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RESEARCH ARTICLE

Fiscal sustainability in the GCC countries

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Abstract

We explore the fiscal sustainability in the six Gulf Cooperation Council (GCC) countries over the period 1990–2017. Panel unit root tests in presence of cross-sectional dependence for government revenues, expenditures, the primary balance, and debt reach mixed results. However, cointegration tests reveal that a long-run relationship exists between government revenues and expenditures, while the relationship between government primary deficit and debt is controversial. Panel estimates of the cointegrating relationship indicate that Saudi Arabia is in a condition of risk, having to keep the debt under control. Yet, Bahrain and Qatar seem to face the toughest challenges. The results of causality tests support the hypothesis of fiscal synchronization, implying that the GCC governments take decisions on their revenues and expenditures simultaneously.

Keywords Fiscal sustainability · Government expenditures · Revenues · Primary balance · Government debt · GCC countries · Panel data

JEL Classification C23 · E62 · H63

Abbreviations

AIC	Akaike information criterion
ANNs	Artificial neural networks
BIC	Bayesian information criterion
FMM	Finite-mixture model
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GMM	Generalized method of moments
IBC	Intertemporal budget constraint
IMF	International Monetary Fund
ML	Machine learning
OPCs	Oil-producing countries

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PVAR	Panel vector auto-regressions
UAE	United Arab Emirates
VAT	Value-added tax
VR	Variance ratio
WEO	World Economic Outlook

Introduction

The Gulf Cooperation Council (GCC) was established in 1981 as a political and economic union of Arab states bordering the Gulf. The GCC includes the United Arab Emirates (UAE), Saudi Arabia, Qatar, Oman, Kuwait, and Bahrain. GCC states have made significant efforts to diversify their economies away from dependence on hydrocarbon resources, but oil remains critical to their economic development. Diversification into finance, logistics, aviation, communications, healthcare, and tourism has been spurred by more liberal political and economic climates. The result is greater foreign cooperation, investment, and modernization with improved diplomatic and commercial relations. Mahmah and Kandil [20] argued that fiscal sustainability will be an issue for GCC members due to the persistence of low oil prices and reduced tax revenues. This new normal will force GCC members to adapt to the lower oil price environment with emphasis on reform of government subsidies and increased diversification toward non-oil revenues. They also see accelerating debt issuance by the GCC which raises issues about fiscal sustainability and macroeconomic stability.

However, despite GCC diversification, the weakness of the GCC recovery in 2018 reinforced the perception that carbon-based energy remains the foundation of GCC economies. While global economic growth slowed in 2018 due to international tensions, the steady increase in oil prices in 2018 lifted GCC growth, from an average of − 0.2% in 2017 to 2.0%. Saudi Arabia and Kuwait (the two largest GCC economies) and Oman, emerged from the recession in 2018 due to increased oil production, the increased capital investment made possible due to the rise in oil revenues, and higher domestic demand [38].

In 2018, GCC fiscal balances improved due to the average increase in oil prices and progress with non-oil revenues mobilization in some countries. This allowed a reduction in fiscal deficits despite increased spending by some GCC countries. The fiscal deficit of Saudi Arabia was reduced in 2018 despite a 10% increase in government spending. Fiscal reforms were undertaken in 2018 by several GCC countries. Saudi Arabia and the UAE implemented a 5% Value Added Tax (VAT) in 2018. Bahrain implemented a similar VAT in 2019. In mid-2018, Oman increased corporate income taxes and imposed excise taxes on tobacco, energy drinks, and soft drinks. Higher oil prices led to increased external account balances for most GCC countries. Higher commodity prices led to surpluses in current account balances in Saudi Arabia, the UAE, Qatar, and Kuwait. Higher petroleum prices and increased sales resulted in doubling Qatar's current account surplus. While the current account deficit for Bahrain increased due to higher remittance outflows.

