Journal of Applied Econometrics

WILEY

Journal of APPLIED ECONOMETRICS

RESEARCH ARTICLE OPEN ACCESS

Fiscal Policy Regimes in Resource-Rich Economies

Hilde C. Bjørnland[1,2,3] | Roberto Casarin[4] | Marco Lorusso[5,6] | Francesco Ravazzolo[1,3,7]

[1]BI Norwegian Business School, Oslo, Norway | [2]Norges Bank, Oslo, Norway | [3]CAMA, Canberra, Australia | [4]Ca' Foscari University Venice, Venice, Italy | [5]Department of Political Science, University of Perugia, Perugia, Italy | [6]Newcastle University Business School, Newcastle upon Tyne, UK | [7]Free University of Bozen-Bolzano, Bolzano, Italy

Correspondence: Marco Lorusso (marco.lorusso@unipg.it)

Received: 27 May 2024 | **Revised:** 22 November 2025 | **Accepted:** 20 April 2026

Keywords: Bayesian inference | dynamic panel model | fiscal policy | Markov switching | oil prices | oil-rich countries

ABSTRACT

We analyse fiscal policy in resource-rich economies using a novel Bayesian regime-switching panel model. The identified regimes capture pro- or countercyclical fiscal behaviour by allowing regime-specific shifts in the average fiscal stance, while the switches between the regimes have the interpretation of changes in fiscal policy. Applying the model to a panel of sixteen oil-producing economies, we show that fiscal policy has alternated between a procyclical and countercyclical regime multiple times over the sample. Furthermore, we find that fiscal policy is more volatile in the procyclical regime and that the probability of being in the procyclical regime is higher for OPEC countries than for non-OPEC countries. We also show that following either an increase or decrease in oil revenues, the growth in government expenditures is mostly increasing, suggesting an upward bias in expenditures in oil-producing countries. These are new findings in the literature.

JEL Classification: C11, C33, C51, E62, Q43

1 | Introduction

Oil-price volatility has remained elevated over recent decades, placing considerable pressure on the fiscal policy framework in resource-rich economies. Because oil revenues often take up a large share of government income, sudden swings in prices can lead to sharp and immediate budgetary adjustments. Resource-rich countries are therefore advised to save windfall revenues and conduct fiscal policy countercyclically to smooth expenditure over the business cycle (see Barro 1979). In practice, however, many oil-rich economies display the opposite pattern: fiscal policy is often procyclical, with governments expanding spending during booms and then being forced to cut back sharply when prices fall, thereby amplifying downturns with severe consequences, as in the oil price crash of 2015 when several major producers had to take substantial spending cuts (see, for example, IMF 2015).

Empirical studies corroborate this notion. Studies focusing on oil-producing countries, including Sturm et al. (2009), Lopez-Murphy and Villafuerte (2010), Erbil (2011) and Bova et al. (2016), consistently find procyclical fiscal behaviour.[1] Similar conclusions are drawn by Céspedes and Velasco (2014), although they argue that procyclicality has declined somewhat as more countries have adopted fiscal rules.

One important caveat of the above-mentioned studies is that their findings will be dependent on the sample under study. As there may be a variety of shocks hitting the economy in different periods, this can affect the results. Countries also adopt fiscal rules in response to changing economic conditions, making fiscal policy design particularly complex, see Schaechter et al. (2012) for an international overview, and Bjørnland and Thorsrud (2019) for an analysis of fiscal policy during changing rules in Norway. Furthermore, the implementation of fiscal policy may not be symmetric across different phases of the economic cycle, contrary to the implicit assumption in models that rely on constant parameters. For example, fiscal policy may be procyclical during commodity price booms but countercyclical when prices decline. As highlighted by Arezki and Ismail (2013), current spending tends to rise during booms but remains downwardly sticky during downturns.[2]

In this paper, we model instead fiscal-policy behaviour using a panel Markov-switching VAR that allows fiscal responses to shift across regimes over time. Such flexibility is important: models with constant parameters or exogenously defined sub-periods may mask shifts in behaviour and lead to biased inference.[3] By allowing regime-dependent dynamics in a unified framework, our approach captures the time-varying nature of fiscal policy in resource-rich economies.

Furthermore, to account for the fact that policy could be asymmetric between commodity booms and busts, we will allow fiscal policy to be operated differently in the different cyclical phases. In particular, in line with Arezki and Ismail (2013), we open up for the possibility that fiscal policy can be expansionary in both booms and busts, that is, that fiscal policy is procyclical when government oil revenues increase, but downward sticky, that is, countercyclical, when the revenues fall (or vice versa). For this purpose, we propose a novel Bayesian Markov-switching panel model in which the parameters change between the procyclical and countercyclical fiscal policy regimes over time according to a Markov process. The panel data framework is particularly suitable for these issues, as we can allow for a large sample of countries to be modelled together. Furthermore, as the sample often varies from country to country, we can solve this by estimating an unbalanced panel where the number of observations can vary depending on the availability of the data series. Finally, in line with most recent literature, we make use of Bayesian inference and prior distributions to estimate our model (see, for example, Canova and Ciccarelli 2004; Canova and Ciccarelli 2009; Koop and Korobilis 2013; Feldkircher et al. 2022).[4]

A highly debated issue in the economic literature is the identification of fiscal policy in structural analysis. Different methodologies have been used to identify fiscal policy shocks or systematic fiscal responses, see for instance Blanchard and Perotti (2002), Mertens and Ravn (2010), Ramey (2011), Leeper et al. (2012), Mertens and Ravn (2012) and Leeper et al. (2013) for important contributions to the literature. However, despite a growing literature, it has been difficult to systematically compare fiscal policy across studies, as each study typically focuses on only a few countries and variables at a time.

Here, we focus on fiscal-policy regimes in a multi-country panel. Regimes capture whether behaviour is pro- or countercyclical, and switches are interpreted as changes in policy that policymakers can influence. Rather than splitting the sample ex ante and comparing periods, we use a panel Markov-switching VAR to infer *when* policy is pro- or countercyclical. Regime dependence is imposed on reduced-form intercepts, which we interpret as regime-specific average drifts in fiscal stance (not structural policy rules). This design lets us classify episodes transparently without claiming identification of deep parameters.

To operationalise the classification, we impose sign restrictions on the *regime-specific intercepts* (drifts) of the variables of interest. These restrictions define a countercyclical regime as one in which the government non-oil fiscal balance generally moves in the same direction as government oil revenues, and a procyclical regime as one in which it moves in the opposite direction.[5] This identifies regimes by their average stance without relying on a structural shock decomposition or reporting impulse responses. Our sign restrictions are in the spirit of sign-restricted SVARs, but applied to regime-specific intercepts; thus, identification concerns regime-specific mean fiscal stances and transitions between them, rather than IRFs.[6]

In choosing this approach, we relate to the literature on Markov-switching models, where the parameters are usually strictly identified (see Allman et al. 2009), but the likelihood is invariant to the permutation of the regime labelling. Previous studies have proposed different alternatives for dealing with this problem.[7] One efficient approach is the permutation sampler (see Frühwirth-Schnatter 2001), which can be applied under the assumption of exchangeability of the posterior density. This assumption is satisfied when one assumes symmetric priors on the transition probabilities of the switching process. As an alternative, one may impose identification constraints on the parameters. This practice is followed to a large extent in macroeconomics, and it is related to the natural interpretation of the different regimes as different phases (e.g., recessions and expansions) of the business cycle (see, for example, Billio et al. 2016). We adopt this latter approach and impose sign restrictions on the regime-specific intercepts of the variables of interest. In particular, we restrict the sign of the intercepts of government oil revenues and non-oil fiscal balance. However, their volatility, as well as the intercept and volatility of the other endogenous variables, will remain unrestricted.

In line with Lopez-Murphy and Villafuerte (2010) and Erbil (2011), our identifying restrictions assume that fiscal policy is procyclical when increased oil revenues are met by negative changes in the non-oil fiscal balance (i.e., changes in government expenditures exceed changes in non-oil government revenues). In particular, an increase in oil revenues, following higher oil prices, can imply increased (net) financial savings and/or an increase in government spending (not financed by increases in non-oil revenue, but by the oil revenues). In this case, fiscal policy would be exacerbating cyclical fluctuations in the economy. In contrast, a countercyclical fiscal policy regime corresponds to the case in which the change in the non-oil fiscal balance is positive when oil revenues are increasing (i.e., changes in non-oil revenues exceed changes in government expenditure). In this case, fiscal policy would be dampening cyclical fluctuations in the economy. Having imposed the economic identification constraints, these will be naturally incorporated within the parameter estimates through the prior-posterior updating. To the best of our knowledge, this is the first study that proposes a Bayesian Markov-switching panel model to analyse fiscal policy over the cycles.

Our model is applied to 16 oil-producing economies. We include countries where oil rents account for more than 5% of GDP over the sample 1990-2016. Our sample includes countries in the Organization of the Petroleum Exporting Countries (OPEC), as well as non-OPEC countries. Oil exports from these countries correspond to 74% of the world oil exports. For each country, we collect data on relevant fiscal variables, including government expenditure, government oil revenues, non-oil fiscal balance and public employment. We also include the real oil price and the real exchange rate, which are important variables for capturing the economic conditions in resource-rich economies. The time series are collected from both international and national data sources and provide us with a novel data set of relevant fiscal variables for oil-rich countries.

We have three main findings. First, we find that there are multiple periods over the sample when fiscal policy alternates between a procyclical and a countercyclical regime. Hence, studies that try to analyse fiscal policy using constant parameters, or that deal with the time-varying changes using a split-sample framework, will misrepresent the changing pattern of how fiscal policy is operated in commodity booms and busts. Second, the probability of being in the procyclical fiscal policy regime is higher for the OPEC countries than for the non-OPEC countries. This result indicates that, on average, OPEC economies are less able to shelter their economies from fluctuations in oil revenues than non-OPEC countries. Third, the timing of the procyclical and countercyclical pattern varies between the countries, as is clearly illustrated in the cases of Russia and Saudi Arabia. However, in some periods, fiscal policy has been predominantly procyclical across all countries. These include the Asian financial crisis in 1996/97, the oil price surge between 2002 and 2005 and the aftermath of the global financial crisis.

Our paper contributes to several strands of the literature. First, by proposing a Bayesian Markov-switching panel model to identify fiscal policy regimes, we contribute to the empirical literature that analyses the effect of fiscal policy. However, in contrast to the studies cited above, our econometric framework does not assume indirect exclusion or expectations-based restrictions to identify fiscal policy, but relies instead on a minimum set of direct restrictions based on actual data. Second, we contribute to the literature on Markov-Switching SVAR models (e.g., Rubio-Ramirez et al. 2006; Lanne et al. 2010; Netsunajev 2013; Lütkepohl and Woźniak 2020) by extending the use of identifying restrictions on the switching parameters to the panel SVAR models. Finally, we contribute in general to the panel data literature, (see e.g., Billio et al. 2016; Casarin et al. 2019; Agudze et al. 2022, for key contributions) by analysing several countries together, despite different samples. This is possible because we follow a Bayesian approach with hierarchical prior distributions to deal with overfitting issues in high dimensional models.

