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Oil and Fiscal Policy Regimes

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Abstract

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Keywords

Dynamic Panel Model, Mixed-Frequency, Markov Switching, Bayesian Inference, Fiscal Policy, Resource Rich Countries, Oil Prices

JEL Classification

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Oil and Fiscal Policy Regimes*

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1 Introduction

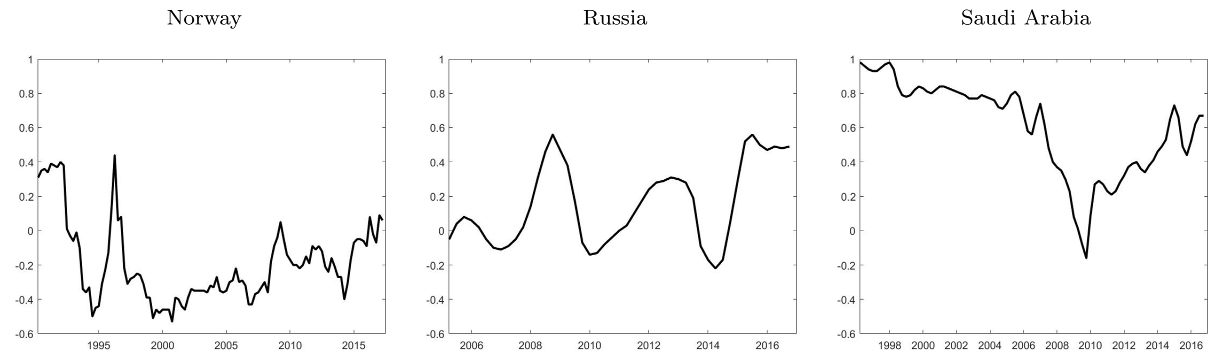
In a standard neoclassical model, fiscal policy should be countercyclical and smoothed over the business cycles (see Barro, 1979). Yet, in many countries fiscal policy is procyclical, so that public spending increases in the boom. This exacerbates the business cycle, leaving the countries more vulnerable in the subsequent recession. The problem seems to be especially worrisome for oil-rich countries. As government oil revenue constitutes a large component of total government revenues, changes in revenues will have a direct impact on public spending. Many resource-rich countries are therefore advised to save parts of their income for rainy days. This would entail government spending to be operated countercyclically, thereby sheltering the economy from fluctuations in revenues and preventing over-spending on the part of the government.

Several papers have investigated the conduct of fiscal policy in oil producing countries, finding evidence of procyclical behaviour. For instance, Lopez-Murphy and Villafuerte (2010) analyse the average fiscal policy responses of oil producing countries to the recent oil price cycle. They find that the non-oil primary balances worsened substantially during the 2003-2008 boom as primary spending increased. Related findings are reported in Bova, Medas, and Poghosyan (2016), suggesting fiscal policy in resource-rich countries have been procyclical during the last decades. Moreover, their findings indicate that the adoption of fiscal rules does not have, on its own, a significant impact on reducing procyclicality, unless supported by strong political institutions. At the other end, Céspedes and Velasco (2014) find results that suggest fiscal policy has been less procyclical over time. Using a panel data analysis, they estimate the response in government expenditures and revenues to commodity prices in a large panel of commodity exporting countries over two different cycles. Doing so they find fiscal spending to be less procyclical in the recent commodity price boom (2000-2009). They argue that the changes have materialised as many countries have improved their institutional quality, i.e., they have adopted fiscal policy rules. This has allowed fiscal policy to be less expansionary when commodity prices increase and more expansionary when commodity prices decrease, i.e., countercyclical behaviour.

One caveat of the above-mentioned studies is that the results will be dependent on the sample under study and the variables examined. As there may be different shocks hitting the economy in different periods, this can affect the results. Countries also adopt fiscal rules in response to changing economic conditions. Fiscal policy design is therefore often particularly complex insofar as countries combine the objectives of sustainability with the need for flexibility in response to shocks. Hence, the conduct of fiscal policy may be changing.

Figure 1 illustrates this well. The figure graphs the correlation between the cyclical component of oil revenues and some fiscal variables in three different oil producing coun-

Figure 1. Five-year rolling correlations between cyclical components of oil revenues and selected fiscal variables in Norway, Russia and Saudi Arabia



(a) Correlations between total government expenditure and government oil revenues

(b) Correlations between the share of public employment (relative to total employment) and government oil revenues

Notes: The cyclical components have been estimated using the Hodrick-Prescott Filter with a smoothing parameter equal to 1,600 on the logarithm of the variables. The sample for Norway is 1990:Q1-2017:Q2, for Russia is 2005:Q1-2016:Q4 and for Saudi Arabia is 1996:Q1-2016:Q4.

tries: Norway, Russia and Saudi Arabia.[1] In particular, Figure 1 (a) exhibits the five-year rolling correlations between government oil revenues and total government expenditure while Figure 1 (b) exhibits the five-year rolling correlations between government oil revenues and the share of public employment (in total employment). The graphs suggest there are large fluctuations in the cyclical pattern for fiscal policy, with the correlation coefficient switching from positive to negative several times over the sample. These aspects call for models with time-varying properties, allowing the cyclical pattern for fiscal policy to change over the sample. Comparing the conduct of fiscal policy on exogenously given sub-periods may therefore yield biased results. This has also been pointed out in Bjørnland and Thorsrud (2019) that analyse fiscal policy in Norway, by controlling for various shocks and allowing for time varying responses.

[1]In Section 2, we present the full list of countries of our empirical analysis.

In this paper we take a different approach. To account for the changing nature of economic conditions and fiscal rules, rather than assuming fiscal policy is constant, we will allow it to switch between regimes of procyclical and countercyclical behaviour over the sample. The switches has a natural interpretation of fiscal policy shocks. Moreover, rather than splitting the sample more or less arbitrarily, and then analysing whether fiscal policy has changed after the split, we infer *when* fiscal policy has been procyclical or countercyclical. 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. Then we use parameter restrictions to identify procyclical and countercyclical fiscal policy regimes, and evaluate fiscal policy's response in the different regimes.

To identify the different regimes, we will place restrictions on the mean responses of variables, keeping volatility unrestricted. We let a procyclical fiscal policy regime be defined as the period when growth in government oil revenues (relative to GDP) and growth in government expenditures (relative to GDP) both increase, or decrease, i.e., a spend as you go fiscal regime. Hence, if oil revenues increase, so does expenditures, and vice versa. A countercyclical fiscal regime, on the other hand, is defined as the period when growth in government oil revenues (relative to GDP) and growth in expenditures (relative to GDP) move in opposite directions. Hence, a countercyclical regime is a period with declining oil revenues is met by increasing government expenditures to smooth the cycle, or vice versa. Based on such minimum identifying restrictions, we can separate a procyclical regime from a countercyclical regime when analysing fiscal policy. We believe this is the first time that fiscal policy has been evaluated in this way.

Our model is applied to 23 oil producing and exporting resource rich countries across the globe, including OECD, non-OECD and OPEC countries. Production from these countries corresponds to 84% of the world oil production. For each country, we collect data on relevant fiscal variables, including government expenditures, government oil revenues, non-oil fiscal balance and public employment. We also include the real oil price, the real exchange rate and real Gross Domestic Product, which are important variables for capturing the economic situation 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 emphasize, however, that while our focus is on analysing fiscal policy in oil-rich countries, the framework suggested may be used for many different policy applications, also for non-oil countries. Indeed, we believe that our MS modelling approach for the analysis of oil fiscal policy presents several advantages over standard linear models. Firstly, fiscal regimes can be easily identified by imposing prior restrictions on the regime-specific intercepts of the variables of interest as we described above. Secondly, the Markov-switching dynamics provides identification schemes for the VAR model based on further restrictions on the switching parameters (see, for example, Rubio-Ramirez, Waggoner, and Zha, 2006; Lanne, Lütkepohl, and Maciejowska, 2010; Netsunajev, 2013), thus avoiding the largely criticized indirect identification methods, such as a recursive identification scheme. In so doing, we extend the idea in Baumeister and Hamilton (2015), Baumeister and Hamilton (2018) and Baumeister and Hamilton (2019) of using Bayesian inference and prior distribution to achieve identification in the inference process. Furthermore, the flexibility of our model makes it possible to compare fiscal policy in a relatively large set of countries and on many variables, that would not be possible adopting a standard VAR model.

We have three main findings. First, we find that there are multiple periods over the sample when fiscal policy is in a procyclical regime. Hence, studies that try to analyse fiscal policy using a split sample framework will misrepresent the changing pattern of how fiscal policy alternates between procyclical and countercyclical regimes. Second, for all countries, government oil revenues and expenditures are always more volatile in the countercyclical regime than in the procyclical regime. This seems plausible, as the decline in oil revenues is often associated with recessionary periods, which are abrupt in nature. Third, in the procyclical regime, fiscal policy is always more volatile and excessive in the non-OECD countries (including OPEC countries) than in the OECD countries. Hence, during the booming periods, when government oil revenues increase, the OECD countries are able to smooth spending and save more than the non-OECD/OPEC countries. A notable exception is the recovery following the oil price decline in 2014/2015, where fiscal policy in OECD and non-OECD countries become more expansionary as oil revenues pick up again. Our results emphasize that it is both possible and important to separate a procyclical regime from a countercyclical regime. Doing so, we have been able to encounter new facts about fiscal policy in oil rich countries.

The remainder of the paper is structured as follows. Section 2 introduces the dataset. Section 3 describes the model and the estimation procedure. Section 4 discusses the results, while Section 5 concludes.

2 Data

We consider the following twenty-three major world oil producing and exporting countries: Algeria, Angola, Australia, Azerbaijan, Canada, Colombia, Ecuador, Gabon, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Nigeria, Norway, Qatar, Russia, Saudi Arabia, UAE, UK, US and Venezuela. These countries are chosen because they represent the majority of

Table 1. Major world oil producing and exporting countries

Average Share of Total Production, 1965-2019		**Average Share of Oil Exports, 1971-2017**	
Country	%	Country	%
US	15.15	Saudi Arabia	18.38
Russia	12.35	Russia	10.00
Saudi Arabia	11.80	Iran	7.63
Iran	5.65	Nigeria	5.36
Venezuela	4.36	United Arab Emirates	5.07
Canada	3.61	Venezuela	5.05
Kuwait	3.47	Iraq	4.70
Mexico	3.40	Kuwait	4.05
Iraq	3.09	Norway	3.83
UAE	3.05	Mexico	3.78
Nigeria	2.61	Libya	3.62
Libya	2.50	Canada	3.54
Norway	2.39	UK	3.20
UK	2.15	Algeria	2.21
Algeria	1.98	Kazakhstan	2.05
Kazakhstan	1.34	Angola	1.85
Qatar	1.11	Qatar	1.59
Angola	0.91	Azerbaijan	0.82
Australia	0.69	Ecuador	0.66
Colombia	0.65	Colombia	0.64
Azerbaijan	0.63	Gabon	0.62
Ecuador	0.43	Australia	0.42
Gabon	0.31	US	0.41
Total	83.63	Total	89.49

Sources: BP Statistical Review of World Energy 2020 and International Energy Agency Oil Information.

world oil producers and exporters. As one can see from Table 1, for the period 1965-2019, the total oil production from these countries corresponds to 84% of world oil production on average over the sample. Table 1 also shows the average share of oil exports for the same set of countries during the period 1971-2017. In total, they add to 89% of world oil exports as an average over the sample. Focusing on individual countries, we observe that Russia and Saudi Arabia are among top three world oil producers and the top two world oil exporters. Norway is the top oil exporter among OECD countries. For this reason, in Section 4, while spelling out the results for all countries, we will also focus in detail on these three countries.

As described in Kaminsky, Reinhart, and Vegh (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 countries in our analysis we consider a set of relevant fiscal variables: total government expenditure relative to GDP ($y_{i1,t}$); government oil revenues relative to GDP ($y_{i2,t}$); non-oil fiscal balance relative to GDP ($y_{i3,t}$) and public employment relative to total employment ($y_{i4,t}$). We also include the real oil price ($y_{i5,t}$) and the real exchange rate ($y_{i6,t}$), which are important variables for capturing the economic situation in resource rich economies.

In total we have 138 variables in our model. The data series are collected from both international and national data sources. The data sample varies according to the data availability of each country.[2] The data is expressed in terms of quarterly growth.[3] For those countries for which data are available only at yearly frequency, we used the Denton method (see Di Fonzo and Marini, 2012) to disaggregate data into quarterly frequency. Appendix B reports a detailed explanation on how we constructed all the variables of our empirical analysis.

3 Model

We jointly model all fiscal variables, including the share of public employment on total employment, the real oil price and the real exchange rate of the oil producing countries following a VAR framework, see 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 prior allows for exchange of information across units and thus is well suited for 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 them, our parameter restrictions identify procyclical and countercyclical regimes. The resulting panel Markov switching VAR (PMS-VAR) model, see Billio, Casarin, Ravazzolo, and Van Dijk (2016); Casarin, Foroni, Marcellino, and Ravazzolo (2019), is applied to make inference on the cyclical fiscal policy of the countries listed in the previous section.

[2]In the online Appendix, we show the number of countries that changes over time in our sample.
[3]Tables B.1-B.4 in Appendix B show the sources, the samples and the frequencies for each variable.

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 depending on Markov chains whereas A_{ip} is kept constant. The residuals are denoted by ε_{it}. Finally, $\{s_{i\,t}\}$ indicate 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 $\boldsymbol{\xi}_{it} = (\xi_{i1t}, \ldots, \xi_{iKt})'$ collects information about the realizations of the i-th unit-specific Markov chain over the sample period. Using these indicator variables, parameter shifts can be written as:

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

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 $\bar{\mathbf{x}}_{i0t} = (\mathbf{y}'_{it-1}, \ldots, \mathbf{y}'_{it-P})'$ and $\bar{\mathbf{x}}_{ikt} = 1$, $k = 1, \ldots, K$. The PMS-VAR in Eq. 1 writes as:

$$\mathbf{y}_{it} = (I_M \otimes \bar{\mathbf{x}}'_{i0t})\boldsymbol{\gamma}_{i0} + \xi_{i1t}\boldsymbol{\gamma}_{i1} + \ldots + \xi_{iKt}\boldsymbol{\gamma}_{iK} + \boldsymbol{\varepsilon}_{it}, \quad \boldsymbol{\varepsilon}_{it} \sim \mathcal{N}_M(\mathbf{0}, \Sigma_i(\boldsymbol{\xi}_{it})) \tag{2}$$

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 $\Sigma_i(\boldsymbol{\xi}_{it}) = \Sigma_i(\boldsymbol{\xi}_{it} \otimes I_M)$ 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 mixture prior, which allows us to model heterogeneity between panel units, including different sample sizes, in combination with a hierarchical specification strategy, which allows us to avoid overfitting issues. In our analysis, we divide OECD versus non-OECD countries. The hierarchical prior value is unique for both groups, but prior believes are updated separately for the two groups. Our decision stems from the fact that we expect *a priori* less uncertain fiscal rules for OECD countries than non-OECD. Moreover, on average, data sample is longer for OECD countries.

For regime identification, we 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. recession and expansion) of the business cycle. We generalize the idea to fiscal policy identification and discuss constraints in Section 3.2. Prior and full posterior distributions are provided in Appendix A. We provide a summary in the next section, before moving to the regime identification in Section 3.2.

3.2 Regimes identification

As emphasized above, the fiscal regimes will be identified by imposing prior restrictions on the regime-specific intercepts of the variables of interest. Regime changes have the interpretation of fiscal policy shocks, thus the prior restrictions on the intercepts can be used to identify procyclical and countercyclical fiscal policy, and the economic identification constrains will be naturally incorporated in the parameter estimates through the prior-posterior updating. This avoids the largely criticized indirect identification methods, such as the recursive (zero) identification scheme. In so doing, we extend the idea in Baumeister and Hamilton (2015), Baumeister and Hamilton (2018) and Baumeister and Hamilton (2019) of using Bayesian inference and prior distribution to achieve identification in the inference process.

Table 2. Regime identification scheme common to all countries $i = 1, \ldots, 23$, based on the intercepts a_{ijk} of the variables $j = 1, \ldots, 6$ and regime $k = 1, 2$.

Variables			Fiscal Regimes Identification	
Label	Description	Intercept	Procyclical ($k = 1$)	Countercyclical ($k = 2$)
y_{i1t}	Total Gov. Exp. / GDP	a_{i1k}	+	+
y_{i2t}	Gov. Oil Rev. / GDP	a_{i2k}	+	-
y_{i3t}	Non-Oil Fiscal Bal. / GDP	a_{i3k}	NA	NA
y_{i4t}	Public Emp. / Total Emp.	a_{i4k}	NA	NA
y_{i5t}	Real Oil Price	a_{i5k}	NA	NA
y_{i6t}	Real Exchange Rate	a_{i6k}	NA	NA

We let the number of regimes be fixed to two, $K = 2$, so that we can identify one regime characterised with procyclical fiscal policy and one regime that is characterised with countercyclical fiscal policy. The restrictions are placed on the intercept parameters $a_i(s_{it})$, whereas autoregressive components are left unrestricted. We interpret the intercept of variable i as the regime conditional expected mean, whereas autoregressive components capture short-term dynamics. Therefore, our restrictions refer to the average patterns in a given regime, even if dynamics can partially vary at each quarter. Furthermore, volatility parameters are left unrestricted (i.e., weak identification) so that we can investigate whether fiscal policy minimizes uncertainty.

Table 2 shows the chosen restrictions to identify the two regimes. In the procyclical regime, intercepts for total government expenditures over GDP and government oil revenues over GDP are both positive. Hence, when growth in government oil revenues relative to GDP increases (decreases), growth in government expenditure relative to GDP increases (decreases). This can be interpreted as a "spend as you go" fiscal regime. In the countercyclical regime, the intercept for total government expenditures over GDP is positive, while the intercept for government oil revenues over GDP is negative.

Hence, when growth in government oil revenues relative to GDP decreases (increases), growth in government expenditure relative to GDP increases (decreases). This can be interpreted as a fiscal regime of saving for a rainy day (i.e., spend more in the recessions).[4] For the other variables, the parameters are left unrestricted.

3.3 Posterior Approximation

A Gibbs sampler is used for posterior approximation, see Krolzig (1997), Frühwirth-Schnatter (2006), Canova and Ciccarelli (2009), Billio, Casarin, Ravazzolo, and Van Dijk (2016), Agudze, Billio, Casarin, and Ravazzolo (2018), Casarin, Foroni, Marcellino, and Ravazzolo (2019). The sampler iterates over different blocks of unit-specific parameters in equation (2).

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

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

$$p(\mathbf{y}, \boldsymbol{\xi} | \boldsymbol{\gamma}, \Sigma, \boldsymbol{\pi}) = \prod_{i=1}^{N} p(\mathbf{y}_i, \boldsymbol{\xi} | \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) \tag{3}$$

[4]Note that the intercepts for the ratios have opposite sign. Still we assume that government oil revenues and GDP move in the same direction. Hence, if the government oil revenues over GDP increase, total government expenditure must decrease (or vice versa) in the countercyclical regime.

where:

$$p(\mathbf{y}_i, \boldsymbol{\xi}|\boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) = (2\pi)^{-\frac{T_i M}{2}} \prod_{t=\tau_i}^{T_i} |\Sigma_i(s_{it})|^{-\frac{1}{2}} \exp\left\{-\frac{1}{2}\mathbf{u}_{it}'\Sigma_i(s_{it})^{-1}\mathbf{u}_{it}\right\} \prod_{k,l=1}^{K} \pi_{i,kl}^{\xi_{ikt}\xi_{ilt-1}} \quad (4)$$

with $\mathbf{u}_{it} = \mathbf{y}_{it} - ((1, \boldsymbol{\xi}_{it}') \otimes I_M)X_{it}\boldsymbol{\gamma}_i$ and $X_{it} = (\boldsymbol{\iota}_K \otimes (I_M \otimes \bar{\mathbf{x}}_{i0t}'), I_{KM})$. The joint posterior distribution associated to 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 $f(\boldsymbol{\gamma}_{i0}|\mathbf{y}_i, \Xi_i, \mathbf{d}_k, \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\lambda}_0)$;

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 $f(\boldsymbol{\gamma}_{ik}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i(-k)}, \Sigma, \boldsymbol{\lambda}_k)$;
- (ii.b) Σ_{ik}^{-1} from $f(\Sigma_{ik}^{-1}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i, \Sigma_{i(-k)})$;
- (ii.c) $(\pi_{i,1k}, \ldots, \pi_{i,K-1\,k})$ from $f(\boldsymbol{\pi}_i|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i)$;
- (ii.d) d_{ik} from $p(d_{ik} = j) \propto p_k f(\boldsymbol{\gamma}_{ik}|\boldsymbol{\lambda}_{jk}, \underline{\Sigma}_{jk})$, $j = 1, 2$.

In the third block, the Gibbs sampler iterates for $k = 1, \ldots, K$: (iii.a) draw $\boldsymbol{\lambda}_{jk}$ from $f(\boldsymbol{\lambda}_k|\mathbf{d}_k, \boldsymbol{\gamma}_k, \Sigma_k)$, $j = 1, 2$ and (iii.b) draw p_k from $p(p_k|\mathbf{d}_k)$.

In the fourth block, the sampler generates: (v) $\boldsymbol{\lambda}_0$ from $f(\boldsymbol{\lambda}_0|\boldsymbol{\gamma}_0, \Sigma_0)$ and (iv) Ξ from $p(\Xi|\mathbf{y}_{1:T}, \boldsymbol{\gamma}, \Sigma, \boldsymbol{\alpha})$. Further details on full conditional distributions and their sampling methods are given in Appendix A.

4 Empirical results

Below we present the empirical results. Our main question is to analyse when fiscal policy is procyclical or countercyclical, and characterise the behaviour in the regimes. We first summarise the posterior estimates across all the countries. Then we investigate the estimated results for the three selected countries in more detail: Norway, Russia and Saudi Arabia, as they represent oil producers and exporters in OECD, non-OECD and OPEC (and non-OECD) respectively.

4.1 Posterior estimates - Mean and volatility

We start this section by presenting intercept and volatility posterior means in the procyclical and countercyclical regimes for all countries, before showing some more details for the three selected countries: Norway, Russia and Saudi Arabia.

4.1.1 Panel results

Figures 2 and 3 show the scatter plots of the intercepts posterior means (a_i; left panels) and the volatility posterior means (σ_i; right panels) for the following variables: growth in government expenditures and non-oil fiscal balance, both plotted against growth in government oil revenues (Figures 2 (a) and (b), respectively) and growth in public employment and the real exchange rate, also both plotted against growth in government oil revenues (Figures 3 (a) and (b), respectively).[5] In all figures, the red dots represent the countercyclical regime whereas the blue dots the procyclical regime. Moreover, our estimates distinguish between OECD (empty dots) and non-OECD (coloured dots) countries. Note that, due to the restrictions imposed, for the procyclical regime, the intercepts for government oil revenues are all normalized to be positive, while in the countercyclical regime, the intercepts for government oil revenues are all normalized to be negative. This is clearly visible reading of the left panels in all the graphs.

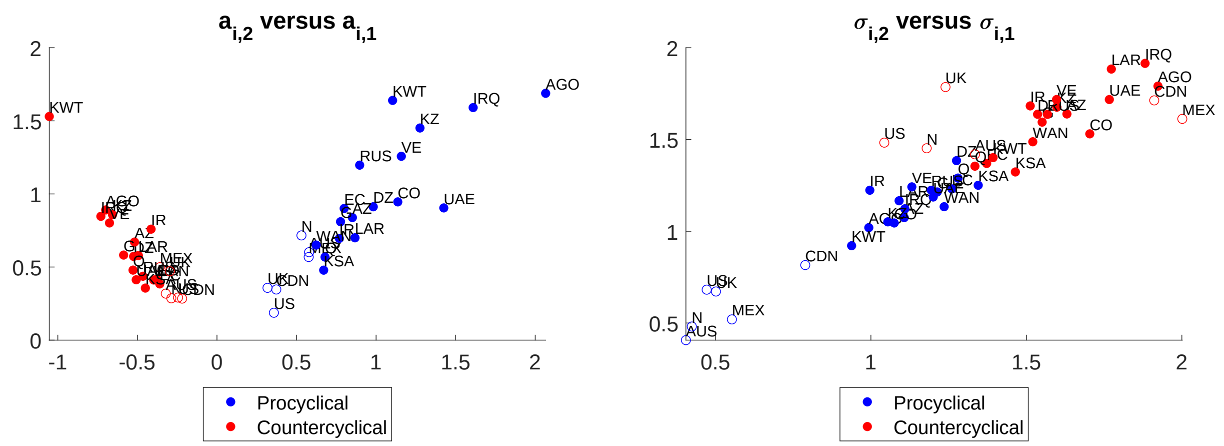
Starting with government expenditures in Figure 2 (a), we note from the right panel that the posterior for volatility is higher in the countercyclical regime than in the procyclical regime. Furthermore, volatility estimates in the procyclical regime are always smaller for OECD countries than for non-OECD countries. For the countercyclical regime, however, results are more mixed, suggesting that both OECD and non-OECD countries are able to pursue quite expansionary policies when revenues fall. These are new results in the literature.

