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Abstract

This paper examines the sustainability of fiscal policy in GCC countries, by exploring governments' reaction to the ongoing energy transition progress via the estimation of a fiscal reaction function. Using the ARDL approach for the GCC, and other similar and non-similar groups over the period 2000 -2022, five main results are found in this investigation. First, GCC countries are increasing the pace of economic reforms as they issue more debt to ensure a sustainable fiscal policy, mainly amid low oil price periods. Second, the primary balance is not affected only by oil price fluctuations but also by oil price volatility. In fact, while higher oil price improves the primary balance only in oil-producing countries, the volatility of the oil price decreases the primary balance of all groups. Third, an increase in the production of Global renewable energy sources may reduce the primary fiscal balances in oil-exporting countries in the long term, as the gradual decline in global demand for oil could affects negatively the government revenues in these countries. Fourth, accelerating the energy transition efforts in the GCC helps to stimulate economic growth and improve environmental sustainability. Fifth, increasing the share of renewable energy sources in the gulf region needs further government spending and consequently increases the debt level to finance the economic reforms, which may reduce the primary balance.

Keywords: Fiscal Policy, energy transition, Debt sustainability, Panel Data Models
JEL Classifications: E62, H63, C33

ملخص

تبحث هذه الورقة في استدامة السياسة المالية في دول مجلس التعاون الخليجي، من خلال استكشاف رد فعل الحكومات على التقدم المستمر في انتقال الطاقة من خلال تقدير وظيفة رد الفعل المالي. باستخدام نهج تأخر التوزيع الذاتي لدول مجلس التعاون الخليجي، وغيرها من المجموعات المماثلة وغير المماثلة خلال الفترة 2000 -2022، وتم العثور على خمس نتائج رئيسية في هذا التحقيق. أولاً، تعمل دول مجلس التعاون الخليجي على زيادة وتيرة الإصلاحات الاقتصادية حيث تصدر المزيد من الديون لضمان سياسة مالية مستدامة، بشكل أساسي، وسط فترات أسعار النفط المنخفضة. وثانيا، لا يتأثر الرصيد الأساسي بتقلبات أسعار النفط فحسب، بل أيضا بتقلب أسعار النفط. والواقع أنه في حين أن ارتفاع أسعار النفط لا يحسن التوازن الأولي إلا في البلدان المنتجة للنفط، فإن تقلب أسعار النفط يقلل من التوازن الأساسي لجميع المجموعات. ثالثاً، قد تؤدي الزيادة في إنتاج مصادر الطاقة المتجددة العالمية إلى خفض التوازنات المالية الأولية في البلدان المصدرة للنفط في الأجل الطويل، لأن الانخفاض التدريجي في الطلب العالمي على النفط يمكن أن يؤثر سلباً على الإيرادات الحكومية في هذه البلدان. رابعا، يساعد تسريع جهود انتقال الطاقة في مجلس التعاون الخليجي على حفز النمو الاقتصادي وتحسين الاستدامة البيئية. خامسا، تحتاج زيادة حصة مصادر الطاقة المتجددة في منطقة الخليج إلى مزيد من الإنفاق الحكومي وبالتالي زيادة مستوى الدين لتمويل الإصلاحات الاقتصادية، مما قد يقلل من التوازن الأساسي.

1. Introduction

Gulf Cooperation Council[1] (GCC) has been one of the fastest-growing regions in the world, enjoying large external and fiscal surpluses over the past decades, supported by rising government spending amid rapidly increasing oil revenues. A portion of these revenues is provided to citizens through transfers and public sector jobs, while another portion is invested in infrastructure and real estate, education, and health. The rest is saved mainly in sovereign wealth funds (SWFs). This growth model has helped achieve rapid economic development and a significant improvement in social indicators over many decades.

However, with oil prices plunging since the second half of 2014, surpluses have turned into deficits, public debt levels have increased, and growth has slowed, raising concerns about fiscal sustainability and its implications on macroeconomic stability. In fact, the reliance on oil revenues means the GCC economies are exposed to developments in the global oil market. Over the medium term, any significant drop in oil prices could affect government spending and consequently dent economic growth. Also, the frequent oil price volatility decreases stable revenues for the government and increases spending to counter the effect of oil price volatility on growth, causing a negative impact on the primary balance. In the longer term, climate change and the associated energy transition pose an important challenge to the region. The gradual decline in global demand for oil and the significant increase in the share of renewable energy sources in the global energy supply will directly affect not only the GCC oil sector, but also their public finances and external accounts. This urges the need to prepare for the post-oil scenario by diversifying GCC economies away from the oil sector and accelerating the energy transition efforts.

In this context, all GCC countries have refocused attention on economic diversification and energy transition, by adopting long-range economic reform strategies[2], to promote sustainable development in the non-hydrocarbon sector. First, diversification would reduce the exposure to volatility and uncertainties in the global oil market. Second, it would help increase productivity and sustainable growth in the long run. Third, it would help to achieve the ambitious net-zero emissions targets.

To that end, successful economic diversification and sustainable economic growth require increasing government spending to build and boost sectors that are truly independent of oil and gas, including renewable energy sector. Thus, GCC started diversifying their non-oil revenues, by implementing new taxes and fees and increasing taxation rates, to support government budgets. Moreover, they mobilized other sources of financing, such as issuing more domestic as well as foreign debt and using their financial buffers and foreign exchange reserves accumulated in periods of high oil prices.