The remainder of the paper is structured as follows. Section 2 presents the data, while Section 3 describes the model and the estimation procedure. In Section 4, we present the empirical results, focusing on the estimated parameters of the fiscal policy regimes, the regime probabilities for the whole panel of countries and details for two important oil producers: Russia and Saudi Arabia. The concluding remarks are found in Section 5.

2 | Data

We consider the following 16 resource-rich countries: Algeria, Angola, Azerbaijan, Ecuador, Gabon, Iran, Iraq, Kazakhstan, Kuwait, Libya, Nigeria, Qatar, Russia, Saudi Arabia, UAE, and Venezuela. These countries are major oil and gas producers, and petroleum also accounts for a major share of these economies. In particular, in this study we include the countries with the highest oil rents (as percentages of GDP) worldwide.[8] Figure 1 shows the average share of oil rent as a share of GDP for this set of countries during the period 1990-2016. As it turns out, in the majority of countries, the oil rent as a share of GDP is above 20%. In this regard, Saudi Arabia, Libya, Kuwait and Iraq all have oil rents as a share of GDP that are notable and above 35%. The shares of UAE, Azerbaijan, Iran, Gabon, Qatar and Angola are between 20% and 35%. The remaining countries have shares that are below 20%. These numbers indicate that our set of countries is composed of resource-rich economies that are heavily dependent on oil. Consequently, it is likely that fiscal policy in these countries will be largely affected by swings in the price of this commodity.

As described in Kaminsky et al. (2004), many indicators can be used to assess the degree of procyclical or countercyclical fiscal policy. In order to allow for more robust conclusions for all the

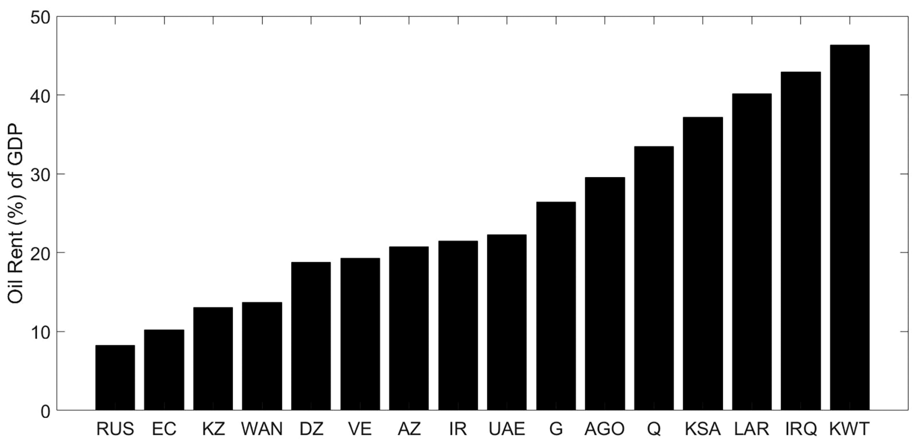

FIGURE 1 | Oil rents as percentage of GDP. World Bank, World Development Indicators. The values in the figure are average shares for the following countries during the period 1990-2016: Algeria (DZ), Angola (AGO), Azerbaijan (AZ), Ecuador (EC), Gabon (G), Iran (IR), Iraq (IRQ), Kazakhstan (KZ), Kuwait (KWT), Libya (LAR), Nigeria (WAN), Qatar (Q), Russia (RUS), Saudi Arabia (KSA), United Arab Emirates (UAE), Venezuela (VE).

countries in our analysis, we consider a set of relevant fiscal variables: the growth rate of total government expenditure ($y_{i1,t}$); the growth rate of government oil revenues ($y_{i2,t}$); the growth rate of non-oil fiscal balance ($y_{i3,t}$) and the growth rate of public employment relative to total employment ($y_{i4,t}$). We also include the growth rate of the real oil price ($y_{i5,t}$), which may capture common shocks in the oil market, and the growth rate of the real exchange rate ($y_{i6,t}$), which is important for capturing the changes in the economic conditions in the resource-rich economies.[9]

In total, we include 81 variables in our model for the sample period 1990:Q3-2016:Q4. The data series are collected from both international and national data sources, and the sample varies according to the data availability of each country. Accordingly, our dataset is unbalanced. All data series are expressed in terms of quarterly growth.[10] We work with growth rates rather than levels as the panel is both short and unbalanced. Imposing country-specific cointegration relationships would be difficult and sensitive to varying sample lengths. Transforming the variables to growth rates avoids spurious regression problems associated with non-stationary levels and ensures comparability across units, following common practice in panel VAR studies with heterogeneous macroeconomic data.

For those countries for which data are available only at yearly frequency, we used the Denton method (see Di Fonzo and Marini 2012) to convert annual data to quarterly frequency. Online Appendix A reports a detailed explanation on how we constructed all the variables used in the empirical analysis.[11]

In Online Appendix B, we report descriptive statistics for the data series that are used to estimate our model. We note that most variables show a large variability. Furthermore, most of the data series are also moderately skewed. We also observe that most of the moments are different from those of a normal distribution. We also graph the time series for all countries in Online Appendix B. While there are some similarities across countries, the graphs illustrate clearly that there are some important country differences, suggesting that both idiosyncratic shocks and policies matter. The figures also clearly show that we have varying sample lengths across variables and countries, which induced us to adopt a panel analysis framework with an unbalanced panel.

3 | Model

We jointly model all variables using a VAR framework, see for instance Canova and Ciccarelli (2009) for a multi-country VAR. Country-specific hidden Markov chain processes are specified in order to extract fiscal regimes and their duration (see Krolzig 1997). We follow a Bayesian approach with hierarchical prior distributions to deal with overfitting issues in high-dimensional models. This class of priors allows for the exchange of information across units and thus is well suited to unbalanced panel data. Moreover, the prior distributions allow for heterogeneity across panel units and for the inclusion of prior identifying restrictions. For each country of the panel and across all of them, our parameter restrictions identify procyclical and countercyclical regimes. The resulting panel Markov-switching VAR (PMS-VAR) model is applied to make inference on the cyclical fiscal policy of the countries listed in the previous section.

3.1 | Panel Markov-Switching VAR Specification

The PMS-VAR model is given by:

$$\mathbf{y}_{it} = \mathbf{a}_i(s_{i\,t}) + \sum_{p=1}^{P} A_{ip}\mathbf{y}_{it-p} + \boldsymbol{\varepsilon}_{it}, \quad \boldsymbol{\varepsilon}_{it} \sim \mathcal{N}_M(\mathbf{0}, \Sigma_i(s_{i\,t})) \tag{1}$$

where $\mathbf{y}_{it}$ is a sequence of $t = \tau_i, \ldots, T_i$ time observations on an M-dimensional vector of variables for $i = 1, \ldots, N$ countries. Moreover, $\mathbf{a}_i(s_{i\,t})$ and $\Sigma_i(s_{i\,t})$ denote the parameters that depend on Markov chains, whereas A_{ip} is kept constant. The residuals are denoted by ε_{it}. Finally, $\{s_{i\,t}\}$ indicates the unit-specific and independent K-states Markov-chain processes with values in $\{1, \ldots, K\}$ and transition probabilities $\mathbb{P}(s_{it} = k|s_{i\,t-1} = l) = \pi_{i,kl}$ with $k, l \in \{1, \ldots, K\}$.

We introduce the indicator variable $\xi_{ikt} = \mathbb{I}(s_{i\,t} = k)$, which takes value 1 if $s_{i\,t} = k$ and 0 otherwise for $k = 1, \ldots, K$, $i = 1, \ldots, N$, and $t = \tau_i, \ldots, T_i$. The vector of indicators $\xi_{it} = (\xi_{i1t}, \ldots, \xi_{iKt})'$ collects information about the realisations of the i-th unit-specific Markov chain over the sample period. Using these indicator variables, parameter shifts can be written as:

$$\mathbf{a}_i(s_{i\,t}) = \sum_{k=1}^{K} \mathbf{a}_{i,k}\xi_{ikt}, \quad \Sigma_i(s_{i\,t}) = \sum_{k=1}^{K} \Sigma_{ik}\xi_{ikt}. \tag{2}$$

where $\mathbf{a}_{i,k} = (a_{i1,k}, \ldots, a_{iM,k})' \in \mathbb{R}^M$ are M dimensional column vectors representing the country- and regime-specific VAR intercepts and $\Sigma_{ik} \in \mathbb{R}^M \times \mathbb{R}^M$ are M-dimensional unit- and regime-specific covariance matrices. Following Frühwirth-Schnatter (2006), in order to simplify the exposition, we consider a re-parameterisation based on a partitioning of the set of regressors $(1, \mathbf{y}'_{it-1}, \cdots, \mathbf{y}'_{it-P})$ into $K+1$ subsets $\overline{\mathbf{x}}_{i0t} = (\mathbf{y}'_{it-1}, \ldots, \mathbf{y}'_{it-P})'$ and $\overline{\mathbf{x}}_{ikt} = 1$, $k = 1, \ldots, K$. The PMS-VAR in Equation (1) writes as:

$$\begin{aligned} \mathbf{y}_{it} &= (I_M \otimes \overline{\mathbf{x}}'_{i0t})\boldsymbol{\gamma}_{i0} + \xi_{i1t}\boldsymbol{\gamma}_{i1} + \cdots + \xi_{iKt}\boldsymbol{\gamma}_{iK} + \boldsymbol{\varepsilon}_{it}, \\ \boldsymbol{\varepsilon}_{it} &\sim \mathcal{N}_M(\mathbf{0}, \Sigma_i(\xi_{it})) \end{aligned} \tag{3}$$

where $\boldsymbol{\gamma}_{i0} \in \mathbb{R}^{MM_0}$, $\boldsymbol{\gamma}_{ik} \in \mathbb{R}^M$, $k = 1, \ldots, K$, $i = 1, \ldots, N$, and $\Sigma_i(\xi_{it}) = \Sigma_i(\xi_{it} \otimes I_M)$ and $\Sigma_i = (\Sigma_{i1}, \cdots, \Sigma_{iK})$. The relationship between the new parameterisation and the previous one is: $\boldsymbol{\gamma}_{i0} = \mathrm{vec}((A_{i1}, \cdots, A_{iP})')'$, and $\boldsymbol{\gamma}_{ik} = \mathbf{a}_{i,k}$.

We assume a hierarchical prior to model heterogeneity across panel units, including different sample sizes, and to avoid overfitting issues. For regime identification, we impose a minimum set of constraints on the intercept parameters. Rather than developing ad hoc assumptions, our restrictions are based on the data series that we use to estimate our model. In the following section, we discuss our regime identification and we provide a summary of the parameter estimation.[12]

3.2 | Regimes Identification

As emphasised above, the fiscal regimes are identified by imposing prior restrictions on the *regime-specific intercepts* of the variables of interest. Accordingly, we address the identification issue associated with label switching by imposing identification constraints directly on the parameters. This practice is widely used in macroeconomics (see, for example, Billio et al. 2016). These prior restrictions follow from economic identification constraints and are naturally incorporated within the parameter estimates through prior-posterior updating.[13] By restricting the parameter space through the use of priors, we avoid the widely criticised indirect identification methods, such as the recursive (zero) identification scheme (see Blanchard and Perotti 2002; and the critique in Ramey 2011). In doing so, we make explicit use of Bayesian inference and prior distributions to estimate our model (see, for example, Canova and Ciccarelli 2004; Canova and Ciccarelli 2009; Koop and Korobilis 2013; Feldkircher et al. 2022).