Most fiscal deficits in GCC countries remained unchanged from 2017 levels. The fiscal health of both Bahrain and Oman improved despite elevated debt levels. With regional exchange rates pegged to the US Dollar, inflation rates remained low for most countries. Pegging regional exchange rates to the US Dollar helped maintain monetary policy credibility and stability. A major area for economic reform is to reduce labor costs by increasing productivity and limiting wage increases to retain international competitiveness. Strategies to improve skills and learning and health outcomes, increase female labor force participation, remove labor market distortions, and increased competitiveness in the private sector. The global outlook continues to be uncertain with the potential for downward pressure on oil prices. Growth in the GCC in 2019 is projected to match that in 2018 with fiscal deficits projected to remain a problem in 2019–2021 for four of the six GCC countries. Consequently, in addition to a renewed focus on non-petroleum exports, there is a continued need to focus on prudent fiscal policies involving stimulus efforts involving taxes and spending.

In recent years, several signs highlighted that the oil market has undergone deep long-term changes. Taking into account the expansion of the world economy and the volatility of the markets, the increased availability of oil and its replacement have been facilitated by both technological progress and environmental concerns [33].

This research continues the line of investigation on public finances' sustainability of some countries or groups of countries, extending it to the GCC area [9–12, 39, 41, 42]. In addition, it uses both time-series and panel-data analyses at the same time.

The originality value of the study lies, above all, in the fact that it is the first applied analysis of fiscal sustainability in the GCC area. Moreover, we investigate this topic both by looking at the government revenues–expenditures nexus and the relationship between government deficit and debt. Furthermore, a battery of recent panel-data tests and estimators is employed, to shed light on this crucial topic. In addition, it should be highlighted the importance of having public accounts in order and fiscal solvency for economies highly dependent on oil, whose price volatility can easily and quickly generate asymmetric shocks. In summary, this research highlights the need for oil-exporting countries to be prepared for a post-oil future—and, therefore, to make their economies less and less dependent on this commodity—already in the short-term.

The layout of the paper proceeds as follows. The next section shows the theoretical framework together with a review of the empirical literature. The third section presents the empirical strategy and briefly describes the applied panel-data methodologies, whereas the fourth section gives empirical findings and their discussion. Finally, the last section concludes, suggesting some policy recommendations.

Theoretical framework and empirical literature

There are no universally accepted empirical criteria for judging the sustainability of a tax program. The key to defining sustainability consists in allowing the government to remain in debt indefinitely, given its infinite life, excluding, in any case, to remove the debt in front of it as in the pyramids and in the Ponzi speculative chains.

Let us put D_t the primary public deficit at year t and B_t the public debt at the end of year t. We assume that the debt is measured at its nominal value. If i is the nominal interest rate, the debt evolution equation is.

$$B_t = (1 + i)B_t - 1 + D_t, \tag{1}$$

where B_t is the stock of debt at the end of period t and d is the primary deficit of period t. By denoting with d_t and b_t, respectively, the primary deficit and the debt as a percentage of nominal GDP, n the nominal growth rate, g the real growth rate, π the inflation rate, and r the real interest rate, we have

$$n = g + \pi \tag{2}$$

$$i = r + \pi \tag{3}$$

If n and i are constant, the debt evolution relationship becomes

$$b_t = \frac{(1 + i)}{(1 + n)} b_{t-1} + d_t \tag{4}$$

$$b_t - b_{t-1} = (i - n)b_{t-1} + d_t. \tag{5}$$

Therefore, we can breakdown the growth of the debt/GDP ratio into three different terms: financial costs, primary deficit, and depreciation of past debt due to nominal growth.

