 3 presents a brief description of the evolution of the Ecuadorian fiscal variables as well as output. Section 4 details the specification and identification of the BVAR, including the data used. Section 5 studies the behavior of output and fiscal variables following fiscal and oil shocks. Section 6 presents policy analyses and possible implications for an oil-exporting economy such as Ecuador. Section 7 shows the robustness checks. Finally, Section 8 concludes.

2 Contacts with the Literature

This paper is at the intersection of two research fronts. On the one hand, it considers the analysis of oil price shocks and their effects on output. On the other hand, it analyzes the effects of fiscal policy, specifically of taxes and government spending components on output, using SVARs.

One of the pioneering studies about the transmission mechanism of an oil price shock for the U.S. economy is Hamilton (1983), who shows that oil price shocks significantly affect the growth rates of gross national product and the unemployment rate as well as being a contributing factor in at least some of the U.S. recessions before 1972. Subsequently after Hamilton's work, a series of papers further explored the effects of oil prices on the macroeconomy (see Burbidge and Harrison, 1984; Gisser and Goodwin, 1986, for example). Among those subsequent works, Mork (1989) and Hamilton (1996) argued about the possibility of asymmetric oil effects, while Hooker (1996) questioned the significance of the effects and the exogeneity assumption of oil prices on the macroeconomy. Additional focus to the exogeneity assumption of oil prices is given by Rotemberg and Woodford (1996), while Barsky and Kilian (2002) argue that oil prices can react to the monetary policy shocks of the U.S. economy. More recently, Kilian (2009), Baumeister and Hamilton (2019), and Caldara, Cavallo and Iacoviello (2019) have investigated the role of oil price supply and demand shocks on economic activity. The consensus of the results indicates that supply shocks tend to affect output, whereas demand shocks do not.

For oil-exporting countries, studies that consider the role of fiscal policy as a transmission mechanism of oil price shocks include Pieschacón (2012). She conducts an empirical analysis for Mexico and Norway and estimates the fiscal policy transmission mechanism of oil price shocks. The results indicate that in Mexico, an oil price shock generates significant increases in government purchases, private consumption, and output. For Norway, the results imply that an oil price shock does not significantly lead to increases in output or government purchases, despite generating significant increases in oil revenue. Unlike Mexico, Norway shields its economy from oil price fluctuations by transferring surpluses to a government fund that serves as protection against idiosyncratic shocks.

Other studies have considered the macroeconomic effects of oil prices in oil-exporting countries. These studies find that oil price shocks are the main cause of output fluctuations in countries that do not have saving funds or that have not implemented structural reforms to diversify their production away from oil, such as Saudi Arabia and Iran (see Mehrara and Oskoui, 2007). Oil prices also tend to affect the size of the government sector in oil-exporting countries (see Anshasy and Bradley, 2012). Sadeghi Emamgholi (2017) estimates a panel VAR for 28 oil-exporting countries and find that an unexpected increase in oil prices leads to an expansion in government expenditure, and that the expansion is larger, the larger the government. On the contrary, Iwayemi and Fowowe (2011) find little evidence of a short-run effect of oil price shocks on the macroeconomic variables of Algeria, Egypt, Libya, and Nigeria.

Regarding fiscal policy, the analysis of its effects on economic activity is largely done with SVAR models. The identification of fiscal policy shocks has been done mostly following four approaches. The first is called the narrative approach as in Ramey and Shapiro (1998) and Romer and Romer (2010). The second is the sign restrictions approach, as in Mountford and Uhlig (2009) and Arias, Rubio-Ramírez and Waggoner (2018); this is the method we use in this paper. The third approach uses Cholesky decompositions of the variance-covariance matrix of the innovations, as in Fatas and Mihov (2001). The fourth identification approach is proposed by Blanchard and Perotti (2002) and uses external fiscal policy instruments.

The literature has emphasized distinguishing among the government spending components to estimate fiscal multipliers because each fiscal instrument can have different impacts on output (see Hemming, Kell and Mahfouz, 2002, for instance). The disaggregation of government spending occurs at the levels of government investment, consumption, and wages. Examples of these studies include Perotti (2004), who, for a set of countries including Australia, Canada, West Germany, the United Kingdom, and the United States, finds that there is no evidence that government investment shocks are more effective than government consumption shocks in boosting GDP, both in the short and the long run, and that there is no evidence that government investment "pays for itself" in the long run. Other similar studies include Giordano et al. (2007), who discriminate between the effects of government consumption in goods and services and government wages on the Italian GDP, and Tenhofen, Wolff and Heppke-Falk (2010), who investigate the effects of government consumption, investment, and personnel expenditures on the German GDP.

Overall, most empirical studies find that the effect of government investment on economic growth is positive (see Romp and de Haan, 2007). In addition to its long-term effects on growth, government investment is also an attractive tool because of its usefulness as a countercyclical tool in the short term. For example, Baxter and King (1993), through a general equilibrium model, find that, under certain conditions, an increase in government investment has positive effects on output in the short and long term. Similarly, Glomm and Ravikumar (1997) highlight the positive effects of government investment in infrastructure and education and its effects on long-term economic growth. However, Romp and de Haan (2007) caution that the effects of public investment on economic growth depend on the degree to which public and private investment are substitutes. Furceri and Li (2017) show that for a large sample of developing economies there exists a larger multiplier for public investment than for public consumption, which is in line with the results reported in Carrière-Swallow, David and Leigh (2018) for Latin American countries. In particular, their results suggest that for the case of Ecuador, output seems to be the most sensible in the Latin American region to a fiscal consolidation that leads to lower public investment, suggesting a larger multiplier of public investment than that of consumption.

3 Brief Description of the Economy of a Dollarized Oil-exporting Country: Ecuador

This section concisely describes the features of an oil-exporting economy which adopted dollarization and which will be the exploration case of this paper: Ecuador. The narrative provided will allow us to frame the discussion of how fiscal policy interacts with oil revenues and their impact on real GDP.

Ecuador starts to explore and extract oil in the late 1920s in a particular region of its coast. The first oil export occurs in 1928 under a private company. Between 1928 and 1959, oil exports are marginal and only reach 6 percent of GDP. During the 1960s, a number of private companies were granted the rights to explore and exploit oil in the rain forest, located in the eastern part of the country. The first profitable oil well is discovered in 1967.[2]

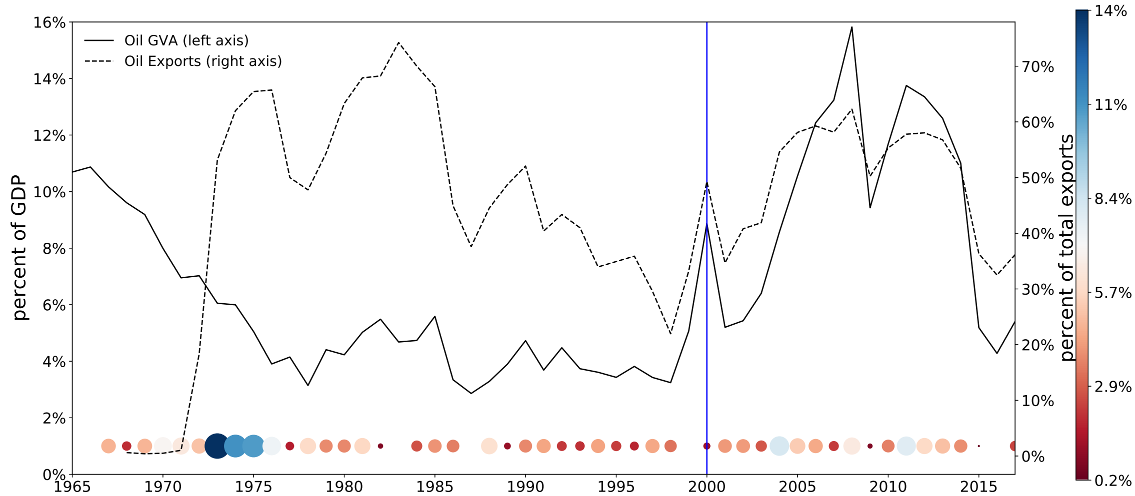
In 1971, the government of Ecuador claims rights over the oil wealth of the country and proclaims it an inalienable and imprescriptible heritage of the Ecuadorian people. At the end of 1972, Ecuador starts extracting and exporting oil at a greater scale. This activity continues for about four decades under various contract figures with private companies, including private-public partnerships, provision of services, and participation (see Ortiz and Cueva, 2013). These contract figures determined the way in which the government, which also had its own oil wells managed by a public company, received the fiscal oil revenues.

Until late 2003, oil exports mixed heavy crude ($< 20°$ API) with light crude ($> 28°$ API), yielding a mix of about 25° API. At the end of 2003, a newly built pipeline began transporting only heavy crude oil (between 18° API and 24° API), which implied an increase in oil revenues and, subsequently, in the oil exporting capacity of Ecuador (see López et al., 2003).

From 1993 to 2010, the majority of private oil companies had private-public partnerships with the Ecuadorian government. These contracts did not include a readjustment clause for the government participation of revenues in case the oil price increased significantly. Starting in 2005, with oil prices increasing, the government unilaterally modified its participation on the extraordinary revenues. Later, in 2010, the contracts with private companies were modified to be of provision of services. Under these contracts, the Ecuadorian government owns 100 percent of the oil revenues, after compensating the private companies for their production costs and a previously agreed profit margin (see Ortiz and Cueva, 2013). Finally, in 2018, the Ecuadorian government returned to the old contract modality of private-public partnerships in order to attract more investment in the sector.

[2] See "La historia de Ecuador contada a través del petróleo." *El Comercio*, June 27, 2012. http://www.elcomercio.com/actualidad/negocios/historia-de-ecuador-contada-a.html.