We further note from the left panel that the intercepts for government expenditures are more dispersed in the procyclical regime than in the countercyclical regime, where the dots are more clustered. Hence, spending varies more between the countries when fiscal policy is procyclical than countercyclical. We also note, that, independent of the regimes, government spending tends to be more excessive in the non-OECD countries than in the OECD countries (as the coloured dots are ordered above the empty dots)

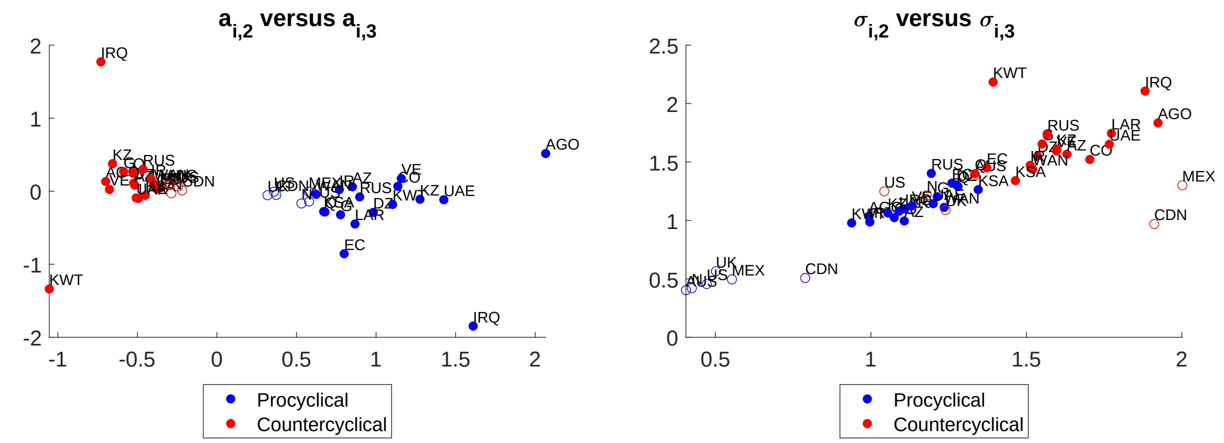
Figure 2 (b) displays non-oil fiscal balance relative to government oil revenues. The figure confirms the main picture from above, although the results for non-oil fiscal balance are less dispersed than what we saw for government expenditures in both regimes above.

[5] As emphasized, government oil revenues, government expenditures and the non-oil fiscal balance are measured relative to GDP, while government employment is measured relative to total employment.

Figure 2. Scatter plots of the estimates for mean (left) and volatility (right) of total government expenditure and non-oil fiscal balance, both plotted versus government oil revenues



(a) Total government expenditure (vertical axis) versus government oil revenues (horizontal axis)

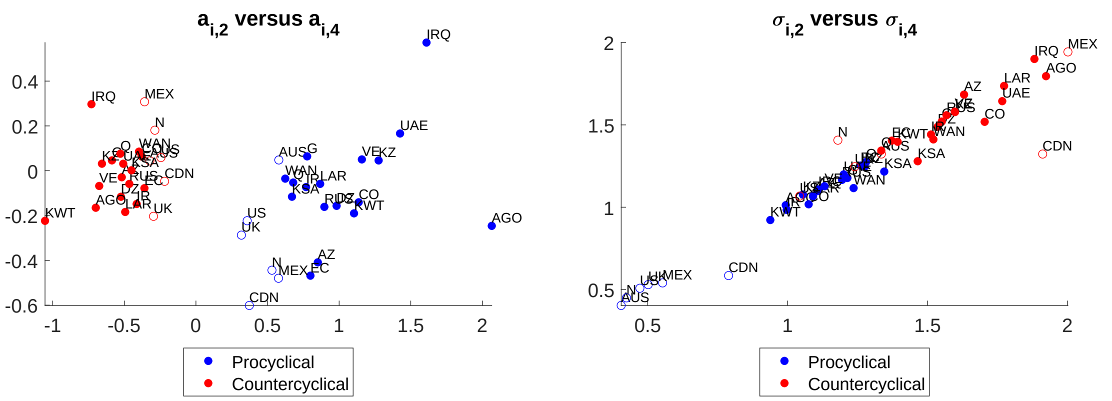


(b) Non-oil fiscal balance (vertical axis) versus government oil revenues (horizontal axis)

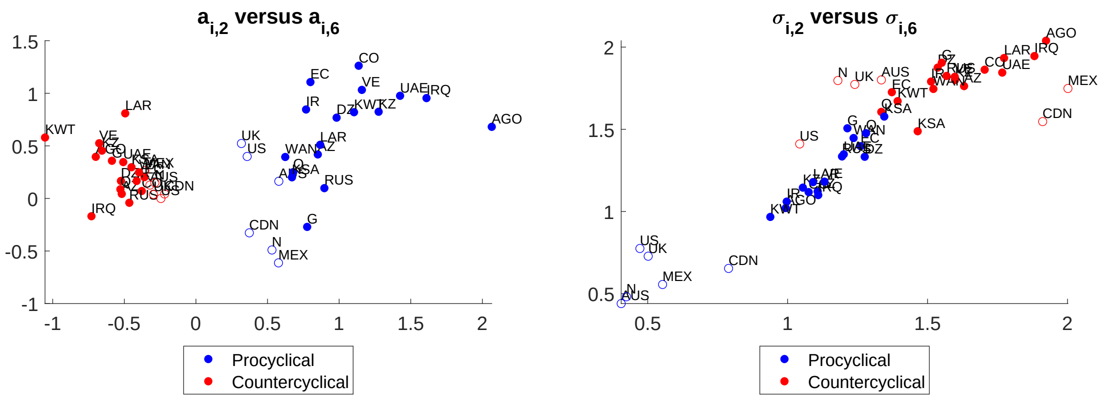
Notes: Intercepts posterior means (a_i; left panels) and the the volatility posterior means (σ_i; right panels) for growth in total government expenditure and non-oil fiscal balance, both plotted against growth in government oil revenues. Government oil revenues and government expenditure are measured relative to GDP. We distinguish between OECD (empty dots) and non-OECD (coloured dots) countries.

Still, volatility in the countercyclical regime is higher than in the procyclical regime. Note also some outliers, such as Iraq, that has a large negative mean value in the procyclical regime and a large positive mean value in the countercyclical regime. The recent war and the dependence on foreign support during the war, and in particular before oil revenues were restored, can probably explain these results.

Figure 3. Scatter plots of the estimates for mean (left) and volatility (right) of public employment and the real exchange rates, both plotted against government oil revenues



(a) Public employment/total employment (vertical axis) versus government oil revenues (horizontal axis)



(b) Real exchange rate (vertical axis) versus government oil revenues (horizontal axis)

Notes: Intercepts posterior means (a_i; left panels) and the the volatility posterior means (σ_i; right panels) for growth in public employment (relative to total employment) and the real exchange rate, both plotted against growth in government oil revenues. We distinguish between OECD (empty dots) and non-OECD (coloured dots) countries.

Turning to the right panel in Figure 3 (a), we confirm again the main picture from above for public employment, namely that volatility is higher in the countercyclical regime than in the procyclical regime, and that the variation tends to be higher in non-OECD countries than in OECD countries. We also note from the left panel, that while public employment responses are clustered around zero in the countercyclical regimes (showing little variation), results are much more dispersed in the procyclical regime.[6] This indicates

[6]This suggests that for OECD countries, public employment falls relative to total employment in the pro-

heterogeneity across countries in response to increased government oil revenues.

Finally, Figure 3 (b), displays the responses in real exchange rates in the procyclical and countercyclical regimes. Focusing on the intercept values, we note that in the countercyclical regime, the exchange rates mostly depreciate (increase) when government oil revenues fall, while in the procyclical regime, results vary: in OECD countries such as Canada, Norway and Mexico, the exchange rate appreciates when government oil revenues increase, while for the other countries, the exchange rate mostly depreciates, although with a lot of variations between countries. The results for Norway are interesting, as they suggest that despite having adopted a fiscal rule, the exchange rate has not been sheltered, consistent with the conclusion also made in Bjørnland and Thorsrud (2019). Finally, we note that, during procyclical periods, there is a larger volatility of the real exchange rate for non-OECD countries than for OECD countries. In general, the countercyclical regimes are associated with a more volatile exchange rate than the procyclical regimes.

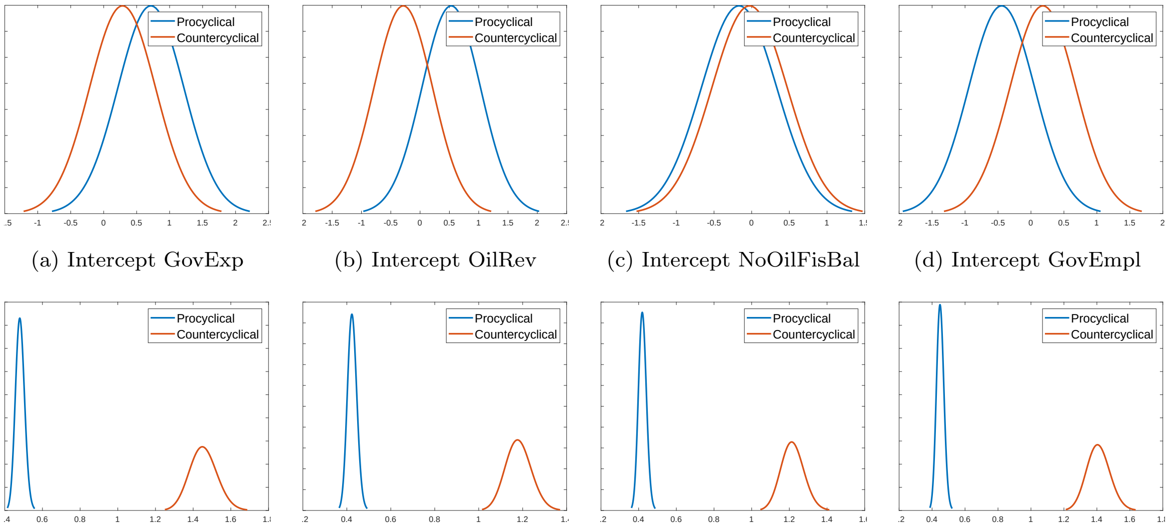
Hence, our first conclusion emphasizes that volatility is higher in the countercyclical fiscal policy regimes than in the procyclical regimes. Our empirical findings therefore show a clear distinction between the two regimes. Moreover, fiscal policy tends to be more volatile in non-OECD countries than in OECD countries, in particular in the procyclical regime. These results essentially support our strategy of estimating two regimes. By only restricting the mean response, we are able to identify systematic differences in volatility in the two regimes, and across countries. Doing so, we have encountered new facts about fiscal policy in oil rich countries.

4.1.2 Details for Norway, Russia and Saudi Arabia

Having seen results for the whole panel, we provide some details about the posterior estimates of the model intercepts and volatility for three selected countries: Norway, Russia and Saudi Arabia in Figures 4-6 respectively. Results for other countries are given in the online Appendix. As discussed above, we choose to focus on Norway, Russia and Saudi Arabia since they are large oil exporters, both in terms of share of world oil production, but also the relative size of oil in the country. However, the countries are diverse in other aspects: Norway is an OECD member, while Russia and Saudi Arabia are not. Moreover, Saudi Arabia is an OPEC member, whereas the other two countries are not. Hence, here we can examine similarities and differences between OECD, non-OECD and OPEC countries. We focus on four variables from our panel: total government

cyclical regime, while for most non-OECD countries, public employment responds little or even increases relative to total employment. For many OECD countries, a rise in oil revenues increases both public and private employment (suggesting little variation in the ratio), while for non-OECD countries, public employment relative to total employment generally increases.

Figure 4. Posterior distribution for intercept and volatility estimates for Norway



(a) Intercept GovExp (b) Intercept OilRev (c) Intercept NoOilFisBal (d) Intercept GovEmpl

(e) Volatility GovExp (f) Volatility OilRev (g) Volatility NoOilFisBal (h) Volatility GovEmpl

Notes: GovExp total government expenditure/GDP; OilRev government oil revenues/GDP; NoOilFisBal non-oil fiscal balance/GDP; GovEmpl public employment/total employment;

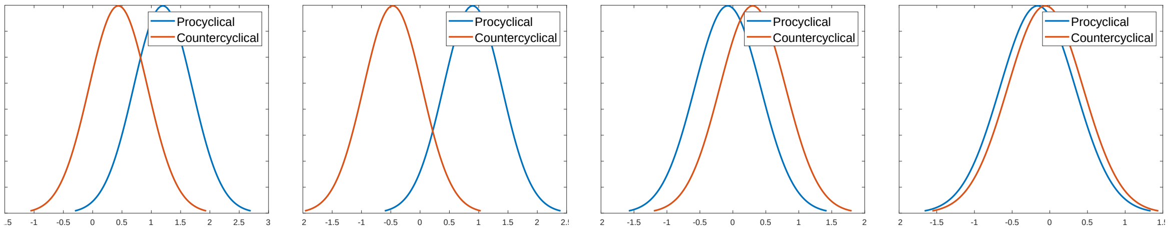
expenditure, government oil revenues, non-oil fiscal balance and public employment. In each figure, panel (a) - (d) present the intercept estimates, while figures (e) - (h) present the volatility estimates.

Starting with the estimated intercepts for the government oil revenues and expenditures, see panel (a) and (b) respectively of Figures 4-6, we note that most of the intercepts are well identified: the estimated intercepts are positive in the procyclical regime, while in the countercyclical regime, the posterior density have larger mass in the negative interval. The exception is Saudi Arabia, where the procyclical and countercyclical regimes for government expenditures are overlapping. The strongest identification is achieved for Russia, where there are clear distinctions between the regimes.

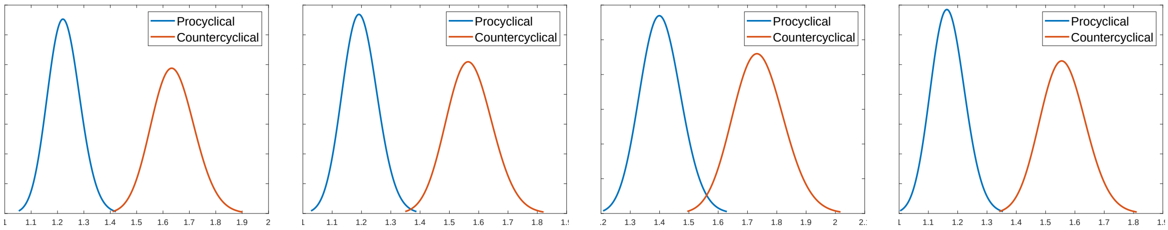
Turning to the estimated intercepts for non-oil fiscal balance and public employment, see panels (c) and (d) respectively of Figures 4-6, the posteriors in the two regimes are more overlapping. The exception is public employment in Norway, where the posterior distributions for public employment is different between the two regimes: Procyclical intercepts have negative values whereas countercyclical intercepts assume positive values. This result confirms evidence in Bjørnland and Thorsrud (2019) that indicates a tendency from Norway to increase public employment to mitigate effects of declines in oil revenues during countercyclical policies.

Regarding volatility, the posterior distribution for the three countries shows some distinct similarities. In particular, for all countries, there are clear differences in the

Figure 5. Posterior distribution for intercept and volatility estimates for Russia



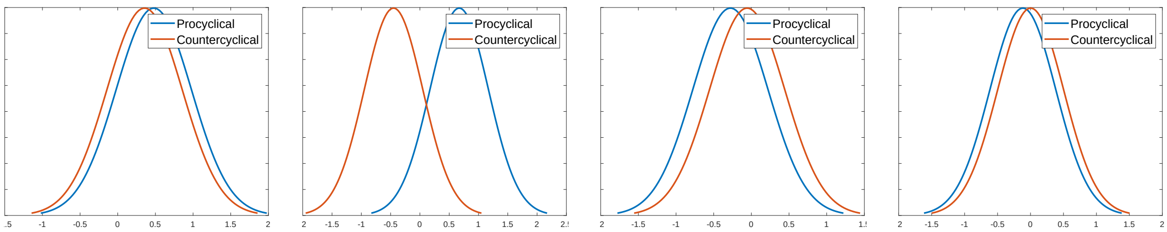
(a) Intercept GovExp (b) Intercept OilRev (c) Intercept NoOilFisBal (d) Intercept GovEmpl



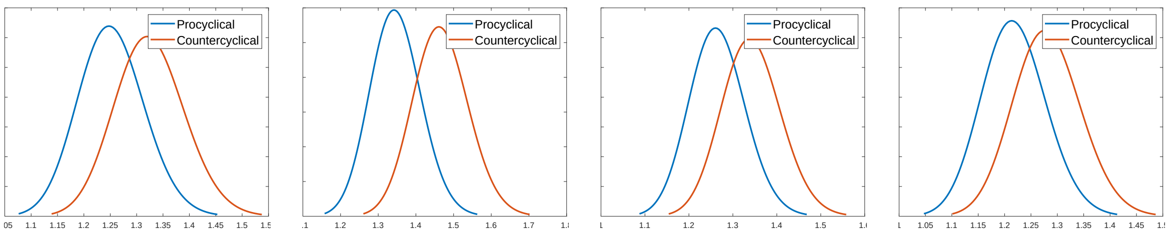
(e) Volatility GovExp (f) Volatility OilRev (g) Volatility NoOilFisBal (h) Volatility GovEmpl

Notes: GovExp total government expenditure/GDP; OilRev government oil revenues/GDP; NoOilFisBal non-oil fiscal balance/GDP; GovEmpl public employment/total employment;

Figure 6. Posterior distribution for intercept and volatility estimates for Saudi Arabia



(a) Intercept GovExp (b) Intercept OilRev (c) Intercept NoOilFisBal (d) Intercept GovEmpl



(e) Volatility GovExp (f) Volatility OilRev (g) Volatility NoOilFisBal (h) Volatility GovEmpl

Notes: GovExp total government expenditure/GDP; OilRev government oil revenues/GDP; NoOilFisBal non-oil fiscal balance/GDP; GovEmpl public employment/total employment;

distribution of volatility between the two regimes: in general, volatility is higher during the countercyclical regimes than during the procyclical periods. This is in particularly notable for Norway, followed by Russia and Saudi Arabia. Furthermore, for Norway, the distribution is much more dispersed during the countercyclical regime than during the procyclical regime. This is not the case for Russia and Saudi Arabia, where the posterior distribution is similarly shaped in the two regimes.

To sum up, we have seen that the data supports the hypothesis that variations in the intercepts are associated with major differences in volatilities among the two regimes. These results support our model set-up of identifying fiscal policy through a regime switching framework. Still, we have seen that Norway (an OECD country) stands out by having the most profound differences between the procyclical and the countercyclical regimes, whereas Russia and Saudi Arabia (Non-OECD, and for Saudi Arabia, also OPEC, countries) are more similar. This supports the conclusion made in the previous section.

4.2 Regime probabilities

We turn now to describe the regime probabilities, defined here as the probabilities of being in the procyclical fiscal policy regime. We start by plotting the probabilities across groups of countries. In particular, Figure 7 shows the probabilities of being in a procyclical fiscal policy regime, aggregated over OECD countries (solid blue line), non-OECD countries (solid red line) and OPEC countries (dashed red line).

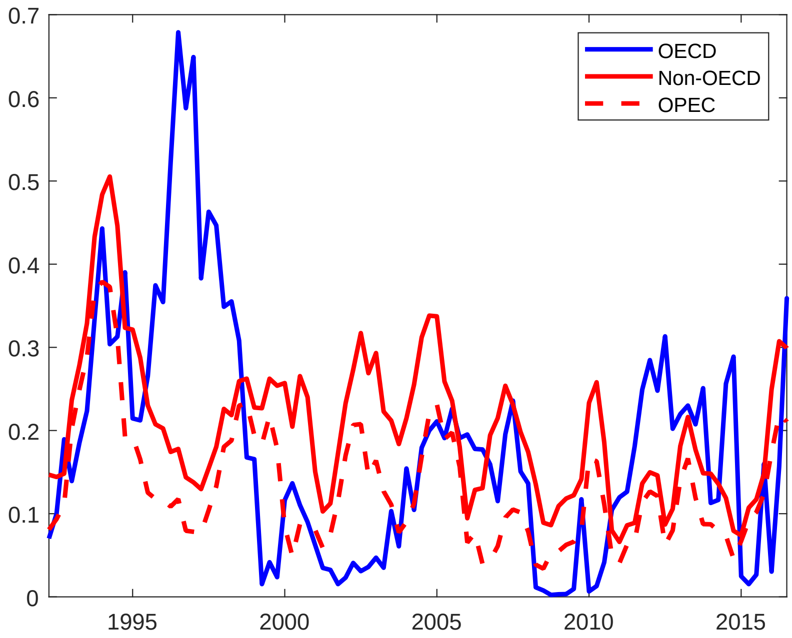
Two findings stand out. First, for all groups of countries, there are multiple periods when fiscal policy is in a procyclical regime over the sample. Hence, we find no evidence that fiscal policy has been mostly procyclical during the last decades, as suggested by Lopez-Murphy and Villafuerte (2010) or Bova, Medas, and Poghosyan (2016), or that fiscal policy has been less procyclical over time, as found in Céspedes and Velasco (2014). Instead, we find all countries to alternate between procyclical and countercyclical regimes over the sample.

Second, the average regime probabilities between OPEC countries and non-OECD countries (red and dashed red lines) have very similar patterns, as opposed to OECD countries (blue line). In particular, the correlation coefficient between the procyclical probabilities of non-OECD and OPEC countries is as high as 0.89. On the other hand, the pattern of fiscal policy in OECD countries is largely unrelated with those of non-OECD and OPEC countries. More specifically, the correlation coefficient between the procyclical probabilities of OECD and non-OECD countries is 0.17, whereas the correlation coefficient between OECD and OPEC countries is 0.22.

By constructing 68% high density posterior (HDP) of the state probabilities, we confirm that procyclical fiscal policies for OECD and non-OECD countries are statistically different in several periods.[7] From Figure 7, we see that there are in particular three periods that stand out. The first period is in the aftermath of the Asian crisis (1996:Q4-

[7] The 68% HDP can be obtained at request. We also not that the 68% HDP of the state probabilities are on average statistically the same the 89% interval.

Figure 7. Aggregate procyclical fiscal policy probabilities for OECD, non-OECD and OPEC countries



Note: Average regime probability of being in a procyclical fiscal policy regime aggregated over OECD countries (solid blue line), non-OECD countries (solid red line) and OPEC countries (dashed red line).

1997:Q3). The resource rich OECD countries relaxed their fiscal policy in response to the crisis, so fiscal policy became procyclical. Contemporaneously, government oil revenues in these countries increased due to the higher real oil price. The second period is the oil price surge between 2002 and 2007 that was caused by the increase in oil demand from emerging countries (notably China and India). During this period, non-OECD countries saw a large increase in their oil revenues and contemporaneously they increased their government spending (became more procyclical). Finally, the last period that stands out relates to the oil price plunge that occurred from 2008:Q3 and the subsequent oil price recovery from 2009/2010. All countries experienced at first a large fall in their government oil revenues and became less procyclical, but OECD countries in particular. From 2010, however, non-OECD countries stand out by becoming more procyclical as revenues increased.

To sum up, our estimated results imply that non-OECD and OPEC countries have very similar patterns in fiscal policy as opposed to OECD countries. A notable exception, however, is the recovery following oil price decline in 2014/2015, when fiscal policy in all countries moves in the same direction of being more procyclical as oil prices increase.