As the medium-term horizon looks more challenging for the oil market, increasing economic diversification efforts require that GCC Governments continue to play a leading role in prioritizing spending in support of further development and private non-energy growth. Financing economic reforms, especially during the low oil prices period, could put more pressure on the fiscal position

[1] The Gulf Cooperation Council is comprised of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates
[2] For example: Vision 2030 in Saudi Arabia, Bahrain, and Qatar ;Vision 2031 in the United Arab Emirates; Vision 2035 in Kuwait, and Vision 2040 in Oman.

of the GCC countries, which could affect negatively the benefits of increasing economic diversification. Even if Government debt stocks remain low in the GCC region compared to the international standards, persistent fiscal deficit, coupled with a shrinking surplus, or larger deficit of the external current account as a percentage of GDP, could cause a rapid rise in debt stocks in the short-run, which might jeopardize fiscal sustainability and macroeconomic stability. Hence, debt financing should be supporting growth conducive spending to maximize the best results for growth and help ensure debt sustainability in the near term as the economies continue on the path of further diversification to reduce dependency on oil resources and the need for continued large government spending going forward.

Despite the consensus on the importance of economic diversification in achieving sustainable growth, there is a very limited understanding of the impact of increasing energy transition on fiscal sustainability, particularly in the context of resource-rich economies. This paper tries to fill this gap and seek answers to the following questions: (i) What are the main factors that influence fiscal sustainability in GCC? (ii) How the increasing global energy transition will affect the GCC fiscal policy? (iii) How financing renewable energy projects in the GCC countries will intersect with the need to raise debt during oil price shocks? And finally, (iv) How different is the response of fiscal efforts to oil price shocks in the most economically diversified countries compared to the GCC response?

The main purpose of this paper is to assess the impact of energy transition on the sustainability of public finances for the GCC countries, using the fiscal reaction function, developed and expanded by Bohn (1998-2011). This approach will provide a straightforward and powerful method to conduct empirical tests that are sufficient to satisfy fiscal solvency. Subsequently, we revise this conventional equation, in order to take into consideration other important factors for such countries. The advantage of this approach is that the sustainability of public debt is interpreted as the result of the interaction of fiscal policy with the economic environment, and not as a statistical concept as in most of the recent literature. The model specification captures more details of the macroeconomic dynamics, such as economic diversification efforts, trade openness, oil price fluctuations, and economic growth, in order to evaluate its implications on fiscal variables and the debt profile.

Moreover, this paper evaluates also the fiscal sustainability for a panel of a group of the most economically diversified countries, as well as other net oil exporting countries, in order to get reliable results, and to evaluate the general impact of the economic reforms on the fiscal budget across varying sample groups (see Appendix Table 1). This allows us to understand the fiscal responses of several countries with different economic structures to the changes in oil prices and their increasing volatility. For estimation purposes, we use annual data for the period 2000 - 2022, since the selected variables are not all available on a quarterly basis in the selected countries. All data are taken from the national authorities, the IMF and the World Bank databases.

The remainder of this paper is as follows. Section II provides the theoretical and empirical literature on energy transition and fiscal sustainability, while section III describes the used data and discusses our adopted macroeconomic framework. Section IV presents the empirical results, and discusses some interpretations. Finally, Section V concludes with some policy implications.

2. Theoretical and empirical literature review

Even if both concepts of energy transition and fiscal sustainability are widely used and generally considered very important for the country's economic stability in the long run, there is no universal approach to how they should be best assessed and how they can affect each other. Various approaches to assessing separately energy transition and fiscal sustainability have been used, but most of the empirical studies have been focused on developed countries, such as the US and other industrial countries. To our best knowledge, no papers have analyzed this issue in a panel of GCC countries, especially by applying recent econometric methods for panel data. There has been little attention to these facts and this paper attempts to fill this gap, given the hard choices facing the GCC region to strike the necessary balance between near-term fiscal sustainability and medium-term growth and energy transition objectives.

At first glance, it may seem easy to define what a sustainable fiscal policy is. A sustainable fiscal policy is the state wherein the government budget can be smoothly financed without generating explosive increases in public debt over time. Thus, when this condition is met, the budget is said to be sustainable and, conversely, when the condition is not met, the budget is unsustainable. This definition may seem sufficiently easy. However, it is very difficult to apply in practice. There is no clear meaning of "smoothly financed" and "explosive increases", as well as no specification of the time horizon. This ambiguity has led many countries to assess their sustainability of fiscal policies based on their own definitions according to their own approaches and using specific indicators.

In this regard, contemporary literature has provided various definitions of fiscal sustainability. It is defined as whether the government will be able to generate surpluses in the future in order to pay off previous debt or whether it finances the debt and interest payments by issuing new debt (Ponzi game[3]). It can also be defined as the situation that requires government expenditures and revenues to be in equilibrium, not only in the short term, but even in the long run. Moreover, some economists find it useful to draw an explicit distinction between (i) static fiscal sustainability, which means that the government can finance its budget smoothly period by period, and (ii) dynamic fiscal sustainability, which means that fiscal policy will not generate explosive increases in public debt over time. Both definitions are important and could be useful for the identification of the adverse implications for macroeconomic and financial instability.

In addition to the theoretical descriptions, some definitions were based on how to measure and quantify fiscal sustainability, using statistical data. For example, Buiter (1985) defines fiscal policy as sustainable if the government's net worth to GDP ratio is maintained at its present level, while Blanchard (1990) defines it as a policy that ensures that the ratio of debt to GDP converges back towards its initial level. However, these famous definitions were criticized for two main reasons (Artis and Marcellino, 2000). Firstly, there is no theoretical reason why those ratios should be required to return to its initial levels and not to any other stable level, even if it is lower or higher. Secondly, the Government could adopt a policy under which the debt ratio initially rises to an excessive level to promote economic growth, while ensuring the debt comes down and returns to the safe and stable level. To overcome this problem, a new definition was adopted, which states

[3] Bergman, M. (2001). "Testing government solvency and the No Ponzi game condition". Applied Economics Letters, 8(1):27–29.

that fiscal policy is sustainable if the present value of future primary surpluses[4] is equal to the current level of debt, which is commonly known as the Inter-temporal Budget Constraint.