Figure 1: Oil Gross Value Added, Oil Exports, and Real GDP Growth



Note: GVA denotes gross value added. The blue line indicates the period from which the economy is dollarized. The balloons indicate the magnitude of annual growth rate of real GDP and the heat bar to the right shows the strength of real GDP growth. Years in which there was a contraction of real GDP do not have a balloon. These years and their growth rates (in parentheses) are: 1966 (-0.3%), 1983 (-0.3%), 1987 (-0.2%), 1999 (-5%), and 2016 (-1.2%).

Figure 1 illustrates the evolution of the value added of the oil-producing sector of the economy from 1965 to 2018 and the contribution of oil exports to total exports from 1968 to 2018. Despite oil exports increasing from a very low contribution in 1969 to above 50 percent of total exports in 1973, participation of the oil sector in GDP declined from about 8 percent to 6 percent. Mechanically, one can explain such a feature by noticing that, even though oil production increases significantly after 1972, production became notably cheaper, hence reducing the nominal participation in GDP. The same is not true for oil exports, which are valued at market prices. Nevertheless, once production prices stabilize, the contribution of the oil value-added sector fluctuates around 4 percent between 1975 and 1998.

The contribution of oil exports to total exports remained around 60 percent between 1973 and 1985, before coming down to about 45 percent in 1986 when oil prices dropped. After that and until 1998, the contribution exhibits a downward trend and averages about 40 percent.

After experiencing the most damaging financial crisis between 1998 and 1999, along with the collapse of oil prices and one of the strongest El Niño phenomenon, which implied both fiscal and balance of payment crises, the Ecuadorian government adopted the U.S. dollar as its currency in 2000 and became an officially dollarized economy. The contribution of oil value added to GDP and of oil exports to total exports between 2000 and 2002 averaged about 7 percent and 40 percent, respectively.

Between 2003 and 2007, once the new pipeline started transporting heavy crude oil and with oil prices increasing slowly over time, oil exports trended upwards averaging above 50 percent of total exports while the oil sector, also trending upwards, averaged 10 percent of GDP.

The boom in oil prices that followed, including the 2008-09 collapse, implied that oil exports averaged about 60 percent of total exports until 2013, while the contribution of the oil sector to GDP reached about 15 percent. The collapse in oil prices that started in 2014 has meant a decline in both contributions, with oil exports bottoming out just above 30 percent of total exports in 2016 while the oil value-added sector reached 4 percent of GDP. The rebound in oil prices after 2016 has brought these two indicators up recently, but to levels lower than the averages of the previous 10 years.

The figure also shows the growth rates of real GDP per year in the balloons. The years following the beginning of the oil-exporting era show an important acceleration in real GDP. Between 1973 and 1975 the economy grows at an average rate of about 12 percent per year. Real GDP decelerates after that, growing at an average rate of about 5 percent until 1981. The first negative growth rate during the oil-exporting era occurs in 1982, which is the beginning of the so-called "lost decade" due to the debt crises that affected countries in Latin America (see Sims and Romero, 2014). In 1987, an earthquake destroyed the oil pipeline and left the country without oil revenues for about six months. This natural disaster implied that the economy experienced a small decline that year. Between 1988 and 1998 the economy expanded at an average annual growth rate of 3 percent. As mentioned before, the macroeconomic and financial market developments at the end of the 1990s hit the economy hard and real GDP contracted by about 5 percent in 1999. During the 2000s, Ecuador experienced growth rates ranging from ½ percent in 2009 (after the collapse of oil prices in 2008 and the runoff of international reserves used as a buffer) to above 8 percent in 2004 (mostly driven by an expansion in the oil-producing sector of the economy due to the beginning of the new pipeline for heavy crude.) Between 2010 and 2015, the average growth rate of real GDP was about 4 percent, until the economy contracted in 2016 with subsequent growth rates well below the average of the previous decade.

We notice the correlation between the trajectories of oil prices (reflected in oil export participation) and the evolution of real GDP, especially when there are large swings in oil prices like in 1974 (positive), 1986 (negative), 1998 (negative) 2009 (negative), 2011 (positive), and 2016 (negative).

Regarding fiscal variables, Figure 2 shows fiscal oil and tax revenues as a proportion of GDP.[3] On average, oil revenues amount to 9 percent of GDP over the period of 1983 to 2018. However, they have shown significant variation over the years. For example, they represented almost 14 percent of GDP in 1985, before prices dropped the following year, and about 4 percent of GDP in 1998 when oil prices dropped to historical lows. Oil revenues grew briskly between 2003 and 2008, reaching above 14 percent of GDP and then declined before recovering to a level above 16 percent of GDP in 2011. After that, oil revenues trended downwards to around 5 percent of GDP in 2016 with a slight rebound

[3]In this case, the longest data horizon provided by the Central Bank of Ecuador starts in 1983.

Figure 2: Oil and Tax Revenues

Note: The blue line indicates the period from which the economy is dollarized.

recently.

Tax revenues as a share of GDP, as opposed to oil revenues, have shown an almost constant upward trend. This behavior is specially true after dollarization in 2000. Until that year, tax revenues averaged 10 percent of GDP; starting in 2001, they grew, ending at about 14 percent in 2018, after a decline of about 2 percentage points between 2015 and 2017. The increase in tax revenues could be the result of multiple factors, including a more efficient tax administration, reductions in tax evasion, tax code reforms that increased tax rates with the aim of a better redistribution of income, and tax policies oriented to the development of the national industry (see Paz y Miño, 2015).

Figure 3 shows the evolution of government consumption and investment spending as shares of GDP between 1983 and 2018. In general, both government consumption and investment shares show similar patterns before 2000. After reaching a peak between 1986 and 1987—16 percent of GDP for consumption and 9 percent for investment spending—both categories decline through 2000 reaching 6 percent and above 4 percent of GDP, respectively, with government investment spending reducing its participation on GDP well into 2006 to bottom out just above 4 percent.

In 2007, the newly elected government gives significant priority to government spending in order to reach the goals of the National Plan for Good Living (see SENPLADES, 2009). Government investment increases briskly in 2007 and 2008 and reaches a maximum above 15 percent of GDP in 2013; it declines thereafter, coinciding with the drop in oil prices, to a level close to half the peak reached 5 years before. Government consumption also increases, but less dramatically, going from 10 percent of GDP in 2007 to 16 percent in

Figure 3: Government Spending

Note: The blue line indicates the period from which the economy is dollarized.

2018. Importantly, government consumption has not been adjusted significantly after the decline in oil prices that have occurred since 2014.

4 Data and Methodology

This section describes the variables used to estimate the vector autoregressive model to evaluate the effects of fiscal policy, including oil revenues, on economic activity. It also describes the econometric model used to estimate these effects.

4.1 Data

This paper considers revenues (oil and tax) and spending (consumption and investment) of the general government, including local governments and public companies. The frequency is quarterly and covers the first quarter of 2004 to the third quarter of 2019. The information is obtained from the Central Bank of Ecuador. Appendix A details how we construct the variables.

As mentioned before, the Ecuadorian economy was dollarized in 2000. To keep tractability of the data, we focus on the post-dollarization period. Additionally, we start in the year 2004 to avoid using data contaminated by the effect of the inflation rate, which was unstable before that period due to the change of the monetary regime.

Oil revenues are received by the general government as part of the production and exports of its oil company (EP-PETROECUADOR) and as royalties through the different contracts with private oil companies.[4] There are at least two reasons to use oil revenues instead of the oil price. The first is that oil revenues allow an easier interpretation of the policy scenarios, in particular, the computation of fiscal multipliers and counterfactuals about government financing options. The second is that oil revenues reflect changes that have occurred in oil production, such as the implementation of the new pipeline, and with contracts between private companies and the government, both of which could have effects on the fiscal variables and on economic activity.

We use net tax revenues as the other fiscal revenue variable. They are defined as tax revenues minus transfers (including social security). Consumption spending is defined as the expenses in government wages and purchases of goods and services. Investment spending, in turn, is the expense in gross capital formation of the central government plus transfers to the rest of the government entities for investment purposes.

All the variables are transformed to real per capita terms. Population statistics are obtained from the National Institute of Statistics and Censuses (INEC). The GDP deflator is used to express all the variables in real terms. We removed seasonality using the U.S. Census Bureau's X-13 method.

4.2 Identification of Fiscal and Oil Revenue Shocks Through a Structural BVAR

The VAR model includes five variables (all in logs): (i) GDP per capita, y_t, (ii) government consumption per capita, g_t, (iii) government investment per capita, k_t, (iv) net tax revenues per capita, τ_t, and (v) oil revenues per capita, o_t.

Let $\mathbf{y}_t$ be the vector that includes the variables mentioned above, $\mathbf{u}_t$ be the vector of the reduced-form VAR residuals, and $\mathbf{A}(\mathbf{L})$ be a lag polynomial. The model in reduced form is defined by the following dynamic equation:

$$\mathbf{y}_t = \mathbf{A}(\mathbf{L})\mathbf{y}_{t-1} + \mathbf{u}_t, \tag{1}$$

with $\mathbf{u}_t \sim$ i.i.d.$\boldsymbol{N}(\mathbf{0}, \mathbf{\Sigma})$. The model in equation (1) also includes a constant and a linear time trend in each of the equations. A key assumption of the model is that oil revenues are strictly exogenous. This assumption is justified because Ecuador is a price-taker country in the world oil market.[5] Hence, we express the model in equation (1) as the following system of equations:

[4]Ecuador does not have the capacity to refine oil to fulfill its domestic demand and has to import refined oil products. Of the domestic consumption, 13 percent was imported in 2000. In 2015, 45 percent of the domestic consumption was imported. The information on oil revenues we use is net of the cost of refined oil imports.