These results suggest that our approach of analysing fiscal policy through procyclical and countercyclical regimes in different countries is meaningful. We do not know a priori whether oil exporter/producer countries have the same probabilities of being in certain fiscal policy regimes. We have seen, however, that while countries within certain groups tend to behave similarly, there are huge differences across groups. In particular, OECD countries behave differently than non-OECD and OPEC countries during the procyclical regimes.

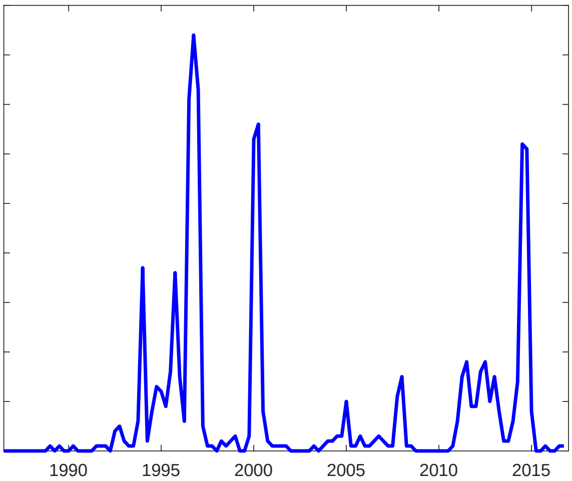
4.2.1 Regime probabilities - Norway, Russia and Saudi Arabia

We now turn to examine in more details the probability of being in a procyclical fiscal policy regime for Norway, Russia and Saudi Arabia in Figure 8, panels (a)-(c), respectively. Starting with Norway, we note from Figure 8 (a) that fiscal policy was procyclical during the middle and late 1990s, during the turn of the millennium, and increasingly so from 2011/2012, and until 2015. This pattern relates well to certain know episodes: the first and most prolonged period in the 1990s relates to the recovery after the Scandinavian bank and real estate crisis, which led to increased government spendings and a substantial widening of the deficit. The second period came after oil revenues started to pour into the economy, and spending picked up. In 2001 the spending rule was adopted, to shelter the economy from the procyclical behaviour.[8] With a few brief exceptions, spending was countercyclical during the first half of the decade. As expected, fiscal policy was also countercyclical during the great recession in 2008/2009, but became procyclical again in line with the increased oil revenues as the economy recovered. This pattern of procyclical fiscal policy is consistent with that which was found in Bjørnland and Thorsrud (2016).

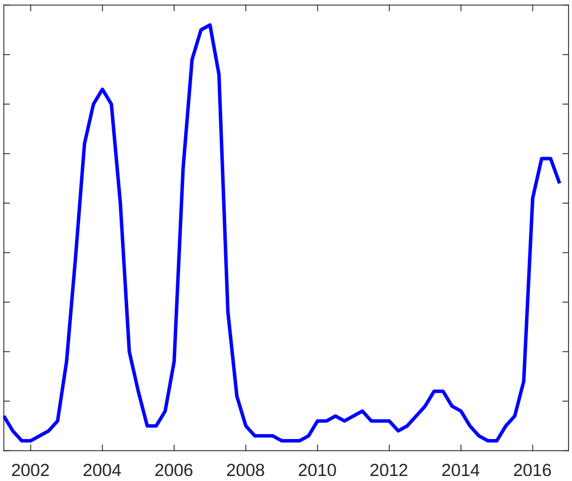
Turning to Russia, see Figure 8 (b), we note that the probabilities that fiscal policy is procyclical were high during 2003/2004, 2006/2007 and in 2015/2016. In 2003/2004, pressures for fiscal relaxation to finance reforms increased, taking advantage of the oil tax windfall to accelerate costly reforms (IMF, 2004). At the same time, less of the revenues from oil taxes were saved. In 2006, propelled by large terms-of-trade gains, Russian real GDP growth accelerated in line with increased government oil revenues, setting the stage for procyclical fiscal spending. In 2016, the recovery in oil prices eased the recession in Russia following the oil price decline in 2014. The doubling of oil prices during the year laid the foundation for a recovery that was also supported by a more expansionary fiscal stance. The rebound of the economy gathered further momentum by the end of 2016, at the same time, the share of government expenditure on GDP increased (IMF, 2017).

[8]The rule specified that the government should spend the expected real return of the fund, that was set to be 4% of the fund value. Subsequently, the rule has been revised down to 3%, see also Bjørnland and Thorsrud (2019) for details.

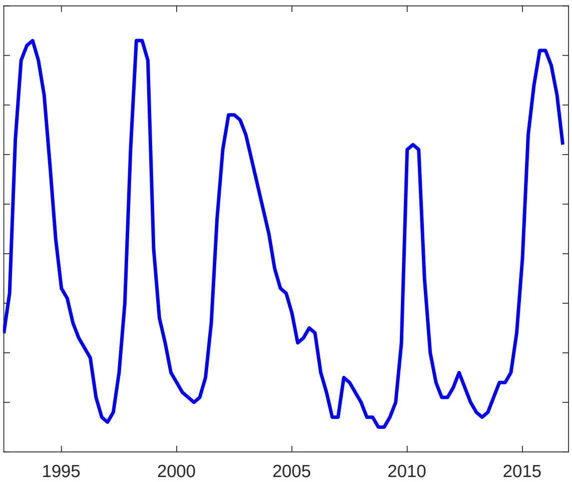
Figure 8. Procyclical fiscal policy probabilities



(a) Norway



(b) Russia



(c) Saudi Arabia

Note: The blue line is the probability of being in a procyclical fiscal policy regime.

Figure 8 (c) shows results for Saudi Arabia. The probabilities that fiscal policy is procyclical were high in many periods: 1993/1994, 1997/1998, 2002/2003, 2010, and 2015/2016. In the early and late 1990s, the Saudi economy showed marked resilience in the face of the depressed condition in the world oil market. The increase in the economy was partly attributed to the growth in government sector through procyclical fiscal spendings (SAMA, 1995). In 2004, the Saudi economy experienced record high growth rates in all its sectors, benefiting from a notable rise in oil prices. The oil sector increased by 32% and total government expenditure increased by 11% (SAMA, 2004). In 2010, the Saudi economy recorded strong growth as global economic recovery lifted up oil prices and enlarged fiscal spending by the government. The economy experienced a rise of 46% in total government revenue compared to 2009. Government expenditure went up by 10% compared to 2009 (SAMA, 2011). Finally, in 2015/2016, both the oil sector, GDP and expenditures increased, as Saudi Arabia's average daily production of oil also rose, in line with the increased oil prices (SAMA, 2017).

To sum up, we have seen that there are multiple periods when fiscal policy is in a procyclical regime over the sample, and these periods fit well with known historical episodes of increased oil revenues and overall growth. While there are some similarities in the timing of the switches between the regimes, i.e., the recovery after the oil price decline of 2014/2015, there are many country specific episodes that need to be accounted for. Hence, studies that try to analyse fiscal policy across countries using, say, a split sample framework, will misrepresent the changing pattern of how fiscal policy alternate between procyclical and countercyclical regimes. In line with this, we have found no evidence that fiscal policy in oil rich countries is mostly procyclical, as suggested by Lopez-Murphy and Villafuerte (2010) or Bova, Medas, and Poghosyan (2016), or that fiscal policy has been less procyclical over time, as found in Céspedes and Velasco (2014). Instead, we find that the probability of being in a procyclical regime varies over the sample.

5 Conclusion

Huge plunges in oil prices that the world has witnessed the last 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 divert from the notion that fiscal policy is conducted in the same way over the sample, and analyse instead whether fiscal policy can switch between procyclical and countercyclical fiscal policy regimes. 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. Then we use parameter restrictions to identify procyclical and countercyclical fiscal policy regimes and evaluate fiscal policy's response in the different regimes. We use mixed frequency data for a large set of oil-exporting (OECD and non-OECD) countries in order to identify their fiscal regimes based on intercept restrictions.

We have three main findings. First, we find that there are multiple periods when fiscal policy is in a procyclical regime during the sample. Hence, studies that try to analyse fiscal policy using a split sample framework will misrepresent the changing pattern of how fiscal policy alternates between procyclical and countercyclical regimes. Second, for all countries, government oil revenues and expenditures are always more volatile in the countercyclical regime than in the procyclical regime. Third, in the procyclical regime, fiscal policy is always more volatile in the non-OECD (including OPEC) countries than in the OECD countries. Hence, during the booming periods, when government oil revenues increase, the OECD countries are able to smooth spending and save more than the non-OECD countries. Our results emphasize that it is both possible and important to separate a procyclical regime from a countercyclical regime. Doing so, we have been able to encounter new facts about fiscal policy in oil-rich countries.

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A Model inference

This section provides the prior distributions and posterior distributions. For the latter, we provide the main steps in Appendix A.2 and the detailed derivation in Appendix A.3.

A.1 Prior distributions

We assume a mixture prior, which allows us to model heterogeneity between panel units, in combination with a hierarchical specification strategy, which allows us to avoid overfitting issues. For the coefficients of the PMS-VAR regression we assume:

$$\boldsymbol{\gamma}_{i0} \overset{iid}{\sim} \mathcal{N}_{MM_0}(\boldsymbol{\lambda}_0, \underline{\Sigma}_{i0}), \quad i = 1, \ldots, N \tag{A.1}$$

$$\boldsymbol{\lambda}_0 \sim \mathcal{N}_{MM_0}(\underline{\boldsymbol{\lambda}}_0, \underline{\Sigma}_0) \tag{A.2}$$

whereas for the intercepts we assume:

$$\boldsymbol{\gamma}_{ik} \overset{iid}{\sim} p_k \mathcal{N}_M(\boldsymbol{\lambda}_{1k}, \underline{\Sigma}_{1k}) + (1 - p_k)\mathcal{N}_M(\boldsymbol{\lambda}_{2k}, \underline{\Sigma}_{2k}), \quad i = 1, \ldots, N \tag{A.3}$$

$$\boldsymbol{\lambda}_{jk} \overset{iid}{\sim} \mathcal{N}_M(\underline{\boldsymbol{\lambda}}_k, \underline{\Sigma}_k), \quad j = 1, 2 \tag{A.4}$$

$$p_k \overset{iid}{\sim} \mathcal{B}e(a, b) \tag{A.5}$$

with $k = 1, \ldots, K$, and for the inverse covariance matrix Σ_{ik}^{-1} we assume independent Wishart priors:

$$\Sigma_{ik}^{-1} \overset{iid}{\sim} \mathcal{W}_M(\underline{\nu}_k, \underline{\Upsilon}_k), \quad i = 1, \ldots, N,\ k = 1, \ldots, K. \tag{A.6}$$

Therefore, the hierarchical prior specification we apply allows for country i specific priors that hierarchically depend on all the $N-$countries. As we show in the full posterior derivation in Appendix A.3, this assumption allows us to combine the country i specific likelihood with the information for all the other countries.

When using Markov-switching processes, one has to deal with the identification issue associated with label switching. See, for example, Frühwirth-Schnatter (2001) for a discussion on the effects that the label switching and the lack of identification have on the results of MCMC-based Bayesian inference. In the literature, different routes have been proposed for dealing with this problem (see Frühwirth-Schnatter, 2006 for a review). 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. recession and expansion) of the business cycle. We follow this latter approach and include constraints on the intercept terms of two equations of the system (see Section 3.2).

A.2 Posterior approximation

A Gibbs sampler is used for posterior approximation (Krolzig, 1997; Frühwirth-Schnatter, 2006; Canova and Ciccarelli, 2009; Billio, Casarin, Ravazzolo, and Van Dijk, 2016; Agudze, Billio, Casarin, and Ravazzolo, 2018; Casarin, Foroni, Marcellino, and Ravazzolo, 2019). The sampler iterates over different blocks of unit-specific parameters in equation (2).

Let $\mathbf{y}_i = \text{vec}\left((\mathbf{y}_{i1}, \ldots, \mathbf{y}_{iT})\right)$ be the MT_i-dimensional vector of observations collected over time for the i-th unit of the panel, $\mathbf{y} = \text{vec}\left((\mathbf{y}_1, \ldots, \mathbf{y}_N)'\right)$ the $(\sum_{i=1}^N MT_i)$-dimensional vector of observations collected over time and panel units and $\boldsymbol{\xi} = \text{vec}\left((\Xi_1, \ldots, \Xi_N)\right)$ the $(\sum_i^N KT_i)$-dimensional vector of allocation variables, with $\Xi_i = (\boldsymbol{\xi}_{i1}, \ldots, \boldsymbol{\xi}_{iT})$. We define the vector of regression coefficients, $\boldsymbol{\gamma} = \text{vec}\left((\boldsymbol{\gamma}_1, \ldots, \boldsymbol{\gamma}_N)\right)$ where $\boldsymbol{\gamma}_i = \text{vec}\left((\boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i1}, \ldots, \boldsymbol{\gamma}_{iK})\right)$, the set of covariance matrices, $\Sigma = (\Sigma_1, \ldots, \Sigma_N)$, and the transition probability vector, $\boldsymbol{\pi} = \text{vec}\left((\boldsymbol{\pi}_1, \ldots, \boldsymbol{\pi}_N)\right)$ where $\boldsymbol{\pi}_i$ is a K-dimensional transition matrix.

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

$$p(\mathbf{y}, \boldsymbol{\xi}|\boldsymbol{\gamma}, \Sigma, \boldsymbol{\pi}) = \prod_{i=1}^{N} p(\mathbf{y}_i, \boldsymbol{\xi}|\boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) \tag{A.7}$$

where

$$p(\mathbf{y}_i, \boldsymbol{\xi}|\boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\pi}_i) = (2\pi)^{-\frac{TM}{2}} \prod_{t=\tau_i}^{T_i} |\Sigma_i(s_{it})|^{-\frac{1}{2}} \exp\left\{-\frac{1}{2}\mathbf{u}_{it}'\Sigma_i(s_{it})^{-1}\mathbf{u}_{it}\right\} \prod_{k,l=1}^{K} \pi_{i,kl}^{\xi_{ikt}\xi_{ilt-1}} \tag{A.8}$$

with $\mathbf{u}_{it} = \mathbf{y}_{it} - ((1, \boldsymbol{\xi}_{it}') \otimes I_M) X_{it} \boldsymbol{\gamma}_i$ and $X_{it} = (\boldsymbol{\iota}_K \otimes (I_M \otimes \bar{\mathbf{x}}_{i0t}'), I_{KM})$. The joint posterior distribution associated to 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 $f(\boldsymbol{\gamma}_{i0}|\mathbf{y}_i, \Xi_i, \mathbf{d}_k, \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\lambda}_0)$;

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 $f(\boldsymbol{\gamma}_{ik}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i(-k)}, \Sigma, \boldsymbol{\lambda}_k)$;
- (ii.b) Σ_{ik}^{-1} from $f(\Sigma_{ik}^{-1}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i, \Sigma_{i(-k)})$;
- (ii.c) $(\pi_{i,1k}, \ldots, \pi_{i,K-1\,k})$ from $f(\boldsymbol{\pi}_i|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i)$;
- (ii.d) d_{ik} from $p(d_{ik} = j) \propto p_k f(\boldsymbol{\gamma}_{ik}|\boldsymbol{\lambda}_{jk}, \underline{\Sigma}_{jk})$, $j = 1, 2$.

In the third block, the Gibbs sampler iterates for $k = 1,\ldots,K$: (iii.a) draw $\boldsymbol{\lambda}_{jk}$ from $f(\boldsymbol{\lambda}_k|\mathbf{d}_k, \boldsymbol{\gamma}_k, \Sigma_k)$, $j = 1, 2$ and (iii.b) draw p_k from $p(p_k|\mathbf{d}_k)$.

In the fourth block, the sampler generates: (v) $\boldsymbol{\lambda}_0$ from $f(\boldsymbol{\lambda}_0|\boldsymbol{\gamma}_0, \Sigma_0)$ and (iv) Ξ from $p(\Xi|\mathbf{y}_{1:T}, \boldsymbol{\gamma}, \Sigma, \boldsymbol{\alpha})$. Further details on the full conditional distributions and their sampling methods are given in the following section.

A.3 Full conditional distributions

The full conditional distribution of the PMS-VAR coefficients $\boldsymbol{\gamma}_{i0}$ is a normal with density function:

$$\begin{aligned} f(\boldsymbol{\gamma}_{i0}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_i, \Sigma_i, \boldsymbol{\lambda}_0) &\propto \exp\left\{-\frac{1}{2}\boldsymbol{\gamma}_{i0}'\left(\sum_{t=\tau_i}^{T_i}(I_M \otimes \bar{\mathbf{x}}_{i0t}')'\Sigma_{it}^{-1}(I_M \otimes \bar{\mathbf{x}}_{i0t}')\underline{\Sigma}_{i0}^{-1}\right)\boldsymbol{\gamma}_{i0}\right\} \cdot \\ &\quad \cdot \exp\left\{\boldsymbol{\gamma}_{i0}\left(\sum_{t=1}^{T}(I_M \otimes \bar{\mathbf{x}}_{i0t}')'\Sigma_{it}^{-1}\mathbf{y}_{i0t} + \underline{\Sigma}_{i0}^{-1}\boldsymbol{\lambda}_0\right)\right\} \\ &\propto \mathcal{N}_{MM_0}(\bar{\boldsymbol{\gamma}}_{i0}, \bar{\Sigma}_{i0}) \end{aligned} \tag{A.9}$$

where $\mathbf{y}_{i0t} = \mathbf{y}_{it} - (\xi_{i1t}\boldsymbol{\gamma}_{i1} + \ldots + \xi_{iKt}\boldsymbol{\gamma}_{iK})$, $\bar{\boldsymbol{\gamma}}_{i0} = \bar{\Sigma}_{i0}(\underline{\Sigma}_{i0}^{-1}\boldsymbol{\lambda}_0 + \sum_{t=\tau_i}^{T_i}(I_M \otimes \bar{\mathbf{x}}_{i0t}')'\Sigma_{it}^{-1}(I_M \otimes \bar{\mathbf{x}}_{i0t}'))$ and $\bar{\Sigma}_{i0}^{-1} = (\underline{\Sigma}_{i0}^{-1} + \sum_{t=\tau_i}^{T_i}(I_M \otimes \bar{\mathbf{x}}_{i0t}')'\Sigma_{it}^{-1}(I_M \otimes \bar{\mathbf{x}}_{i0t}'))$.

The full conditional distributions of the PMS-VAR intercepts $\boldsymbol{\gamma}_{ik}$, with $k = 1,\ldots,K$ are normal with density function:

$$\begin{aligned} &f(\boldsymbol{\gamma}_{ik}|\mathbf{y}_i, \Xi_i, d_{ik}, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_{i(-k)}, \Sigma, \boldsymbol{\lambda}_k) \propto \\ &\propto \exp\left\{-\frac{1}{2}\boldsymbol{\gamma}_i'\left(T_{ik}\Sigma_k^{-1} + \underline{\Sigma}_{d_{ik}k}^{-1}\right)\boldsymbol{\gamma}_i + \boldsymbol{\gamma}_i'\left(\sum_{t\in\mathcal{T}_{ik}}\Sigma_{it}^{-1}\mathbf{y}_{ikt} + \underline{\Sigma}_{ik}^{-1}\boldsymbol{\lambda}_{d_{ik}k}\right)\right\} \\ &\propto \mathcal{N}_M(\bar{\boldsymbol{\gamma}}_{ik}, \bar{\Sigma}_{ik}) \end{aligned} \tag{A.10}$$

with $\bar{\boldsymbol{\gamma}}_{ik} = \bar{\Sigma}_{ik}^{-1}(\underline{\Sigma}_{d_{ik}k}^{-1}\boldsymbol{\lambda}_{d_{ik}k} + \sum_{t\in\mathcal{T}_{ik}}\Sigma_{it}^{-1}\mathbf{y}_{it})$ and $\bar{\Sigma}_{ik}^{-1} = (\underline{\Sigma}_{d_{ik}k}^{-1} + T_{ik}\Sigma_{it}^{-1})$, where we defined $\mathcal{T}_{ik} = \{t|\xi_{ikt} = 1, t = \tau_i,\ldots,T_i\}$, $T_{ik} = \text{Card}(\mathcal{T}_{ik})$, and $\mathbf{y}_{ikt} = \mathbf{y}_{it} - (I_M \otimes \bar{\mathbf{x}}_{i0t}')\boldsymbol{\gamma}_{i0}$. An accept/reject method is applied to account for the identification constraints on $\boldsymbol{\gamma}_{ik}$, $k = 1,\ldots,K$ (see, e.g., Celeux, 1998; Frühwirth-Schnatter, 2001).

The full conditional distributions of the regime-dependent inverse variance-covariance matrix Σ_{ik}^{-1}, $k = 1,\ldots,K$, are Wishart distributions with density:

$$\begin{aligned} &f(\Sigma_{ik}^{-1}|\mathbf{y}_i, \Xi_i, \boldsymbol{\gamma}_{i0}, \boldsymbol{\gamma}_i, \Sigma_{i(-k)}) \propto \\ &\propto |\Sigma_{ik}^{-1}|^{\frac{\nu_k + T_{ik} - M - 1}{2}}\exp\left\{-\frac{1}{2}\text{tr}\left(\left(\underline{\Upsilon}_k^{-1} + \sum_{t\in\mathcal{T}_{ik}}\mathbf{u}_{ikt}\mathbf{u}_{ikt}'\right)\Sigma_{ik}^{-1}\right)\right\} \\ &\propto \mathcal{W}_M(\bar{\nu}_{ik}, \bar{\Upsilon}_{ik}) \end{aligned} \tag{A.11}$$

where $\mathbf{u}_{ikt} = \mathbf{y}_{it} - (I_M \otimes \bar{\mathbf{x}}'_{i0t})\boldsymbol{\gamma}_{i0} - \boldsymbol{\gamma}_{ik}$, $\bar{\nu}_{ik} = \underline{\nu}_k + T_{ik}$ and $\bar{\Upsilon}_{ik}^{-1} = \underline{\Upsilon}_k^{-1} + \sum_{t\in\mathcal{T}_{ik}} \mathbf{u}_{ikt}\mathbf{u}'_{ikt}$.

The full conditional distribution of the parameter $\boldsymbol{\lambda}_0$, of the third stage of the hierarchical structure, is a normal distribution with density function:

$$\begin{aligned} &f(\boldsymbol{\lambda}_0|\boldsymbol{\gamma}_0, \Sigma_0) \propto \\ &\propto \exp\left\{-\frac{1}{2}\left[\boldsymbol{\lambda}'_0\left(\sum_{i=1}^{N}\underline{\Sigma}_{i0}^{-1} + \underline{\Sigma}_0^{-1}\right)\boldsymbol{\lambda}_0 - 2\boldsymbol{\lambda}'_0\left(\sum_{i=1}^{N}\underline{\Sigma}_{i0}^{-1}\boldsymbol{\gamma}_{i0} + \underline{\Sigma}_0^{-1}\underline{\boldsymbol{\lambda}}_0\right)\right]\right\} \\ &\propto \mathcal{N}_{MM_0}(\bar{\boldsymbol{\lambda}}_0, \bar{\Sigma}_0) \end{aligned} \tag{A.12}$$

where $\bar{\Sigma}_0^{-1} = \sum_{i=1}^{N}\underline{\Sigma}_{i0}^{-1} + \underline{\Sigma}_0^{-1}$ and $\bar{\boldsymbol{\lambda}}_0 = \bar{\Sigma}_0\left(\sum_{i=1}^{N}\underline{\Sigma}_{i0}^{-1}\boldsymbol{\gamma}_{i0} + \underline{\Sigma}_0^{-1}\underline{\boldsymbol{\lambda}}_0\right)$.