However, this innovative definition could be used to establish conditions for solvency and sustainability. In fact, the government is said to be solvent[5] if it is capable, over an infinite horizon, of paying its debt via future primary surpluses. In other words, the government is solvent if the inter-temporal budget constraint is fulfilled, and hence, not engaging in Ponzi game of financing. Therefore, this new definition, which is based on the inter-temporal budget constraint, has become the most widely accepted and the starting point for estimating the fiscal reaction function to assess debt sustainability.

In general, a fiscal reaction function studies the relationship between the fiscal balance and the debt level, in order to help governments to determine the achievement of the fiscal policy in different time periods and to react against some macroeconomic changes. Having the right fiscal reaction function makes fiscal policy and public finance sound and stable.

According to the literature, most fiscal reaction functions originate from the government inter-temporal budget constraint, but differs according to some specific conditions related to the country or the purpose of the research. Thus, the standard fiscal reaction function used in most of the existing literature is the one developed and expanded by Bohn (1998-2011) about the US public debt:

$$\boldsymbol{PB_t = \alpha_0 + \alpha_1 D_{t-1} + \alpha_2 GS_t + \alpha_3 X_t + \varepsilon_t} \qquad \textbf{(1)}$$

Where, $\boldsymbol{PB_t}$ is the primary balance and D_t is the outstanding debt, while $\boldsymbol{GS_t}$ reflects government spending and $\boldsymbol{X_t}$ reflects a measure of business indicator, such as GDP growth or Output gap, or GDP per capita. In fact, Bohn (1998) used a multivariate OLS estimation, including government expenditure and a business cycle indicator, to show a significant positive response of the primary surplus to changes in debt/GDP ratio in the US, which provides reliable information about sustainability irrespective of how interest rate and GDP growth compare. Bohn focuses mainly on the coefficient of the variable that indicates the public debt, along with co-integration of a number of fiscal variables, reflecting the reaction of the primary deficit to the changes in the level of debt. A statistically significant positive sign of the debt level coefficient in the fiscal reaction function means that a government reduces the budget deficit by targeting a higher primary surplus, or smaller primary deficit, in response to the debt growth.

However, despite the importance of the oil price in many countries, fewer studies investigated how the fiscal policy in such countries responds to the oil price shocks and volatility. For example, some studies concluded that the oil price influences fiscal policy and that can be a key propagation mechanism for transmitting oil price shocks to the domestic economy (Husain et al, 2008; Arezki and Ismail, 2010). Similarly, Ossowski et al (2008) emphasize the trade-offs between increasing spending and the fiscal ability to effectively and efficiently absorb such an increase, in response to higher oil prices. In fact, they find that while the latest oil price boom (2004-2008) allowed oil-producing countries to increase public spending, these countries had relatively low indices of

[4] Primary surplus is defined as the overall budget balance minus debt service interest cost plus net interest income on assets plus the monetary issuance of the sovereign.

[5] Insolvency is often referred to as Ponzi game financing.

government effectiveness. Moreover, El Anshasy (2011) estimates a fiscal policy equation that links government spending to oil price shocks in oil-producing countries, and finds that, in the short run, government expenditures rise less than proportionately to the increase in oil revenues, reflecting increased prudence in fiscal policy.

In our paper, we extend the above-mentioned literature, with a focus on the GCC countries, which differs from the existing papers as follows. First, most of the existing studies focus mainly on how the fiscal primary balance responds to an increase in debt, neglecting other main determinants of fiscal policy, such as energy transition efforts, oil price fluctuations, and the openness of the economy. For that reason, we revise the conventional fiscal reaction function, in order to take into consideration other important factors for such countries. Second, the role of energy transition in achieving inclusive growth and ensuring fiscal sustainability in GCC countries has received little attention in the existing literature. Thus, this paper focuses on assessing the impact of economic reforms on raising debt in the GCC countries. Third, we focus not only on the government's fiscal response to oil price shocks, but also to price volatility. In fact, we tried to examine if those countries are not affected by the price volatility or if they become more prudent when oil prices become more volatile. Finally, this paper compares the obtained results for the GCC, with other similar and non-similar groups, in terms of economic diversification and oil dependency. This comparison allows us to understand how some macroeconomic factors affect differently the fiscal policy responses, in the context of oil price shocks and high price volatility.

3. Adopted methodology

This section focuses mainly on evaluating the sustainability of GCC's public finance to determine whether the authorities pursued appropriate policies to avoid excessive debt accumulation and assess the energy transition's impact on fiscal sustainability in the context of oil price shocks and high price volatility. To this end, the sustainability of fiscal policy is assessed in a sample of the GCC countries, then compared with a sample of the most economically diversified countries, such as the G7[6], as well as a group of the top 10 countries in low-carbon energy investment in 2022 (Top10ETI). Moreover, given that oil[7] revenue is a critical source of fiscal revenue for those countries, the analysis of this paper also evaluates the fiscal sustainability for a panel of other net oil exporting countries (NOEC), in order to get reliable results, and to evaluate the general impact of oil price on the fiscal budget. The choice of this set of countries is motivated by their relative homogeneity in terms of oil dependency, in line with the data constraints (see Appendix Table 1). This allows us to understand the fiscal responses of different governments to the changes in oil prices and their increased volatility. The results could, therefore, inform policymakers regarding the importance of stabilization of their fiscal budget, in line with the overarching objectives of promoting energy transition.