[5]Even though the Ecuadorian oil production has increased from 143.8 million barrels in 2002 to 198.2 million barrels in 2015, which exhibits a trend, the short-run fluctuations in oil revenues are driven by variations in the oil price. Given the quarterly frequency of the data that reflects short-run variations and the exogeneity of the oil price, we assume that oil revenues are exogenous.

$$\mathbf{x}_t = \mathbf{C}(\mathbf{L})o_{t-1} + \mathbf{D}(\mathbf{L})\mathbf{x}_{t-1} + \mathbf{v}_t \quad (2)$$
$$o_t = B(L)o_{t-1} + u_t^o, \quad (3)$$

where $\mathbf{x}_t \equiv [\tau_t, k_t, g_t, y_t]'$ and $\mathbf{v}_t \equiv [u_t^\tau, u_t^k, u_t^g, u_t^y]'$. Notice that in equation (3), oil revenues depend only on lags of itself and not on lags of the other variables of the system, by the exogeneity assumption mentioned before. In our empirical analysis, we use a VAR with two lags.

The reduced-form VAR residuals, $\mathbf{u}_t$, do not have an economic interpretation because they are linear combinations of the structural shocks, $\boldsymbol{\varepsilon}_t$, as follows:

$$\mathbf{u}_t = \mathbf{A}_0\boldsymbol{\varepsilon}_t, \quad (4)$$

where $\mathbf{A}_0$ is the matrix that contains the contemporaneous structural parameters. In order to estimate the fiscal policy shocks, ε_t, we use the sign and zero restrictions scheme developed by Arias, Rubio-Ramírez and Waggoner (2018), which makes it possible to set restrictions on the impulse-response functions of a VAR model.

Using this identification scheme, we aim to identify the following four structural fiscal policy shocks: (i) a public investment shock, (ii) a public consumption shock, (iii) a tax shock, and (iv) an oil revenue shock. The impact sign and zero restrictions for the four shocks are summarized in Table 1.

Table 1: Sign and Zero Restrictions on Impact

	Shocks				
	Business cycle	Tax revenue	Public investment	Public consumption	Oil revenue
GDP	+				
Net tax revenues	+	+			
Investment spending	0	0	+		
Consumption spending	0			+	
Oil revenues	0	0	0	0	+

Note: This table shows the sign restrictions on the impulse responses for each identified shock. A "+" means that the impulse response of the variable in question is restricted to be positive on impact. A "0" indicates that the variable does not react contemporaneously to the shock. A blank entry indicates that no restrictions have been imposed.

Notice that although imposing restrictions on responses to the business cycle shock is useful for identification, it is not the aim of this paper to recover business cycle shocks and their effects. Under the identification assumptions in Table 1, a positive business cycle shock increases tax revenues but does not increase government spending, following Mountford and Uhlig (2009). Additionally, we assume that a tax revenue shock does not affect investment spending contemporaneously, but with lags. This assumption has to do with the fact that, in the case of Ecuador, consumption spending is supposed to be fully financed with tax revenues, according to Ecuadorian legislation, whereas investment spending can be financed with a combination of tax and oil revenues in addition to public debt issuance. Therefore, we assume that investment spending jumps only if there are increases in any of the latter two sources. Finally, oil revenues are not affected by the business cycle or fiscal variables because of our exogeneity assumption.

We introduce parameter uncertainty through Bayesian estimation techniques. We assume an independent Normal-Wishart prior distribution over the reduced-form model in equation (1). The identification of structural fiscal policy shocks in Arias, Rubio-Ramírez and Waggoner (2018) implies using the Choleski factorisation on the variance-covariance matrix of the reduced-form residuals, $\mathbf{\Sigma} = \mathbf{PP}'$, to obtain the $\mathbf{P}$ matrix and to draw a random matrix $\mathbf{Q}$ that satisfies the sign and zero restrictions from the uniform distribution over $\mathcal{O}(n)$, which is the set of all $n \times n$ orthonormal matrices. Once $\mathbf{P}$ and $\mathbf{Q}$ are obtained, the matrix of structural parameters is recovered such that $\mathbf{A}_0 = \mathbf{PQ}$, and the impulse-response functions are estimated in a standard way. If the sign restrictions hold, the impulse-response function is stored and if not, it is discarded. The procedure is repeated for each draw from the posterior distribution of the reduced form parameters. We estimate our model using standard Bayesian Markov Chain Monte Carlo (MCMC) methods provided by the Bayesian Estimation, Analysis, and Regression (BEAR) toolbox developed by Dieppe, van Roye and Legrand (2016).

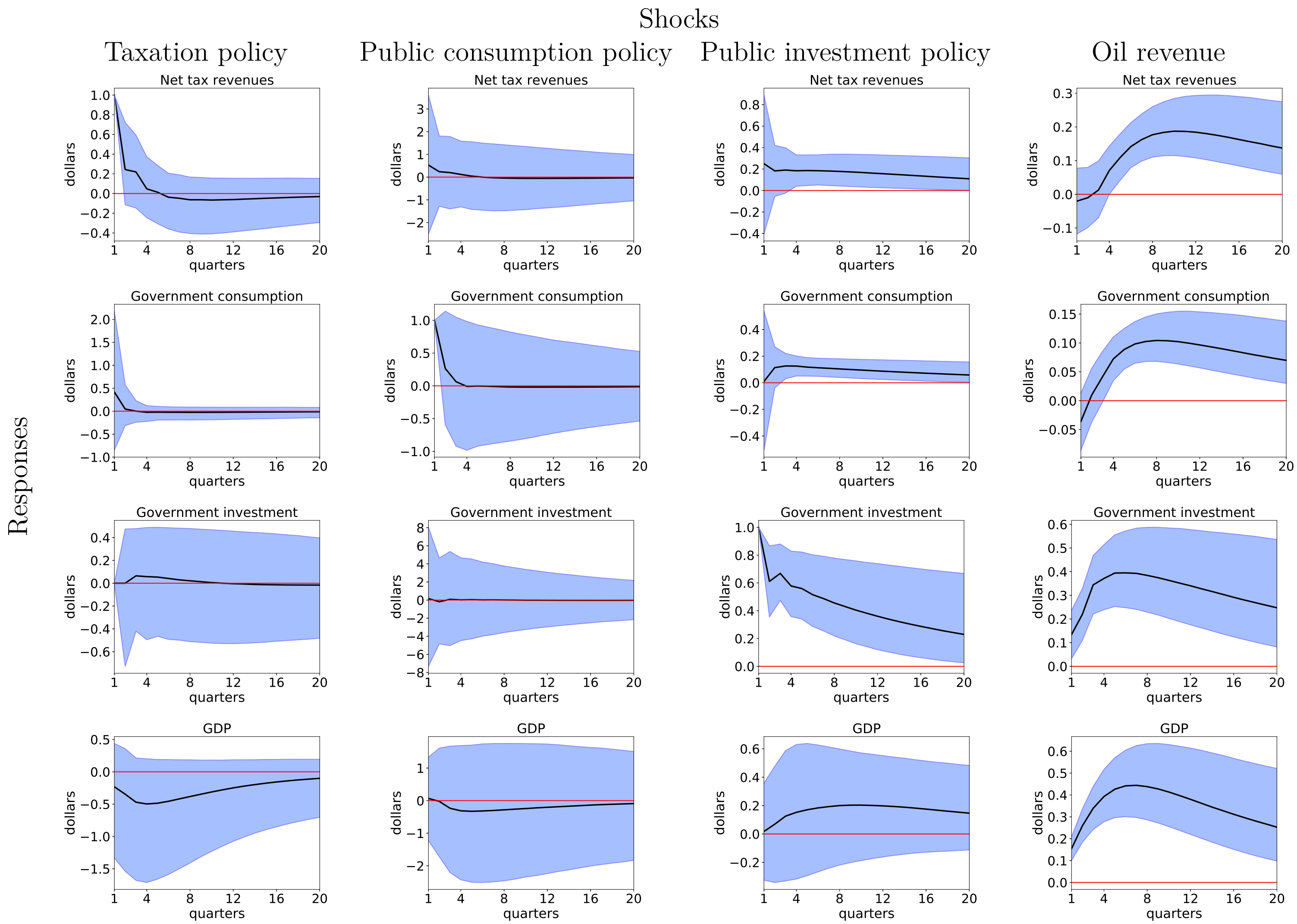
5 The Dynamic Effects of Fiscal Policy and Oil Revenue Shocks

In this section, we investigate the effects of the different components of fiscal policy and oil revenues on output. Figure 4 presents the responses of GDP and the fiscal variables to the three fiscal shocks in addition to that of oil revenues identified as indicated in Section 4. The impulse-response functions are transformations of the original impulse responses so that they represent the effect in dollars to a one-dollar shock in the fiscal variables and net oil revenues.[6] The impulse-response functions correspond to the median of the posterior distribution, while the credible bands correspond to 16th and 84th percentiles of such distribution.[7]

[6]To convert percent changes into dollar changes, we divide the original impulse-response function by the average ratio between the impulse and the response variables, as in Blanchard and Perotti (2002). When the response variable is GDP and the shocked variable is a fiscal one, the impulse-response functions are called fiscal multipliers.

[7]Sims and Zha (1999) point out that bands corresponding to 50 percent or 68 percent probability are often more useful than 95 percent or 99 percent because they provide a more precise estimate of the true coverage probability.

Figure 4: Response of Fiscal Variables and GDP to Fiscal and Oil Revenue Shocks



Note: Blue shaded areas correspond to 68% credible sets. Black lines are the median response

5.1 The Effects of Taxation Policy Shocks

The first column of the plots in Figure 4 shows the responses to a tax revenue shock. The response of net tax revenues shows little persistence and almost all of the initial shock disappears after two quarters, as could be expected from an increase in one of the tax rates. Higher tax revenues encourage government consumption, which increases for the first two quarters, but only to half the size of the tax shock. The effect on government investment is negligible, in part because our identification assumption is that the response is null on impact. The GDP response to the tax shock points to a negative effect that reaches its largest magnitude after four quarters at half the size of the tax shock. In general, however, the distribution of impulse-responses to the tax shock do not rule out zero, indicating the high degree of uncertainty of the model with respect to the effect of taxes.