Let $\mathbf{d}_k = (d_{1k}, \ldots, d_{Nk})$ be a collection of allocation variables, $\mathcal{D}_{jk} = \{i|d_{ik} = j, i = 1, \ldots, N\}$ the set of country indexes allocated to the j-th component of the mixture, and $D_{jk} = \text{Card}(\mathcal{D}_{jk})$ the number of countries in the j-th group. The full conditional distributions of the parameters $\boldsymbol{\lambda}_k$, $k = 1, \ldots, K$, of the third stage of the hierarchical structure, are normal distributions with density functions:

$$\begin{aligned} &f(\boldsymbol{\lambda}_{jk}|\mathbf{d}_k, \boldsymbol{\gamma}_k, \Sigma_k) \propto \\ &\propto \exp\left\{-\frac{1}{2}\left[\boldsymbol{\lambda}'_{jk}\left(D_{jk}\underline{\Sigma}_{jk}^{-1} + \underline{\Sigma}_k^{-1}\right)\boldsymbol{\lambda}_{jk} - 2\boldsymbol{\lambda}'_{jk}\left(\sum_{i\in\mathcal{D}_{jk}}\underline{\Sigma}_{jk}^{-1}\boldsymbol{\gamma}_{ik} + \underline{\Sigma}_k^{-1}\underline{\boldsymbol{\lambda}}_k\right)\right]\right\} \\ &\propto \mathcal{N}_M(\bar{\boldsymbol{\lambda}}_k, \bar{\Sigma}_k) \end{aligned} \tag{A.13}$$

where $\bar{\Sigma}_k^{-1} = \sum_{i\in\mathcal{D}_{jk}}\underline{\Sigma}_{jk}^{-1} + \underline{\Sigma}_k^{-1}$ and $\bar{\boldsymbol{\lambda}}_k = \bar{\Sigma}_k\left(\sum_{i\in\mathcal{D}_{jk}}\underline{\Sigma}_{jk}^{-1}\boldsymbol{\gamma}_{ik} + \underline{\Sigma}_k^{-1}\underline{\boldsymbol{\lambda}}_k\right)$.

A.3.1 Allocation variable full conditional distributions

To sample the hidden states, we propose a multi-move strategy. In Krolzig (1997) a multi-move Gibbs sampler (see Carter and Kohn, 1994; Shephard, 1994) is presented for Markov-switching vector autoregressive models as an alternative to the single-move Gibbs sampler introduced, for example, in Albert and Chib (1993). The multi-move procedure, also known as a forward-filtering backward sampling (FFBS) algorithm, is particularly useful in a highly parameterised model, because it can improve the mixing of the MCMC chain over a large parameter space, thus leading to a more efficient posterior approximation. Unfortunately, the FFBS does not apply easily to our model due to the presence of the chain interaction mechanism. In fact, the FFBS should be iterated jointly for all the Markov-switching processes of the panel implying large matrix operations and, therefore, a high computational cost. We follow a different route and apply here the FFBS to the unit-specific chains, conditioning on the sampled value of other chains in the panel.

B Data Description

As we explained in the main body of the paper, our dataset is unbalanced. In particular, the data sample varies according to the data availability of each country and our data are at quarterly frequency. The data sources and sample periods of all countries are summarised in Tables B.1-B.4. Here, we provide the information about the construction of the observed series.

Share of Total Government Expenditure on GDP. Both series of Total Government Expenditure and GDP for Australia, Canada, UK and US are obtained from the OECD Economic Outlook. Data for Azerbaijan and Kazakhstan are obtained from the IMF Country Reports. Data for Colombia, Kuwait, Saudi Arabia and Venezuela are obtained from the IMF World Economic Outlook. Data for Algeria, Ecuador, Gabon, Iraq, Libya and Russia are obtained from IMF World Economic Outlook and IMF Country Reports. Data for Angola are obtained from the Republica de Angola, Ministerio das Financas and US FRED. Data for the remaining countries are obtained from national sources: Statistics Norway; Banco de México; Central Bank of the Islamic Republic of Iran; Nigeria Central Bank; Qatar Central Bank; UAE Federal Competitiveness and Statistics Authority. All original series are seasonally adjusted.

Table B.1 shows data frequency for each country. For those countries for which data are available only at yearly frequency, we use the Denton method (Di Fonzo and Marini, 2012) to disaggregate data into quarterly frequency. In general, we apply the Denton method using the series of Crude Oil Production obtained from the US EIA Monthly Energy Review. There are some exceptions: Azerbaijan (for which we use the series of Petroleum Production taken from US EIA), Colombia (for which we use the series of GDP taken from the OECD Quarterly National Account), Gabon (for which we use the series of Real Effective Exchange Rate taken from IMF IFS), Russia (for which we use the series of GDP taken from the OECD Quarterly National Account) and Venezuela (for which we use the series of GDP taken from Banco Central de Venezuela).

For all countries the series of Total Government Expenditure is expressed as a share of GDP and in terms of quarterly growth.

Share of Government of Oil Revenues on GDP. The series of Government Oil Revenues for Azerbaijan, Colombia, Ecuador, Gabon, Kazakhstan, Libya and Russia are obtained from IMF Country Reports. Data for Algeria are obtained from IMF World Economic Outlook and IMF Country Reports. Data for remaining countries are obtained from national sources: Australia, Department of Industry, Innovation and Science(DIIS); Canada, Alberta Energy; Norway Statistics; UK Office National Statistics; US Bureau of Economic Analysis; Banco de México; Republica de Angola, Ministerio das Financas; Central Bank of the Islamic Republic of Iran; Kuwait Central Statistical Bureau; Nigeria Central Bank; Qatar Central Bank; Saudi Arabian Monetary Agency (SAMA); Gobierno Bolivariano de Venuezuela; UAE Federal Competitiveness and Statistics Authority. Data for Iraq are obtained from the Iraqi Ministry of Finance and US EIA. All original series are seasonally adjusted.

Table B.2 shows data frequency for each country. For those countries for which data are available only at yearly frequency, we use the Denton method (Di Fonzo and Marini, 2012) to disaggregate data into quarterly frequency. In general, we apply the Denton method using the series of Crude Oil Production. There are some exceptions: Azerbaijan (for which we use the series of Petroleum Production), Australia (for which we use the series of Total Government Revenues taken from the OECD Economic Outlook), Colombia (for which we use the series of GDP), Gabon (for which we use the series of Real Effective Exchange Rate), Russia (for which we use the series of GDP), US (for which we use the series of Corporate Income Tax Revenues taken from the US BEA) and Venezuela (for which we use the series of GDP).

For all countries, the series of Government Oil Revenues is expressed as a share of GDP and in terms of quarterly growth.

Share of Non-Oil Fiscal Balance on GDP. We define Non-Oil Fiscal Balance as:

$$NOFB = NOGR - TGE \tag{B.1}$$

where $NOGR$ corresponds to Non-Oil Government Revenues and TGE is the Total Government Expenditure. In equation B.1, we define Non-Oil Government Revenues as:

$$NOGR = TGR - GOR \tag{B.2}$$

where TGR corresponds to Total Government Revenues and GOR stands for Government Oil Revenues.

We presented above the sources for the series of Total Government Expenditure and Government Oil Revenues. The sources for the series of Total Government Revenues are the same as those for the series of Total Government Expenditure. All original series of Total Government Revenues are seasonally adjusted. In order to convert annual series into quarterly frequency, we followed the same steps that we described above for the series of Total Government Expenditure.

For all countries, the series of Non-Oil Fiscal Balance is expressed as a share of GDP and in terms of quarterly growth.

Share of Public Employment on Total Employment. The series of Public Sector Employment and Total Employment for Australia are obtained from the OECD Labour Force Statistics. Data for Canada, Norway, UK and US are obtained from OECD Economic Outlook. Data for Angola, Azerbaijan, Colombia, Ecuador, Gabon, Iraq, Kazakhstan, Nigeria and Russia are obtained from Key Indicators of the Labour Market - ILO. Data for Mexico are obtained from the OECD Labour Force Statistics, Instituto Nacional de Estadística y Geografía (INEGI) and the OECD Economic Outlook. Data for Algeria are obtained from Key Indicators of the Labour Market - ILO - and the IMF Country Report. Data for Iran are obtained from the Iran Data Portal. Data for Kuwait are obtained from the Kuwait Central Statistical Bureau and World Bank WDI. Data for Libya are obtained from IMF World Economic Outlook and IMF Country Reports. Data for Qatar are obtained from the Qatar Statistics Authority and Key Indicators of the Labour Market - ILO. Data for Saudi Arabia are obtained from SAMA and the World Bank WDI. Data for Venezuela are obtained from Gobierno Bolivariano de Venuezuela, Istituto Nacional de Estadistica. Data for the UAE are obtained from the Ministry of the Economy and Key Indicators of the Labour Market - ILO. All original series are seasonally adjusted.

Table B.3 shows data frequency for each country. For those countries for which data are available only at yearly frequency, we use the Denton method (Di Fonzo and Marini, 2012) to disaggregate data into quarterly frequency. For Algeria, Angola, Ecuador, Iraq, Kazakhstan, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia and UAE we apply the Denton method using the series of Crude Oil Production. For Australia and Mexico we use the series of Total Employment. For Azerbaijan we use the series of Petroleum Production. For Gabon we use the series of Real Effective Exchange Rate. For Colombia, Russia and Venezuela we use the series of GDP.

For all countries the series of Public Sector Employment is expressed as a share of Total Employment and in terms of quarterly growth.

Real Oil Price. For the period 1947:Q1-1973:Q4 data are taken from Baumeister and Peersman (2013). From 1974:Q1 to 2017:Q3, the nominal series of US Refiners Acquisition Cost of Imported Crude Oil is taken from the US EIA Monthly Energy Review. This series is deflated by the US CPI that is obtained from US FRED (Consumer Price Index for All Urban Consumers: All Items, Index 1982-1984=100, Quarterly, Seasonally Adjusted). We merge the two samples and we express the final series of the Real Oil Price in terms of quarterly growth.

Real Exchange Rate. Data for Algeria, Australia, Canada, Colombia, Ecuador, Gabon, Iran, Mexico, Nigeria, Norway, Russia and Saudi Arabia are obtained from IMF IFS. Data for Angola, Azerbaijan, Iraq, Kazakhstan, Kuwait, Libya, Qatar, UAE, UK, US and Venezuela are obtained from US FRED. We collect the series of the Real Effective Exchange Rate for all countries, except Azerbaijan, Iraq, Kazakhstan, Kuwait, Mexico and Russia. For these countries, we collect the series of the Nominal Exchange Rate and we deflate it by the respective CPI. All original series are seasonally adjusted. Table B.4 shows data frequency for each country. For those countries for which data are available only at yearly frequency, we use the Denton method (Di Fonzo and Marini, 2012) to disaggregate data into quarterly frequency. For Angola, Iraq, Libya and Qatar, we apply the Denton method using the series of Crude Oil Production. For Azerbaijan, we use the series of Petroleum Production. For Kazakhstan, we use the series of Crude Oil Production and Government Oil Revenues. For Kuwait, we use the series of Crude Oil Production and GDP. For all countries, the series of the Real Exchange Rate are expressed in terms of quarterly growth.

Table B.1. Total government expenditure, total government revenues and GDP data

Variable	Country	Status	Source	Sample/Frequency
Total Government Expenditure, Total Government Revenues and GDP	Australia	OECD	OECD Economic Outlook No. 99	1989:Q1-2016:Q4
	Canada	OECD	OECD Economic Outlook No. 99	1970:Q1-2017:Q4
	Mexico	OECD	Banco de México	1977:Q1-2017:Q2
	Norway	OECD	Statistics Norway	1985:Q1-2017:Q2
	UK	OECD	OECD Economic Outlook No. 99	1970:Q1-2017:Q4
	US	OECD	OECD Economic Outlook No. 99	1960:Q1-2017:Q4
	Algeria	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1997-2016
	Angola	NON-OECD	Republica de Angola: Ministerio das Financas & US FRED	2002-2016
	Azerbaijan	NON-OECD	IMF Country Reports	1999-2016
	Colombia	NON-OECD	IMF World Economic Outlook	1996-2015
	Ecuador	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1995-2016
	Gabon	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1998-2016
	Iran	NON-OECD	Central Bank of the Islamic Republic of Iran	1990:Q2-2012:Q1
	Iraq	NON-OECD	IMF World Economic Outlook	2004-2016
	Kazakhstan	NON-OECD	IMF Country Reports	1999-2016
	Kuwait	NON-OECD	IMF World Economic Outlook	1990-2017
	Libya	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1997-2013
	Nigeria	NON-OECD	Nigeria Central Bank	1991-2016
	Qatar	NON-OECD	Qatar Central Bank	1991-2016
	Russia	NON-OECD	IMF World Economic Outlook & IMF Country Reports	2000-2016
	Saudi Arabia	NON-OECD	IMF World Economic Outlook	1990-2017
	UAE	NON-OECD	Federal Competitiveness and Statistics Authority	2001-2016
	Venezuela	NON-OECD	IMF World Economic Outlook	1997-2014

Table B.2. Government oil revenues data

Variable	Country	Status	Source	Sample/Frequency
Government Oil Revenues	Australia	OECD	Department of Industry, Innovation and Science	1989-2016
	Canada	OECD	Alberta Energy	1973:Q1-2016:Q4
	Mexico	OECD	Banco de México	1977:Q1-2017:Q2
	Norway	OECD	Statistics Norway	1985:Q1-2017:Q2
	UK	OECD	UK Office of National Statistics	1978:Q4-2016:Q2
	US	OECD	Bureau of Economic Analysis	1950-2015
	Algeria	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1997-2016
	Angola	NON-OECD	Republica de Angola: Ministerio das Financas	2002-2016
	Azerbaijan	NON-OECD	IMF Country Reports	1999-2016
	Colombia	NON-OECD	IMF Country Reports	1996-2015
	Ecuador	NON-OECD	IMF Country Reports	1995-2016
	Gabon	NON-OECD	IMF Country Reports	1998-2016
	Iran	NON-OECD	Central Bank of the Islamic Republic of Iran	1990:Q2-2012:Q1
	Iraq	NON-OECD	Iraqi Ministry of Finance & US EIA	2004:Q1-2016:Q4
	Kazakhstan	NON-OECD	IMF Country Reports	1999-2016
	Kuwait	NON-OECD	Kuwait Central Statistical Bureau	1999-2016
	Libya	NON-OECD	IMF Country Reports	1997-2013
	Nigeria	NON-OECD	Nigeria Central Bank	1991-2016
	Qatar	NON-OECD	Qatar Central Bank	1991-2016
	Russia	NON-OECD	IMF Country Reports	2000-2016
	Saudi Arabia	NON-OECD	Saudi Arabian Monetary Agency	1969-2016
	UAE	NON-OECD	Federal Competitiveness and Statistics Authority	2001-2016
	Venezuela	NON-OECD	Gobierno Bolivariano de Venuezuela: Istituto Nacional de Estadistica	1997-2014

Table B.3. Public sector and total employment data

Variable	Country	Status	Source	Sample/Frequency
Public Sector and Total Employment	Australia	OECD	OECD Labour Force Statistics	1989-2016
	Canada	OECD	OECD Economic Outlook No. 99	1966:Q1-2017:Q4
	Mexico	OECD	OECD Labour Force Statistics, Instituto Nacional de Estadística y Geografía & OECD Economic Outlook No. 99	2000-2016
	Norway	OECD	OECD Economic Outlook No. 99	1985:Q1-2017:Q2
	UK	OECD	OECD Economic Outlook No. 99	1970:Q1-2017:Q4
	US	OECD	OECD Economic Outlook No. 99	1960:Q1-2017:Q4
	Algeria	NON-OECD	ILO: Key Indicators of the Lab. Market & IMF Country Reports	1997-2016
	Angola	NON-OECD	ILO: Key Indicators of the Lab. Market	2002-2016
	Azerbaijan	NON-OECD	ILO: Key Indicators of the Lab. Market	1999-2016
	Colombia	NON-OECD	ILO: Key Indicators of the Lab. Market	1996-2015
	Ecuador	NON-OECD	ILO: Key Indicators of the Lab. Market	1995-2016
	Gabon	NON-OECD	ILO: Key Indicators of the Lab. Market	1998-2016
	Iran	NON-OECD	Iran Data Portal	1990:Q2-2012:Q1
	Iraq	NON-OECD	ILO: Key Indicators of the Lab. Market	2004-2016
	Kazakhstan	NON-OECD	ILO: Key Indicators of the Lab. Market	1999-2016
	Kuwait	NON-OECD	Kuwait Central Statistical Bureau & World Bank WDI	1999-2016
	Libya	NON-OECD	IMF World Economic Outlook & IMF Country Reports	1997-2013
	Nigeria	NON-OECD	ILO: Key Indicators of the Lab. Market	1991-2016
	Qatar	NON-OECD	Qatar Statistics Authority & ILO: Key Indicators of the Lab. Market	1991-2016
	Russia	NON-OECD	ILO: Key Indicators of the Lab. Market	2000-2016
	Saudi Arabia	NON-OECD	Saudi Arabian Monetary Agency & World Bank WDI	1990-2016
	UAE	NON-OECD	Ministry of the Economy: AER 2015 & ILO: Key Indicators of the Lab. Market	2001-2016
	Venezuela	NON-OECD	Gobierno Bolivariano de Venuezuela: Istituto Nacional de Estadistica	1997-2014

Table B.4. Real oil price and real exchange rate data

Variable	Country	Status	Source	Sample/Frequency
Real Oil Price	All countries	OECD & NON-OECD	Baumeister and Peersman (2012), US EIA & US FRED	1960:Q1-2017:Q3
Real Exchange Rate	Australia	OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Canada	OECD	IMF: International Financial Statistics	1970:Q1-2016:Q4
	Mexico	OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Norway	OECD	IMF: International Financial Statistics	1970:Q1-2016:Q4
	UK	OECD	US FRED	1972:Q1-2017:Q3
	US	OECD	US FRED	1964:Q1-2017:Q3
	Algeria	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Angola	NON-OECD	US FRED	2004-2015
	Azerbaijan	NON-OECD	US FRED	1994-2014
	Colombia	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Ecuador	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Gabon	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Iran	NON-OECD	IMF: International Financial Statistics	1973:Q1-2016:Q4
	Iraq	NON-OECD	US FRED	1973-2014
	Kazakhstan	NON-OECD	US FRED	1999-2014
	Kuwait	NON-OECD	US FRED	1999-2014
	Libya	NON-OECD	US FRED	1980-2010
	Nigeria	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	Qatar	NON-OECD	US FRED	1981-2014
	Russia	NON-OECD	IMF: International Financial Statistics	1994:Q1-2016:Q4
	Saudi Arabia	NON-OECD	IMF: International Financial Statistics	1980:Q1-2016:Q4
	UAE	NON-OECD	US FRED	1994:Q1-2017:Q3
	Venezuela	NON-OECD	US FRED	1994:Q1-2017:Q3

Online Appendix for "Oil and Fiscal Policy Regimes"

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Marco Lorusso‡ Francesco Ravazzolo§

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†Ca' Foscari University Venice.
‡Newcastle University Business School.
§Free University of Bozen-Bolzano, BI Norwegian Business School, CAMA and RCEA.

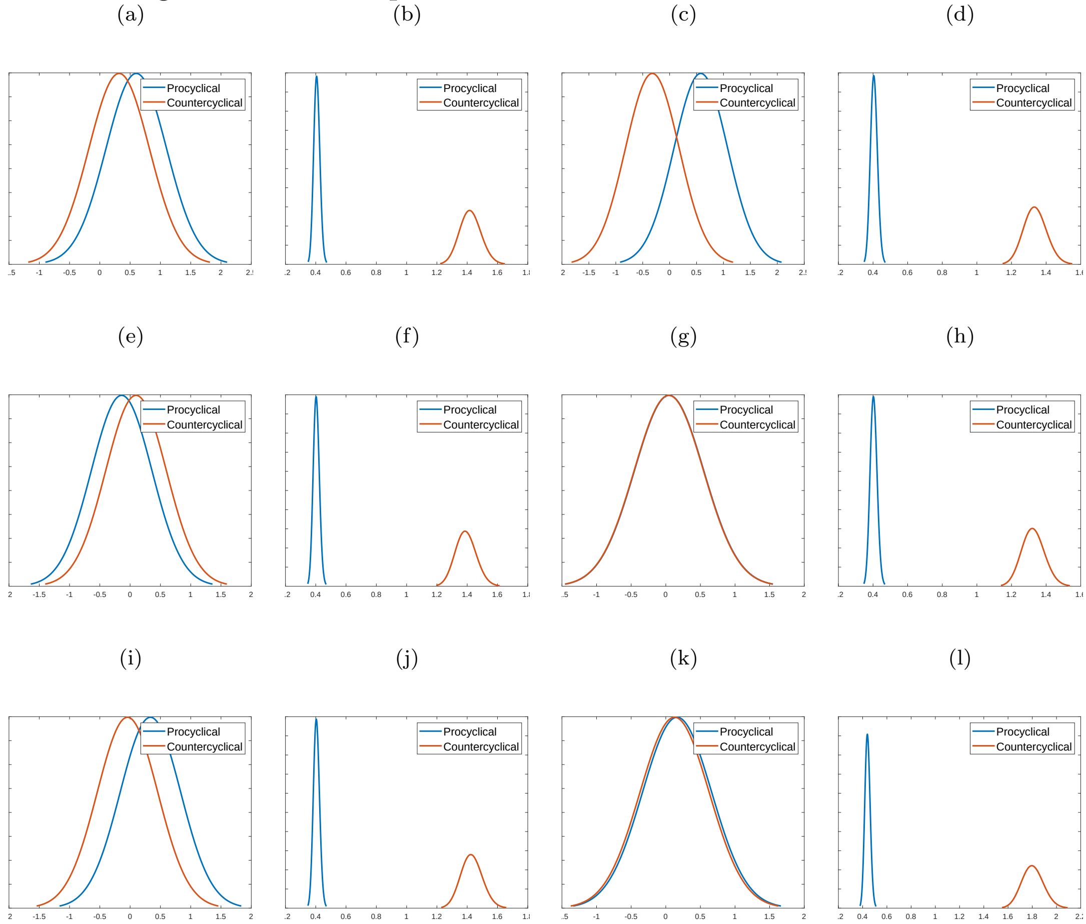
Appendix A: Estimates for intercepts and volatilities for individual countries

Figures A.1-A.20 present a graphical analysis using posterior densities for all the countries of our sample excluding Norway, Russia and Saudi Arabia (for which we present the results in the main body of the paper).

In particular, the figures below show the kernel density estimates of the posterior densities of the Markov-switching intercepts and volatilities for the different countries in the two regimes for the six variables of our model. Such figures present evidence of regime identification and a description of the two regimes.

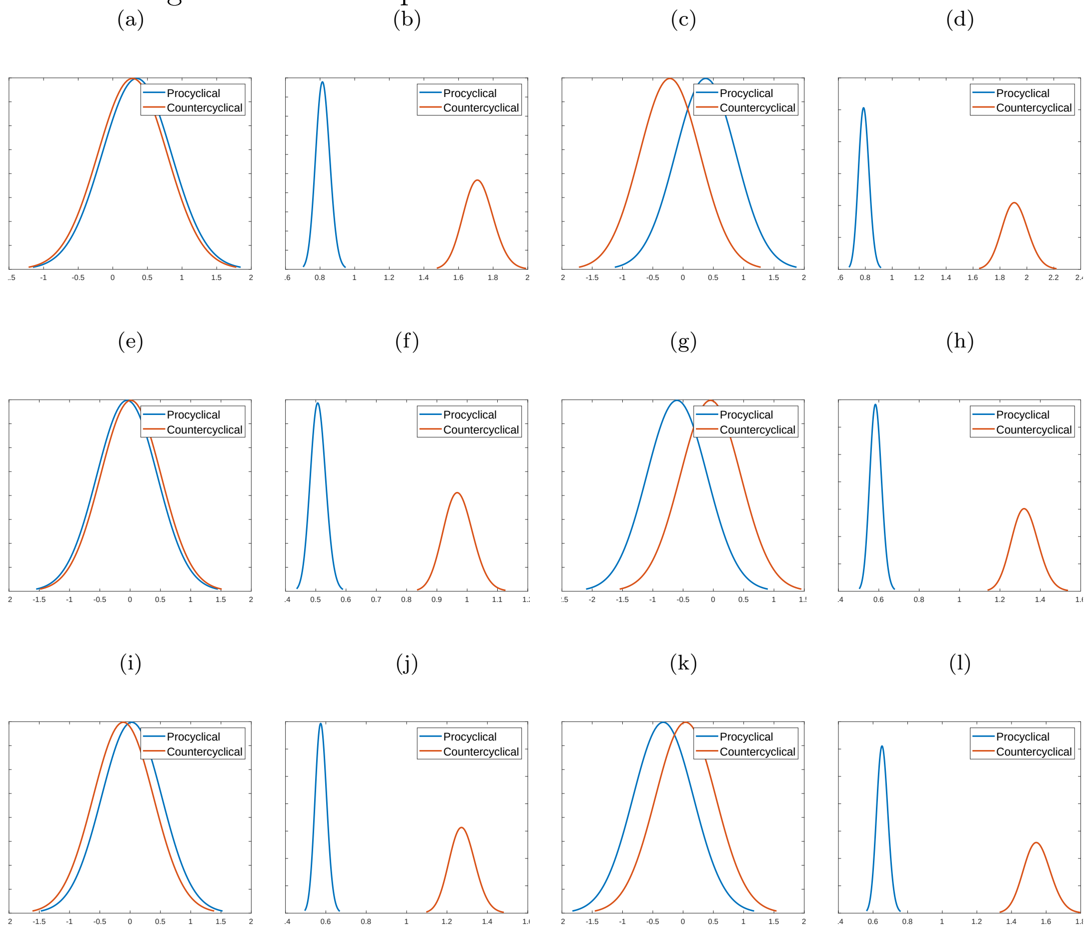
In the left panels of the graphs, the horizontal axes report the values of the intercepts, whereas the vertical axes the probability density functions.