In terms of budget deficits, we will have

$$b_t - b_{t-1} = \delta_t - nb_{t-1}. \tag{6}$$

The "stability condition" indicates the balances that stabilize the debt/GDP ratio over time. It implies for budget deficit,

$$\delta = nb \tag{7}$$

while for primary budget deficit,

$$d = (n - i)b. \tag{8}$$

To calculate the structural budget balance, we can first estimate the output gap, that is the deviation of GDP (y) from its potential level (y^*), and then the sensitivity of the budget balance (s) to a change in the output gap (y–y^*):

$$s^* = s - \varepsilon(y - y^*), \tag{9}$$

where s^* is the structural balance, or the deficit that would have arisen if GDP had been equal to its potential level.

Another approach takes into account the past public debt dynamics. This method tests the existence of a "pull force" of the tax rate toward the government expenditure/GDP ratio [24, 25, 36, 37].

According to the Intertemporal Budget Constraint (IBC), it does not matter what level of debt is sustainable as long as the primary surpluses can be kept permanently at an adequate level in the future. In reality, large and lasting primary budget surpluses are not politically sustainable, requiring the current generation to cover the deficits made by previous ones. This creates a link between the sustainability of the public budget and the so-called "fiscal or budgetary space", which means the room for maneuver for fiscal stimulus policies, without risking an unsustainable debt spiral. The fiscal space is particularly limited for countries participating in a monetary union: in fact, the risk of insolvency depends on the level of interest rates on the debt, which modifies the interest expenditure curve [40]. De Grauwe [16] considered the fact that this phenomenon can open the door to self-fulfilling crises.

If the debt accumulation differential equation, expressed in continuous time, is

$$\frac{\mathrm{d}b}{\mathrm{d}t} = (i - n)b + d = (r - g)b + d, \tag{10}$$

where b is the variation of the debt/GDP ratio, t is the time period, i is the nominal interest rate, n is the nominal economic growth rate, d is the primary deficit/GDP ratio, r is the real interest rate, and g is the real economic growth rate.

When t approaches infinity, the present value of the debt/GDP ratio must tend to zero:

$$b_0 = -\int_0^\infty d_s \mathrm{e}^{-(r-g)s} \mathrm{d}s \tag{11}$$

The "transversality condition" implies that if $r > g$, it is sufficient that the debt-to-GDP ratio increases at a rate slower than the discount rate $(r - g)$. While, if $r < g$, the government can finance the debt service with new loans, while remaining solvent. In addition, a second condition requires that the present value of the future primary surpluses covers the interest to be paid on the initial debt [7].

The literature on fiscal sustainability is pretty vast. Therefore, in what follows, we focus only on empirical studies devoted to the GCC area. Liuksila et al. [35] argued that for countries in which a significant proportion of government revenues is derived from the exploitation of an exhaustible natural resource, fiscal policy sustainability could best be assessed within a permanent income framework that takes into account total government wealth, including the imputed wealth from reserves of natural resources. Ghali [28] analyzed the impact of fiscal policy on the economic growth process in the UAE using quarterly data ranging from 1973:1 to 1995:4. The results reveal that government investment expenditures exert a positive effect on growth, while government consumption expenditures do not present a statistically significant role. Engel and Valdés [21] illustrated some guidelines for fiscal policy in oil-producing countries, showing how revenues generated by an exhaustible source of wealth belonging to the Government might be distributed between current and future generations.

Regarding applied papers on the GCC area, Fasano and Wang [23] examined the direction of causality between total government expenditures and revenues in oil-dependent GCC countries. The results confirm expectations that government spending follows oil revenues.

Al-Jarrah [4] showed the existence of bidirectional causality between economic growth and defense spending, using time-series techniques for Saudi Arabia in the period 1970–2003.

Al-Kawaz [5] produced descriptive analyses of fiscal sustainability for Kuwait, Saudi Arabia, and UAE between 1980 and 2001, suggesting that governments should respond positively to a period of oil boom as well as an increase in tax revenues.

Chemingui and Roe [14] simulated a test of policies to make the private sector more profitable. They found that the capacity of the private sector to employ all nationals seeking employment during the 2001–2015 period was unlikely to be realized.