3.1. Data description

Since this paper attempted to empirically assess fiscal sustainability and to evaluate how accelerating energy transition (global and national levels) can affect rising public debt levels, the

[6] The Group of Seven (G7) is an intergovernmental political forum consisting of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

[7] Throughout this paper, the term "oil" is used as a substitute for the terms "hydrocarbon" or "petroleum", because gas is also an important resource in several countries.

key variables used in this paper are the primary fiscal balance and public debt, as well as other macroeconomic variables that are considered important in our fiscal reaction function (See Appendix Table 2).

Therefore, the Primary balance, in percent of nominal GDP, is the dependent variable in our model. It is simply defined as the fiscal balance excluding net interest payments on public debt. The choice of primary balance is reasonable, because it reflects better the government discretionary fiscal behavior and helps to evaluate the impact of automatic stabilizers and discretionary policy.

Concerning the explanatory variables, the existing stock of public debt (sum of domestic and external debt), in percent of nominal GDP, is the most used determinant of fiscal performance in the literature. In fact, Governments take permanently into consideration the debt to GDP ratio in their budget planning. It may choose to borrow and accumulate debt to fund spending, which contributes to improving physical infrastructures and other social projects, but at the same time, the government should avoid a number of potential risks associated with high public debt, such as the adverse impact on economic performance and debt crises. Thus, many studies showed that the primary balance systematically responds to past changes in the public debt. Indeed, Bohn (1998) argues that debt is sustainable if primary surpluses are a strictly positive function of the debt-to-income ratio.

Moreover, in the existing literature, different measures of output are introduced to capture the transitory impact of the state of the economy on fiscal performance. In this regard, real GDP growth is considered in this paper. Another factor that could affect fiscal performance is Trade openness. It could be favorable to growth through its impact on total factor productivity (TFP), by enhancing revenue performance. However, openness could also increase a country's exposure and vulnerabilities to external shocks, with an adverse impact on revenues and even on expenditures. For the commodities-producing countries, some studies, such as Combes and Saadi-Sedik (2006), indicate that trade openness increases a country's exposure to external shocks, regardless of its underlying causes, which could possibly have an adverse impact on its fiscal performance. In our paper, Openness is defined as the ratio of exports of goods and services plus imports of goods and services to GDP, sourced from the World Bank database.

Regarding energy transition, we tested several variables to reflect the ongoing efforts to reduce the share of carbon-based energy in the energy mix on global and national levels. However, under data availability constraints, we used in this paper, the renewable energy share of electricity generation (REEG), to capture the production of non-hydrocarbon energy in national and global level. Data is taken from the International Renewable Energy Agency (IRENA).

One of the most key determinants of fiscal sustainability for the GCC countries is the oil price, given its influence on their fiscal policies and economic growth. Therefore, this paper's focus is not only on the government fiscal response to oil price shocks, but also to price volatility. To do this, the annual oil prices are used to construct the changes in oil prices, which reflects the oil price shocks. In addition, we constructed an alternative measure of volatility, from the monthly oil price series. The standard deviation in the 12 months for each year is considered as one observation of the annual volatility series for a particular year.

All the above-described variables are available on an annual basis, covering the period 2000 - 2022. Except for GDP per capita, REEG and oil prices (variation and volatility), all the above-mentioned variables are measured in terms of their ratio to nominal GDP, because several researchers, including (Bohn, 2005; and Afonso, 2005) are of the view that analysis based on GDP ratios provide more credible information about the fiscal series than the raw and growth data. Finally, stationarity of the variables was tested using Phillips-Perron (PP) and Augmented Dickey Fuller (ADF), which indicates that all variables are integrated for order 1 (I(1)). (see Appendix Table 3). It should be emphasized that PB, debt, oil price and GFCF present a stochastic behavior with trend-stationary type, since one of the two tests shows that these variables are non-stationary in level (with constant and trend) and become stationary in level when we remove the trend, (i.e., with constant). The dependent variable (PB) is integrated for order 1. The absence of variables I(2) justifies the adoption of the ARDL model in our study.

Concerning the countries' selection, for availability reasons and data limitations over the period 2000 - 2022, we selected a set of 32 countries, aggregated into 5 relatively homogeneous groups, namely GCC, G7, OPEC[8], NOEC, and Top10ETI (see Appendix Table 1). Each sample contains between 6 countries (for the GCC group) and 13 countries (for the NOEC), according to some specific characteristics, such as economic homogeneity, economic diversification, oil dependency, and being a member of an organization.

It should be noted that these are quite varied samples of countries, dispersed geographically, with differing trends in terms of oil and fiscal balance dependency, as well as with different levels of economic diversification and energy transition. For this reason, the main reliable results will focus on the GCC countries, given their similarity in terms of history, geography, politics, population (small size, except for Saudi Arabia), as well as economic structure (highly reliant on oil), monetary policy and exchange regime (pegged to the US dollar, except for Kuwait). Thus, the other groups were used as a reference to compare the finals results.

3.2. Model specification

Based on the equation (1) as mentioned in section II, we estimate in this subsection the fiscal reaction function over the period 2000 – 2022 for the 5 groups described above, by conducting a panel data approach, as well as some diagnostic tests to make sure that the underlying assumptions for a good model are fulfilled. In fact, panel data have the advantage, over cross-section and time-series data, to account for latent heterogeneity and to reduce standard errors of point estimates. Thus, our dynamic model specified in the equation below is characterized by the presence of a lagged dependent variable among the other explanatory variables, to ascertain the degree of persistence. This empirical model could be expressed as follows:

$$\boldsymbol{PB_{it} = c + \alpha PB_{it-1} + \lambda D_{it-1} + \beta X_{it} + \tau_i + \varepsilon_{it}} \qquad \textbf{(2)}$$