Figure A.1: Intercepts and volatilities estimates for Australia



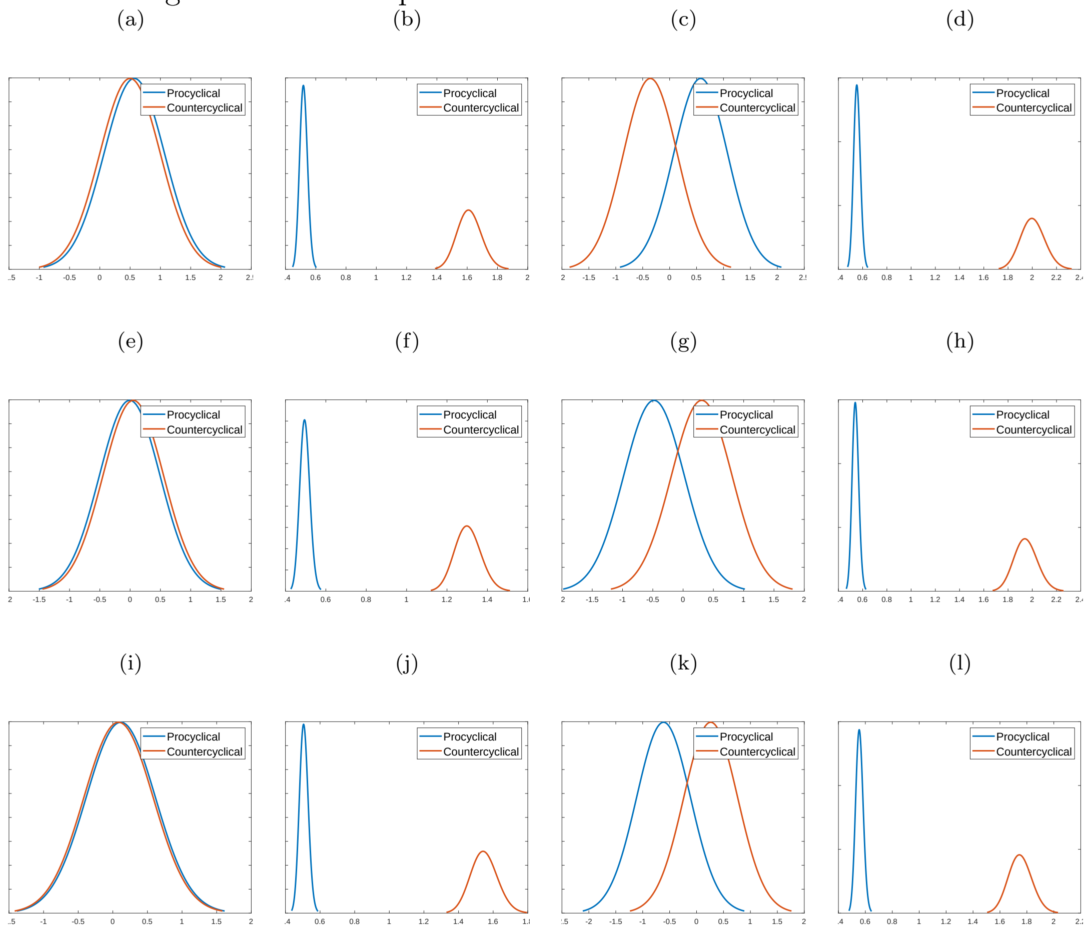
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.2: Intercepts and volatilities estimates for Canada



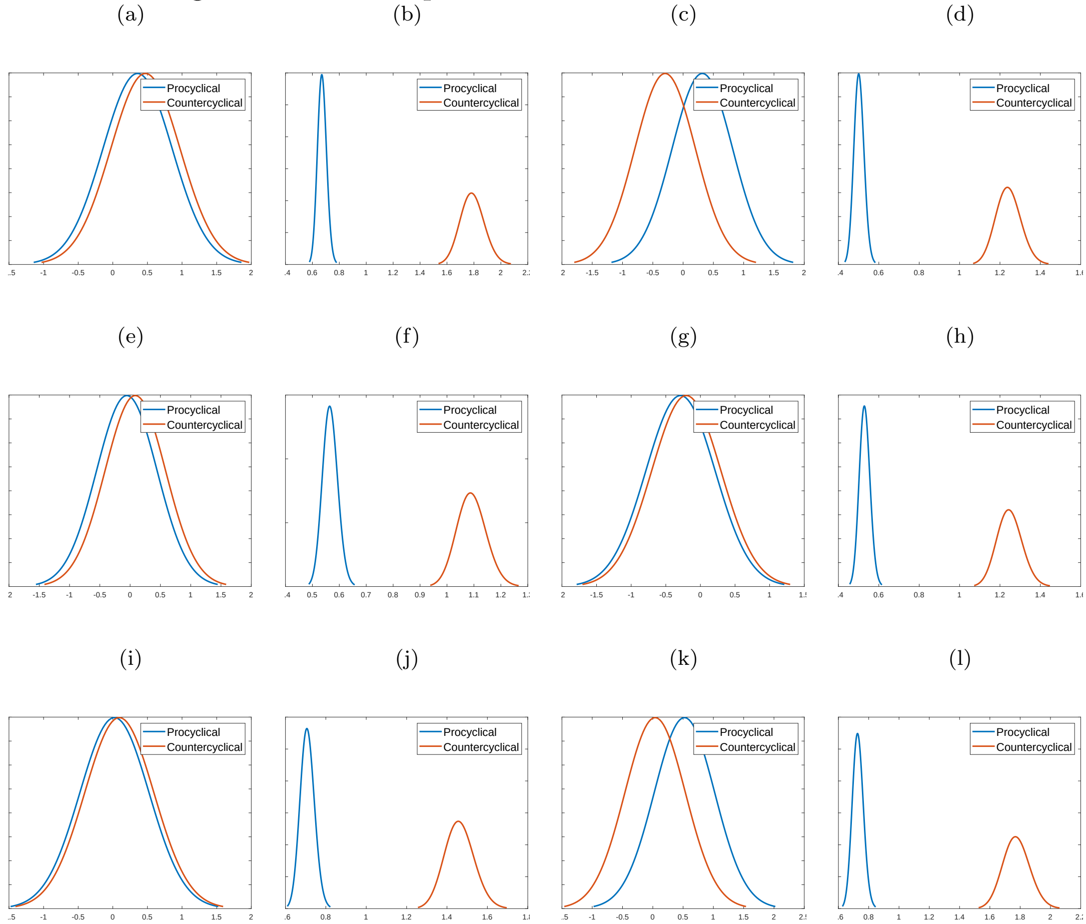
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.3: Intercepts and volatilities estimates for Mexico



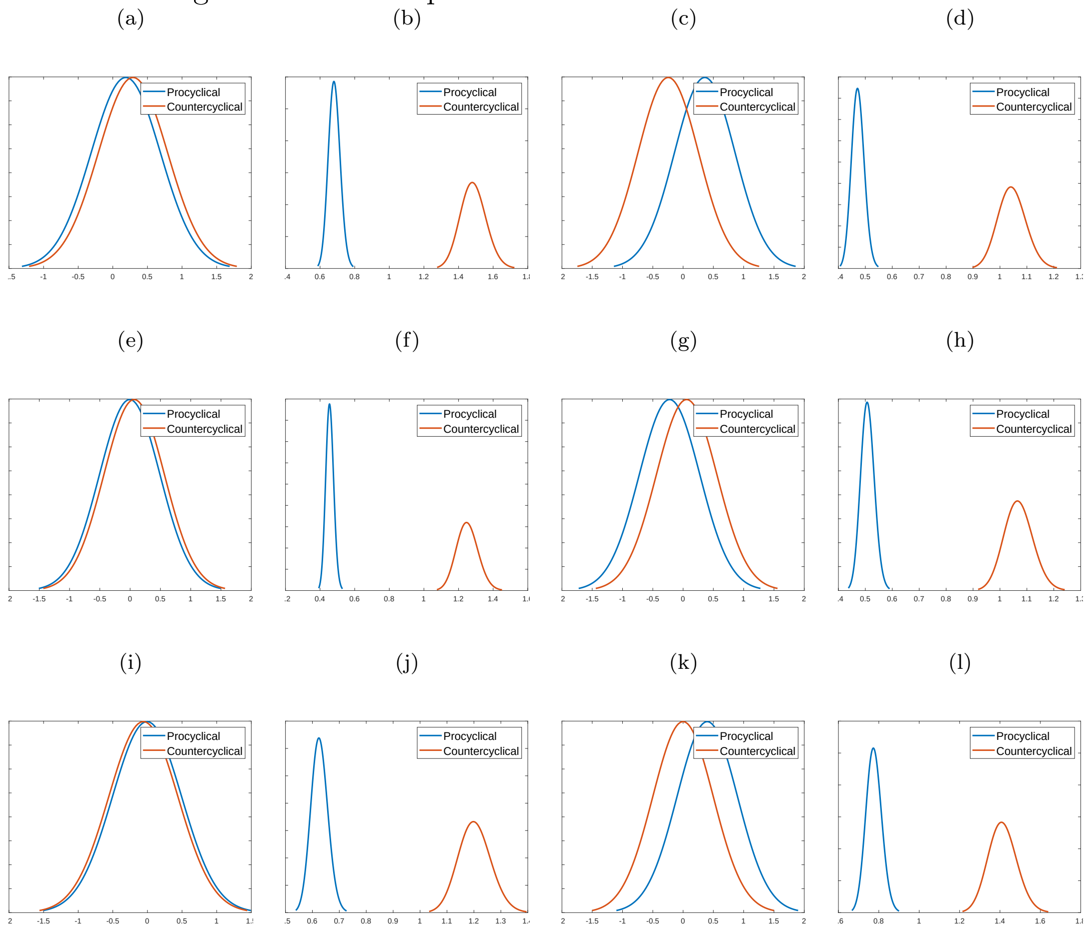
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.4: Intercepts and volatilities estimates for UK



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

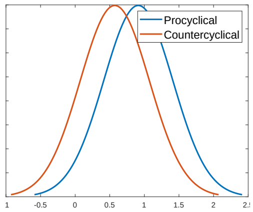
Figure A.5: Intercepts and volatilities estimates for US



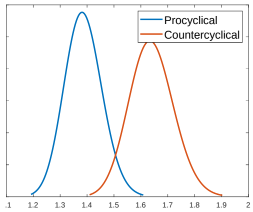
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.6: Intercepts and volatilities estimates for Algeria

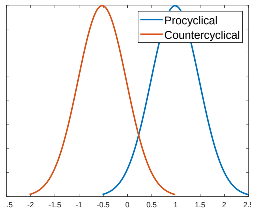
(a)



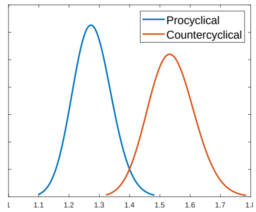
(b)



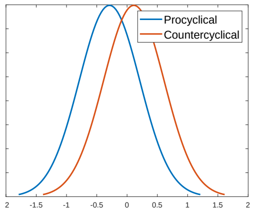
(c)



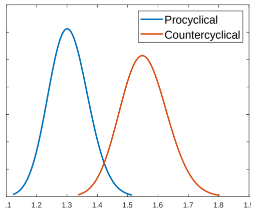
(d)



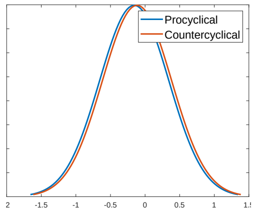
(e)



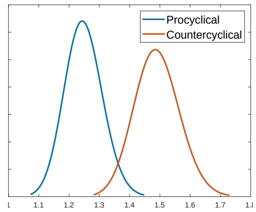
(f)



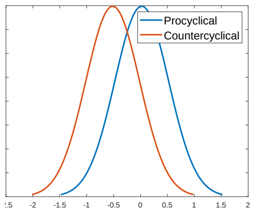
(g)



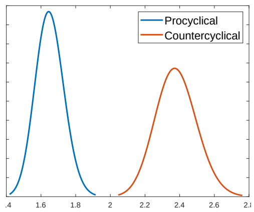
(h)



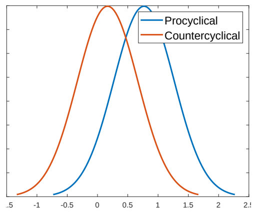
(i)



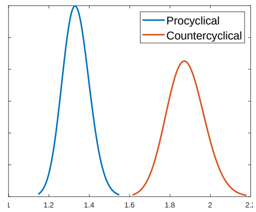
(j)



(k)

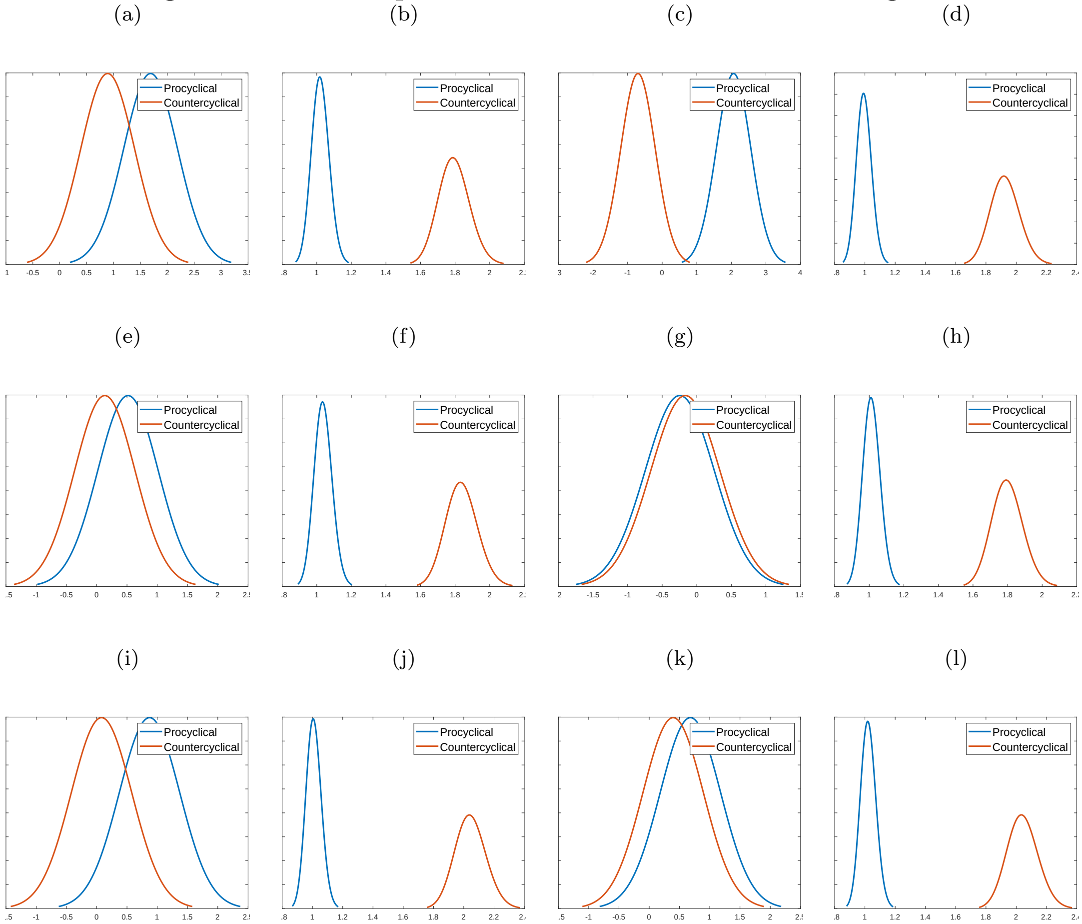


(l)



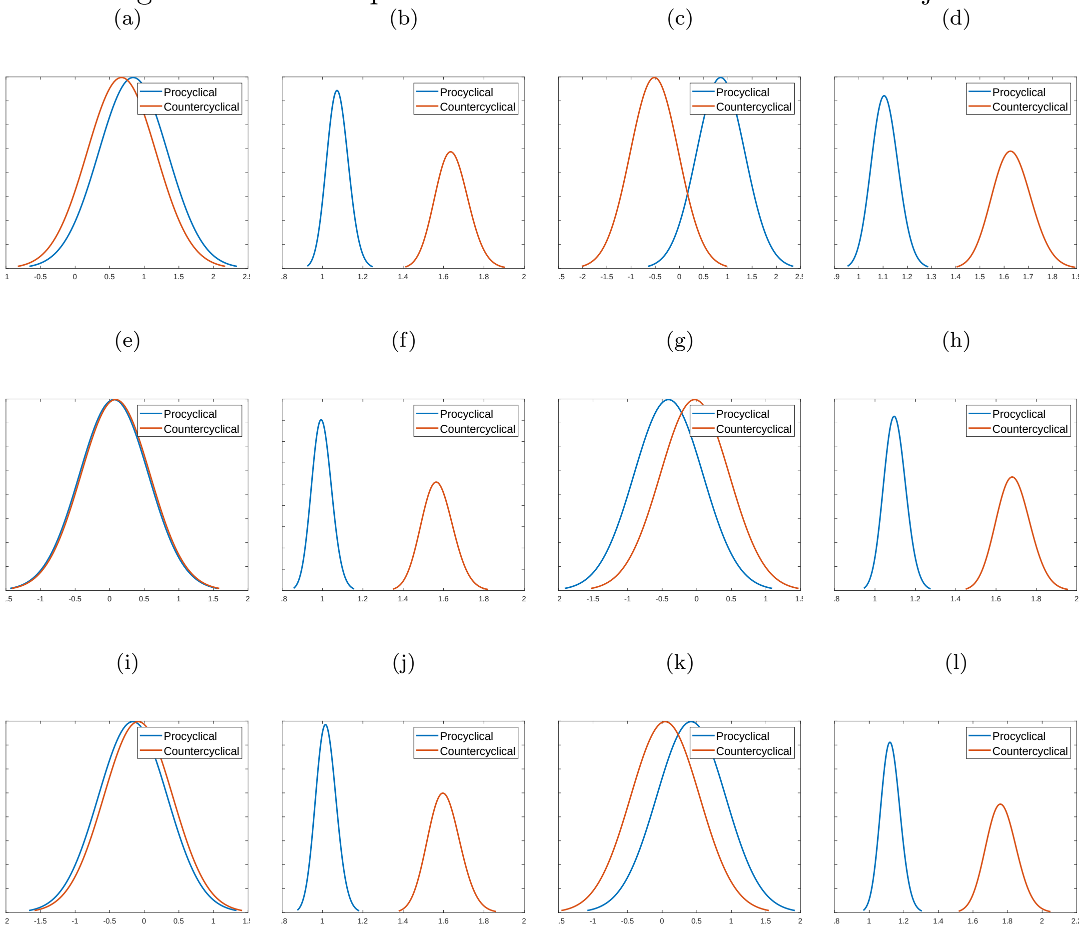
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.7: Intercepts and volatilities estimates for Angola



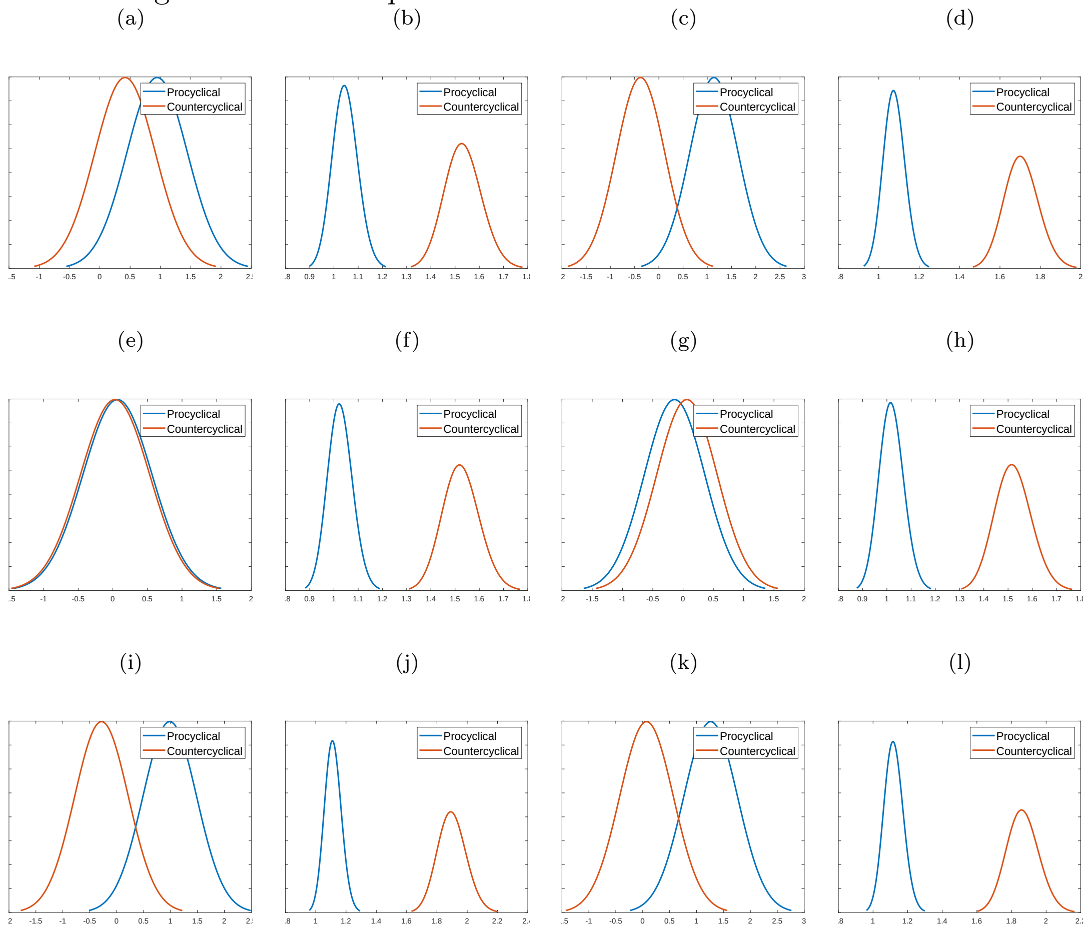
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.8: Intercepts and volatilities estimates for Azerbaijan