In our model, regime switches are interpreted as changes in fiscal policy. Regarding economic intuition, we examine to what extent a change in oil revenues leads to procyclical or countercyclical fiscal policy. The first challenge is to include relevant fiscal variables so as to identify different regimes. As described in Kaminsky et al. (2004), it may be necessary to include several indicators to evaluate the degree of procyclical or countercyclical fiscal policy in different countries. One advantage of the panel VAR model used here is precisely that we can investigate several variables at the same time, allowing for more robust conclusions. For this reason, we include the non-oil fiscal balance, government expenditure, public employment (as a share of total employment), the real oil price and the real exchange rate, together with oil revenues. These are all relevant variables for examining fiscal policy in oil-rich countries (see, for instance, Kaminsky et al. 2004; Lopez-Murphy and Villafuerte 2010; Bjørnland and Thorsrud 2016; Bjørnland and Thorsrud 2019).

Next, we determine how to identify different fiscal policy regimes. Typically, in oil-rich countries, fiscal policy is said to be procyclical if government revenues and spending move in the same direction as oil prices, which leads to an expansionary fiscal policy that further stimulates economic growth, and vice versa when oil prices fall. One challenge when analysing fiscal policy in this way is that oil prices are quite volatile, whereas public spending only changes gradually due to implementation lags and the gradual phase-in of oil revenues (see, for example, Bjørnland and Thorsrud 2019 for an analysis of fiscal policy in Norway). Furthermore, the conduct of fiscal policy may be asymmetric over the cycles. As discussed in the introduction, Arezki and Ismail (2013) show theoretically and empirically how government expenditure increases during economic booms, but is not cut equally in the busts. They also find limited evidence that fiscal rules have helped reduce the degree of responsiveness of fiscal policy, and that the bias in the fiscal response to commodity price shocks may explain the tendency for the level of the real exchange rate to remain elevated in commodity-rich countries following a decrease in commodity prices.

To analyse the government's fiscal position after adjusting for the volatility of oil prices and the impact of oil revenues on the overall budget, we examine the non-oil fiscal balance. This is a measure of the fiscal position of a government that excludes revenues and expenditures related to the production and export of oil. In oil-rich countries, oil revenues can be a major source of government revenue and fluctuations in oil prices can have a significant impact on the government's budget. As a result, the non-oil fiscal balance provides a better indication of the government's underlying fiscal position. This indicator is also a reasonable measure of the injection (or use) of oil revenue in the economy and the level of fiscal effort. In particular, if oil revenues increase (during a boom in oil prices), this can lead to either

i. increased (net) financial savings (the change in the overall balance), and/or

ii. an increase in government spending (not financed by increases in non-oil revenue).

Accordingly, we define fiscal policy in oil-producing countries as expansionary (or contractionary) when we observe a negative (or positive) non-oil fiscal balance. This definition focuses on fiscal policy changes over which policymakers can exert more control. As a consequence, a procyclical fiscal regime occurs when a positive (negative) change in government oil revenues leads to an expansionary (contractionary) fiscal policy, a "spend as you go" regime. By contrast, a countercyclical fiscal regime occurs when an expansionary (or contractionary) fiscal policy is associated with a negative (or positive) change in government oil revenues, a "save for a rainy day/lean against the wind" regime.

Now, let $\mathrm{GOR_t}$ denote Government Oil Revenues at time t, $\mathrm{NOGR_t}$ Non-Oil Government Revenues, $\mathrm{GEXP_t}$ Government Expenditure, $\mathrm{OBAL_t}$ the Overall Balance, and $\mathrm{NOFB_t}$ the Non-Oil Fiscal Balance ($\mathrm{NOFB_t} \equiv \mathrm{NOGR_t} - \mathrm{GEXP_t}$). The budget identity implies:

$$\mathrm{OBAL_t} = \mathrm{GOR_t} + \mathrm{NOGR_t} - \mathrm{GEXP_t}, \tag{4}$$

$$\Delta\mathrm{OBAL_t} = \Delta\mathrm{GOR_t} + \Delta\mathrm{NOGR_t} - \Delta\mathrm{GEXP_t}, \tag{5}$$

$$\Delta\mathrm{NOFB_t} \equiv \Delta\mathrm{NOGR_t} - \Delta\mathrm{GEXP_t}, \tag{6}$$

$$\begin{aligned} \Rightarrow \Delta\mathrm{GOR_t} &= \Delta\mathrm{OBAL_t} - \Delta\mathrm{NOFB_t} \\ &= \underbrace{\Delta\mathrm{OBAL_t}}_{\text{Savings}} + \underbrace{(-\Delta\mathrm{NOFB_t})}_{\text{Use}}. \end{aligned} \tag{7}$$

Here ΔX_t denotes the first difference $X_t - X_{t-1}$, so that the budget identity carries over to changes. In the empirical model, the same variables enter as quarterly growth rates for stationarity reasons; the savings/use decomposition in (7) then holds as a log-linear approximation, while its economic interpretation, splitting a change in oil revenues into savings ($\Delta\mathrm{OBAL_t}$) and use ($-\Delta\mathrm{NOFB_t}$), is preserved. This decomposition motivates four regimes ($k = 4$): two procyclical (associated with increases or decreases in oil revenues) and two countercyclical, allowing for asymmetries between revenue rises and falls.

Before presenting the signs imposed, we relate our regime classification to a simple permanent-income benchmark. Under a permanent-income view, temporary oil-revenue fluctuations have little effect on permanent income, so optimal government spending responds only weakly due to expenditure smoothing. A stylised representation is:

$$\mathrm{GEXP}_t = \overline{G} + \theta\, y_t^{\mathrm{oil}} + \varepsilon_t,$$

where y_t^{oil} denotes oil income (proxied by government oil revenues), $\overline{G}$ is the average level of expenditure, and θ measures

TABLE 1 | Regime identification scheme.

Variables			Fiscal regimes identification			
Label	**Description**	**Intercept**	**Countercyclical-pos ($k = 1$)**	**Countercyclical-neg ($k = 2$)**	**Procyclical-neg ($k = 3$)**	**Procyclical-pos ($k = 4$)**
y_{i1t}	Δ GEXP	a_{i1k}	NA	NA	NA	NA
y_{i2t}	Δ GOR	a_{i2k}	+	—	—	+
y_{i3t}	Δ NOFB	a_{i3k}	+	—	+	—
y_{i4t}	Δ Public Emp. / Total Emp.	a_{i4k}	NA	NA	NA	NA
y_{i5t}	Δ Real Oil Price	a_{i5k}	NA	NA	NA	NA
y_{i6t}	Δ Real Exchange Rate	a_{i6k}	NA	NA	NA	NA

Note: The regime identification scheme is common to all countries $i = 1, \ldots, 16$, based on the intercepts a_{ijk} of the variables $j = 1, \ldots, 6$ and regimes $k = 1, 2, 3, 4$. The terminology positive (pos) or negative (neg) refers to a regime where the growth rate of government oil revenues is positive or negative, respectively.

the contemporaneous response of spending to oil income. Under expenditure smoothing, $\theta \approx 0$ and $\overline{G}$ remains stable. In a growing economy, permanent income trends upward, so a more general stylised representation is:

$$\text{GEXP}_t = \overline{G} + g \cdot t + \theta\ y_t^{\text{oil}} + \varepsilon_t,$$

where g denotes the trend growth of permanent income. Equivalently, in growth-rate form:

$$\Delta\text{GEXP}_t = g + \theta\ \Delta y_t^{\text{oil}} + \varepsilon_t.$$

Under expenditure smoothing $\theta \approx 0$, while g captures the smooth trend that spending shares with non-oil revenues, so that ΔNOFB_t remains approximately zero along the permanent-income path. Because we work in growth rates and leave the intercept on ΔGEXP_t unrestricted (see Table 1), this trend component is absorbed by the regime-specific intercept, and our identification of deviations from the permanent-income benchmark is unaffected. In our empirical framework, deviations from this benchmark show up as changes in the regime-specific reduced-form intercepts of the panel MS-VAR, which represent the unconditional means of each regime. A higher intercept in high-revenue states indicates that expenditure systematically co-moves with oil income.

We use this feature to classify fiscal regimes. Regimes with higher expenditure intercepts when oil revenues are high are interpreted as *procyclical*, while regimes with lower or unchanged intercepts are *countercyclical* or *acyclical*. Shifts in the intercepts thus provide direct evidence of systematic fiscal behaviour across regimes and offer a reduced-form counterpart to the permanent-income benchmark.

Table 1 summarises the restrictions imposed on the intercepts of the growth rate of the *non-oil fiscal balance* and *government oil revenues*, which are the key variables used to identify the fiscal-policy regimes. The intercepts of the other variables are left unrestricted. The restrictions define four regimes, allowing for asymmetry between periods of *positive (pos)* and *negative (neg)* changes in government oil revenues. When oil revenues rise (*pos*) and the non-oil fiscal balance also improves, fiscal policy is **countercyclical-pos**, reflecting a “saving-in-booms” behaviour (regime 1). When oil revenues fall (*neg*) and the non-oil fiscal balance deteriorates, policy is **countercyclical-neg**, corresponding to “support-in-busts” (regime 2). Conversely, when oil revenues fall (*neg*) but the non-oil fiscal balance improves, governments are **procyclical-neg**, tightening fiscal policy during downturns (regime 3). Finally, when oil revenues rise (*pos*) and the non-oil fiscal balance weakens, policy is **procyclical-pos**, representing “overspending in booms” (regime 4).

These four configurations capture the main systematic fiscal responses to changes in oil revenues and provide the basis for the regime probabilities and intercept estimates discussed in Section 4. Note also that the sign restrictions used for regime classification are imposed only on the regime-specific intercepts $a_i(s_{it})$. The autoregressive coefficient matrices A_{ip} are not sign-restricted, but they are assumed to be constant across regimes, as specified in Equation (1).[14] Regime dependence therefore enters through the intercepts $a_i(s_{it})$ and covariance matrices $\Sigma_i(s_{it})$ only. The covariance matrices are regime-specific and otherwise unrestricted. Therefore, our approach assumes a minimum set of restrictions and allows us to investigate the extent to which different regimes can be characterised by different volatility.

3.2.1 | Relation to the SVAR Literature

Our identification strategy is related to, but conceptually distinct from, the structural VAR (SVAR) literature that separates policy into systematic and unsystematic components, see, for example, Arias et al. (2019) and Caldara and Kamps (2017). In that framework, identifying a policy shock requires recovering the underlying policy rule, and exclusion or sign restrictions are imposed on contemporaneous relationships to deliver impulse responses with structural interpretation.