5.2 The Effects of Public Consumption Policy Shocks

Next, in the second column of Figure 4, we assess how changes in government consumption policy affect different fiscal variables as well as output. Government consumption policy shocks do not seem to be too persistent and do not seem to significantly affect government investment. However, net tax revenues increase by about half the magnitude of the government consumption policy shock. This could be an indication that not only tax revenues cause government consumption, but that the latter can also influence the former, a feature we mentioned before by which government consumption has to be financed by tax revenues in the Ecuadorian case.

Regarding output, we find a weak negative response to the government consumption policy shock. This effect is surprising, as we expected output to be positively affected after an increase in government consumption. However, this weak response is in line with the empirical predictions by Ilzetzki and Végh (2008), who find a negative output response on impact for developing countries. Similarly, studies in advanced economies such as Spain (see De Castro and Hernández de Cos, 2008) find that current government spending (consumption and wage bill) shocks have negative effects on GDP. The authors argue that public wage and consumption increases may exert upward pressure on the equilibrium wage, leading to lower profits and investment which, in turn, exert a negative effect on economic activity. These papers and our results contrast with many findings of the literature, especially for advanced economies, that report that government consumption and compensation are highly effective ways of boosting private consumption and output (see Fatas and Mihov, 2001, for example). However, we must point out that the uncertainty surrounding the response of output is significantly large.

5.3 The Effects of Public Investment Policy Shocks

As opposed to consumption, the effect of a government investment policy shock is strong and persistent, as can be seen in the third column of Figure 4. Government consumption and net tax revenues react positively to a government investment policy shock.

The response of government consumption peaks in the third quarter and has credible intervals away from zero; it remains below 15 cents throughout. The tax revenue response reaches its maximum of 25 cents on impact and declines slowly, with a credible interval that does not include zero.

Real GDP responds with a hump-shaped pattern. It increases on impact by around 3 cents and then further to reach a peak of 19 cents at the end of the second year; it slowly returns to trend by the beginning of the third year. This finding suggests that government investment policy shocks generate resources that lead to higher private consumption and investment, at least in the short run.

5.4 The Effects of Oil Revenue Shocks

An oil revenue shock has a positive and long-lived effect on fiscal variables as well as output, as the last column of Figure 4 shows. Government investment increases through the fifth quarter, reaching a peak of 40 cents. From then on, it declines steadily back to trend, although the credible interval remains positive over the entire horizon. The response of government consumption is smaller than that of government investment and reaches a maximum of about 10 cents in the seventh quarter. The response of net tax revenues has a similar shape to that of government consumption, but with a slightly higher magnitude. In particular, there are no significant effects on net tax revenues for the first three quarters; tax revenues expand significantly after the first year and reach a ceiling of 17 cents at the end of the second year. Finally, the response of GDP to an oil revenue shock is also significantly positive. On impact, output increases by 16 cents and then goes up to reach a peak of 44 cents in the sixth quarter. The effect of oil revenue shocks on GDP is highly persistent over the entire horizon.

All told, oil revenue shocks have a significant effect on all the variables. These results evidence the vulnerability of the Ecuadorian economy to fluctuations in oil revenues (mostly driven by oil prices). However, this does not have to be the case; Pieschacón (2012) shows that for a small oil-exporting country in which fiscal policy is an important transmission mechanism of oil price shocks, fiscal rules could play an important role in the degree of exposure to unexpected oil shocks. An informative example is Norway, which shields its economy from oil price fluctuations by transferring the totality of its oil revenues to a sovereign wealth fund, and only the expected real return on the fund is used for expenditure purposes.

6 Policy Simulations

We use the fiscal policy shocks identified in in Section 5 to analyze the effects of different fiscal policies. Following Mountford and Uhlig (2009), we describe a fiscal policy scenario as sequences of different linear combinations of the basic fiscal policy shocks, since each of them represents only one fiscal shock at a time without constraining the response of the other fiscal variables.

We focus on six policy scenarios: (i) a deficit-financed tax cut, (ii) a deficit-financed investment spending expansion, (iii) an oil revenue-financed investment spending expansion, (iv) a balanced-budget investment spending expansion, (v) a balanced-budget consumption spending expansion, and (vi) a pure oil shock. We present the results of the policy scenarios for the response of the fiscal variables and GDP.

In what follows, we denote as $\theta_{ij,(t)}$ the dollar response at horizon t of variable $i = \tau, k, g, o$ to a shock in variable $j = \tau, k, g, o$ (where τ, k, g, o stand for net tax revenues, capital spending, consumption spending, and oil revenues, respectively) that we obtained in Section 5.

6.1 A Deficit-Financed Tax Cut

This scenario is designed as a sequence of basic fiscal shocks such that net tax revenues fall by 1 dollar and government spending (consumption and investment) remains unchanged for four quarters following the initial shock.

Formally, we solve the following system of equations for λ_s^τ, λ_s^k and λ_s^g, which are the weights of the three basic fiscal shocks (net tax revenue, government investment, and consumption, respectively), in period s, given the original responses, $\theta_{ij,(t)}$:

$$\begin{aligned} -1 &= \sum_{s=0}^{t}(\theta_{\tau\tau,(t-s)}\lambda_s^\tau + \theta_{\tau k,(t-s)}\lambda_s^k + \theta_{\tau g,(t-s)}\lambda_s^g), && \text{for } t = 0, \dots T, \\ 0 &= \sum_{s=0}^{t}(\theta_{k\tau,(t-s)}\lambda_s^\tau + \theta_{kk,(t-s)}\lambda_s^k + \theta_{kg,(t-s)}\lambda_s^g), && \text{for } t = 0, \dots T, \\ 0 &= \sum_{s=0}^{t}(\theta_{g\tau,(t-s)}\lambda_s^\tau + \theta_{gk,(t-s)}\lambda_s^k + \theta_{gg,(t-s)}\lambda_s^g), && \text{for } t = 0, \dots T, \end{aligned} \tag{5}$$

where $T = 3$.

The results appear in Figure 5. Under this scenario, the responses of government investment and consumption are negligible at all horizons. However, the tax cut stimulates GDP, reaching a peak of 1.52 dollars in the fifth quarter. This result indicates that lowering taxes and financing the deficit with debt can be effective to stimulate the economy in the short run. In those regards, our findings are similar to those of Mountford and Uhlig (2009) for the same policy simulation.

6.2 A Deficit-Financed Investment Spending Expansion

In the following two scenarios, we examine the response of output and the rest of the fiscal variables when investment is increased. In the first case, covered in this section, we assume that investment increases by 1 dollar and net tax revenues remain constant for four periods, so that the increase is financed with public debt. The system of equations we solve in this case is the same as the system of equations (5), except that the first equation has a zero on the left hand side and the second equation has a one. The results appear in Figure 6.

Figure 5: A Deficit-Financed tax cut

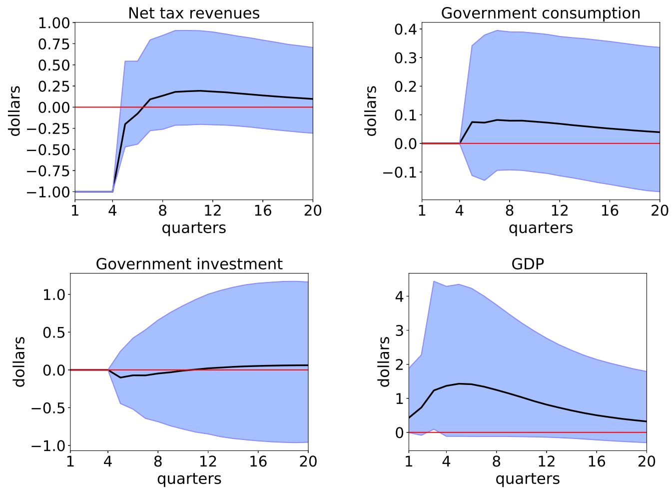
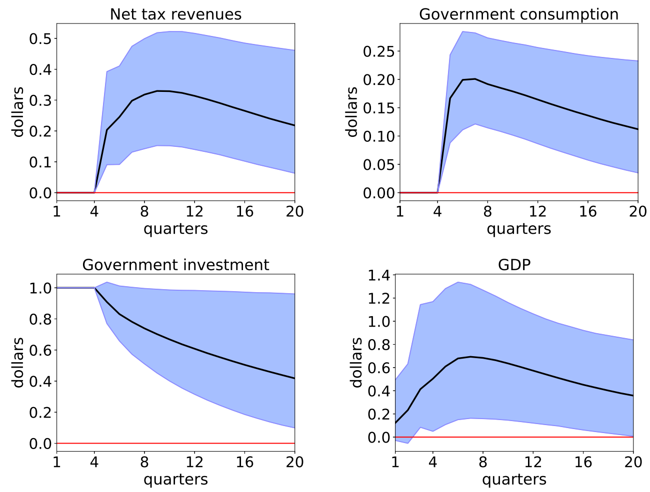


Figure 6: Deficit-Financed Investment Spending Expansion



When the government commits to finance government investment with debt for four quarters, GDP increases significantly, but it does so less than when there is a tax cut. This result indicates that government investment could be an adequate tool to promote economic activity in times of low aggregate demand.

6.3 An Oil-Financed Investment Spending Expansion

Sachs and Warner (1995) and Vandycke (2013) highlight the role of oil resources in the economic development of countries such as Australia, Canada, Norway, the United States, and point out how Indonesia and Malaysia have used oil revenues for industrial development. In a similar vein, Albino-War et al. (2014) mention that rising oil prices between 2004 and 2014 translated into high levels of public investment in most oil importers of the Middle East, North Africa, and the Caucasus and Central Asia. In this scenario, we assume a sequence of basic government investment and oil revenue shocks such that government investment and oil revenues rise by 1 dollar for four quarters following the initial shock. That is, we assume that the increase in government investment is fully financed with oil revenues.