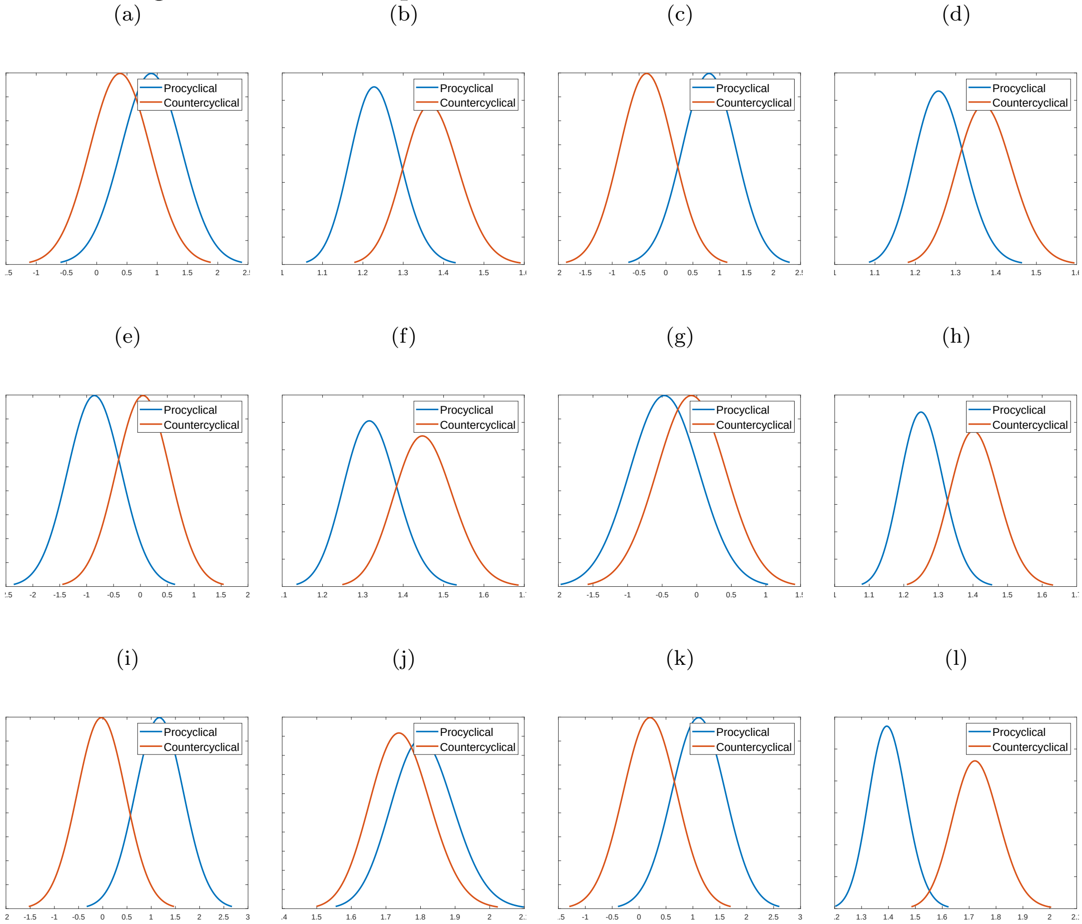
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.9: Intercepts and volatilities estimates for Colombia



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.10: Intercepts and volatilities estimates for Ecuador



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

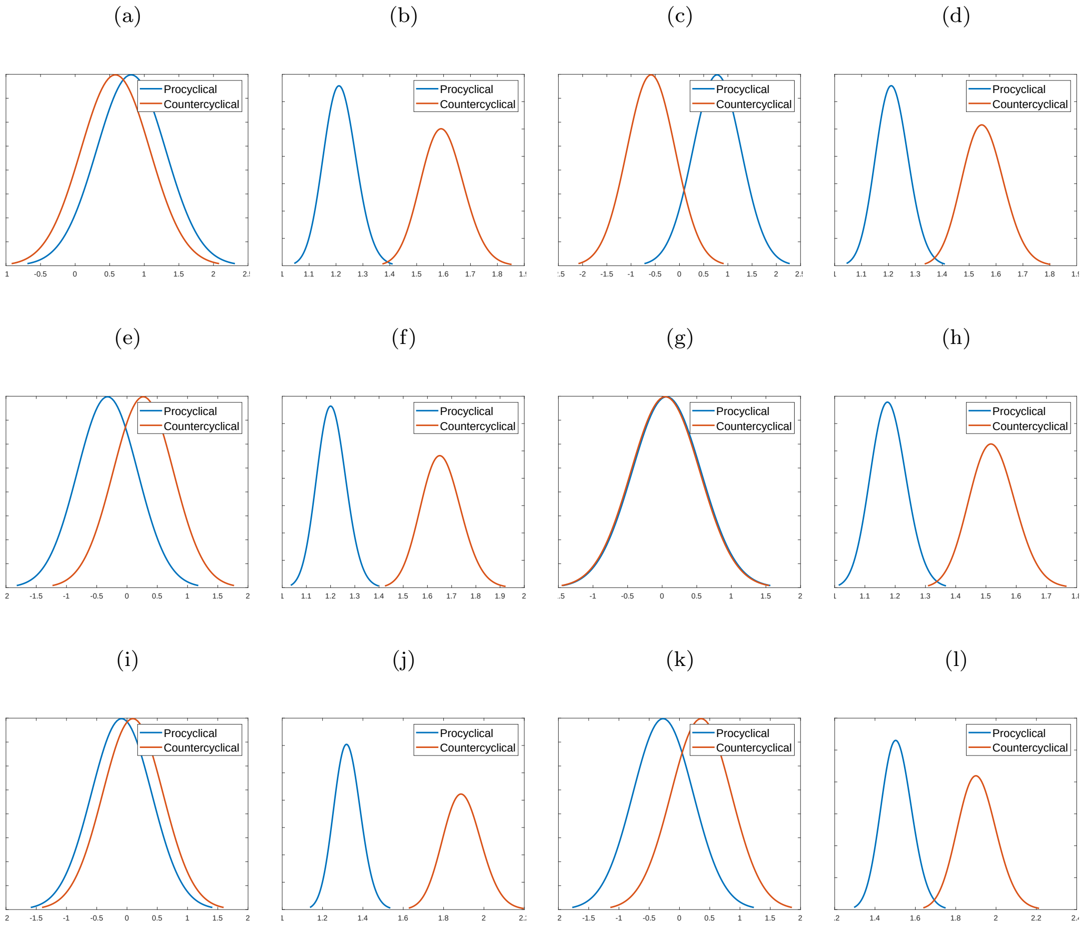
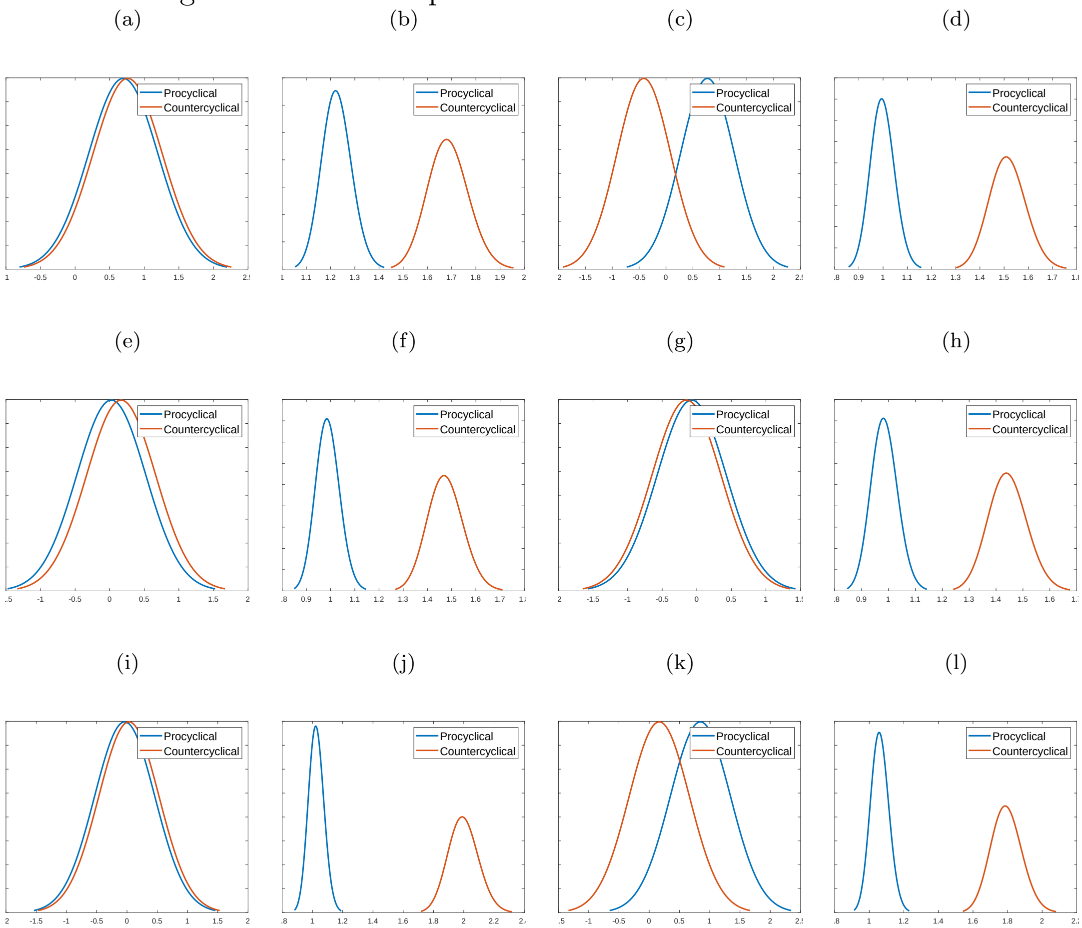


Figure A.11: Intercepts and volatilities estimates for Gabon

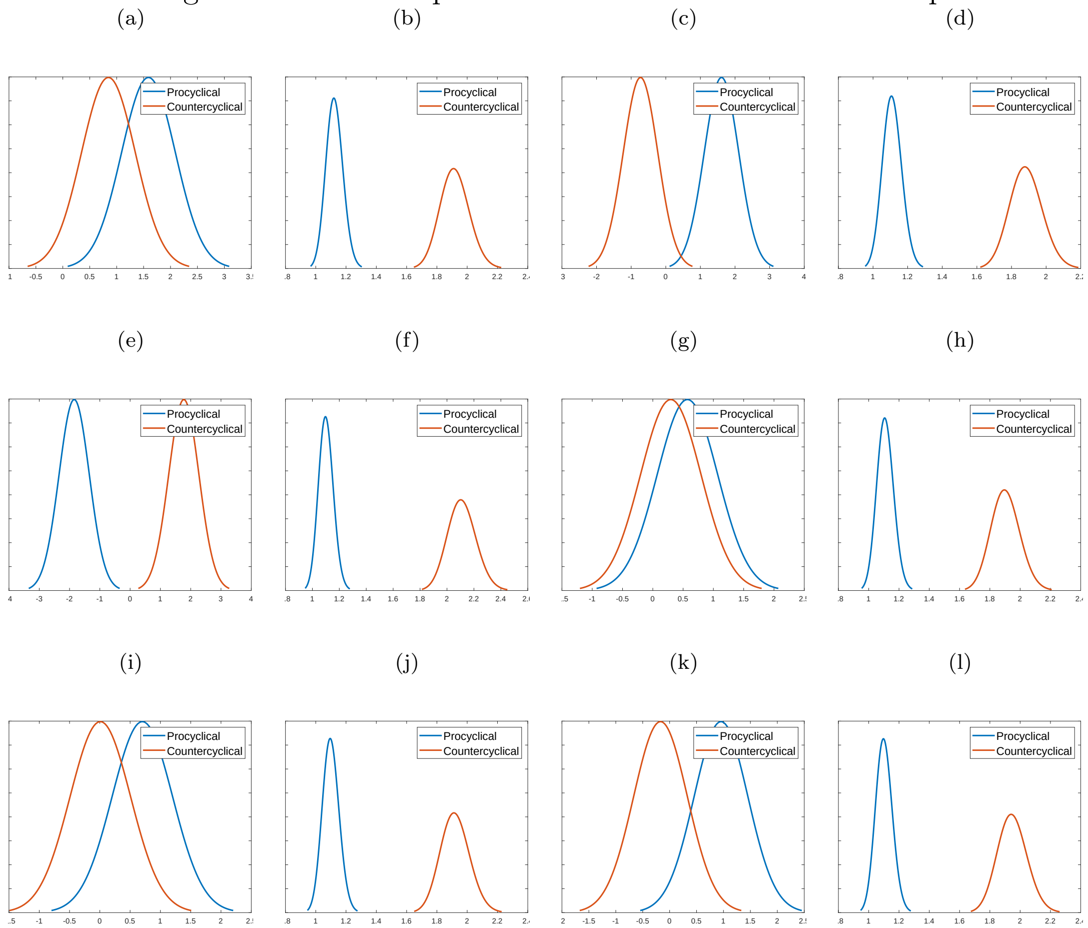
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.12: Intercepts and volatilities estimates for Iran



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.13: Intercepts and volatilities estimates for Iraq



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.14: Intercepts and volatilities estimates for Kazakhstan

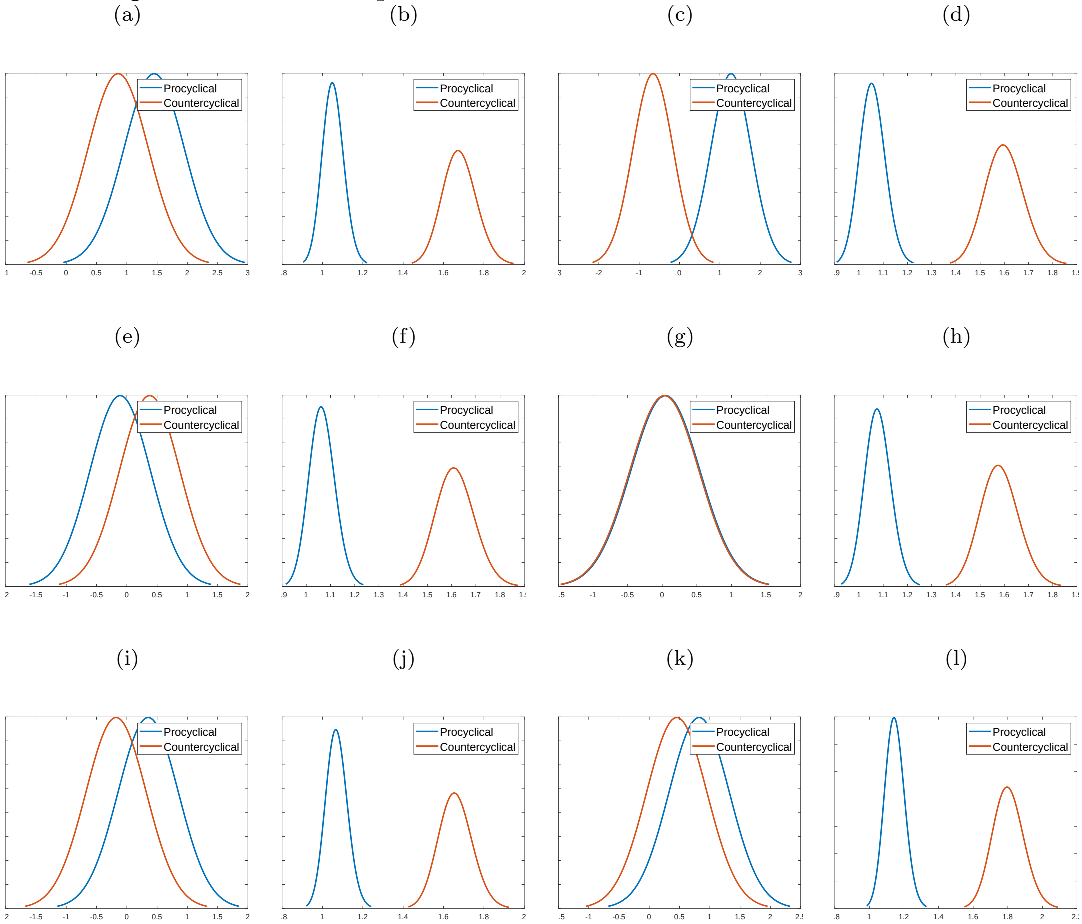


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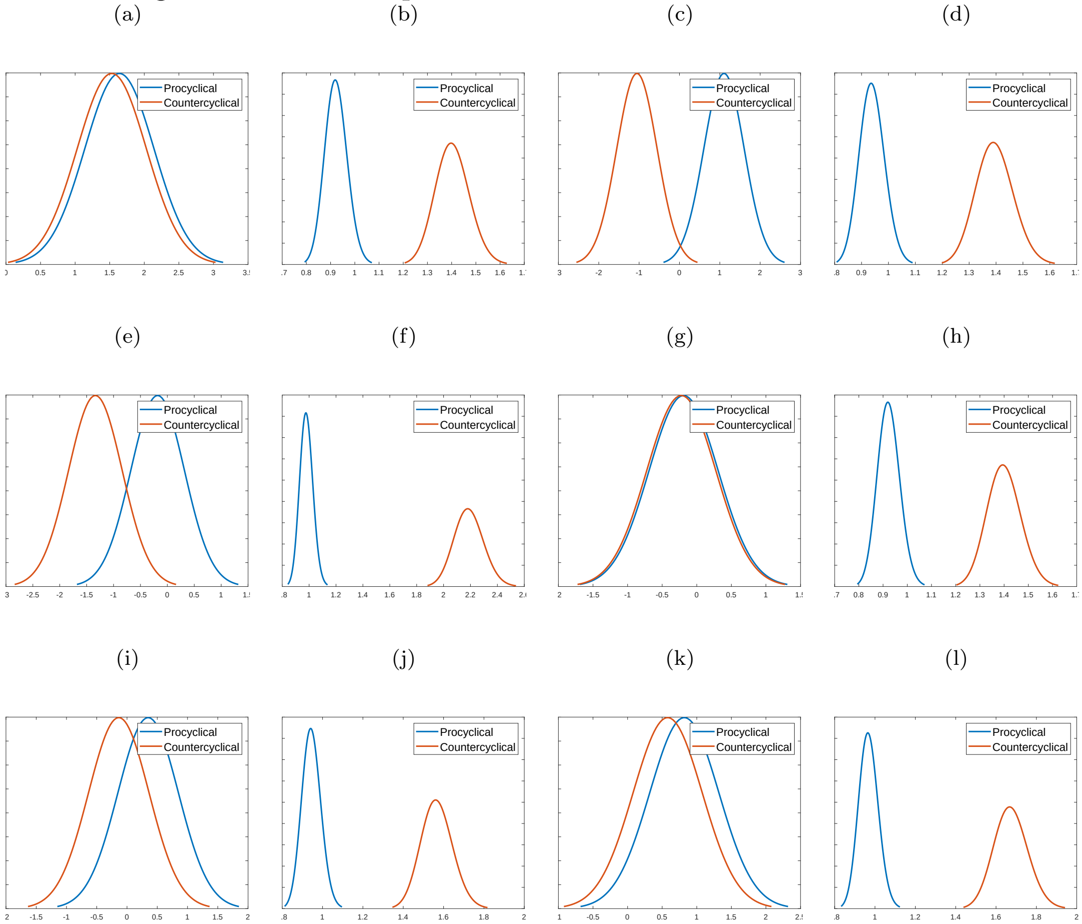
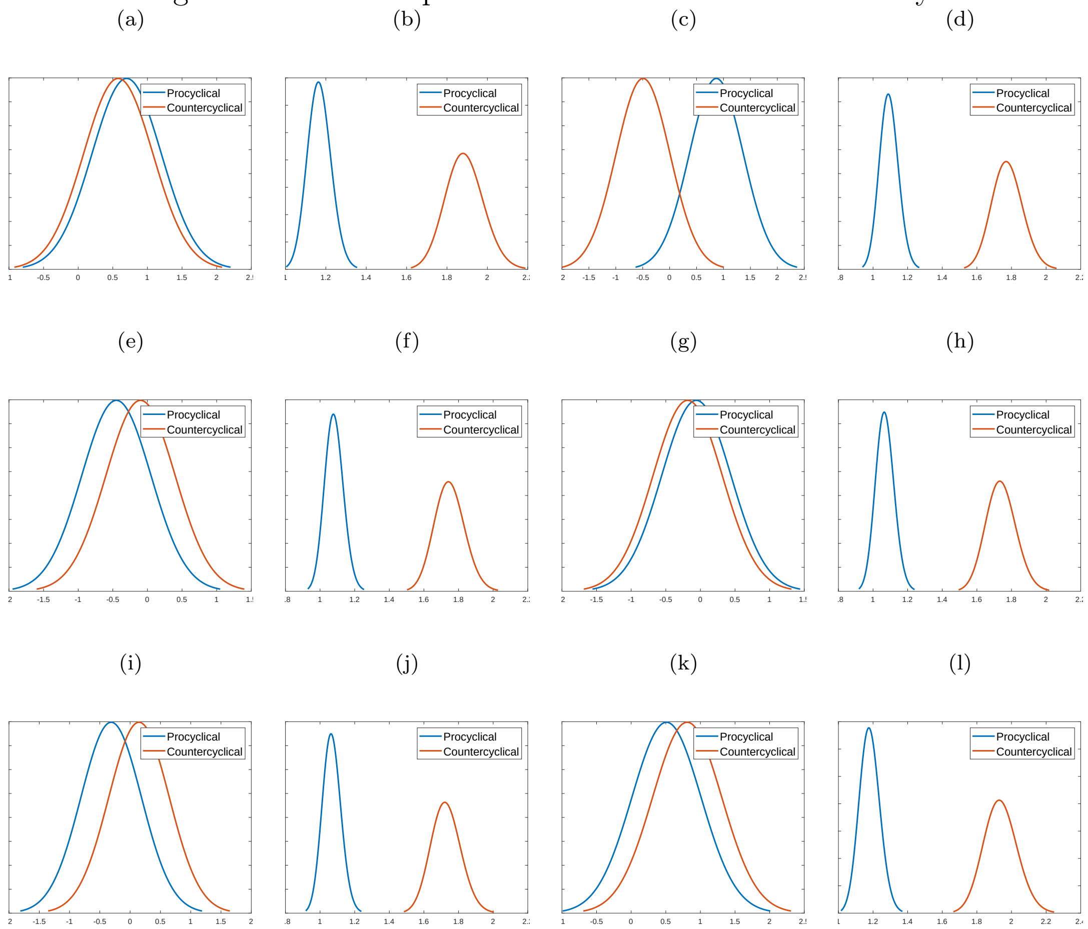
Figure A.15: Intercepts and volatilities estimates for Kuwait



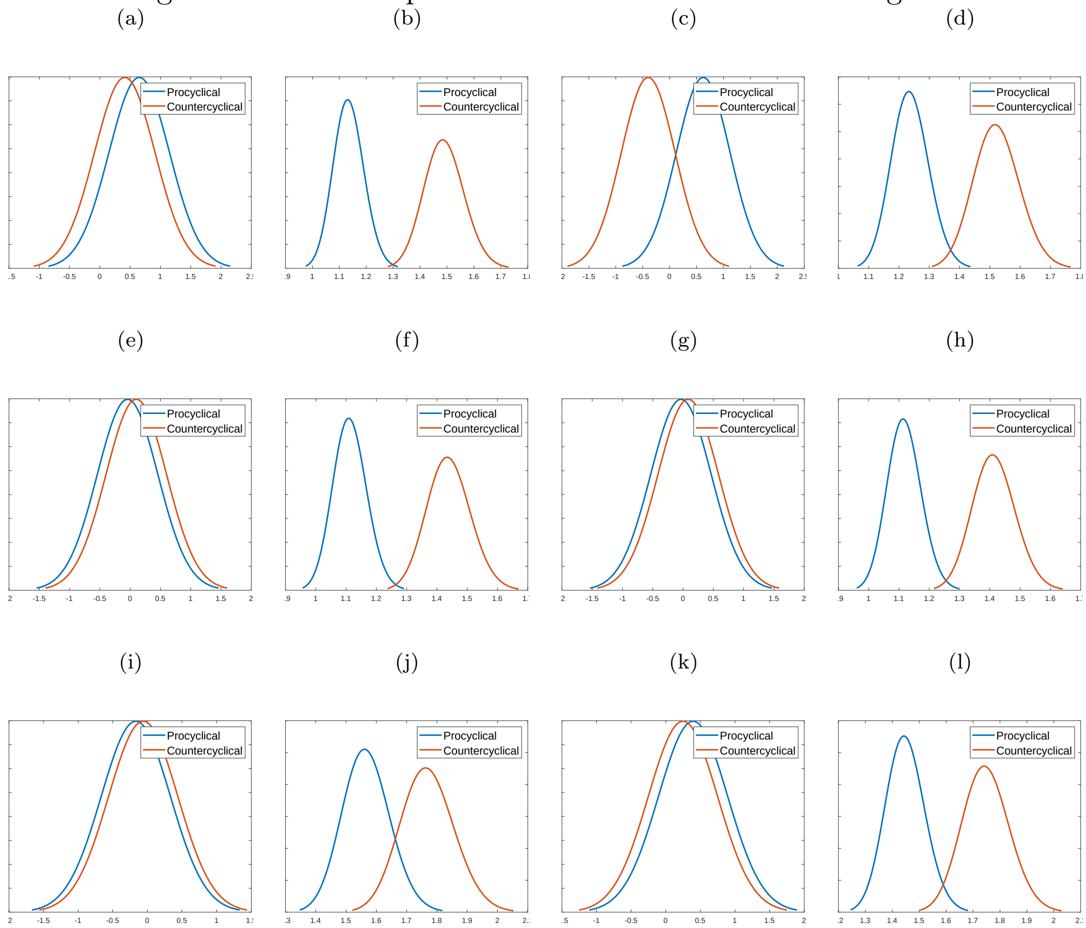
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.16: Intercepts and volatilities estimates for Libya