Where $\boldsymbol{PB_{it}}$ is the primary balance of the country i for the period t. $\boldsymbol{D_{it}}$ is the outstanding debt, as percentages of GDP, while $\boldsymbol{X_{it}}$ is a set of additional determinants of the primary balance such as

[8] OPEC is an intergovernmental organization enabling the co-operation of leading oil-producing countries. We used in this paper a sample of 13 countries, namely Algeria, Angola, Republic of Congo, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Saudi Arabia, United Arab Emirates, and Venezuela. Meanwhile, Ecuador, Indonesia and Qatar are former OPEC members.

government spending, EDI, economic growth, and trade openness, in order to estimate the fiscal reaction functions, which illustrate the response of the primary balance to changes in outstanding debt. $\boldsymbol{\alpha}$, $\boldsymbol{\lambda}$ and $\boldsymbol{\beta}$ are the coefficients, while $\boldsymbol{\tau_i}$ and $\boldsymbol{\varepsilon_{it}}$ are the unobserved country-specific fixed effect and error terms.

However, there is a broad consensus in the literature that the study of long-run relationships through cointegration' analysis suggests the non-stationarity of series and they should present the same order of integration. In this context, the Autoregressive Distributed Lag (ARDL) modeling proposed by Pesaran et al. (1996) is considered relevant as it can be specified as an error correction model when the underlying variables are integrated of order one (I(1)), or fractionally integrated (I(0) and I(1)), except that the dependent variable is constrained to be I(1). However, this technique cannot be applied in the case where variables are integrated for order 2. In addition, ARDL modeling provides consistent and efficient estimators because it eliminates endogeneity problems by including lag length in both endogenous and exogenous variables. According to Pesaran, Shin and Smith (1996), the Panel-ARDL model used in this study can be expressed as follows:

$$\Delta PB_{it} = \mu_i + \gamma_{1i} PB_{it-1} + \gamma_{2i} debt_{it-1} + \gamma_{3i} RGDPC_{it-1} + \gamma_{4i} oil_{it-1} + \gamma_{5i} GFCF_{it-1} + \gamma_{6i} NREG_{it-1} + \sum_{j=1}^{p-1} \delta_{1ij}\ \Delta PB_{it-j} + \sum_{j=0}^{q-1} \delta_{2ij}\ \Delta debt_{it-j} + \sum_{j=0}^{q-1} \delta_{3ij}\, \Delta RGDPC_{it-j} + \sum_{j=0}^{q-1} \delta_{4ij}\, \Delta oil_{it-j}\ \sum_{j=0}^{q-1} \delta_{5ij}\, \Delta GFCF_{it-j} + \sum_{j=0}^{q-1} \delta_{6ij}\, \Delta NREG_{it-j} + \varepsilon_{it}$$

where terms in level reflect long-run dynamics, while terms in first difference reflect short-run effects. ε_{it} denotes the error term and Δ the first difference operator. The choice of lags value (p, q) is determined using the Akaike Information Criterion (AIC) or Schwarz Bayesian criterion (S.B.C).

An error correction model (ECM) could be specified and will be used accordingly to identify the short-run association between the interest variables. The error correction model (ECM) is defined as follows:

$$\Delta PB_{it} = \alpha_i + \sum_{j=1}^{p-1} \omega_{1ij}\ \Delta PB_{it-j} + \sum_{j=0}^{q-1} \omega_{2ij}\ \Delta debt_{it-j} + \sum_{j=0}^{q-1} \omega_{3ij}\ \Delta RGDPC_{it-j} + \sum_{j=0}^{q-1} \omega_{4ij}\ \Delta oil_{it-j} + \sum_{j=0}^{q-1} \omega_{5ij}\ \Delta GFCF_{it-j} + \sum_{j=0}^{q-1} \omega_{5ij}\ \Delta NREG_{it-j} + \omega\ ECT_{t-1} + \Omega_{it}$$

ω_{lij} are the short-run coefficients. The residual term is independently and identically distributed with zero mean and constant variance. ECT is the error correction term derived from the long-run relationship. ω indicates the speed of adjustment of the model to equilibrium. This coefficient should be negative and between 0 and 1 in absolute value.

Regarding the estimation of the panel ARDL model, Pesaran, Shin and Smith (1995 and 1999) introduced two techniques respectively the Mean Group (MG) (1995) and the Pooled Mean Group (PMG) (1999) estimation. However, these procedures, based on the maximum likelihood method,

are considered the most consistent since they take into account the specificities of the different regions and make a better interpretation of long-run equilibrium. Unlike the Mean Group estimation (MG), which requires the heterogeneity of the different coefficients of the ARDL model in both short and long-run, the PMG approach suggests the heterogeneity of the short-run coefficients, while long-run coefficients are restricted to be identical and homogeneous for all countries of the panel.

In this study, the choice of the PMG procedure is appreciated since the response of the primary balance (PB) in short term may differ from one country to another, whereas a long-run homogeneous effect may be occurred for all countries considering the similarity of the economic structure and policies of the GCC countries.

4. Empirical results

After presenting our theoretical approach, we started this section by estimating the adopted fiscal reaction function over the period 2000 - 2022, under data availability constraints. The same model is applied to the 5 defined groups, using the same explanatory variables described above. This is to assess fiscal sustainability, as well as to understand how some macroeconomic factors affect fiscal policy responses, including energy transition progress and oil price shocks.

4.1. Main drivers of fiscal sustainability

The estimation results of both short- and long-term relationships using the PMG-ARDL method are presented in Table 1 for all selected countries group over the period 2000 - 2022. As previously mentioned, the estimation of ARDL model is accomplished, respecting the restrictions regarding the homogeneity of the long-run coefficients for all countries. The obtained results are generally satisfactory and in line with the hypothesis of the study.