While it is true that oil revenues are outside the scope of government control, we can still include the oil revenue shock to determine the response of policymakers to sequences of oil revenue shocks. We use a new system of equations of the following form:

$$
\begin{aligned}
1 &= \sum_{s=0}^{t}(\theta_{kk,(t-s)}\lambda_s^k + \theta_{ko,(t-s)}\lambda_s^o), && \text{for } t = 0, \dots T, \\
1 &= \sum_{s=0}^{t}(\theta_{ok,(t-s)}\lambda_s^k + \theta_{oo,(t-s)}\lambda_s^o), && \text{for } t = 0, \dots T,
\end{aligned}
$$

where, for all $t-s$, $\theta_{ok,(t-s)} = 0$ because of the exogeneity assumption of oil revenues. Note that in this scenario we do not restrict the response of government consumption or net tax revenues.

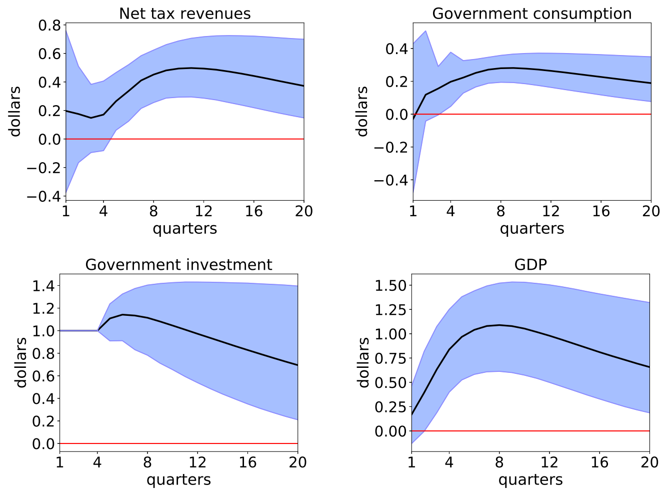
Figure 7 displays the results. The response of output is positive over the entire horizon, reaching a peak of 1.1 dollars in the middle of the second year. Thus, the government investment shock financed with oil revenues stimulates output and government consumption and leads to an increase in tax revenues. Moreover, the credible intervals of these responses are away from zero after a few quarters of the initial government investment shock.

In sum, this choice of policy, among the three already mentioned, seems to be highly effective to promote economic activity. Importantly, this choice of policy is only available to oil-exporting countries and could be a way to not only affect the business cycle, but also the structural features of the economy in the long run.

6.4 An Investment Spending Expansion Financed with Taxes

The following two scenarios are particular to the Ecuadorian economy, but can also illustrate the effects of the use of similar policy tools for other oil-exporting countries.

Figure 7: Oil-Financed Investment Spending Expansion



In April 2016, Ecuador was struck by an earthquake that devastated a portion of two coastal provinces. The reconstruction cost was estimated at $3.3 billion (see Grigoli, 2016). To fund the reconstruction efforts, the government temporarily raised the sales tax rate in addition to other special contributions (see Helsel and The Associated Press, 2016) that collected $1.6 billion, according to the Ecuadorian Internal Revenue Service (see El Diario, 2017). In this scenario, we simulate an increase in government investment fully financed with net tax revenues for four quarters.

Figure 8 shows the responses of the different variables following this policy scenario. In this case, after the initial four periods of the policy in place, investment spending declines, but is above tax revenues while government consumption increases slightly. However, the higher investment and consumption spending do not seem to offset the effect of the increase in taxes. As a result, GDP contracts in this policy scenario, falling by about 1 dollar in the third quarter and staying in negative territory for most of the response horizon.

6.5 A Balanced-Budget Consumption Spending Expansion

The second exercise that is particular to the Ecuadorian economy builds on the requirement that government consumption has to be financed with tax revenues.[8] The balanced-budget consumption spending expansion scenario is designed in such a way that both government consumption and net tax revenues increase by 1 dollar, while government investment remains unchanged for four quarters following the initial shock.

[8]Strictly speaking, the Ecuadorian constitution mandates in its article 286 that "permanent outlays shall be financed by permanent revenues." Permanent outlays are all the obligations that the country must pay constantly, that is, they represent a continuous expense made by institutions, entities and other public sector organizations. Permanent revenues are all the resources that the government can capture and estimate in a predictable way, and that in no way cause a decrease in natural wealth; an example is taxes.

Figure 8: Investment Spending Expansion Financed with Taxes

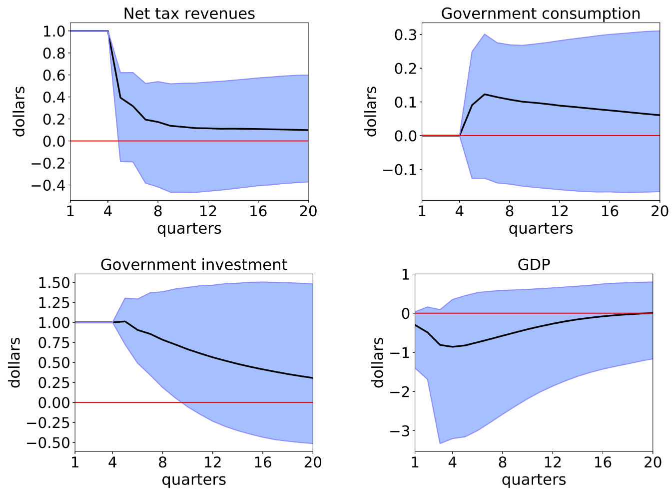


Figure 9 displays the results. The combined and sustained increase in tax revenues in addition to the negligible effect of government consumption previously described imply a highly contractionary effect on GDP, whereas investment remains basically unchanged. This policy would not be recommended in the case of the Ecuadorian economy.

6.6 An Oil Revenue Shock Fully Saved

Finally, we would like to use the policy analysis to answer the following question: *What are the effects of an oil shock on economic activity if the government does not respond to it?* We tackle this question by estimating the effect of an oil revenue shock on economic activity as sequences of linear combinations of the basic government investment and oil revenue shocks, such that government investment remains unchanged for four quarters, but government consumption and tax revenues do not. We call this an oil revenue shock fully saved.

Figure 10 displays the effects of the pure oil shock. On the one hand, the response of GDP is qualitatively similar to that under the oil-financed investment spending increase scenario. Here, the peak response of output is about 78 cents and happens in the seventh quarter. On the other hand, the responses of government consumption and net taxes are negative and have a similar shape, but net tax revenues respond more strongly than government consumption. In both cases, the credible intervals include zero for the initial quarters and then stay in positive territory from the seventh quarter on. The results are in line with those of Figure 4, confirming our findings of the importance of oil revenues not only on fiscal variables but also on macroeconomic activity.

Figure 9: Balanced-Budget Consumption Spending Expansion

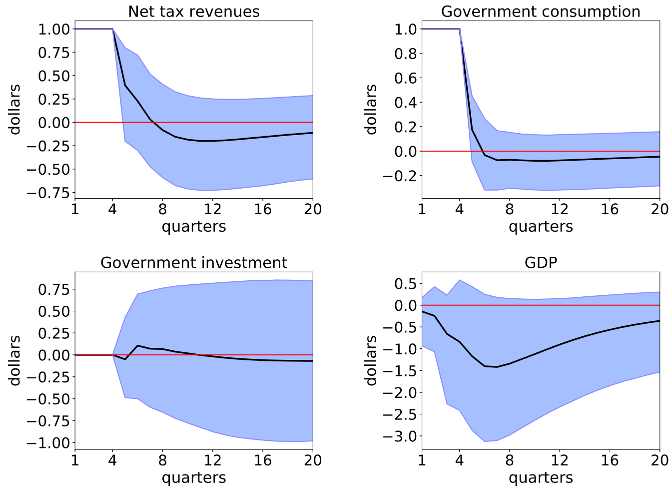
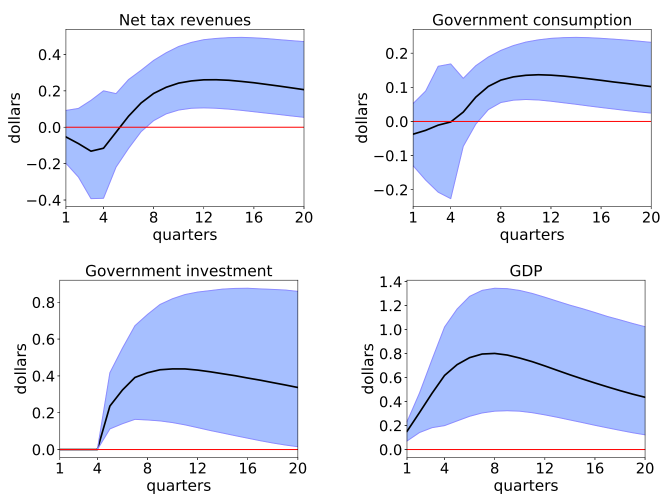


Figure 10: Oil Revenue Shock Fully Saved



6.7 Fiscal Multipliers

In order to compare the effects of the fiscal shocks and the fiscal policy scenarios, we need a more robust measure than the simple impulse-responses or multipliers calculated previously. Mountford and Uhlig (2009), Uhlig (2010) and Fisher and Peters (2010), argue that fiscal multipliers should be calculated as the present value of the output response to a fiscal shock divided by the present value of the fiscal variable response. Ramey (2016) explains that these kinds of "integral multipliers" address the relevant policy question because they measure the cumulative GDP gain relative to the cumulative government spending (or another fiscal shock) during a given period.