Husain et al. [31] empirically assessed the impact of oil price shocks on the underlying non-oil economic cycle in oil-exporting countries via panel vector autoregressions (PVAR) analysis. The results indicate that in countries where the oil sector is large in relation to the economy, oil price changes affect the economic cycle only through their impact on fiscal policy.

Medas and Zakharova [43] proposed an integrated approach to fiscal policy analysis in oil-producing countries, suggesting that conventional fiscal indicators should be complemented by non-oil ones.

Villafuerte and Lopez-Murphy [51] found that oil-producing countries (OPCs) registered a deterioration in their primary non-oil balances over the period 2003–2008. However, with the decline in oil prices in 2009, the situation has changed. Furthermore, the authors found evidence that fiscal policy was pro-cyclical, thus widening the fluctuations of the business cycle.

Erbil [22] examined the cyclicality of fiscal behavior in 28 developing oil-producing countries in the years 1990–2009. The results show that expenditures are pro-cyclical in the low- and middle-income countries, while they are counter-cyclical in the high-income countries. In addition, the quality of institutions and political structure seems to be more significant for the low-income group.

Al-Hamidy [3] stressed the challenges that Saudi Arabia's fiscal policymakers face given the volatile and uncertain nature of the oil revenues on which the state budget depends.

El Anshasy and Bradley [19] investigated the role that oil prices play in determining fiscal policy in a sample of 16 oil-exporting countries with annual data for the period 1972–2007. They found that, in the long-run, higher oil prices provoke larger government size, whereas, in the short-run, government expenditures rise less than proportionately to the increase in oil revenues.

Snudden [50] evaluated the appropriateness of budget-balance tax-gap rules for oil exporters. Counter-cyclical budget-balance rules are found to be well suited to stabilize the macroeconomic volatility of oil-exporting countries.

Waheed [52] analyzed the sustainability of public debt of Bahrain over the period 1990–2014. The findings confirm that the fiscal policy measures were appropriate in maintaining fiscal solvency and public debt sustainability.

IMF [32] evidenced that GCC countries need to consolidate their fiscal positions further to adjust to the new environment of lower oil prices. The expenditures reform agenda should focus on areas with potential fiscal and efficiency gains, notably the wage bill, subsidies, and capital spending.

Pandow [45] suggested a separation of debt management and monetary policy objectives and accountabilities. The government of Oman should strive to achieve a broad investor base for its domestic and foreign obligations.

El Mahmah and Kandil [20] the sustainability of public finances in GCC countries using yearly data over the period 1990–2016 estimating the fiscal reaction function via generalized method of moments (GMM) models. The results show that the region's public finances improved in response to recent fiscal adjustments (Table 1).

Methodology and data

A standard assumption in panel-data models is that the error terms are independent across cross-sections. Cross-sectional dependence in macro-panel data has received a lot of attention in the emerging panel time-series literature over the past decade. It can be due to local spillover effects or global common shocks [18, 44]. We present the results of a battery of tests to detect (eventual) cross-section dependence in our original data [6, 13, 15, 26, 27, 49].

Afterwards, to control for cross-section dependence, we run the second-generation panel unit root tests [47, 48].

Furthermore, we run three different cointegration tests: (1) the Pedroni [46] seven tests statistics, (2) the Kao [34] test, which specifies cross-section intercepts and homogenous coefficients on the first stage regression, (3) the four panel cointegration tests developed by Westerlund [53].

The causality test developed by Dumitrescu and Hurlin [17], which can return successful results even under the conditions of cross-sectional dependence, was used for the analysis. We also run the standard Granger [29] causality tests.

Finally, regression mixture models are a tool to investigate population heterogeneity. This application of regression mixture modeling to an actual data set indicated that multiple latent classes might be embedded with the single regression functional form. Compared to conventional regression analysis that assumes one equation would fit all countries, a regression mixture analysis can provide a detailed description of sub-populations of countries within a sample. Thus, regression mixture models may improve predictability because the countries' differences are systematically classified to form homogeneous groups.