Table 1: Panel PMG-ARDL results, with oil price

Variables	GCC	OPEC	NOEC	G7	Top10ETI
Short term					
ECT (error correction term)	**-0.423*** **	**-0.497*** **	**-0.427*** **	**-0.374*** **	**-0.366*** **
Debt	0.281**	0.231**	0.201**	0.098**	0.103**
RGDPpc	0.135*	0.117*	0.112*	0.142*	0.133*
GFCF	0.073**	0.094**	0.063*	-0.034**	-0.036**
Trade openness	-0.036*	-0.051*	-0.041*	0.031*	0.038*
Oil price	0.238**	0.291**	0.193**	-0.087**	-0.106**
Long term					
Debt	0.295**	0.275**	0.277**	0.088**	0.110**
RGDPpc	0.133***	0.121*	0.111*	0.143*	0.131*
GFCF	0.026*	0.094**	0.063*	-0.033**	-0.031**
Trade openness	-0.156**	-0.114*	-0.106*	0.061*	0.058*
Oil price	0.140*	0.231**	0.213**	-0.187**	-0.210**

Note: *;**;*** design significance At 10%, 5% and 1% respectively.

First, we find a statistically significant positive relationship between the primary fiscal balance and the debt to GDP in the short-run (row 2), indicating that fiscal authorities react systematically to the rising public debt ratio by raising the primary balance to ensure fiscal sustainability. However, the magnitude of the coefficients is not comparable in all groups. GCC has the highest coefficient (0.281), while the G7 has the lowest one (0.098). This suggests a much stronger adjustment of GCC's fiscal authorities to an increase in debt levels to ensure higher primary

balance than the response of other groups. The difference signifies bigger fiscal space in GCC and more scope to press ahead with public finance reforms to satisfy the inter-temporal budget constraint in the long run. This relationship is still valid in the long run. In fact, given that Government debt stocks remain low in the GCC region compared to the international standards, they can afford to issue more debt while continuing on the path of fiscal reforms to increase the primary balance and ensure sustainability. In other countries with higher debt to GDP ratio and high debt service, more fiscal efforts are needed to increase the primary balance and ensure debt sustainability. However, the fiscal effort may be constrained by limited space to press ahead with fiscal reforms without jeopardizing growth and increasing social vulnerability.

Second, we find clear evidence that economic position positively affects the fiscal performance of all groups in both short- and long-term. This positive relationship is confirmed by other researchs for developed countries, showing that an increase in real GDP improves the tax revenues and non-tax revenues and, therefore, the primary balance. However, results show that the GCC sample has the second highest coefficient after G7, despite the small contribution of tax and fees to the government revenue. This could be explained by the high correlation between oil revenue and GDP, given the fiscal pro-cyclicality in GCC countries. It may also signify less government spending, relative to revenues, during periods of high growth given constraints on absorptive capacity.

Third, the coefficient of the investment (reflected by the formation brute de capital fixe) is positive and significant in the fiscal reaction functions for the groups of oil exporting countries in the short and long terms (GCC, OPEC, and NEOC), suggesting that the primary balance is likely to be pro-cyclical which magnifies the duration and the amplitude of the cycle.

Next, estimations show that Openness increases a country's exposure and vulnerabilities to external shocks, which decreases the primary balance. In fact, except for the G7 and Top10ETI, the coefficient on openness is negative in all groups in the short and long terms. On balance, openness increases government spending on imports. As high dependency on imports increases with openness, the risk of exposure to higher cost outweighed the favorable impact on growth, thereby decreasing fiscal performance. In contrast, the impact of openness is positive on the primary balance in G7 and Top10ETI, signifying a more diversified export structure that mobilizes higher openness to generate more fiscal revenues.

Moreover, the obtained results confirmed the crucial role played by the oil price in the long run on the primary balance in GCC and all other selected groups (row 5). For the oil exporting countries, an increase in oil price is expected to increase government revenues, and therefore, boost primary surpluses. This is reflected by the statistically significant positive coefficient in all groups, except in the G7 and Top10ETI, as an increase in the oil price increases government expenditure on imports and subsidies and consequently reduces the primary fiscal balance.

After estimating the impact of the Oil price shock on the fiscal response, we re-estimate our adopted equation, by replacing the oil price variation with the oil price volatility. Table 2 shows the results of the regression estimated using the PMG-ARDL model for 5 selected groups over the period 2000 - 2022.

Table 2: Panel PMG-ARDL results, with oil price volatility

Variables	GCC	OPEC	NOEC	G7	Top10ETI
Short term					
ECT (error correction term)	**-0.414*** **	**-0.456*** **	**-0.454*** **	**-0.398*** **	**-0.375*** **
Debt	0.184**	0.241**	0.211**	0.088**	0.113**
RGDPpc	0.123*	0.114*	0.114*	0.143*	0.137*
GFCF	0.075**	0.095**	0.064*	0.036**	0.037**
Trade openness	-0.037*	-0.049*	-0.048*	0.038*	0.037*
Oil price Volatility	-0.235**	-0.295*	-0.195**	-0.085**	-0.105*
Long term					
Debt	0.211**	0.266**	0.267**	0.086**	0.107**
RGDPpc	0.123***	0.122*	0.111*	0.143*	0.136*
GFCF	0.026*	0.099**	0.063*	0.035**	0.035**
Trade openness	-0.158**	-0.111*	-0.104*	0.064*	0.055*
Oil price Volatility	-0.155*	-0.251**	-0.224**	-0.006**	-0.007**

Note: *;**;*** design significance At 10%, 5% and 1% respectively.