The present value multiplier or discounted multiplier can be calculated using the following formula:

$$\text{discounted multiplier at horizon H} = \frac{\sum_{h=0}^{H}(1+r)^{-h}\theta_{yj(h)}}{\sum_{h=0}^{H}(1+r)^{-h}\theta_{jj(h)}}. \tag{6}$$

Following a similar notation from the previous subsections, $\theta_{yj(h)}$ represents the dollar response at horizon h of GDP to a shock in fiscal variable j, $\theta_{jj(h)}$ is the dollar response of the fiscal variable j, and r is the quarterly interest rate.[9]

We start by calculating the discounted multipliers of the basic fiscal policy shocks shown in the impulse-response analysis of Section 5. Table 2 displays the results.

Table 2: Discounted Fiscal Multipliers

Shock	Impact	4 qrts	8 qrts	12 qrts	20 qrts	peak
Net tax revenue	0.23	0.82	0.86	0.16	-1.11	0.97 (6)
Government consumption	0.07	0.47	1.12	1.52	1.95	1.95 (20)
Government investment	0.02	0.13	0.23	0.30	0.39	0.39 (20)

Note: Median of the present value multipliers across posterior distribution draws. The net taxes multiplier is the negative of equation (6). In parentheses besides the peak multiplier is the quarter at which it occurs.

The discounted multipliers based on the basic fiscal shocks indicate that a net tax revenue shock is more effective in boosting GDP, at least in the short term, reaching a peak in the second year; our multipliers are smaller than those in Blanchard and Perotti (2002) obtained for the United States. Additionally, on the one hand, the government consumption multiplier is above 1 starting at the end of the second year. On the other hand, the government investment multiplier is relatively small, reaching just 0.39 at the end of the fifth year. We must point out that the 68 percent credible bands include zero in all cases, indicating the high degree of uncertainty surrounding our results.

The negligible estimated posterior median multiplier of government investment can have several explanations. Spilimbergo, Symansky and Schindler (2009) argue that a multiplier can be smaller or even negative mainly for three reasons: 1) monetary conditions are not accommodative, 2) a big part of the stimulus is saved or spent on imports, and 3) the country's fiscal position after the stimulus is unsustainable. The last two reasons seem to be in line with the Ecuadorian situation. Because Ecuador is a developing country, it is difficult to produce capital goods. Production efforts require the imports of capital and commodity goods that represent an average of about 60 percent of total imports in recent years. That is, any stimulus that is aimed to boost government investment will likely raise imports and remove part of the multiplier effect on output. Moreover, fiscal

[9]Some authors assume that r is zero and call this simply the cumulative multiplier. On the other hand, other authors call fiscal multipliers to the cumulative fiscal multipliers and present value multipliers. Spilimbergo, Symansky and Schindler (2009) present a definition for the distinct types of multipliers used in the literature.

sustainability is a problem that the government has had at least since 2008, as it is shown by Zambrano and Franco (2015).[10] The major problem with fiscal unsustainability is that it decreases consumers and investors confidence. Moreover as Spilimbergo, Symansky and Schindler explain, it is only necessary that the fiscal expansion raises or reinforces fiscal sustainability concerns for the confidence of economic agents to decrease. For instance, in the case of Ecuador, the country risk rating or sovereign bonds risk rating, measured by the EMBI (Emerging Markets Bond Index), has been higher over the sample period compared with the average of other Latin American and Caribbean countries.

Perotti (2004) argues that the common wisdom is that the effects of public investment are higher in the long run, since its externalities take time to work through the economy. However, for the Ecuadorian case, even at long horizons the effects of capital spending (when it is not financed by oil revenues) are negligible. Another reason why the effect of public investment could be low is that the level of public capital is too high relative to its optimal level. This causes public investment to have a very low marginal product, although this seems implausible for a developing economy such as Ecuador. Perotti also argues that government investment might be particularly prone to political pressure, resulting in the execution of projects with no economic rationale. This situation implies an inefficient spending in cost-benefit terms, generating a negative effect on the economy.

In addition, as found by Avellán et al. (2020), institutional strength could be a factor for more efficient government spending and a higher multiplier. According to the authors's calculations, Ecuador is in the set of countries with low institutional quality, which accords with our low public investment multiplier.

Table 3 displays the present value multiplier for some of the policy scenarios we discussed previously: (i) a deficit-financed tax cut, (ii) a deficit-financed investment spending expansion, and (iii) an oil revenue shock fully saved, assuming an annual real interest rate of 4 percent.[11]

[10] Zambrano and Franco (2015) test for the presence of a structural break after the first quarter of 2008 (after this date, government investment has grown considerably until recently, as we described in Section 3), and conclude that fiscal policy goes from a scenario of strong sustainability before the break, to a scenario of weak sustainability after 2008, or even of unsustainability if the break is assumed in 2011.

[11] Not all the scenarios allow us to compute the present value multiplier because there are more than one fiscal instrument changing at the same time, which is not consistent with the way in which the multiplier is defined in equation (6). In the oil-financed capital spending and the fully saved oil revenue shock scenarios, we assume the denominator of (6) is based on the response of oil revenues instead of a fiscal variable.

Table 3: Present Value Fiscal Multipliers of Selected Policy Scenarios

	Impact	4 qrts	8 qrts	12 qrts	20 qrts	peak
Deficit-financed tax cut	0.43	0.91	1.70	1.19	-0.11	1.70 (8)
Oil-financed capital spending	0.17	0.51*	1.10*	1.71*	2.64*	2.64* (20)
Oil revenue shock fully saved	0.15*	0.38*	0.83*	1.26*	1.88*	1.88* (20)

Note: Median of the present value multipliers across posterior distribution draws. In parentheses besides the peak multiplier is the quarter at which it occurs. * denotes the 68 percent credible set does not include zero.

A capital spending increase financed with oil revenues delivers the highest peak present value multiplier (2.64 dollars) among the three alternatives considered, followed by the oil revenue shock that is fully saved (1.88 dollars). In the short run, the deficit-financed tax cut implies the highest present value multipliers, eventually fading out and disappearing in the longer run. These features are an indication that oil revenue shocks tend to take time to show returns in terms of output and that tax cuts financed with debt could provide faster positive returns.

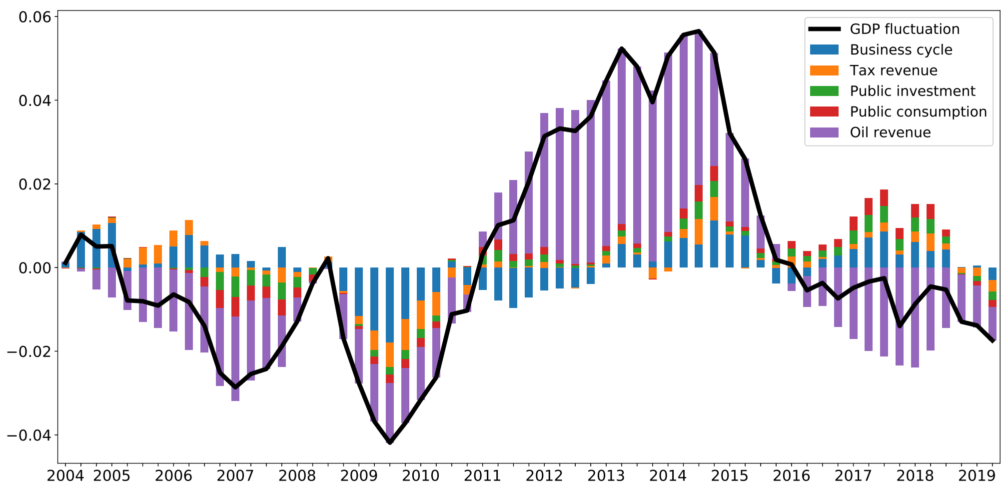
With respect to the two scenarios financed with oil revenues, the scenario in which capital spending increases delivers a higher present value multiplier than the scenario in which the extra oil revenues are saved. In fact, figures 7 and 10 show that the effect of oil-financed capital spending on GDP is higher than that of the fully saved oil revenue shock. This result accords with the findings in Guerra-Salas (2014), who shows that in a small open oil-exporting country with a non-prudent fiscal policy (similar to that of Ecuador), government investment can exacerbate the business cycle through the productivity-enhancing effect of public capital. However, we must point out that the 68 percent credible set of the difference between the multipliers of the two aforementioned scenarios includes zero.

6.8 Good Luck or Good Policy?

As a final exercise, we aim to answer the question that we postulated as the title of our paper. The SVAR framework allows us to determine what the historical contribution of the structural shocks listed in Table 1 (business cycle, tax revenue, public investment, public consumption, and oil revenues) has been on the deviations of GDP from its trend. If, on the one hand, the shocks to fiscal policy—in particular those to government investment—are the most important in generating GDP growth, we would conclude that the economy has gone through a period of good policymaking. If, on the other hand, oil revenue shocks have been the most important in explaining growth, then the economy has experienced good or back luck. Figure 11 shows the results for the Ecuadorian economy, using the benchmark sign restrictions.