To clarify how our approach differs, consider a simplified two-equation system for government oil revenues and the non-oil fiscal balance:

$$\Delta GOR_t = \mu^{GOR}(s_t) + \varepsilon_t^{GOR}, \tag{8}$$

$$\Delta NOFB_t = \mu^{NOFB}(s_t) + \alpha\ \Delta GOR_t + \varepsilon_t^{NOFB}. \tag{9}$$

where ε_t^{GOR} and ε_t^{NOFB} are i.i.d., independent for $t - j \neq t$, with standard deviations σ^{GOR} and σ^{NOFB}. Stacking, we obtain the reduced-form representation:

$$\begin{bmatrix} \Delta GOR_t \\ \Delta NOFB_t \end{bmatrix} = \underbrace{\begin{bmatrix} \mu^{GOR}(s_t) \\ \mu^{NOFB}(s_t) + \alpha \ \mu^{GOR}(s_t) \end{bmatrix}}_{\text{reduced-form intercept}} + \begin{bmatrix} 1 & 0 \\ \alpha & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{GOR} \\ \varepsilon_t^{NOFB} \end{bmatrix}. \tag{10}$$

This simple system shows that the reduced-form intercepts are linear combinations of the structural constants (μ_{GOR}, μ_{NOFB}) and the contemporaneous coefficient (α). Accordingly, the regime-specific intercepts in our panel Markov-switching VAR capture average drifts in fiscal stance.

This distinction is central for understanding how our approach differs from the SVAR literature. SVARs aim to identify structural shocks and policy rules, typically relying on strong timing or behavioural assumptions to obtain impulse responses with structural interpretation. Our objective is different: we impose sign restrictions on reduced-form intercepts to classify regime-dependent fiscal behaviour. These intercepts summarise systematic patterns across regimes but do not identify shocks or structural dynamics.

In this respect, our approach is conceptually related to set-identified SVARs, which use sign restrictions to restrict the admissible space of responses, but the objects of interest differ. Whereas SVARs seek structural policy shocks, we classify systematic regime-dependent behaviour. The two approaches are therefore complementary: SVARs uncover structural dynamics under explicit identifying assumptions, while our method provides a transparent, data-driven classification of fiscal regimes across a heterogeneous multi-country panel.

3.3 | Parameter Estimation

A Gibbs sampler is used for posterior approximation (see, for example, Krolzig 1997; Frühwirth-Schnatter 2006; Canova and Ciccarelli 2009; Billio et al. 2016; Agudze et al. 2022; Casarin et al. 2019). The sampler iterates over different blocks of unit-specific parameters in Equation (3).

We define $\mathbf{y}_i = \text{vec}(\mathbf{y}_{i1}, \ldots, \mathbf{y}_{iT_i})$ as the MT_i-dimensional vector of observations collected over time for the i-th unit of the panel and $\mathbf{y} = \text{vec}(\mathbf{y}_1, \ldots, \mathbf{y}'_N)'$ as the $(\sum_i^N MT_i)$-dimensional vector of observations collected over time and panel units. Moreover, we define $\boldsymbol{\xi} = \text{vec}(\Xi_1, \ldots, \Xi_N)$ as the $(\sum_i^N KT_i)$-dimensional vector of allocation variables, with $\Xi_i = (\xi_{i1}, \ldots, \xi_{iT})$. The vector of regression coefficients is defined as $\boldsymbol{\gamma} = \text{vec}(\boldsymbol{\gamma}_1, \ldots, \boldsymbol{\gamma}_N)$, where $\boldsymbol{\gamma}_i = \text{vec}(\boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i1}, \ldots, \boldsymbol{\gamma}_{iK})$. Moreover, we define the set of covariance matrices, $\Sigma = (\Sigma_1, \ldots, \Sigma_N)$, and the transition probability vector, $\boldsymbol{\pi} = \text{vec}(\boldsymbol{\pi}_1, \ldots, \boldsymbol{\pi}_N)$, where $\boldsymbol{\pi}_i$ is a K-dimensional transition matrix.

Under the conditional independence assumption, the complete data likelihood function associated with the PMS-VAR model writes as:

$$p(\mathbf{y}, \xi | \boldsymbol{\gamma}, \Sigma, \boldsymbol{\pi}) = \prod_{i=1}^{N} p(\mathbf{y}_i, \xi | \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) \tag{11}$$

where:

$$p(\mathbf{y}_i, \xi | \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) = (2\pi)^{-\frac{T_i M}{2}} \prod_{t=\tau_i}^{T_i} |\Sigma_i(s_{it})|^{-\frac{1}{2}} \exp\left\{ -\frac{1}{2} \mathbf{u}'_{it} \Sigma_i(s_{it})^{-1} \mathbf{u}_{it} \right\} \prod_{k,l=1}^{K} \pi_{i,kl}^{\xi_{ikt}\xi_{ilt-1}} \tag{12}$$

with $\mathbf{u}_{it} = \mathbf{y}_{it} - ((1, \xi'_{it}) \otimes I_M) X_{it} \boldsymbol{\gamma}_i$ and $X_{it} = (\boldsymbol{\iota}_K \otimes (I_M \otimes \overline{\mathbf{x}}'_{i0t}), I_{KM})$. The joint posterior distribution associated with the likelihood function and the prior distribution is not tractable, and this calls for the use of posterior approximation methods. In this paper, we apply MCMC and derive the following Gibbs sampling algorithm.

Let us define $\boldsymbol{\gamma}_{i(-k)} = (\boldsymbol{\gamma}_{i1}, \ldots, \boldsymbol{\gamma}_{ik-1}, \boldsymbol{\gamma}_{ik+1}, \ldots, \boldsymbol{\gamma}_{iK})$ and $\Sigma_{i(-k)} = (\Sigma_{i1}, \ldots, \Sigma_{ik-1}, \Sigma_{ik+1}, \ldots, \Sigma_{iK})$. The first block in the Gibbs sampler is:

i. for $i = 1, \ldots, N$, draw $\boldsymbol{\gamma}_{i0}$ from $f(\boldsymbol{\gamma}_{i0} | \mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_i, \Sigma_i, \lambda_0)$. The conditional posterior distribution of the parameter $\boldsymbol{\gamma}_{i0}$ is a normal density with the mean and variance values given in Equation (C.8) in Online Appendix C.

The second block consists of the following steps:

ii. for $i = 1, \ldots, N$ and $k = 1, \ldots, K$ draw:
   - ii.a. $\boldsymbol{\gamma}_{ik}$ from $f(\boldsymbol{\gamma}_{ik} | \mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i(-k)}, \Sigma, \lambda_k)$. The conditional posterior distribution of the parameter $\boldsymbol{\gamma}_{ik}$ is a normal density with the mean and variance values given in (C.9) in Online Appendix C.
   - ii.b. Σ_{ik}^{-1} from $f(\Sigma_{ik}^{-1} | \mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i, \Sigma_{i(-k)})$. The conditional posterior distribution of the parameter Σ_{ik}^{-1} is a Wishart density with scale and location values given in Equation (C.10) in Online Appendix C.
   - ii.c. $(\pi_{i,1k}, \ldots, \pi_{i,K-1\ k})$ from a Dirichlet distribution $f(\boldsymbol{\pi}_{ik} | \mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i)$.

In the third block, the Gibbs sampler generates for each regime $k = 1, \ldots, K$ and unit $i = 1, \ldots, N$:

iii. The locations of time-invariant and time-variant hierarchical posterior distributions are computed as:
   - iii.a. λ_0 from the normal distribution $f(\lambda_0 | \boldsymbol{\gamma}_0, \Sigma_0)$ given in Equation (C.11) in Online Appendix C;
   - iii.b. λ_k from the normal distribution $f(\lambda_k | \mathbf{d}_k, \boldsymbol{\gamma}_k, \Sigma_k)$ given in Equation (C.12) in Online Appendix C;

In the last block, the Gibbs sampler generates Ξ from the posterior $p(\Xi | \mathbf{y}_{1:T}, \boldsymbol{\gamma}, \Sigma, \boldsymbol{\alpha})$ by standard Forward Filtering Backward Sampling for each unit i of the panel given the other unit hidden states (e.g., see Billio et al. 2016). Further details are given in Online Appendix C.

4 | Empirical Results

Below, we present the empirical results for the overall panel of countries. We fixed the number of autoregressive lags, $p = 4$, to account for the yearly variability of the fiscal variables. Our main

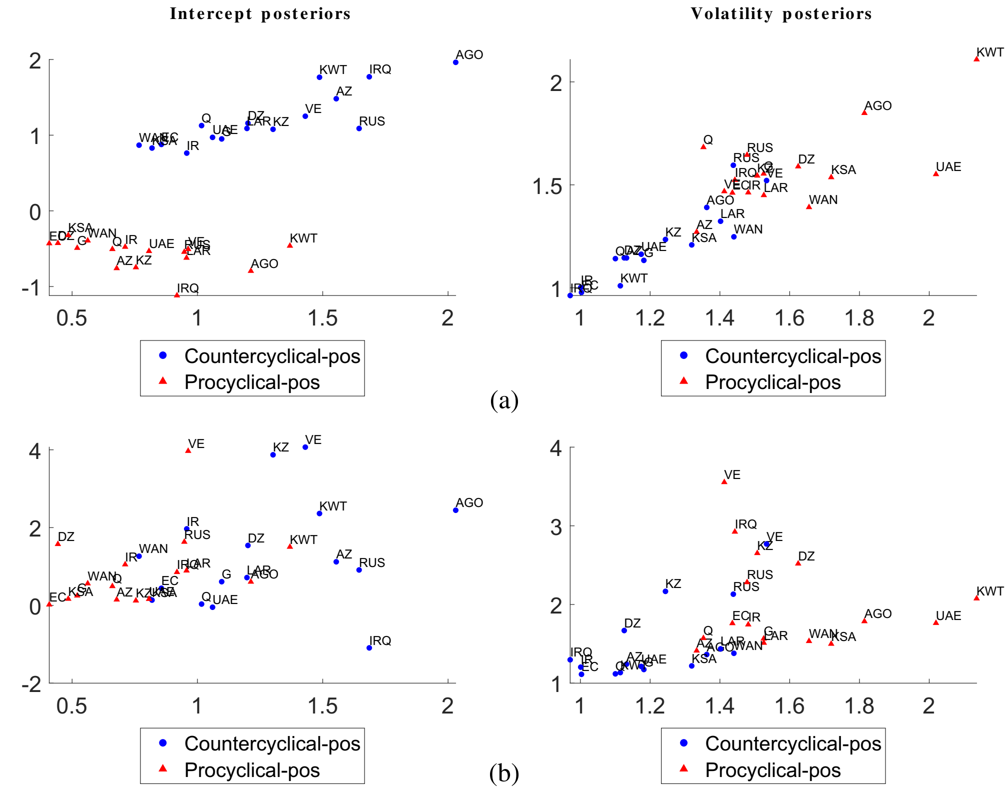

FIGURE 2 | Positive change in government oil revenues. (a) Non-oil fiscal balance (vertical axis) plotted against government oil revenues (horizontal axis), (b) total government expenditure (vertical axis) plotted against government oil revenues (horizontal axis). Intercept posteriors (left panels) and volatility posteriors (right panels) for the growth in non-oil fiscal balance (top row) and the growth in total government expenditure (bottom row), both plotted against growth in government oil revenues. We focus on the means of the posteriors. Blue dots represent the countercyclical-pos regime ($k = 1$, as defined in Table 1), whereas the red triangles refer to the procyclical-pos regime ($k = 4$, as defined in Table 1). Acronyms are as follows: Algeria (DZ), Angola (AGO), Azerbaijan (AZ), Ecuador (EC), Gabon (G), Iran (IR), Iraq (IRQ), Kazakhstan (KZ), Kuwait (KWT), Libya (LAR), Nigeria (WAN), Qatar (Q), Russia (RUS), Saudi Arabia (KSA), United Arab Emirates (UAE), Venezuela (VE).

focus is to characterise the behaviour of the fiscal policy regimes, before examining the periods in which fiscal policy was procyclical or countercyclical. We do so by first summarising the posterior estimates and then turning to describe the regime probabilities. Finally, we focus on fiscal policy in two major oil economies, namely Russia and Saudi Arabia.