The obtained results are generally satisfactory and similar to the results in Table 1. Our findings indicate that the primary balance is not affected only by oil price fluctuations but also by oil price volatility. In fact, while higher oil prices improve the primary balance only in oil-producing countries, the volatility of the oil price decreases the primary balance of all groups. Table 2 shows a negative relationship between this volatility and the fiscal primary balance in all the country groups. This is consistent with the high volatility that makes it difficult to sustain a stable stream of revenues in the budget in support of a higher primary balance. It also reflects that the speed of fiscal reforms and adjustments may lag behind the volatility of the oil price, necessitating a reduction in the primary balance. In fact, we find some evidence that high oil price volatility makes it more difficult for fiscal planning to adjust spending plans to continued volatility of the oil price, particularly for oil exporting countries with a high share of the oil revenues in the budget.

4.2. Impact of the global energy transition

In this sub-section, we turn our attention to the impact of the ongoing increase in the share of global renewable energy sources, to understand how this could affect GCC fiscal sustainability. We applied the same model to the 5 defined groups, by adding the global renewable energy share of electricity generation (Global REEG) reflecting the global energy transition in the global level.

Table 3: Panel PMG-ARDL results, with global energy transition

Variables	GCC	OPEC	NOEC	G7	Top10ETI
Short term					
ECT (error correction term)	**-0.419*** **	**-0.486*** **	**-0.434*** **	**-0.366*** **	**-0.376*** **
Debt	0.187**	0.246**	0.215**	0.084**	0.112**
RGDPpc	0.125*	0.111*	0.121*	0.153*	0.157*
GFCF	0.085**	0.098**	0.054*	0.032**	0.033**
Trade openness	-0.033*	-0.042*	-0.042*	0.035*	0.035*
Oil price	0.244**	0.294*	0.175**	-0.087**	-0.107*
Global REEG	-0.088**	-0.111**	-0.078**	0.112*	0.166*
Long term					
Debt	-0.091**	-0.106**	-0.137**	0.083**	0.103**
RGDPpc	0.105***	0.120*	0.110*	0.141*	0.130*
GFCF	0.025*	0.090**	0.060*	0.031**	0.032**
Trade openness	-0.150**	-0.101*	-0.102*	-0.066*	-0.057*
Oil price	0.151*	0.250**	0.220**	-0.083**	-0.106**
Global REEG	-0.223**	-0.256**	-0.208**	0.312*	0.366*

Note: *;**;*** design significance At 10%, 5% and 1% respectively.

The results obtained in Table 3 confirm the findings in the previous section about the main drivers of fiscal sustainability and highlight the impact of global energy transition on the public finance of the selected groups. First, the sign of the energy transition variables varies among groups. The

negative sign in oil exporters means that an increase in the global production of renewable energy sources reduces their primary fiscal balances, as the decline in global demand for oil affects negatively the government revenues in these countries. This trend has a limited effect on fiscal position in the short term but could have a significant negative effect in the long term for oil exporting countries. In contrast, the impact of increasing energy transition is positive on the public finance in G7 and Top10ETI, signifying a more diversified energy structure that relies less on hydrocarbon energy and tends to increase its renewable energy sources.

4.3. Impact of the national energy transition efforts

Given the gradual reduction in the share of hydrocarbons in the global energy mix, GCC countries are seeking to develop the production of alternative energy sources. In this context, we re-estimate the same fiscal reaction function, by replacing the global energy transition variable (Global REEG) with the national energy transition variable (National REEG). This allows us to understand the impact of GCC efforts in increasing renewable energy production on their fiscal sustainability. Table 4 shows the results of the regression estimated using the PMG-ARDL model for 5 selected groups over the period 2000 - 2022.

Table 4: Panel PMG-ARDL results, with National energy transition

Variables	GCC	OPEC	NOEC	G7	Top10ETI
Short term					
ECT (error correction term)	**-0.432*** **	**-0.490*** **	**-0.455*** **	**-0.332*** **	**-0.388*** **
Debt	0.181**	0.226**	0.245**	0.094**	0.102**
RGDPpc	0.023*	0.014*	0.024*	0.056*	0.067*
GFCF	0.083**	0.094**	0.053*	0.035**	0.036**
Trade openness	-0.034*	-0.047*	-0.043*	0.034*	0.037*
Oil price	0.204**	0.264*	0.155**	-0.097**	-0.114*
National REEG	0.088**	0.071**	0.098**	0.202*	0.266*
Long term					
Debt	0.291**	0.206**	0.237**	0.113**	0.143**
RGDPpc	0.121***	0.125*	0.114*	0.141*	0.130*
GFCF	0.025*	0.090**	0.060*	0.031**	0.032**
Trade openness	-0.150**	-0.101*	-0.102*	-0.066*	-0.057*
Oil price	0.151*	0.250**	0.220**	-0.083**	-0.106**
National REEG	0.113**	0.056**	0.093**	0.309*	0.346*

Note: *;**;*** design significance At 10%, 5% and 1% respectively.

In term of the main drivers of fiscal sustainability, the obtained results are generally satisfactory and similar to the previous findings. In addition, the results indicate a positive relationship between GCC fiscal primary balance and national energy transition efforts in the short and long run. This could be explained by the role of the renewable energy sector in stimulating economic growth and improving environmental sustainability. This positive relation is confirmed by the G7 and Top10ETI groups, as most of these countries are well-diversified and well-advanced in the energy transition. Also, it's worth noting that the sign of the debt level coefficient is significantly positive in the short and long run with a higher coefficient compared to the previous results, which means that the GCC government increased its debt insurance to sustain its primary balance and ensure fiscal sustainability.

5. Conclusion

The paper focuses on evaluating the long-run sustainability of GCC's public finance by estimating a reaction function of the government's primary balance to determine whether energy transition on global and national levels could influence debt insurance, rein in the deficit, and improve fiscal position.