The graph shows that oil revenue shocks have had an important contribution in explaining the deviations of GDP from trend over the sample considered. In addition, four

Figure 11: Historical Decomposition of Data into Shocks



Note: The black line is the deviation of GDP from its trend whose units in the y-axis are log deviations.

well-defined periods can be distinguished. The first is a period of GDP below trend going into the presidential elections of 2006 and the beginning of the government of Rafael Correa in which GDP was initially declining, characterized by a negative impact of oil revenue shocks and government spending and a positive contribution of business cycle shocks. As the economy recovered, the contribution of oil revenue shocks to GDP became smaller. The second period is associated with the Global Financial Crisis and the decline and subsequent recovery of oil prices. During this period, all the shocks imprinted a negative impact on GDP, especially those related with the business cycle, which could indicate that the nature of the below-trend behavior went beyond oil price fluctuations and had a structural feature. According to the model, the third period is dominated by oil revenue shocks, starting in 2011 and ending in 2015. Through 2014, although business cycle shocks were a drag on GDP at the beginning, increasing oil revenue shocks positively impacted output almost exclusively. It is only at the end of 2014 and through 2015, with oil revenue shocks losing their power, that fiscal policy shocks start to positively affect output. The fourth period, starting in 2016, sees negative oil revenue shocks pulling down GDP whereas fiscal policy and business cycle shocks pull it up, but the effect of the former is larger than the latter. In the last year of the sample (2019), fiscal policy shocks have lost all the power to positively influence GDP and oil revenue shocks continue to be a drag on economic activity.

Hence, the answer to our question is that the Ecuadorian economy has mostly suffered from good and back luck that has affected oil revenues through oil price variations which, in turn, have affected GDP.

7 Robustness Analyses

We performed a variety of robustness checks to our five-variable benchmark specification. For instance, we estimate the model assuming other sign restrictions specifications. Under an alternative scheme, we maintain the benchmark set of restrictions, except that the response of government consumption to a tax revenue shock is restricted to zero while we are agnostic with respect to the response of government investment to changes in tax policy. We perform this exercise to examine the sensitivity of our results to our initial assumption with respect to the contemporaneous effects of tax revenues on government spending.

Table 4: Alternative Sign and Zero Restrictions on Impact

	Shocks				
	Business cycle	Tax revenue	Public investment	Public consumption	Oil revenue
GDP	+				
Net tax revenues	+	+			
Investment spending	0		+		
Consumption spending	0	0		+	
Oil revenues	0	0	0	0	+

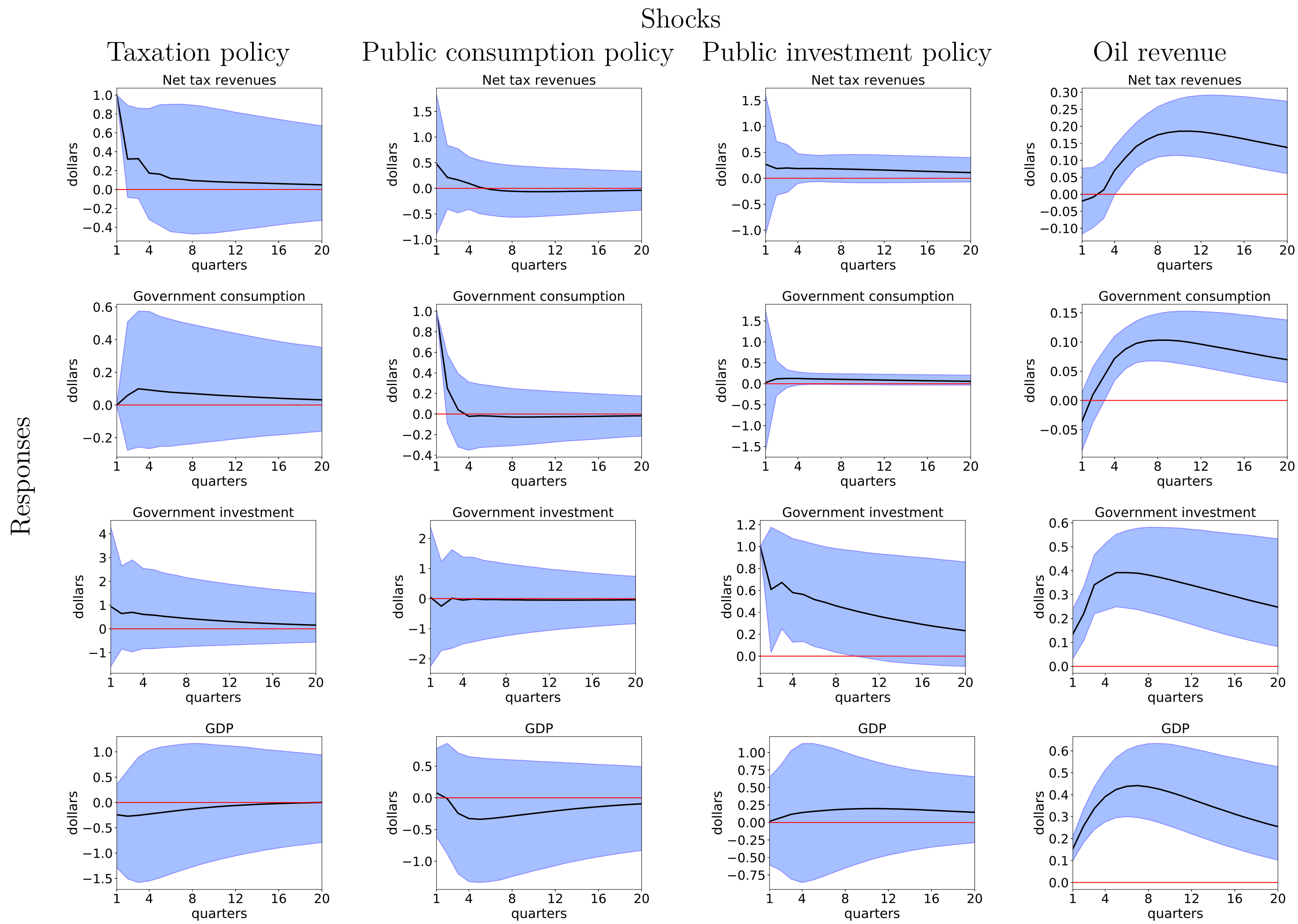
Note: This table shows the sign restrictions on the impulse responses for each identified shock. A "+" means that the impulse response of the variable in question is restricted to be positive on impact. A "0" indicates that the variable does not react contemporaneously to the shock. A blank entry indicates that no restrictions have been imposed.

Results under this specification appear in Figure 12. The results do not change qualitatively. We find that output declines after an increase in taxes and it is negatively affected by an increase in government consumption. Similar to the benchmark specification, output increases following an increase in government investment and in oil revenues, with the reaction to the latter much larger than to the former. However, there is a quantitative difference, albeit not likely significant because of the wide credible sets: The response of investment to tax revenue shocks is larger in this alternative identification scheme, which makes output to decline a little less than in the benchmark sign restrictions.

We also assess whether using international oil prices provides different results than using the net oil revenue variable. The sign restrictions used were as in the benchmark model. Figure 13 displays these results, which, again, are qualitatively similar to the original specification; the direction of the responses is virtually the same. We conclude from these exercises that controlling for different specifications and the use of oil revenues instead of oil prices, as is usual in this literature, do not change our results when analyzing the consequences of fiscal policy and oil revenue shocks in the Ecuadorian economy.

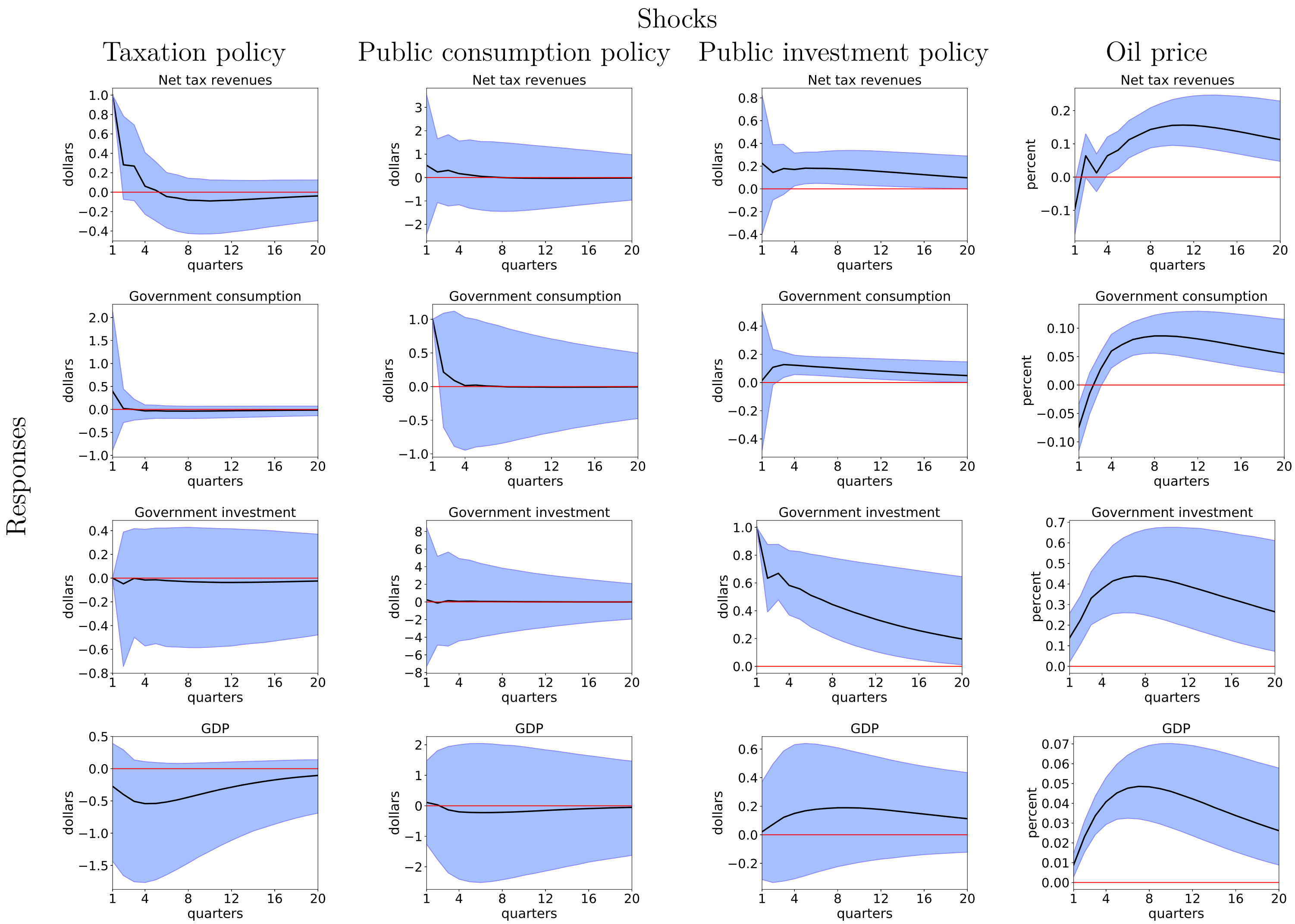
Finally, instead of using GDP in our analysis, we use non-oil GDP. In this case, we expect the effect of oil revenues to be smaller than in the case with GDP. Figure 14 shows the impulse-response functions under the benchmark identification scheme. The results