4.1 | Posterior Estimates of Intercept and Volatility for the Overall Panel

We start this section by presenting intercept and volatility posteriors. Here, we focus on the means of the posteriors, while the complete distributions are reported in Online Appendix D. Following the identification proposed in Section 3, we distinguish between a procyclical and a countercyclical regime, for decreasing or increasing oil revenues. Hence, we have four regimes. To recap, we assume that a procyclical fiscal policy regime is a scenario in which expansionary (or contractionary) fiscal policy, measured by a negative (or positive) change in the non-oil fiscal balance, is associated with a positive (or negative) change in government oil revenues. In either case, fiscal policy would be exacerbating cyclical fluctuations in the economy. On the other hand, a countercyclical fiscal policy regime is a scenario in which expansionary (or contractionary) fiscal policy is associated with a negative (or positive) change in the non-oil fiscal balance and a negative (or positive) change in government oil revenues. In these cases, fiscal policy would be dampening cyclical fluctuations in the economy.

First, we examine the regimes with a positive change in government oil revenues in Figures 2 and 3, followed by a negative change in government oil revenues in Figures 4 and 5. In all figures, the left panels refer to the intercept posterior estimates (a_i), whereas the right panels refer to the volatility posterior estimates (σ_i). All figures show scatter plots of selected variables plotted against government oil revenues. In particular, Figure 2, panel (a) focuses on non-oil fiscal balance, whereas panel (b) focuses on government expenditures. Figure 3, panel (a) displays the results for public employment, whereas panel (b) focuses on the real exchange rate. In Figures 2–3, the blue dots represent the countercyclical-pos regime ($k = 1$, as defined in Table 1), whereas the red triangles refer to the procyclical-pos regime ($k = 4$, as defined in Table 1).

Starting with Figure 2a, from the right panel, we note that the posterior estimates for volatility of the non-oil fiscal balance are higher in the procyclical regime than in the countercyclical regime. The countries that show the highest volatility in the procyclical regime are Kuwait, Angola, Qatar and Russia. This result suggests that an increase in oil revenues in these countries is associated with large changes in the

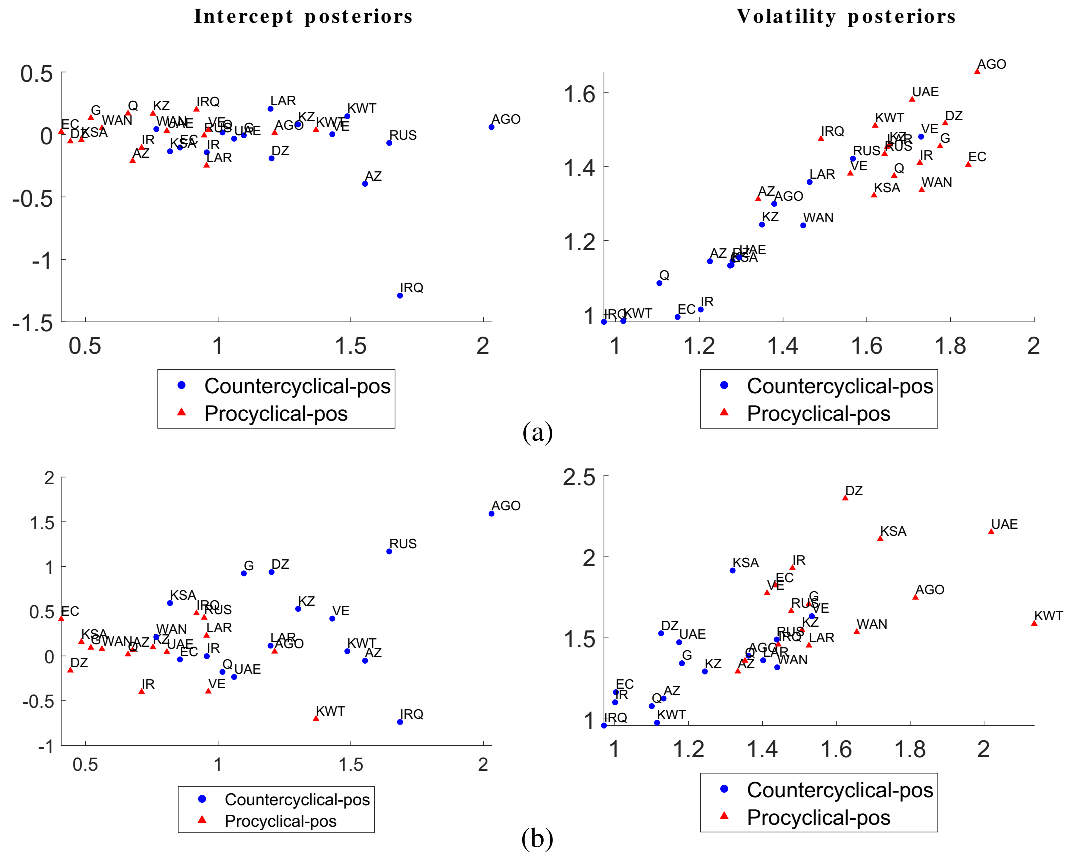

FIGURE 3 | Positive change in government oil revenues. (a) Public employment/total employment (vertical axis) plotted against government oil revenues (horizontal axis) (b) Real exchange rate (vertical axis) plotted against government oil revenues (horizontal axis). Intercept posteriors (left panels) and volatility posteriors (right panels) for the growth in the public employment ratio (top row) and the real exchange rate (bottom row), both plotted against the growth in government oil revenues. We focus on the means of the posteriors. Blue dots represent the countercyclical-pos regime ($k = 1$, as defined in Table 1), whereas the red triangles refer to the procyclical-pos regime ($k = 4$, as defined in Table 1). Acronyms are as follows: Algeria (DZ), Angola (AGO), Azerbaijan (AZ), Ecuador (EC), Gabon (G), Iran (IR), Iraq (IRQ), Kazakhstan (KZ), Kuwait (KWT), Libya (LAR), Nigeria (WAN), Qatar (Q), Russia (RUS), Saudi Arabia (KSA), United Arab Emirates (UAE), Venezuela (VE).

volatility of the non-oil fiscal balance in the procyclical regime.

Turning to the left panel, we observe a clear difference in the regimes. In line with our imposed identifying assumption, the growth in non-oil fiscal balance falls in the procyclical regime, but is positive in the countercyclical regime. Interestingly, we note a more dispersed response in the intercept estimates in the countercyclical regime, where countries such as Kuwait, Angola, Iraq, Azerbaijan, Venezuela and Russia have the largest growth in the non-oil fiscal balance.

Turning to government expenditure in Figure 2b, we confirm the main picture from above: from the right panel, we observe that the posterior for volatility is higher in the procyclical regime than in the countercyclical regime. The countries that experience the highest volatility in the procyclical regime are Venezuela, Iraq, Kazakhstan, Algeria and Russia. This result suggests that an increase in oil revenues in these countries causes the most volatile changes in their government spending in the procyclical regime. The left panel of the same figure shows that the intercepts for government expenditure are mostly positive in both regimes, although they are more dispersed in the countercyclical regime.

The right panel of Figure 3a once again confirms that volatility for public employment is higher in the procyclical regime than in the countercyclical regime. We also note from the left panel that while public employment responses are clustered around zero in the procyclical regime (showing little variation), results are again slightly more dispersed in the countercyclical regime, with some countries having reductions in public employment, whereas others have increases. This indicates heterogeneity across countries in response to increased government oil revenues in this fiscal policy regime.

Figure 3b displays the responses of the real exchange rate in the procyclical and countercyclical regimes. Focusing on the intercept values in the left panel, we note that in the procyclical regime the exchange rates mostly appreciate (increase) when government oil revenues increase, with the exception of Algeria, Iran, Kuwait and Venezuela, where their exchange rates depreciate. In the countercyclical regime, the intercepts of the exchange rate are more dispersed: most countries experience large appreciations, with the exceptions of Iraq, Qatar and the UAE. Finally, from the right panel, we note that the procyclical regime is associated with more volatile exchange rate changes than the countercyclical regime.

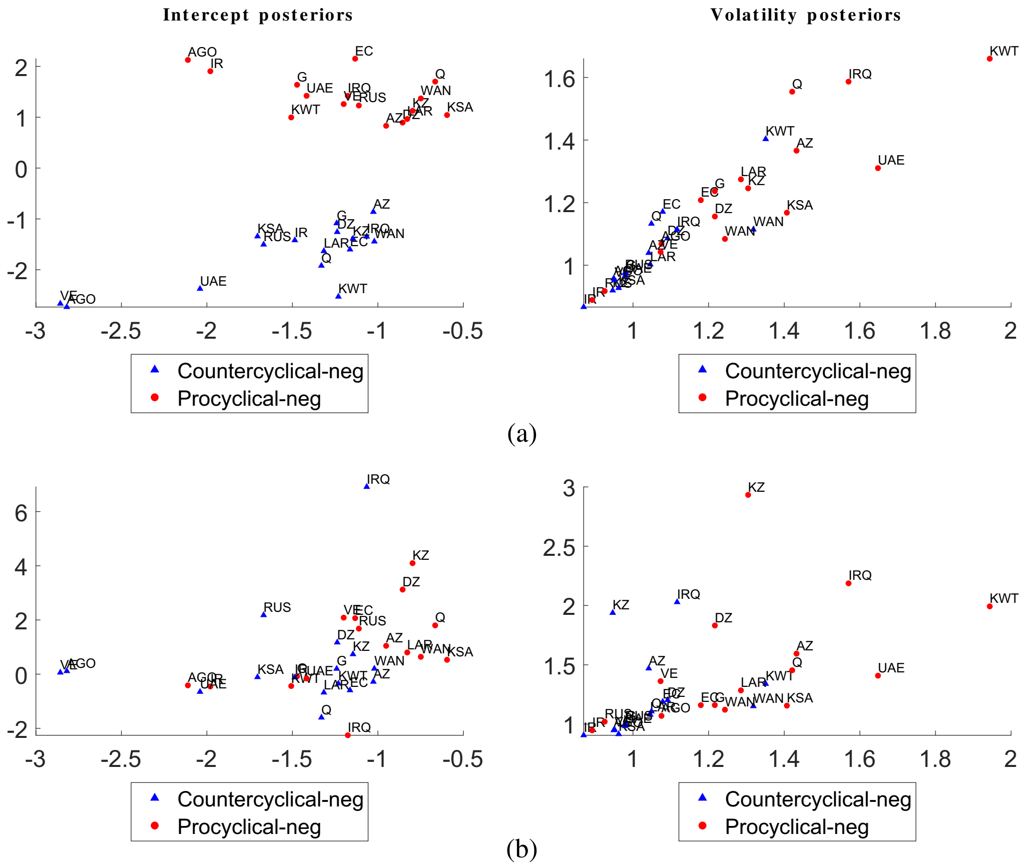

FIGURE 4 | Negative change in government oil revenues. (a) Non-oil fiscal balance (vertical axis) plotted against government oil revenues (horizontal axis), (b) Total government expenditure (vertical axis) plotted against government oil revenues (horizontal axis). Intercept posteriors (left panels) and volatility posteriors (right panels) for the growth in non-oil fiscal balance (top row) and total government expenditure (bottom row), both plotted against growth in government oil revenues. We focus on the means of the posteriors. Blue triangles represent the countercyclical-neg regime ($k = 2$, as defined in Table 1), whereas the red dots represent the procyclical-neg regime ($k = 3$, as defined in Table 1). Acronyms are as follows: Algeria (DZ), Angola (AGO), Azerbaijan (AZ), Ecuador (EC), Gabon (G), Iran (IR), Iraq (IRQ), Kazakhstan (KZ), Kuwait (KWT), Libya (LAR), Nigeria (WAN), Qatar (Q), Russia (RUS), Saudi Arabia (KSA), United Arab Emirates (UAE), Venezuela (VE).