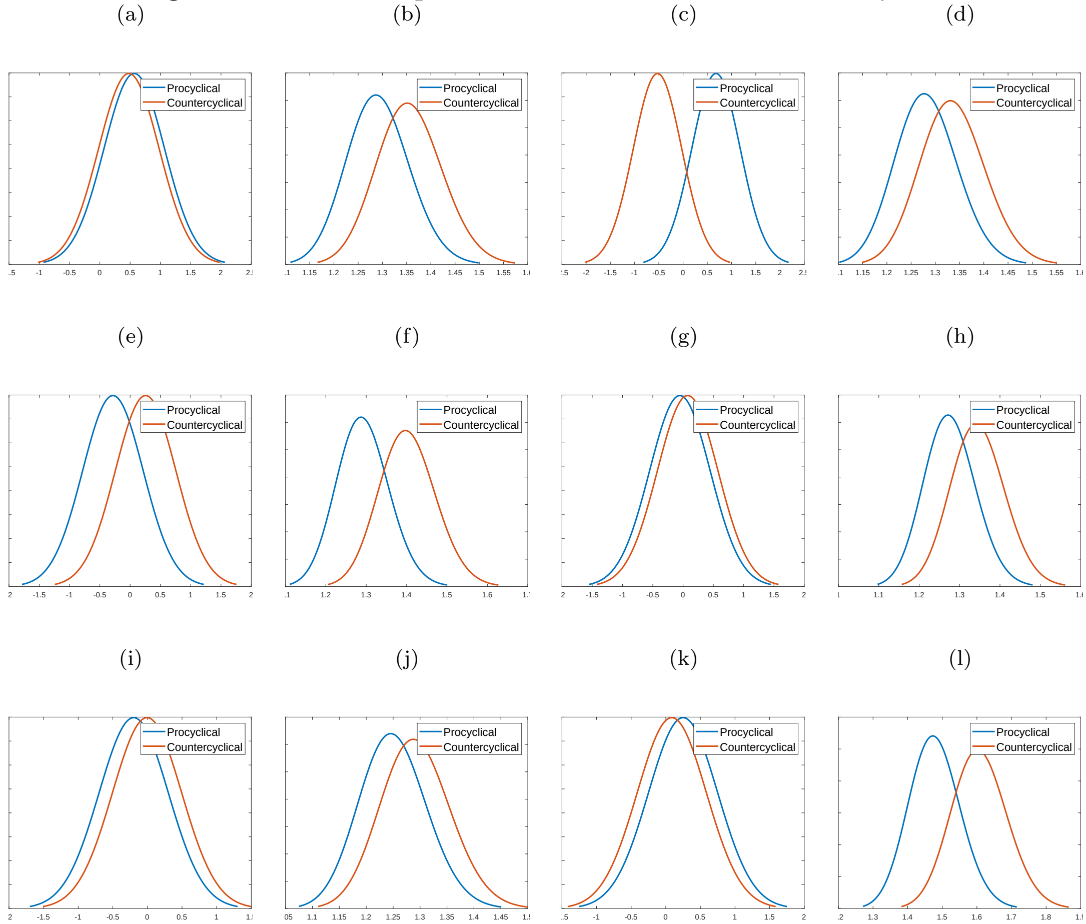
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.17: Intercepts and volatilities estimates for Nigeria



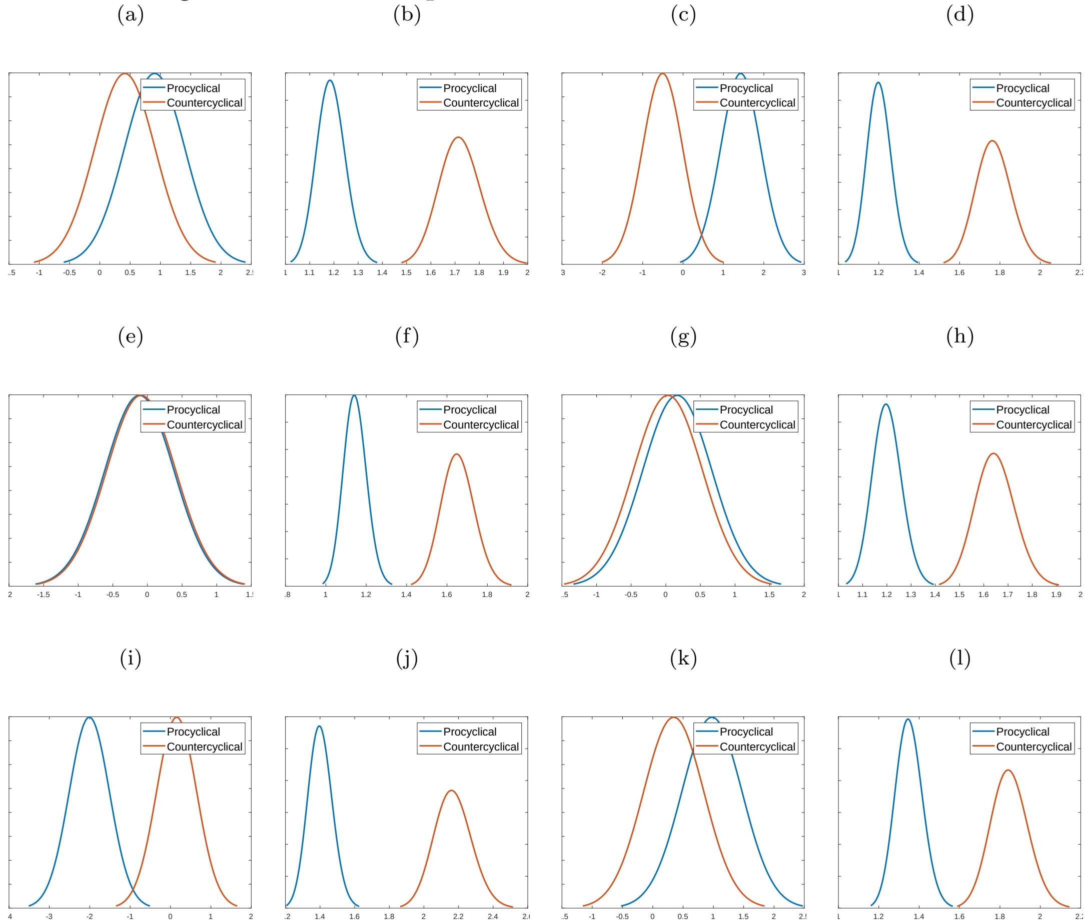
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.18: Intercepts and volatilities estimates for Qatar



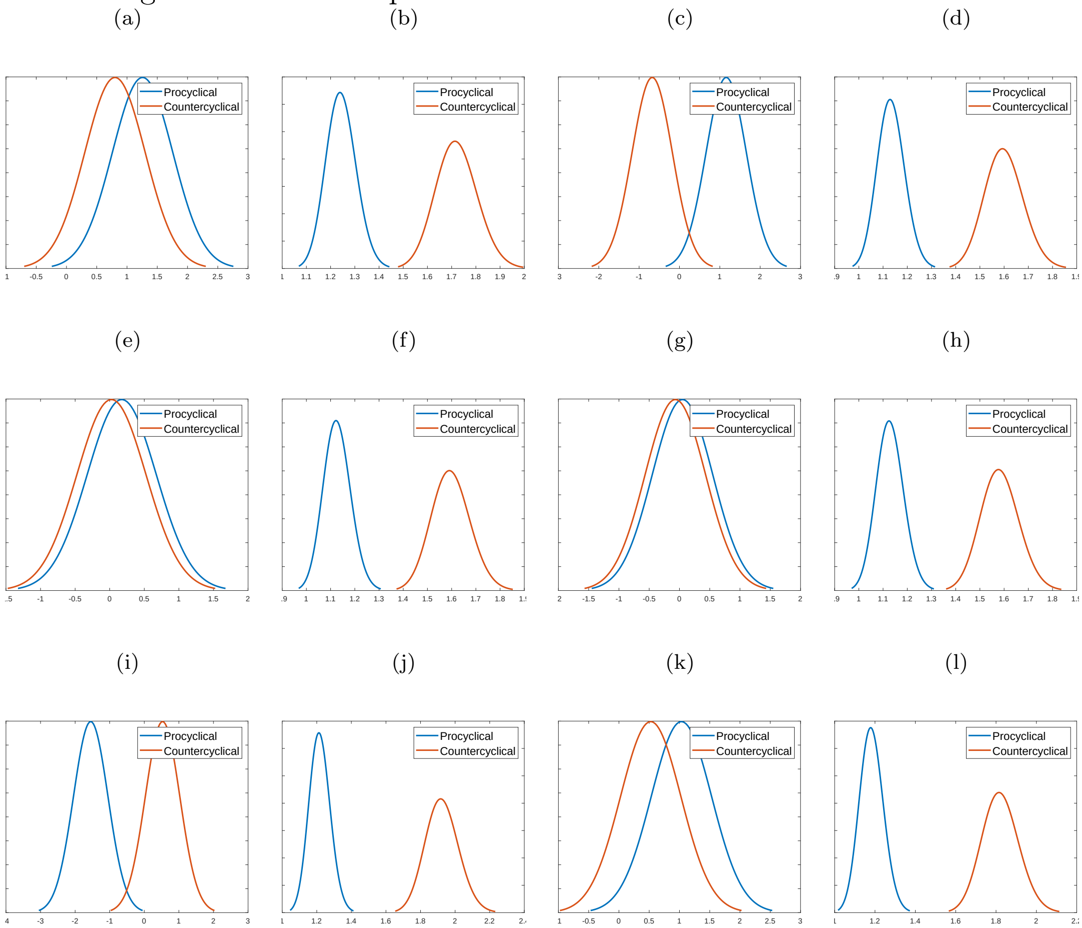
Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.19: Intercepts and volatilities estimates for UAE



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Figure A.20: Intercepts and volatilities estimates for Venezuela



Notes: Graph (a) corresponds to the intercept of total government expenditure / GDP; Graph (b) corresponds to the volatility of total government expenditure / GDP; Graph (c) corresponds to the intercept of government oil revenues / GDP; Graph (d) corresponds to the volatility of government oil revenues / GDP; Graph (e) corresponds to the intercept of non-oil fiscal balance / GDP; Graph (f) corresponds to the volatility of non-oil fiscal balance / GDP; Graph (g) corresponds to the intercept of public employment / total employment; Graph (h) corresponds to the volatility of public employment / total employment; Graph (i) corresponds to the intercept of real oil price; Graph (j) corresponds to the volatility of real oil price; Graph (k) corresponds to the intercept of real exchange rate; Graph (l) corresponds to the volatility of real exchange rate.

Appendix B: Regime probabilities for individual countries

Figures B.1-B.3 report the procyclical fiscal policy probabilities for all the countries of our sample excluding Norway, Russia and Saudi Arabia (for which we present the results in the main body of the paper). In what follows, we provide a short description of these probabilities for both OECD and non-OECD countries.

OECD countries:

Australia. Fiscal policy in Australia has been mainly countercyclical in the period considered. There are only two exceptions. The first exception is during the early 1990s when a recession interrupted the fiscal consolidation. This recession originated from the extremely tight monetary policy, which contributed to the bursting of the commercial property price bubble, combined with a worldwide economic recession, see Gruen and Sayegh (2005). The second episode of procyclical fiscal policy was during 2016, when aggregate demand was led by strong public investment growth in infrastructures, see IMF (2018).

Canada. In 1981/1982 Canada experienced a strong economic recession. This was also an era of high federal-provincial tension as the federal government and the provinces dealt with reduced productivity, slower economic growth, and inflation. This resulted in an increase in government spending that caused in budget deficit. As a share of GDP, the deficit peaked during the recession era of the early 1980s, hitting 8.2% in 1984, see Di Matteo (2017).

In mid-1990s Canada faced the federal fiscal crisis. The ratio of net debt to GDP achieved an historical record of 72.8% in 1995. Therefore, in this period debt crisis became a primary issue, see Di Matteo (2017).

Mexico. In the first half of the 1990s, the Mexican government issued a growing amount of short-term debt with nominal value indexed in dollars and payable in pesos, the so-called “tesobono” debt. This became the largest source of short-term borrowing for the federal government. At end of 1994, the government allowed free floating and the peso lost value. Investors refused to buy new issues of “tesobonos”. This caused a debt crisis, see Meza (2018).

In the second half of the 1990s the Mexican economy experienced a banking crisis. This happened because, at the beginning of 1995, high real interest rates produced an increase in past due loans. As a consequence, both borrowers and banks received financial support from the government. The debt originated by the rescue of banks and borrowers achieved 11.7% of GDP in 1999, see Meza (2018).

In 2009, both primary deficit and domestic debt increased in response to the beginning of the financial crisis. Two additional facts induced an increase in debt between 2008 and 2009. The first was the implementation of the reform to the “Ley del ISSSTE”.[1] The cost of this reform represents 2.6% of the increase in total debt. The second fact was the elimination of a special investment regime for PEMEX.[2] This accounted for 8.8% of the total increase in debt, see Meza (2018).

According to OECD (2015), between 2012 and 2015, Mexico adopted an expansionary fiscal policy with the peak of government expenditure relative to GDP achieved in 2015.

United Kingdom. In 1986, the UK experienced a drop in the government non-oil balance following a savings and loan crisis. During the 1990s the UK saw the most violent swings in public deficit of the entire post-war era. The decade started with an extremely rapid rise in borrowing, so that in just a few years the surpluses of the late 1980s had turned into a deficit of unprecedented peacetime proportions. In 1993, the public sector net borrowing reached 7.8% of GDP. Between 1994 and 1997, according to Clark and Dilnot (2002), there can be no doubt that fiscal policy was significantly expansionary.

[1]The ISSSTE was an institution that provided health and other services to workers in the public sector.

[2]PEMEX is the Mexican state-owned petroleum company.

At the end of 2007 the first consequences of the Global Financial Crisis started to be evident in the UK. The economy was particularly exposed to the crisis because of its large financial sector, high household indebtedness, and strong cross-border links. Economic activity contracted sharply, the unemployment rate increased, property prices plunged, and inflation decreased despite a significant depreciation of sterling. The financial crisis led to a dramatic deterioration in public finances, see IMF (2009c).

The current account deficit continued to increase after the Global Financial Crisis. It reached 5.1% of GDP in 2014. The increase was due almost entirely to a weaker income balance. Part of this decline could reflect structural factors, such as the UK's increasingly favourable corporate tax rates attracting more inward FDI. However, part of the decline in the income balance was temporary, reflecting factors such as unusually low returns on British investments abroad, possibly due to relatively subdued growth in major investment destinations such as continental Europe, see IMF (2016).

United States. In 1972/1973, the US government non-oil balance deteriorated due to stagflation induced by both the oil crisis and stock market crash, see Merrill (2007).

In 1976/1977, President Carter adopted fiscal policy measures that were expansionary. In particular, the US government proposed a reduction in personal and business taxes. Moreover, an expansion in public works and job training programs were adopted, see May (1993).

In 1982/1983, the US economy experienced an economic recession induced by the increase of oil prices after the Iranian Revolution. Tight monetary policy was adopted by the US FED in order to control inflation. This induced a fall in GDP. In that period, the government non-oil balance deteriorated, see Sablik et al. (2013).

The combination of the 1990 oil price shock, the debt accumulation of the 1980s, and growing consumer pessimism combined with the weakened economy produced a brief recession in the early 1990s. This caused the deterioration of the government budget between 1990 and 1993. In subsequent years, President Clinton aimed at reducing the budget deficit as well as tackled the public investment deficit, see Elmendorf, Liebman, and Wilcox (2001).

In 2004/2005, tax cuts and expenditure increases turned the US public sector into a significant borrower. The federal government budget shifted from a 2.5% of GDP surplus in 2000 to a 3.5% of GDP deficit in 2004, see IMF (2005c).

The US general government deficit was at about 9.5% percent of GDP in 2011, one of the highest among major advanced economies, reflecting both cyclical weakness and a supportive structural stance. Policy-makers have provided support to the weak recovery by extending the payroll tax cut and emergency unemployment benefits through 2012, see IMF (2012b).

Non-OECD countries:

Algeria. From Figure B.2, first panel, we observe that procyclical probabilities are high during 2000, 2004 and 2005. According to IMF (2001a), the combination of high oil revenues and increased political and social tensions led the authorities to announce a 2001-2004 recovery plan involving a substantial boost to aggregate demand. At the same time, hydrocarbon production increased by 5%. With the surge in oil prices, hydrocarbon revenues reached 30% of GDP. Government expenditure, fuelled by a surge in capital outlays, increased by 22%, see IMF (2001a).

During 2004-2005, Algeria experienced a period of economic growth led by increased output in the hydrocarbon sector and sustained activity in the construction and services sectors. In light of Algeria's buoyant hydrocarbon revenue, the government decided to boost public spending. In this regard, the authorities launched the "Growth Consolidation Plan", a public investment program for 2005-2009 that amounted to US$50 billion. As a result, government spending in 2005 increased by 4% of non-hydrocarbon GDP, see IMF (2001b).

Angola. Figure B.2, second panel, shows the regime probabilities for Angola. We note that procyclical probabilities are high during 2011-2012. This period was characterized by larger than expected spending on goods and services, surging subsidies, and quasi-fiscal operations conducted by Sonangol[3] on behalf of the government contributed to widen the non-oil primary deficit. In late 2011, Angola introduced important institutional reforms to enhance accountability in public spending and predictability of oil revenue transfers to the budget. Despite these efforts, transfers of 2012 oil revenues from Sonangol to the budget were delayed. These delays undermined the major source of budget revenue and required unplanned adjustment to the pace of budget execution, see IMF (2012a).

Azerbaijan. Focusing on Azerbaijan, we observe high procyclical probabilities in 2005, 2007, 2013 and 2014 (Figure B.2, third panel). In 2005, the oil boom resulted in exceptionally high real GDP growth and a significant improvement in the external position. It also made it possible to increase government expenditure by almost 30%. Capital expenditure more than tripled, and wages, pensions, and other current expenditure increased by about 50%, see IMF (2007a).

In 2007, Azerbaijan experienced a strong economic growth led by a major increase in oil production. Non-oil GDP expanded rapidly and was pushed by large increases in public expenditure, including wages and pensions.[4] Oil revenue grew by about 60%, and rising incomes and consumption (together with improved tax administration) boosted non-oil revenue, see IMF (2008a).

During the period 2013-2014, in Azerbaijan, the growth of non-oil GDP reached almost 10% supported by high public spending and a rapid increase in consumer loans, see IMF (2014a).

Colombia. Turning to Colombia, we note that procyclical probabilities are high in 2008 and 2010 (Figure B.2, fourth panel). During 2008, fiscal policy contributed

[3]Sonangol is the state-owned oil company in Angola.
[4]Wages and transfers together increased by 46%.

to support demand. With respect to 2007, total revenues were broadly constant in real terms, as oil revenues compensated for weak proceeds from the VAT and international trade.[5] Meanwhile, total spending grew by 7% in real terms, with capital expenditure increasing by 25% in real terms, see IMF (2010a).

During 2010, in Colombia, fiscal policy continued to support domestic demand. An important tax reform was enacted. President Santos used flood-related state of emergency powers to adopt reforms that broadened the tax base (by eliminating the fixed asset tax credit in 2012 and closing loopholes in the financial transactions tax) and increased the net wealth tax, see IMF (2011a).

Ecuador. Figure B.2, firth panel, shows the regime probability for Ecuador. We note that procyclical probabilities are large in 2000, 2006, 2007 and 2009. Ecuador went through a difficult period during 1990's but in January 2000 the economic activity began to turn around. Oil prices recovered and domestic demand increased due to the start of the construction of a new private oil pipeline (Oleoducto de Crudo Pesados) as well as higher public spending. Primary expenditures surged. The main drivers were an increase in the wage bill, increases in purchases of goods and services and capital spending, and a boost in social security benefits. Revenue gains automatically resulted in higher expenditures, see IMF (2003a).

In Ecuador, between 2006 and 2009, social spending nearly doubled as a percent of GDP. As reported by Ray, Kozameh, et al. (2012), government spending on education doubled (from 2.6 to 5.2% of GDP) and spending on social welfare more than doubled (from 0.7 to 1.8% of GDP).

Ecuador's economy suffered only a mild recession during the 2008-2009 global downturn. The government fought the recession in two main ways: through expansionary fiscal policy and through what limited monetary policy it had available, keeping interest rates low and limiting the amount of bank reserves that could leave the country. The government implemented fiscal stimulus by extending

[5] Government oil revenues related to transfers of dividends from Ecopetrol (89% government-owned petroleum company) to the government.

widespread housing assistance programs to low income households, nearly doubling the amount of housing finance. The 2009 stimulus was funded largely from reserves, which had accumulated during the oil boom prior to the last quarter of 2008, more than doubling in two years, see Ray, Kozameh, et al. (2012).

Gabon. From Figure B.2, sixth panel, we note that procyclical probabilities in Gabon are high in 1999, 2008, 2009, 2011, 2012 and 2014. According to IMF (2003b), during the 1990s, the authorities did not take sufficient actions to reduce Gabon's oil dependency and pursued a procyclical fiscal policy that did not encouraged diversification and failed to improve the country's poor social indicators. The dependency on oil led to a high-cost structure across the economy, with a high salary level in the public sector, excessive dominance by the public sector in the economy and weak governance.

During 2008-2009, public spending substantially increased due to higher government investment and wages, see IMF (2009a). Real GDP growth was about 6% on the back of substantial scaling-up of public investment. Higher oil and manganese export prices improved the external current account balance. However, the fiscal position came under pressure due to a very rapid increase in spending, especially on investment, notwithstanding high oil prices. Government expenditure increased from 38% of non-oil GDP in 2009 to 47% in 2013, see IMF (2014b).

In 2014, Gabon was still oil-dependent and therefore highly vulnerable to oil price shocks. The continued drawdown of fiscal buffers increased the risks of fiscal sustainability and the adequate financing of needed investment, see IMF (2015).

Iran. Since 1979 Iran has suffered from several rounds of international sanctions. The first round of sanctions was imposed by the US in November 1979 after a group of radical students seized the American Embassy in Tehran and took hostage the people inside. These sanctions included freezing Iranian assets and a trade embargo. The second round of sanctions was imposed by President Reagan in 1987 after Iran's actions from 1981-1987 against US and other shipping vessels in the Persian Gulf and support for terrorism. The third round of sanctions was in 1995, when the US banned trade and investment activities in the oil sector with Iran. The fourth round of sanctions was imposed by the UN in relation to Iran's proliferation of its nuclear program. Initially, these sanctions targeted investments in oil, gas, and petrochemicals, exports of refined petroleum products. Successively, this round of sanctions has been extended in 2007, 2008, 2010, 2011 and 2012 including a long list of individuals and entities subject to a travel ban and assets freeze, see Levs (2012).

Figure B.2, seventh panel, shows that procyclical probabilities are high in 1999 and 2007. In 1999, crude oil production was 3.4 million barrels per day (mbpd), in line with the quota set by OPEC 1999. The average price for crude oil exports was approximately US$ 19 per barrel and led to an increase in oil exports earnings by 64%. The net exports of refined product increased from 113,000 barrels per day (bpd) in 1998 to 197,000 bpd in 1999 representing over 74% increase, see IMF (2000).

Iran has a tradition of relatively prudent budgetary management. In 1999-2000, mirroring the oil price increase, budget performance improved sharply. This strong improvement in budgetary performance reflected primarily higher oil revenue. Government expenditure (mainly capital outlays) adjusted in response to fluctuations in oil and gas revenues. Current expenditures expanded significantly, largely reflecting a significant increase in the wage bill, which was facilitated by oil and gas revenues, see IMF (2000).