Figure 12: Response of Fiscal Variables and GDP to Fiscal and Oil Revenue Shocks Under Alternative Sign Restrictions



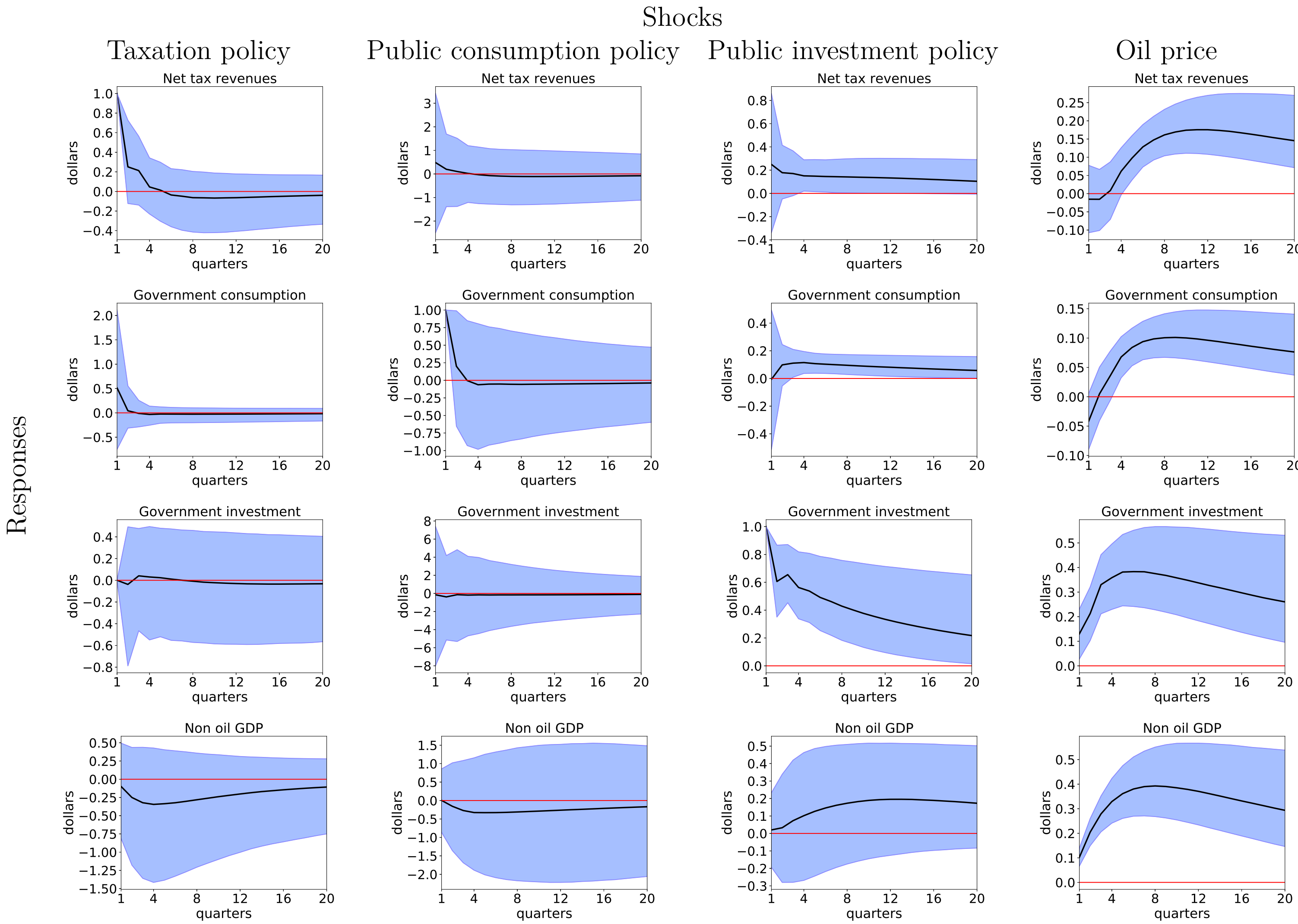
Note: Blue shaded areas correspond to 68% credible sets. Black lines are the median response

Figure 13: Response of Fiscal Variables and GDP to Fiscal and Oil Price Shocks



Note: Blue shaded areas correspond to 68% credible sets. Black lines are the median response

Figure 14: Response of fiscal variables and non oil GDP to fiscal and revenue shocks shocks



Note: Blue shaded areas correspond to 68% credible sets. Black lines are the median response

show that the main features of our original analysis hold: (i) a tax policy shock reduces output, (ii) an unexpected increase in government consumption reduces non-oil GDP, (iii) a surprise increase in capital spending causes non-oil GDP to rise, and (iv) the most important effect on output occurs from a shock to oil revenues. Although the difference is likely not different from zero, the response to a shock to oil revenues is smaller for non-oil GDP than for total GDP, the latter shown in the lower-right panel of Figure 4.

8 Conclusions

In this study, we conducted empirical research to obtain the impact of fiscal and oil revenue shocks on output for a small oil exporter such as Ecuador. By including oil revenue shocks on the dynamic relationship between government expenditures and government revenues with output, we are better able to understand the role of fiscal policy after discriminating the effect of oil revenues in the structure of government expenditures, which is a special characteristic of oil-exporting countries.

Overall, our results evidence the vulnerability of the Ecuadorian economy to fluctuations of oil revenues and their importance not only on fiscal variables but also on macroeconomic activity. Our empirical results suggest that the Ecuadorian government could reduce the dependence of its expenditures on oil revenues by financing spending through non-oil sources such as tax revenues. In addition, an oil stabilization fund could be a tool to shield the economy from oil price fluctuations. The methodology we propose and our recommendations may prove useful for other small oil exporters.

A Data Details

The revenues and expenditures data correspond to the Non-Financial Public Sector (NFPS) and are on accrual basis.[12] NFPS includes the central government, non financial public companies and other public sector entities, such as universities, local governments and Social Security Ecuadorian Institute. In the following text, we describe the accounts of NFPS needed for the construction of the variables used in this paper.

- **ingresos petroleros** ($\mathbf{ing_{petro}}$): Sum of revenues from oil exports and revenues from the sale of hydrocarbons and its products within the country.
- **IVA**: Revenues from value-added tax.
- **ICE**: Revenues from special consumption tax.
- **renta**: Revenues from income tax.
- **arancelarios**: Revenues from tax on imported goods.
- **otros impuestos**: Revenues generated by other types of taxes.
- **contribuciones a la seguridadsocial** (**SSC**): Mandatory and voluntary income in favor of public institutions that provide social security benefits.
- **otros ingresos** ($\mathbf{otr_{ing}}$): Non-tax (and non-oil) revenues, non-operating income of companies from SPNF and other self-management income that receive some entities.
- **intereses**: Assignments to cover expenditure for concept of interests of domestic and foreign public debt.
- **sueldos** (**w**): Expenditure on wages of staff in direct dependency from public employer.
- **compras de bienes y servicios** ($\mathbf{gov_{pur}}$): Necesary expenditure for the operational functioning of the state.
- **prestaciones de seguridadsocial** (**SSP**): Expenditure of public institutions that provide social security benefits.
- **otros gastos corrientes** ($\mathbf{otr_{cur}}$): Sum of current transfers, payment of human development bonus, cost of importing oil products for domestic consumption, and non-operational expenditure executed by companies of SPNF.
- **gastos de capital** ($\mathbf{gov_{cap}}$): Sum of gross fixed capital formation and capital transfers of central government to other SPNF entitites.

[12] The data can be downloaded from the bulletin "Operaciones del Sector Público No Financiero" in the web page of the Central Bank of Ecuador (BCE).

- **costo de importación de derivados** (**cost**): Cost of importing oil products for domestic consumption.[13]

Before 2008 the account ing_{petro} did not include oil revenues that are used to cover the cost of importing oil products. Furthermore, this absence of importing costs in the income account is also reflected in its accounting counterpart, otr_{cur}. Consequently, the accounts ing_{petro} and otr_{cur} are not comparable with themselves before and after 2008. In order to fix this problem and homogenize the series, we added the cost of importing oil products ($cost$), to both accounts before 2008.

Below describes the construction of the revenues and expenditures variables used in the VAR model as well as in the estimation of elasticity of taxes to GDP, which are taxes (τ^*), net taxes (τ), government investment (k), government consumption (g) and net oil revenues (o).

$$\tau^* = IVA + ICE + renta + arancelarios + otros\, impuestos$$

$$\tau = \tau^* + otr_{ing} + (SSC - SSP) - (otr_{cur} - cost) - intereses$$

$$k = gov_{cap}$$

$$g = gov_{pur} + w$$

$$o = ing_{petro} - cost$$

[13] This account was obtained from the bulletin "Ingresos y egresos por comercialización interna de derivados importados" in the web page of the Central Bank of Ecuador (BCE).

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