Having investigated fiscal regimes when oil revenues are increasing, we now turn to the regimes when oil revenues are declining (Figures 4 and 5). In these figures, the blue dots represent the countercyclical-neg regime ($k = 2$, as defined in Table 1), whereas the red triangles refer to the procyclical-neg regime ($k = 3$, as defined in Table 1). Starting with Figure 4a, the left panel shows, in line with our identifying restrictions, that when oil revenues fall, non-oil fiscal balance increases in the procyclical regime and declines in the countercyclical regime. Compared to the case when oil revenues increased, we observe that heterogeneity is smaller across regimes, although the countercyclical regime is still the most dispersed. The right panel shows that when oil revenues fall, volatility is higher in the procyclical regime compared to the countercyclical regime. Kuwait, Iraq and Qatar are the countries that show the highest volatility.

Turning to government spending in Figure 4b, the right panel indicates again that the volatility of government spending is higher in the procyclical regime than in the countercyclical regime. This is particularly evident for Kazakhstan, Iraq, Kuwait and Algeria. Thus, government spending varies greatly in response to lower oil revenues in the procyclical regime for these countries. From the left panel, we observe a strong heterogeneity in terms of government spending across countries both in the procyclical and countercyclical regimes. In particular, when oil revenues fall, there is no clear evidence that government expenditures are cut. This is consistent with the results in Arezki and Bruckner (2010) and Arezki and Ismail (2013).

From the right panel of Figure 5a, we observe that the volatility of public employment is higher in the procyclical regime than in the countercyclical regime. In particular, Azerbaijan, Iraq and Qatar display the highest volatility. This implies that, for these countries, when oil revenues decrease, public employment relative to total employment tends to change substantially in the procyclical regime. The left panel shows that most countries are dispersed around zero, suggesting no typical pattern for public employment (relative to total employment) when oil revenues fall.

Finally, the left panel of Figure 5b shows that in almost all countries, the exchange rate depreciates when oil revenues fall, and there seems to be no clear difference between the procyclical and countercyclical regimes. From the right panel, however, we still see that the procyclical regime has the highest volatility.

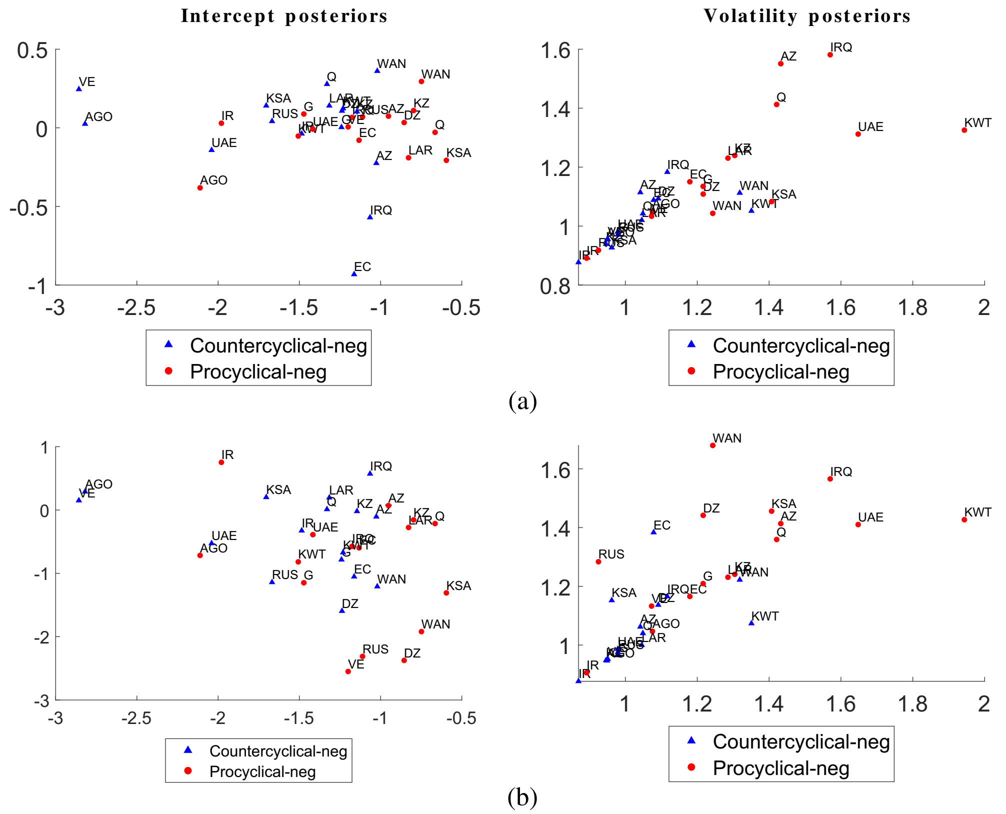

FIGURE 5 | Negative change in government oil revenues. (a) Public employment/total employment (vertical axis) plotted against government oil revenues (horizontal axis), (b) Real exchange rate (vertical axis) plotted against government oil revenues (horizontal axis) Intercept posteriors (left panels) and volatility posteriors (right panels) for the growth in the public employment ratio (top row) and the real exchange rate (bottom row), both plotted against the growth in government oil revenues. We focus on the means of the posteriors. Blue triangles represent the countercyclical-neg regime ($k = 2$, as defined in Table 1), whereas the red dots represent the procyclical-neg regime ($k = 3$, as defined in Table 1). Acronyms are as follows: Algeria (DZ), Angola (AGO), Azerbaijan (AZ), Ecuador (EC), Gabon (G), Iran (IR), Iraq (IRQ), Kazakhstan (KZ), Kuwait (KWT), Libya (LAR), Nigeria (WAN), Qatar (Q), Russia (RUS), Saudi Arabia (KSA), United Arab Emirates (UAE), Venezuela (VE).

To summarise, by simply restricting the intercept responses of a few variables, we have been able to identify systematic differences in the pro- and countercyclical regimes. By doing so, we uncover new empirical regularities about fiscal policy in oil-rich countries. In particular, we show that volatility is higher in the procyclical fiscal policy regime than in the countercyclical regime and that the procyclical behaviour exacerbates (rather than smooths) the cycles. We also show that, following either an increase or decrease in oil revenues, the growth in government expenditure mostly increases. This indicates that there is an upward bias in expenditures, in line with the model predictions of Arezki and Bruckner (2010). We also find that the exchange rate mostly appreciates following an increase in oil revenues, but depreciates when oil revenues fall, independent of the regime. We find no particular pattern for public employment. Our findings illustrate that most countries are not able to smooth spending and save more during the booms, thereby exacerbating the business cycles.

4.2 | Regime Probabilities for All Countries

Next, we turn to the description of the regime probabilities. In particular, we focus on the probability of being in the procyclical fiscal policy regime when oil revenues are increasing, that is, procyclical-pos regime ($k = 4$, as defined in Table 1). Figure 6 shows the probabilities of being in this regime, aggregated across all countries (solid blue line), across OPEC countries (solid red line) and across non-OPEC countries (dashed red line).

Three main findings stand out. First, for all countries, there are multiple periods when fiscal policy alternated between a procyclical and a countercyclical regime over the sample. Hence, we find no evidence that fiscal policy has been mostly procyclical over the last few decades, as suggested by Lopez-Murphy and Villafuerte (2010), as well as Bova et al. (2016), or that fiscal policy has been less procyclical over time, as found in Céspedes and Velasco (2014). Instead, we find that countries have alternated between procyclical and countercyclical regimes over the sample.

Second, for the entire sample, the probability of being in the procyclical fiscal policy regime when oil revenues are increasing is higher for the OPEC countries than for the non-OPEC countries. This indicates that, on average, OPEC economies were less able to insulate their fiscal positions from fluctuations in oil revenues than non-OPEC countries. Moreover, we observe that the average regime probabilities in the OPEC and non-OPEC countries have divergent patterns prior to the 2000s. Indeed, the correlation coefficient between the procyclical probabilities of OPEC and

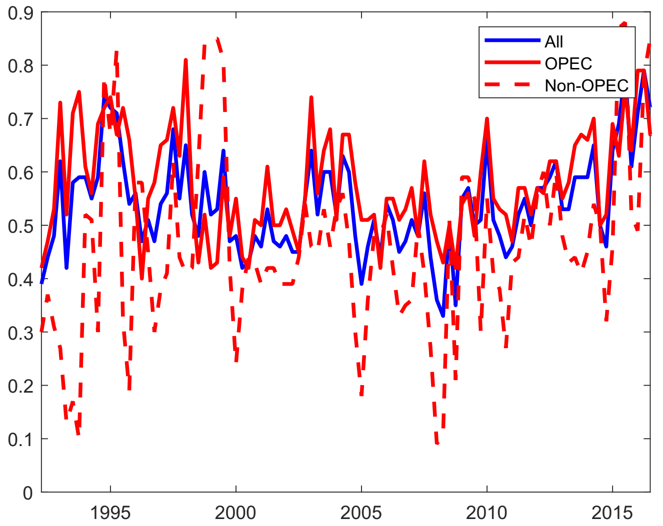

FIGURE 6 | Aggregate probabilities of the procyclical-pos regime for all countries, OPEC and non-OPEC countries. Average regime probability of being in the procyclical-pos regime when the growth of government oil revenues is positive ($k = 4$ regime) aggregated across all countries (solid blue line), OPEC countries (solid red line) and non-OPEC countries (dashed red line).

non-OPEC economies prior to 2000 corresponds to −0.26, but it is positive and equal to 0.54 thereafter, that is, during the commodity boom from the 2000s.

Finally, at least three periods deserve closer scrutiny. The first period corresponds to the intensification of the Asian financial crisis (1996:Q4-1997:Q4). Over this period, the higher real oil price induced an increase in the oil revenues in these resource-rich countries. Accordingly, the OPEC countries first increased their spending in response to this crisis, so fiscal policy became more procyclical. A similar pattern was observed in non-OPEC countries one year later. The second period relates to the oil price surge between 2002 and 2005, which was caused by the increase in oil demand from emerging and oil importing countries (notably, China and India), see Aastveit et al. (2015). During this period, all countries observed a large increase in their oil revenues and, as a consequence, fiscal policy became more procyclical, exacerbating the business cycles in the countries. Finally, the last period that stands out relates to the aftermath of the global financial crisis when the real oil price and oil revenues bounced back from the end of 2009. In this period, both groups of countries, and in particular OPEC countries, adopted a more procyclical fiscal policy. While the expansionary fiscal policy may have prevented a deepening of the recession in countries that had the fiscal space, it also most likely contributed to the recovery of the overall global economy following the global financial crisis.