Our study uses the World Economic Outlook (WEO) database of the International Monetary Fund (IMF).[1] We collected data on government revenues (GGR), expenditures (GGTE), net primary lending (GGNPL), and gross debt (GGGD) for the six GCC countries over the 1990–2017 period, for 168 total observations (28 for each country). Our analysis provides new evidence for the fiscal sustainability of these countries.

It is relevant to note that we applied the tests to the above-mentioned variables in terms of GDP ratios, because several researchers, including Hakkio and Rush [30], Afonso [1], Bohn [8], and Brady and Magazzino y[9, 10] are of the view that

[1] https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx.

Table 1 Empirical evidence regarding fiscal policy sustainability for GCC countries

Author(s) and date	Countries	Study period	Estimation strategy
Al-Hamidy [3]	Saudi Arabia	2000–2010	Descriptive analyses
Al-Jarrah [4]	Saudi Arabia	1970–2003	Unit roots tests, cointegration, VECM, FEVD, causality tests
Al-Kawaz [5]	5 oil-producing countries	1979–2001	Descriptive analyses
El Anshasy and Bradley [19]	16 oil-exporting countries	1972–2007	GMM, PMG
El Mahmah and Kandil [20]	UAE	1980–2015	OLS, scenario analysis
Erbil [22]	28 developing oil-producing countries	1990–2009	GMM
Fasano and Wang [23]	6 GCC countries	1975–2000	Unit roots tests, cointegration, VECM, IRF, FEVD, causality tests
Ghali [28]	UAE	1973–1995	Unit roots tests, cointegration, VECM, causality tests
Husain et al. [31]	10 oil-producing countries	1990–2007	FE, PVAR, IRF
Liuksila et al. [35]	6 oil-producing countries	1980–1992	Descriptive analyses
Pandow [45]	Oman	2010–2016	Descriptive analyses
Waheed [52]	Bahrain	1990–2014	Unit roots tests, cointegration, VECM

Our elaborations

FE fixed effects, *FEVD* forecast error variance decomposition, *IRF* impulse-response functions, *GMM* generalized method of moments, *PMG* pooled mean group, *PVAR* panel vector auto-regressive, *VECM* vector error correction models

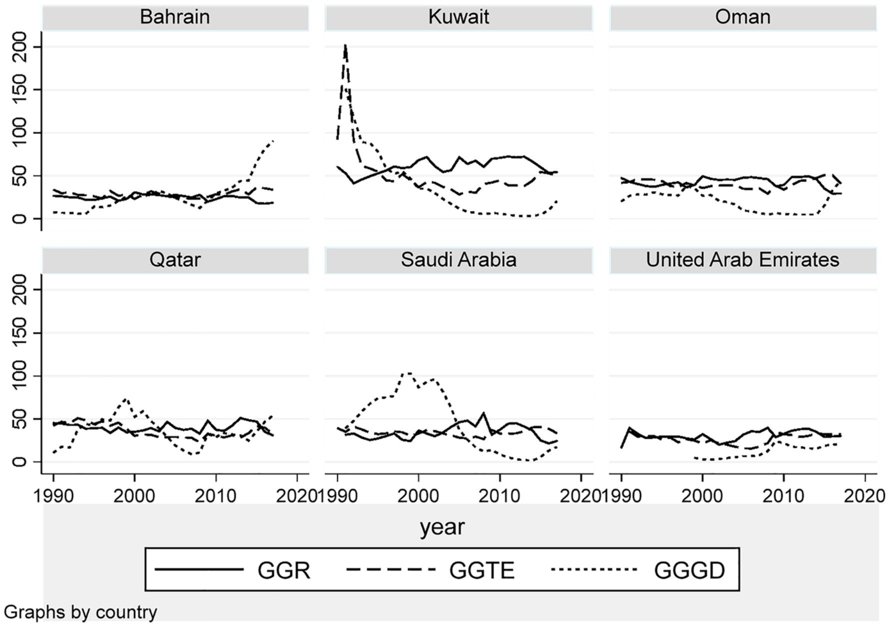

Fig. 1 Government revenues, total expenditures, and gross debt in GCC countries. Sources: our elaborations on IMF data

analysis based on GDP ratios provide more credible information about the fiscal series than the raw and real data.