In 2006, Iran had the second largest proven oil and gas reserves, and it was the fourth largest oil producer in the world. However, its oil production has remained virtually flat due to insufficient investment. Real GDP growth was 6.6% in 2007, see IMF (2009b). Increased direct government support to priority sectors, scaled-up budgetary capital expenditure, and strong credit growth underpinned a robust and broad based growth of the non-oil economy. Fiscal policy had a significant fiscal relaxation during 2006-2007. Central government increased transfers to households, subsidies and capital expenditure.

Iraq. Focusing on Iraq, from Figure B.2, eightieth panel, we observe that procyclical probabilities assume high values during 2005, 2006 and 2010. In 2004, GDP increased by nearly 50% driven mainly by the recovery of the oil sector 2005. Oil production expanded by 74% from 2003, see IMF (2005a).[6] Non-oil GDP expanded more moderately, as lack of security, electricity shortages, and poor communications hampered the recovery in private sector activity. The fiscal deficit for 2004 was slightly larger than envisaged under the Emergency Post Conflict Assistance (EPCA) program. While wage and pension outlays were slightly lower than budgeted for 2004, spending on goods and services was higher than under the budget, see IMF (2005a).

In 2006, Iraq's economic situation was very difficult, mainly due to the deterioration in security, but progress was made in strengthening macroeconomic management while structural reforms continued. Official fuel prices were increased to regional levels and progress was made in modernizing public financial management, strengthening central bank safeguards, and banking sector reform. The 2006 Iraqi budget included an ambitious investment program, while maintaining overall fiscal sustainability. The authorities took a number of administrative measures to increase the execution rate of investment projects, including accelerating cabinet approval of large projects and shortening the procurement period. At the same time, they were determined to keep current spending, notably on wages and pensions, within budget to make room for public investment and security outlays, and to avoid putting excessive demand pressures on Iraq's small non-oil economy, see IMF (2007b).

In 2010, although the Iraqi economic outlook was more favourable, it still presented large risks. Oil production increased substantially as domestic and foreign investment in the sector started to bear fruit. Moreover, oil prices in the first half of 2010 were higher than assumed under the program. With the

[6]Although the production level in 2004 was still below the pre-war production level.

higher-than-budgeted oil prices more than offsetting the lower export volumes, government oil revenues were higher than projected in the first half of the year 2010. However, a prolonged political vacuum resulted in a worsening of the security situation. This created risks for the development of new oil fields by the international oil companies, which delayed the envisaged increase in oil production 2010, see IMF (2010b).

Kazakhstan. Figure B.2, ninth panel, shows that, in Kazakhstan, procyclical probabilities are high in 2000, 2002 and 2003. In particular, during 2000, the real GDP had a strong increase driven by the strong growth in the petroleum sector. Petroleum production grew by 15% from the previous year, and the oil sector alone accounted for approximately one quarter of GDP. Similarly, government revenues surged. Revenue performance was very strong, one-quarter of which was from the petroleum sector. There was also an increase in expenditure of about 1% of GDP, largely to provide capital for a new development bank and to clear more social arrears, see IMF (2001c).

In 2002-2003, Kazakhstan's economy was booming, with average annual growth of more than 10%. Economic growth was driven by increasing oil production, supported by high oil prices and rising foreign investments. The production of oil and gas condensate reached 51 million tons in 2003, an increase of 9% over the preceding year. Led by the petroleum sector, other key sectors such as services, manufacturing, and construction had significant gains, with an average growth rate of 9%. The rise in expenditures by 2% of GDP was mainly driven by higher outlays for infrastructure, and construction of the new capital Astana, see IMF (2004). Capital injections to state-owned development institutions were also significant, while the increase in social spending remained limited.

Kuwait. Figure B.2, tenth panel, shows that procyclical probabilities for Kuwait are large in 2005, 2010 and 2013. During 2004 and 2005 Kuwait's macroeconomic performance was strong. Real GDP expanded at an average rate of 7.5%, as a result of higher oil production and buoyant non-oil activity. Central government budgetary position strengthened further due to higher oil revenues. Fiscal policy was expansionary as expenditures increased by more than 14%. The expansionary fiscal stance was primarily attributable to sharply higher subsidies and transfers and higher capital outlays, while the growth in the wage bill was moderate and expenditures on goods and services declined after a sharp pickup in 2003-2004 associated with emergency security spending. In that period, Kuwait's government saving rate of 28% of GDP was the highest amongst all Gulf Cooperation Council (GCC) countries, see IMF (2005b).

In 2010, real GDP growth was at 3.3%, comprising oil growth of 3.2% and non-oil growth of 3.4%. Activity was driven mostly by government expenditure; credit growth was small, with lending growth of 3.3% to the productive sectors (industry, services, and trade) partially offset by a reduction in credit to the real estate and financial sectors. At the same time, Kuwait increased its oil production to assist in the effort to stabilize the global market. The fiscal stance was expansionary. Government expenditure in fiscal year 2010-2011 (excluding energy-related subsidies and recapitalization of social security) increased by 21.5%. Higher international oil prices bolstered revenue with oil export receipts increasing by 19%, see IMF (2011b).

In 2013, non-oil growth was 2.8%, driven by a combination of continued increase in domestic consumption and some pickup in government capital spending and private investment. Fiscal surplus was supported by high oil prices but increases in salaries and subsidies put under pressure the public sector. Wages and salaries constituted 50% of total expenditure. Total spending increased by 25% in the budget, reflecting both increased current and capital expenditures, see IMF (2014c).

Libya. Focusing on Libya, Figure B.2, eleventh panel, show that procyclical probabilities assume large values during 2004, 2005 and 2007. Historically, Libya has been a hydrocarbon rich country but has been one of the least diversified economies in the Maghreb region and among the oil producing countries. Libya has suffered from central economic management and excessive reliance on the public sector and started its transition to a market economy in 2002, after ten years of international economic sanctions related to the Lockerbie bombing of 1988, see IMF (2006a).

In 2004, Libya's macroeconomic performance was satisfactory with strong economic growth and large fiscal and external current account surpluses, reflecting higher oil prices and increased oil output. Growth in the construction, utilities, and mining sectors reached 5%, boosted by increased government spending. The fiscal stance was expansionary. However, reflecting high oil revenues (about 51% of GDP) the overall fiscal surplus rose to about 17.5% percent of GDP, see IMF (2006a).

Contrary to previous years, overall economic growth in 2005 was generated mainly in the non-oil economy. While activity in the oil sector grew only 1.5% percent due to output capacity constraints, pick-up in the non-hydrocarbon sector's activity was essentially the result of increased government expenditure. Oil revenues reached 68% of GDP. Non-oil revenue declined by about 15% because of the non-transfer of the interest on the Oil Reserve Fund (ORF) balances by the Central Bank Libya, and lower collections by customs and local governments, partly reflecting the downside effects of the new tax law and customs tariff. Government spending increased by about 33%, reflecting a sharp increase in the wage bill and an improved execution of the development budget, see IMF (2006a).

In 2007, Libyan macroeconomic performance strengthened, notwithstanding an acceleration in inflation. Real GDP grew by 6.8%, supported by an expansion in the hydrocarbon sector and a rapid increase in non-hydrocarbon activities, see IMF (2008b). Despite higher oil revenues, Libya's fiscal surplus narrowed to 26 percent of GDP. This reflected a rapid increase in virtually all expenditure items. The wage bill increased by around 50%. The raise in public wages was accompanied by an initiation of a large civil service reform, with about one third of public employees being transferred to a central labour office for retraining or retrenchment.

Nigeria. Historically, Nigeria's fiscal operations have relied heavily on oil sector receipts. This reliance started in mid-1970's and, despite numerous efforts by the authorities to diversify the revenue base, continues still today. Figure B.2, twelfth panel, shows that procyclical probabilities assume high values during 1993, 1994, 2002 and 2014. In 1993, government oil revenues accounted for the 84% of total government revenues, see IMF (1994). In terms of government expenditure, the share of government capital spending was well over 50% of total investment. In 1994 government and community services increased by nearly 10%, see IMF (1995).

In 2002, Nigerian fiscal policy was highly expansionary. Despite the cut in oil production, oil revenues were higher than expected. Expenditure pressures stemmed primarily from recurrent budget which, in turn, largely reflected an oversized civil service and related pensions costs. Moreover, government capital spending increased by 7.2%, see IMF (2002).

In 2014, while the Nigerian economy was more diversified even if the oil sector remained a critical source for fiscal revenues and foreign exchange. In particular, non-oil revenue was just 4.5% of non-oil GDP (compared to an average of 10-15% of non-oil GDP for other oil producers) providing inadequate financing for infrastructure and social needs and leaving the budget vulnerable to oil shocks, see IMF (2014d).

Qatar. As we can observe from Figure B.3, first panel, procyclical probabilities have large values in 1994, 1995, 2000, 2001, 2002, 2003, 2004, 2007, 2008 and 2010. During the period 1994-1995, the value of the oil sector product increased by 4%. This led to an increase of the oil sector product's relative importance in GDP from 32% in 1994 to 33% in 1995. Total government increased because of the rise in the oil price and, in turn, higher oil revenues. Oil and gas revenues represented the main source of public revenue. Actual total expenditure increased by 7% in the same period, see QCB (1995).

In 2000, the oil and gas sector increase by 75%. Such increase was a result of both price and production increases. Qatar crude oil production increased by 54%. The relative importance of oil and gas sector on GDP increased to 58% compared to 45% in 1999. Public revenues soared and government expenditure increased as well, see QCB (2000).

In 2004, GDP registered an increase of 20%. Thus, the Qatar economy extended five years of rapid growth since the year 2000. Most of the economic sectors achieved a high rate of growth in 2004. The product of the oil and gas sector increased by 24%. Such increase came as a result of increases in oil and gas production and in the price of oil. Crude oil production increased by 5% to reach 754 thousand barrels per day. Public expenditure was the main source of the domestic liquidity, and a vital source for the economic and social development projects in Qatar. During the period 2001-2004 the increase in government expenditure was substantial. This spending was distributed upon wages and salaries, loan interest payments and infrastructure projects allocations. Public revenues in Qatar were mainly achieved from oil and gas sector with an increase of such revenues of 64% in 2004, see QCB (2004).

In 2008, the oil and gas sector, the major component of GDP, recorded a substantial increase despite the sharp decline in oil prices during the second half of the year. This sector increased by 52%. Public revenues increased by 16%, compared to an increase in the public expenditures by 15%. The significant increase in government revenues was driven primarily by the rapid development of the hydrocarbon sector. Public expenditure increased because various measures were undertaken by the government to ensure substantial spending in key areas such as infrastructure, education and healthcare, see QCB (2008).

During 2010, the oil and gas sector witnessed a growth during of almost the 50%. This growth was mainly attributed to the higher international oil prices. The developments in the oil and gas sector led to an increase in its relative share of GDP by 7% achieving the 52%. Oil and gas government revenues, which represented the first main source of public revenues in Qatar, increased by 17%. Public expenditures also increased at about the same pace of growth witnessed of previous years to accelerate the pace of economic development QCB (2010).

UAE. Figure B.3, fourth panel, shows that the regime probabilities for the UAE are high during 2003 and 2005. In 2003, the real GDP grew by 7%. The output of oil and natural gas sector constituted the 77% of the GDP value and it increased by 14% with respect to the previous year. The manufacturing sector (mainly constituted of liquefied gas and petroleum products) achieved the highest rate of increase compared to other sectors, reaching a 10% increase. The increase in output of this sector was mainly due to the increase in the refining capacity. In the same year, government revenue increased by 32% mainly due to the increase in oil and gas earnings. Similarly, government expenditure increased by 3%. Current expenditures (such as salaries, wages, expenditures on goods and services, subsidies and transfers) constituted the 83% of total government expenditure, see UAE CB (2010).

In 2005, reflecting high oil prices and production, UAE real GDP grew by 9% percent. Growth was broad-based and most sectors grew at historically high rates. Real non-hydrocarbon GDP growth was 13%. The hydrocarbon sector registered a growth rate of 2%. Government expenditure grew by 8% largely due to the outsourcing of some services previously provided by the municipality to the private sector. The sectors that were largely transferred off-budget included housing and community centre programs and general administration. Oil revenues increased by 7% and constituted the 50% of total government revenues IMF (2006b).

Venezuela. At the end of the 1990's, the oil sector played a dominant role in Venezuela as it contributed to about 25% percent of its total GDP, 50% of public sector revenues, and about 80% of exports.[7] As a result, Venezuela's macroeconomic stability was highly dependent on, and therefore vulnerable to,

[7] These percentage refer to the sample period 1991-2002. For more details, see Baldini (2005).

the oil sector. The oil sector component of the GDP of Venezuela was also highly correlated to oil price fluctuations. Moreover, Venezuela recorded both high public sector revenue and expenditure volatility, with an annual average standard deviation of around 4% of GDP.[8]

In 2002, Venezuela held proven oil reserves of about 78 billion barrels. Moreover, Venezuela was one of the top suppliers of US oil imports and was among the top ten crude oil producers in the world. The petroleum industry was the mainstay for Venezuela's economy, accounting for more than 3/4 of total Venezuelan export revenues, about half of total government revenues, and about one-third of GDP. Crude oil production was around 2.5 million barrels per day, see US EIA (2005).

In 2010, Venezuela contained some of the largest oil and natural gas reserves in the world. In particular, it had 211 billion barrels of proven oil reserves. Moreover, Venezuela was one of the world's largest exporters of crude oil and the largest in the Western Hemisphere. The country had net oil exports of 1.7 million barrels per day. The oil sector was of central importance to the Venezuelan economy. The national oil industry (PDVSA) accounted for a significant share of the country's GDP, government revenue, and export earnings, see US EIA (2012).

In 2013, Venezuela was the world's $9th$ largest exporter and $12th$ largest producer of petroleum and other liquids. It had nearly 298 billion barrels of proved oil reserves, the largest in the world. After Chavez's death in 2013, President Maduro continued Chavez's policies implementing the nationalization of oil exploration and production in Venezuela through the PDVSA. Venezuela also increased pressure on foreign operators that remained in the country to increase investment to offset production declines, see US EIA (2014).

[8]The estimated values are for the sample period 1990-2002. For more details refer to Baldini (2005).

Figure B.1: Procyclical fiscal policy probabilities: remaining OECD countries

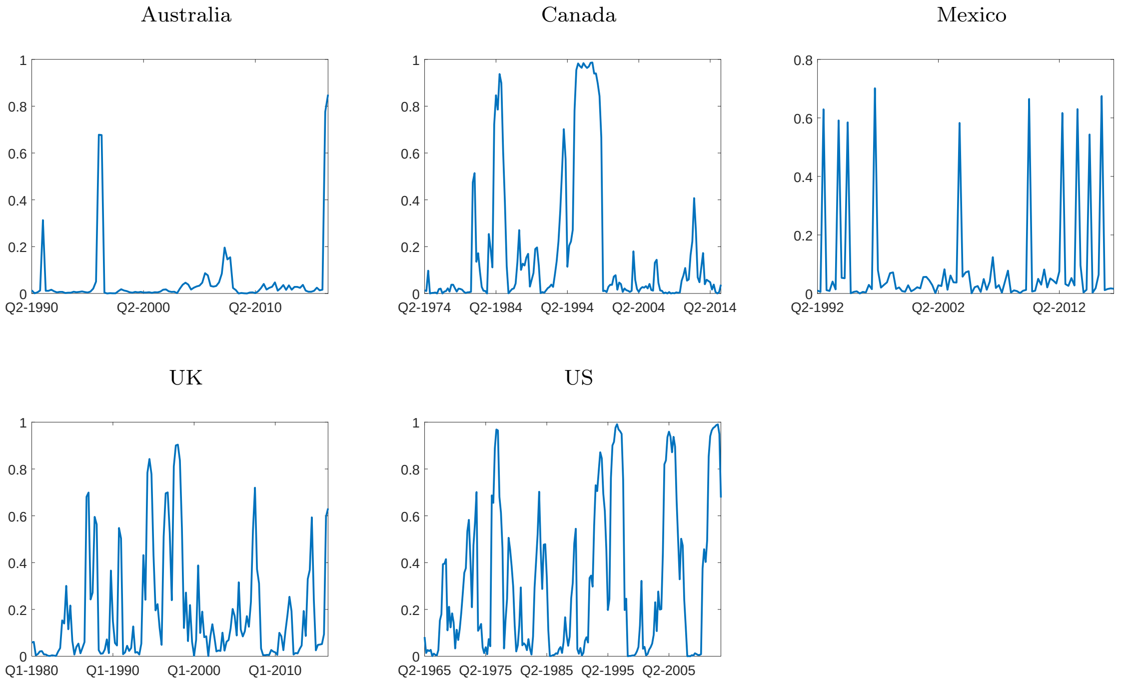


Figure B.2: Procyclical fiscal policy probabilities: remaining non-OECD countries (1)

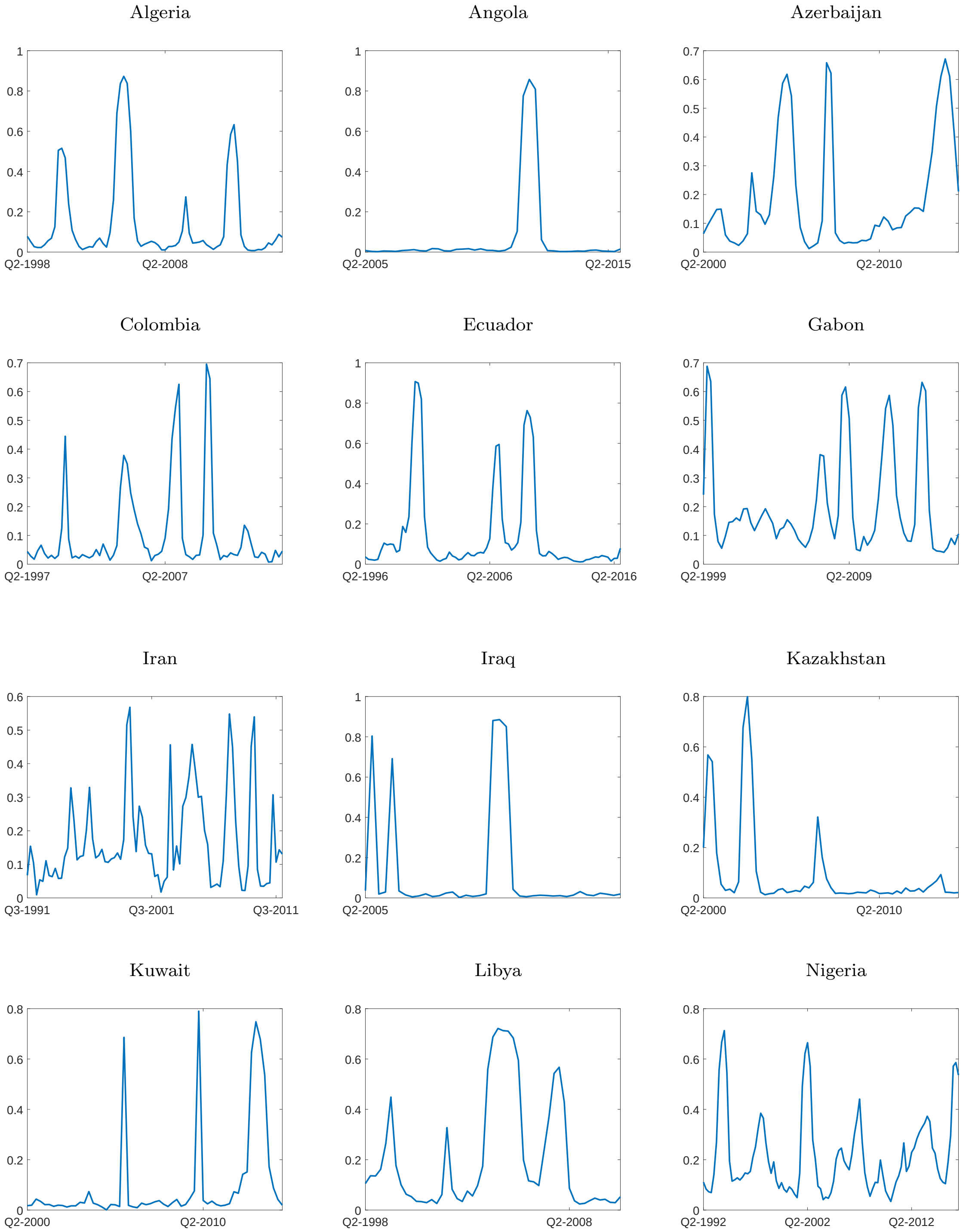
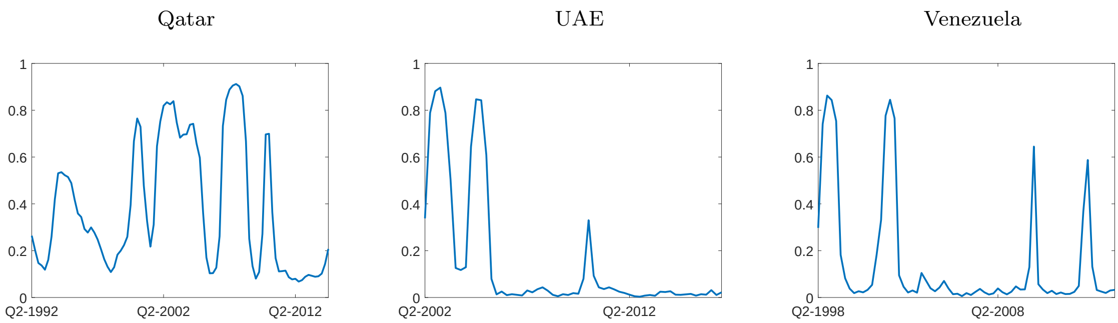


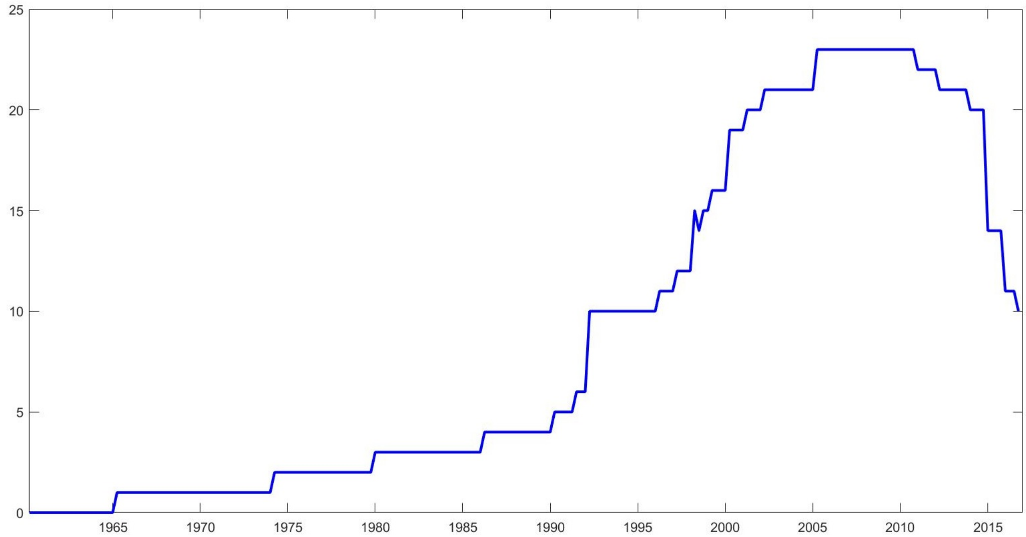
Figure B.3: Procyclical fiscal policy probabilities: remaining non-OECD countries (2)



Appendix C: The number of countries in the sample

Since we have an unbalanced panel, it is important to see the size of the sample in the different periods of time.

Figure C.1: The number of countries in the sample, 1960-2016



The figure above shows that between 1965 and 1980 the number of countries was relatively low. The US has been part of the sample since the beginning of the sample period. During this period, the share of global oil production of the countries included in the sample was more or less 15%. Between 1980 and 1990, Australia, Canada, Norway, UK and US were part of the sample. The share of global oil production of these countries is approximately 24%. Between 1990 and 1995, Iran, Mexico, Qatar and Saudi Arabia joined the sample. The share of global oil production of the countries included in the sample during this period was approximately 40%. Starting from 2000 the number of countries grew to 20. The share of global oil production of the countries included in the sample during this period was more or less 76%. The last countries included in the sample were Angola, Iraq and UAE. The maximum number of countries was reached between

2005 and 2010. At the peak, the share of global oil production of the countries included in the sample was approximately 84%.

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