4.3 | Fiscal Policy in Russia and Saudi Arabia

In the previous section, we analysed the results for the whole panel of countries. Here, we provide some more detail about the regime probabilities for two selected countries: Russia and Saudi Arabia.[15] We focus on these two countries since they are the largest oil producers in our sample, measured by their share of world oil production.[16] Moreover, these countries are interesting to compare for additional reasons: Saudi Arabia is an OPEC member, whereas Russia is not. Hence, although both are large enough to move prices when they change their production volumes, there will be different mechanisms in the price setting. These countries are also diverse in terms of their trade. While 82% of Saudi Arabia's exports came from minerals, fuels, ores and salts over the sample,[17] Russia had a higher level of diversification: in our sample period, on average, Russia's share of exports related to minerals, fuels, ores and salts was just 50%. However, since 2010 this share has increased to 60%.[18]

Figure 7 shows the probability of being in the different regimes in the two countries. As defined in Table 1, we have four regimes: countercyclical-pos ($k = 1$), countercyclical-neg ($k = 2$), procyclical-neg ($k = 3$) and procyclical-pos ($k = 4$). Note that the regimes for $k = 1$ and 4 are defined for increasing oil revenues, while regimes for $k = 2$ and 3 are defined for decreasing oil revenues. Starting with the regime probabilities for Russia (left panel of Figure 7), we note that before 2010 the fiscal policy in Russia alternated between the countercyclical-pos ($k = 1$) and procyclical-pos ($k = 4$) regimes multiple times. Two periods stand out. In 2002/2003, pressures for fiscal relaxation to finance costly reforms increased in line with an increased oil tax windfall (IMF 2004), leading to a procyclical fiscal policy. Between 2004 and 2006, however, fiscal policy became countercyclical. From 2006, fiscal policy was again procyclical, propelled by large terms-of-trade gains, and Russian real GDP growth accelerated in line with increased government oil revenues, setting the stage for procyclical fiscal spending. Since 2010, fiscal policy in Russia has been largely procyclical with the predominance of the regime $k = 4$. In response to the global financial crisis, the Russian government adopted an expansionary fiscal policy that almost entirely took the form of permanent measures (IMF 2010). More recently, the doubling of oil prices following the oil price collapse in 2014 laid the foundation for a recovery that was also supported by a more expansionary fiscal stance. During this period, the share of government expenditure increased (IMF 2017).

Turning to the results for Saudi Arabia, the right panel of Figure 7 shows that the country has predominantly adopted a procyclical fiscal policy. The procyclical fiscal regime that has been dominant relates to high oil revenues and a negative non-oil fiscal balance, that is, procyclical-pos regime ($k = 4$). This fiscal regime was dominant throughout the 1990s. According to SAMA (1995), during this period Saudi Arabia saw a growth in the economy that was mainly attributed to the growth in the government sector through procyclical fiscal spending. In the early 2000s, the Saudi economy experienced record-high growth rates in all its sectors, including the government sector, benefiting from a notable rise in oil prices and revenues (SAMA 2004). During the global financial crisis, oil revenues declined, leading to the procyclical ($k = 3$) regime (low oil revenues and positive non-oil fiscal balance). After 2010, the procyclical behaviour in fiscal policy was due to an increase in oil prices and subsequent enlarged fiscal spending (SAMA 2011). More recently, the oil sector, GDP and expenditures increased, as Saudi Arabia's average daily production of oil also rose, in line with increased oil prices and subsequent higher oil revenues (SAMA 2017).

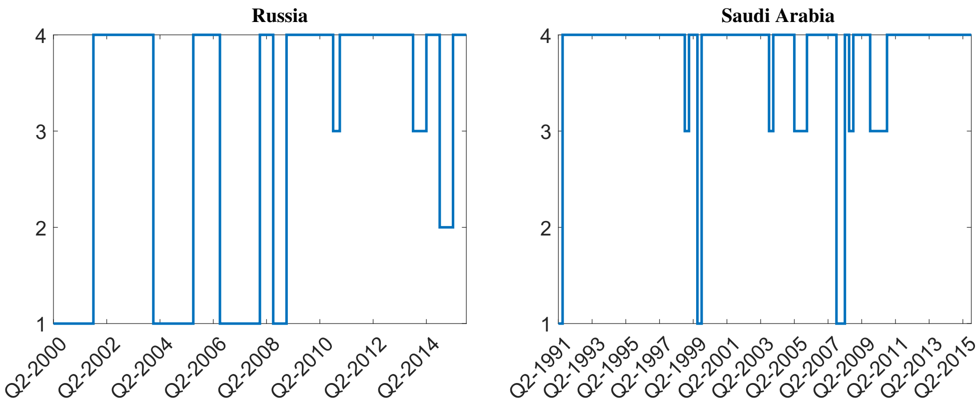

FIGURE 7 | Fiscal policy regimes for Russia and Saudi Arabia. The blue line is the probability of being in the following fiscal policy regimes: countercyclical-pos ($k = 1$), countercyclical-neg ($k = 2$), procyclical-neg ($k = 3$) and procyclical-pos ($k = 4$). Countercyclical-pos regime ($k = 1$): when government oil revenues rise (*pos*) and the non-oil fiscal balance also improves. Countercyclical-neg ($k = 2$): when government oil revenues fall (*neg*) and the non-oil fiscal balance deteriorates. Procyclical-neg ($k = 3$): when government oil revenues fall (*neg*) but the non-oil fiscal balance improves. Procyclical-pos ($k = 4$): when government oil revenues rise (*pos*) and the non-oil fiscal balance weakens. See Table 1 for the full definition of the four regimes.

To sum up, while both countries are predominantly in a procyclical fiscal policy regime, at least after the financial crisis, Russia alternated between the procyclical and countercyclical fiscal policy regimes prior to 2010. Furthermore, while there are some similarities in the timing of the switches between the regimes, that is, the recovery after the oil price decline of 2014/2015, there are many country-specific episodes that need to be accounted for. Hence, studies attempting to analyse fiscal policy across countries using, say, a split sample framework, will misrepresent the changing pattern of how fiscal policy alternates between procyclical and countercyclical regimes.

5 | Conclusion

The significant changes in oil prices that the world has witnessed over the last few decades represent an opportune moment to review how oil-rich countries are conducting fiscal policy in order to manage their resource wealth. In this regard, our paper tries to answer the following question: how do oil-rich countries conduct fiscal policy in light of huge oil price volatility? This question is particularly relevant as there are large costs associated with sharp and unpredictable swings in oil prices and, in turn, oil revenues, for the oil-rich countries. Hence, if not well managed, oil price volatility can destabilise such economies through fiscal policy and undermine their long-term growth.

In this paper, we depart from the idea that fiscal policy is stable over the sample and instead analyse to what extent fiscal policy can switch between procyclical and countercyclical fiscal policy regimes over the cycles. For this purpose, we propose a Bayesian Markov-switching panel model where parameters change between the procyclical and countercyclical fiscal policy regimes over time according to a Markov process. We use parameter restrictions to identify procyclical and countercyclical fiscal policy regimes and evaluate the response of fiscal policy within the different regimes. We rely on data for a large set of oil-exporting countries in order to identify their fiscal regimes based on intercept restrictions. Because our identification uses reduced-form intercepts, the regimes capture systematic fiscal stances rather than structural policy rules.

We find that there are multiple periods over the sample when fiscal policy alternates between a procyclical and a countercyclical regime. Hence, studies attempting to analyse fiscal policy using a split-sample framework will misrepresent the changing pattern of how fiscal policy is operated. Moreover, our results indicate that, for all countries, fiscal variables (government spending, non-oil fiscal balance and public employment) and the real exchange rate are more volatile in the procyclical regime than in the countercyclical regime, and that OPEC countries have a higher probability of being in the procyclical regimes. We also find that following either an increase or decrease in oil revenues, the growth in government expenditures mostly increases, confirming the model predictions in Arezki and Bruckner (2010) of an upward bias in government spending in oil-rich countries. Other institutional mechanisms, including sovereign wealth funds, may also matter, but lie outside the scope of this paper.

Hence, by restricting the intercept responses of a few variables, we have shown that we are able to identify systematic differences in fiscal-policy regimes across countries. In doing so, we uncover new facts about how fiscal policy is conducted in oil-rich economies.

Acknowledgments

The authors thank the Editor Michael McCracken, two anonymous referees, Christiane Baumeister, Raffaella Giacomini, Leif Anders Thorsrud and participants at the Bayesian Analysis and Modeling Research Group Summer Workshop in Melbourne, the third CAMP and CAMA Macroeconomics Workshop in Canberra, the 31st Annual SNDE Symposium, the 12th European Seminar on Bayesian Econometrics and seminar participants at the University of Warwick for their valuable comments. This paper is part of the research activities at the Centre for Applied Macroeconomics, Commodity Prices (CAMP) at the BI Norwegian Business School. The usual disclaimers apply. The views expressed in this paper are those of the authors and do not necessarily reflect those of

Norges Bank. This paper was previously circulated under the title "Oil and Fiscal Policy Regimes". Open access publishing facilitated by Universita degli Studi di Perugia, as part of the Wiley - CRUI-CARE agreement.

Data Availability Statement

The data that support the findings of this study are openly available in the Journal Data Archive at https://doi.org/10.15456/jae.2026143.1450853586.

Endnotes

[1]See Ilzetzki and Végh (2008) for related evidence in developing economies.

[2]Analysing thirty-two oil-exporting countries using panel data, Arezki and Ismail (2013) argue that this asymmetric behaviour could relate to the political pressures that governments in resource-rich countries face, making it easier to increase public spending during commodity price booms rather than cut spending during commodity price busts.

[3]See also Tian and Anderson (2014), who argue more generally that breaks and regime changes are central features of econometric modelling and forecasting.

[4]To deal with the unbalanced panel and to avoid overfitting issues, we will assume a hierarchical prior to model heterogeneity across panel units, including different sample sizes.

[5]As we will explain later, we define non-oil fiscal balance as the difference between non-oil government revenues and government expenditure.

[6]See Giacomini et al. (2022) for discussion of sign-restricted identification.

[7]See Frühwirth-Schnatter (2006) for a review.

[8]According to the definition of the World Bank: "Oil rents are the difference between the value of crude oil production at regional prices and total costs of production" (see World Bank World Development Indicators, 1960–2020, 27th Edition, https://doi.org/10.5257/wb/wdi/2022Q1).

[9]In particular, the real exchange rate may change due to changes in the nominal exchange rate, and/or changes in relative prices. Hence, even for those countries with nominal exchange rates pegged to other currencies, the real exchange rate may change with economic conditions.

[10]Tables A.1–A.4 in the Online Appendix A show sources, samples and frequencies for each variable.