Our finding reveals that GCC still runs a sustainable fiscal policy in the short run and its public finances have improved in response to recent fiscal adjustments. The evidence illustrates that the issuance of debt, which has accelerated since 2015, has helped to diversify sources of financing amid a higher drive for fiscal consolidation to increase the primary balance and render the debt sustainable over time. However, national experiences differ considerably, especially given the variation in the fiscal breakeven prices against the current oil prices.

As historically the higher oil price has helped sustain higher fiscal primary balances in the GCC, lower oil price coupled with higher volatility does not bode well for sustained improvement on the primary balance in GCC, warranting additional efforts to consolidate without reducing the accelerated path of economic diversification. To that end, the ongoing economic reforms provide an opportunity to press ahead with energy subsidy reforms, increase efficiency and reduce unproductive spending, in order to increase the fiscal primary balance and ensure debt sustainability despite the need to issue more debt to finance the deficit if oil price drops. Enduring fiscal deficits in the near term is not a problem, but managing and financing those deficits without compromising non-energy growth and debt sustainability objectives in the long run is the key challenge.

Hence, short-term priorities should be focused on designing the appropriate paths of fiscal consolidation to strike the right balance between fiscal sustainability and growth objectives. At the core is the need to sustain priority government spending towards attaining further diversification and higher non-energy growth over the medium term, while ensuring debt sustainability for GCC countries.

Finally, faced with this challenge of the decarbonization of economies, Gulf countries have a dual strategy: over the medium term, to maximize their oil and gas production in order to benefit from favorable production and market conditions; and in the longer term, to be involved in the development of low-carbon energy sources.

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Appendices

Appendix Table A1: Adopted groups of the selected countries

GCC	OPEC	NOEC	G7	Top10ETI
Bahrain	Algeria	Algeria	Canada	China
Kuwait	Angola	Angola	France	United States
Oman	Ecuador	Azerbaijan	Germany	Germany
Qatar	Iran	Canada	Italy	United Kingdom
Saudi Arabia	Kuwait	Colombia	Japan	France
UAE	Nigeria	Ecuador	United Kingdom	Japan
	Saudi Arabia	Iran	United States	India
	UAE	Kazakhstan		South Korea
	Venezuela	Mexico		Brazil
		Nigeria		Spain
		Norway		
		Russia		
		Venezuela		

Appendix Table A2: Descriptive analysis of the selected variables

Average	GCC			OPEC			NOEC			G7			Top10ETI		
	1995-2021	2000-2014	2015-2021	1995-2021	2000-2014	2015-2021	1995-2021	2000-2014	2015-2021	1995-2021	2000-2014	2015-2021	1995-2021	2000-2014	2015-2021
Primary Balance, in % of GDP	1.7	8.9	-11.0	2.0	5.7	-7.4	1.8	2.8	-4.1	0.3	3.9	-7.0	0.2	0.1	-1.3
Debt, in % of GDP	30.5	22.7	31.4	37.2	27.2	29.2	39.5	32.2	39.5	53.8	46.2	53.7	49.0	48.0	51.5
GDP growth (%)	5.4	5.6	3.0	4.6	5.6	1.0	3.1	5.0	0.4	4.7	4.8	3.0	4.7	4.9	3.2
Trade, in % of GDP	104.7	107.8	120.4	76.8	80.2	74.1	64.4	66.1	54.9	88.3	92.0	95.3	61.8	67.6	61.8
Brent price growth (%)	5.8	14.9	-31.4	5.8	14.9	-31.4	5.8	14.9	-31.4	5.8	14.9	-31.4	5.8	14.9	-31.4
Brent price volatility	5.9	8.2	7.4	5.9	8.2	7.4	5.9	8.2	7.4	5.9	8.2	7.4	5.9	8.2	7.4

Notes:
GCC: Gulf Cooperation Council countries
OPEC: Organization of the Petroleum Exporting Countries.
NOEC: Net Oil Exporting Countries, excluding GCC countries.
G7: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.
Top10ETI: Top 10 countries with low-carbon energy investment in 2022.

Appendix Table A3: Unit root test results

Test			PB	debt	RGPC	oil	GFCF	NREG	GREG
PP	intercept	level	23.06**	8.24	9.74	9.02	19.15*	0.37	0.007
			(0.02)	(0.76)	(0.63)	(0.7)	(0.08)	(1.00)	(1.00)
	intercept & trend		15.37	5.85	7.39	4.58	8.19	2.44	0.006
			(0.22)	(0.92)	(0.83)	(097)	(0.77)	(0.99)	(1.00)
	intercept	first difference	95.66***	34.2***	64.5***	55.05***	65.46***	9.52***	81.41***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	intercept & trend		74.52***	22.45**	55.12***	37.24***	51.1***	46.82***	93.47***
			(0.000)	(0.03)	(0.000)	(0.000)	(0.000)	(0.000)	(0.00)
ADF	intercept	level	17.81	21.91**	15.37	19.8*	23.65**	0.8	0.003
			(0.12)	(0.03)	(0.22)	(0.07)	(0.02)	(1.000)	(1.00)
	intercept & trend		13.42	17.06	14.48	9.84	12.48	3.4	0.64
			(0.33)	(0. 14)	(0.27)	(0.62)	(0.4)	(0.99)	(1.00)
	intercept	first difference	49.62***	26.06**	53.3***	47.68***	35.41***	38.15**	58.11**
			(0.000)	(0.0105)	(0.000)	(0.000)	(0.000)	(0.03)	(0.04)
	intercept & trend		32.5***	19.33*	46.9***	35.4***	23.53**	29.52**	42.17***
			(0.000)	(0.08)	(0.000)	(0.000)	(0.02)	(0.015)	(0.000)

Note: ***, **, * imply significance at 1%, 5% and 10 % respectively. Values in brackets are P-values.