[11]As a robustness check on the quarterly disaggregation procedure, we also estimated the model using annual data for the two countries with sufficiently long annual fiscal series (Nigeria and Saudi Arabia). The annual estimates yield fiscal-regime patterns that are qualitatively similar to those obtained using quarterly data, suggesting that our main findings are not driven by the interpolation method or by spurious co-movement induced by the quarterly indicator. Results are available upon request.

[12]Full details of the parameter estimation, including prior distributions, are provided in Online Appendix C.

[13]The parameters of our MS model are *strictly* identified; see Allman et al. (2009).

[14]There is extensive empirical evidence for specifications in which regime dependence enters through intercepts and volatility parameters, while autoregressive coefficients are kept regime-invariant; see, for example, (Clements and Krolzig 1998; Krolzig 2000; Billio et al. 2012; and Baştürk et al. 2014).

[15]We show results for the remaining countries of our sample in Online Appendix E. As a robustness check, we have also estimated the model for two advanced oil-producing economies, Canada and Norway. The regime patterns are similar to those in our main sample, with both countries spending most of the sample in the procyclical-pos regime and exhibiting only brief switches into the other regimes. Results are available upon request.

[16]During the period 1992-2016, Russia and Saudi Arabia's shares of world oil production were 12% and 13%, respectively.

[17]Vision 2030 aims to diversify the Saudi Arabian economy and its exports (CEDA 2016).

[18]See the Comtrade database (UN 2023) for more details about the current gross exports disaggregated by product type for Russia and Saudi Arabia. The sample period of these data corresponds to 1995-2016.

References

Aastveit, K. A., H. C. Bjørnland, and L. A. Thorsrud. 2015. "What Drives Oil Prices? Emerging Versus Developed Economies." *Journal of Applied Econometrics* 30, no. 7: 1013–1028.

Agudze, K. M., M. Billio, R. Casarin, and F. Ravazzolo. 2022. "Markov Switching Panel With Endogenous Synchronization Effects." *Journal of Econometrics* 230, no. 2: 281–298.

Allman, E., C. Matias, and J. Rhodes. 2009. "Identifiability of Parameters in Latent Structure Models With Many Observed Variables." *Annals of Statistics* 37, no. 6A: 3099–3132.

Arezki, R., and M. Bruckner. 2010. *International Commodity Price Shocks, Democracy, and External Debt*. International Monetary Fund.

Arezki, R., and K. Ismail. 2013. "Boom-Bust Cycle, Asymmetrical Fiscal Response and the Dutch Disease." *Journal of Development Economics* 101: 256–267.

Arias, J. E., D. Caldara, and J. F. Rubio-Ramírez. 2019. "The Systematic Component of Monetary Policy in SVARs: An Agnostic Identification Procedure." *Journal of Monetary Economics* 101: 1–13.

Barro, R. J. 1979. "On the Determination of Public Debt." *Journal of Political Economy* 87: 940–971.

Baştürk, N., C. Çakmakli, S. P. Ceyhan, and H. K. Van Dijk. 2014. "Posterior-Predictive Evidence on US Inflation Using Extended New Keynesian Phillips Curve Models With Non-Filtered Data." *Journal of Applied Econometrics* 29, no. 7: 1164–1182.

Billio, M., R. Casarin, F. Ravazzolo, and H. K. van Dijk. 2012. "Combination Schemes for Turning Point Predictions." *Quarterly Review of Economics and Finance* 52, no. 4: 402–412.

Billio, M., R. Casarin, F. Ravazzolo, and H. Van Dijk. 2016. "Interactions Between Eurozone and US Booms and Busts: A Bayesian Panel Markov-Switching VAR Model." *Journal of Applied Econometrics* 31, no. 7: 1352–1370.

Bjørnland, H. C., and L. A. Thorsrud. 2016. "Boom or Gloom? Examining the Dutch Disease in Two-Speed Economies." *Economic Journal* 126, no. 598: 2219–2256.

Bjørnland, H. C., and L. A. Thorsrud. 2019. "Commodity Prices and Fiscal Policy Design: Procyclical Despite a Rule." *Journal of Applied Econometrics* 34, no. 2: 161–180.

Blanchard, O., and R. Perotti. 2002. "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output." *Quarterly Journal of Economics* 117, no. 4: 1329–1368.

Bova, E., P. Medas, and T. Poghosyan. 2016. "Macroeconomic Stability in Resource-Rich Countries: The Role of Fiscal Policy," Working Paper 2016/16/36, IMF.

Caldara, D., and C. Kamps. 2017. "The Analytics of SVARs: A Unified Framework to Measure Fiscal Multipliers." *Review of Economic Studies* 83, no. 3: 1015–1040.

Canova, F., and M. Ciccarelli. 2004. "Forecasting and Turning Point Predictions in a Bayesian Panel VAR Model." *Journal of Econometrics* 120, no. 2: 327–359.

Canova, F., and M. Ciccarelli. 2009. "Estimating Multicountry VAR Models." *International Economic Review* 50, no. 3: 929–959.

Casarin, R., C. Foroni, M. Marcellino, and F. Ravazzolo. 2019. "Uncertainty Through the Lenses of a Mixed-Frequency Bayesian Panel Markov Switching Model." *Annals of Applied Statistics* 12, no. 4: 2559–2586.

CEDA. 2016. "Saudi Vision 2030," Discussion Paper, Kingdom of Saudi Arabia, Council of Economic and Development Affairs.

Céspedes, L., and A. Velasco. 2014. "Was This Time Different? Fiscal Policy in Commodity Republics." *Journal of Development Economics* 106: 92–106.

Clements, M. P., and H.-M. Krolzig. 1998. "A Comparison of the Forecast Performance of Markov-Switching and Threshold Autoregressive Models of US GNP." *Econometrics Journal* 1, no. 1: 47–75.

Di Fonzo, T., and M. Marini. 2012. "On the Extrapolation With the Denton Proportional Benchmarking Method," IMF Working Papers.

Erbil, N. 2011. "Is Fiscal Policy Procyclical in Developing Oil-Producing Countries?" IMF Working Paper 171.

Feldkircher, M., F. Huber, G. Koop, and M. Pfarrhofer. 2022. "Approximate Inference and Forecasting in Huge-Dimensional Multycountry VARs." *International Economic Review* 63, no. 4: 1625–1658.

Frühwirth-Schnatter, S. 2001. "Markov Chain Monte Carlo Estimation of Classical and Dynamic Switching and Mixture Models." *Journal of the American Statistical Association* 96, no. 453: 194–209.

Frühwirth-Schnatter, S. 2006. *Finite Mixture and Markov Switching Models*. Springer.

Giacomini, R., T. Kitagawa, and A. Volpicella. 2022. "Uncertain Identification." *Quantitative Economics* 13, no. 1: 95–123.

Ilzetzki, E., and C. A. Végh. 2008. "Procyclical Fiscal Policy in Developing Countries: Truth or Fiction?" Discussion Paper, National Bureau of Economic Research.

IMF. 2004. "Russian Federation: Article IV Consultation," Discussion Paper, IMF Country Report, International Monetary Fund.

IMF. 2010. "Russian Federation: Article IV Consultation," Discussion Paper, IMF Country Report, International Monetary Fund.

IMF. 2015. "The Commodities Roller Coaster: A Fiscal Framework for Uncertain Times," Discussion Paper, IMF Fiscal Monitor, International Monetary Fund.

IMF. 2017. "Russian Federation: Article IV Consultation," Discussion Paper, IMF Country Report, International Monetary Fund.

Kaminsky, G. L., C. M. Reinhart, and C. A. Vegh. 2004. "When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies." In *NBER Macroeconomics Annual*, 19. MIT Press.

Koop, G., and D. Korobilis. 2013. "Large Time-Varying Parameter VARs." *Journal of Econometrics* 177, no. 2: 185–198.

Krolzig, H.-M. 1997. *Markov Switching Vector Autoregressions. Modelling, Statistical Inference and Application to Business Cycle Analysis*. Springer.

Krolzig, H.-M. 2000. "Predicting Markov-Switching Vector Autoregressive Processes," Nuffield College Economics Working Papers, 2000-WP31.

Lanne, M., H. Lütkepohl, and K. Maciejowska. 2010. "Structural Vector Autoregressions With Markov Switching." *Journal of Economic Dynamics and Control* 34, no. 2: 121–131.

Leeper, E. M., A. W. Richter, and T. B. Walker. 2012. "Quantitative Effects of Fiscal Foresight." *American Economic Journal: Economic Policy* 4, no. 2: 115–144.

Leeper, E. M., T. B. Walker, and S.-C. S. Yang. 2013. "Fiscal Foresight and Information Flows." *Econometrica* 81, no. 3: 1115–1145.

Lopez-Murphy, P., and M. Villafuerte. 2010. "Fiscal Policy in Oil Producing Countries During the Recent Oil Price Cycle," IMF Working Papers WP/10/28.

Lütkepohl, H., and T. Woźniak. 2020. "Bayesian Inference for Structural Vector Autoregressions Identified by Markov-Switching Heteroskedasticity." *Journal of Economic Dynamics and Control* 113: 103862.

Mertens, K., and M. O. Ravn. 2010. "Measuring the Impact of Fiscal Policy in the Face of Anticipation: A Structural VAR Approach." *Economic Journal* 120, no. 544: 393–413.

Mertens, K., and M. O. Ravn. 2012. "Empirical Evidence on the Aggregate Effects of Anticipated and Unanticipated US Tax Policy Shocks." *American Economic Journal: Economic Policy* 4, no. 2: 145–181.

Netsunajev, A. 2013. "Reaction to Technology Shocks in Markov-Switching Structural VARs: Identification via Heteroskedasticity." *Journal of Macroeconomics* 36: 51–62.

Ramey, V. A. 2011. "Identifying Government Spending Shocks: It's All in the Timing." *Quarterly Journal of Economics* 126, no. 1: 1–50.

Rubio-Ramirez, J. F., D. Waggoner, and T. Zha. 2006. "Markov-Switching Structural Vector Autoregressions: Theory and Application." In *Computing in Economics and Finance 2006*, vol. 69. Society for Computational Economics.

SAMA. 1995. "Thirty-Second Annual Report," Discussion Paper, Saudi Arabian Monetary Agency, Research and Statistics Department.

SAMA. 2004. "Fortieth Annual Report," Discussion Paper, Saudi Arabian Monetary Agency, Research and Statistics Department.

SAMA. 2011. "Forty-Seven Annual Report," Discussion Paper, Saudi Arabian Monetary Agency, Research and Statistics Department.

SAMA. 2017. "Fifty-Third Annual Report," Discussion Paper, Saudi Arabian Monetary Agency, Research and Statistics Department.

Schaechter, M. A., M. T. Kinda, M. N. Budina, and A. Weber. 2012. *Fiscal Rules in Response to the Crisis: Toward the Next-Generation Rules: A New Dataset*. International Monetary Fund.

Sturm, M., F. J. Gurtner, and J. Gonzalez-Alegre. 2009. "Fiscal Policy Challenges in Oil-Exporting Countries-A Review of Key Issues," ECB Occasional Paper, 104.

Tian, J., and H. M. Anderson. 2014. "Forecast Combinations Under Structural Break Uncertainty." *International Journal of Forecasting* 30, no. 1: 161–175.

UN. 2023. "United Nations Comtrade Database," Discussion Paper, United Nations, Trade Statistics.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Online Appendix S1**: Supporting Information.