In addition, Figs. 1 and 2 in the Appendix contain a graphical description of the data, while Table A gives exploratory data analyses.

Empirical results

For the GCC sample, some possible cross-country dependence can be envisaged in the presence of similar policy measures, coupled with similar fiscal behavior, linked to the oil prices.

In Table 2, we show the results of panel cross-sectional dependence tests for GCC countries. The null hypothesis (H_0) of these tests is the absence of cross-sectional dependence. Here, for all variables we clearly reject the null hypothesis at any level of significance in each test, concluding that cross-sectional dependence should be taken into account in our analysis.

To take into account this type of dependence, we run the so-called "second generation" panel unit root tests. Here, controlling for cross-sectional dependence, the evidence is ambiguous. In fact, we reject the null hypothesis that all series are non-stationary, when the specification of the deterministic part includes only the intercept, while for the specification with constant and trend the results are controversial, since only half of the tests suggest the presence of stationarity (Table 3).

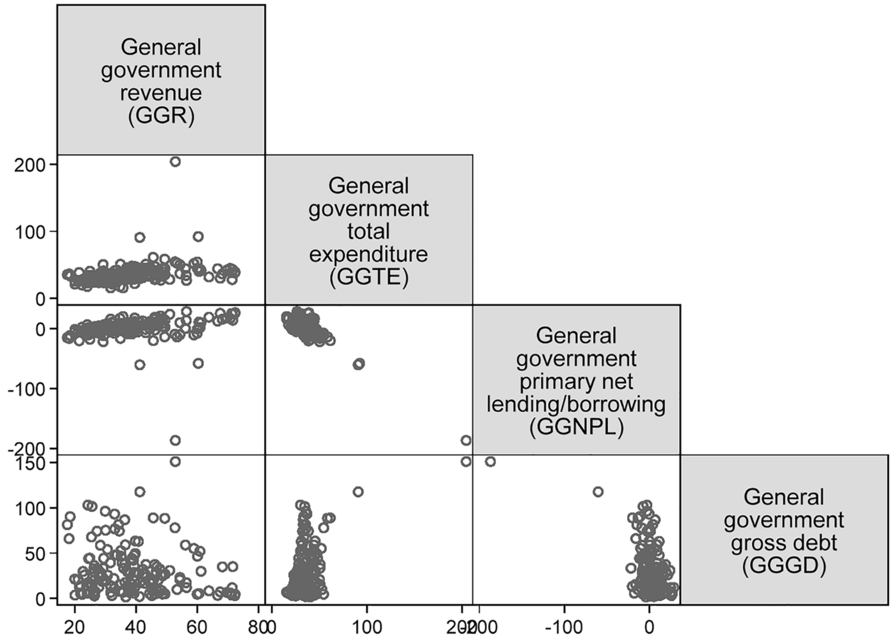

Fig. 2 Scatterplot matrices. Sources: our elaborations on IMF data

This, however, does not exclude a priori the possibility that there may be sustainability, given the possible presence of cointegration between the series.

Therefore, we implement three different panel cointegration tests. Table 4 shows the outcomes of the cointegration tests between total government revenues and expenditures, and the primary balance and lagged debt.

The first test is due to Pedroni [46], a residual-based test for the null of no cointegration in heterogeneous panels. We use four within-group tests and three between-group tests to check panel cointegration [2]. The second test is due to Kao [34], and it assumes a cointegrating vector that is the same across all panels, estimating panel-specific means, and does not allow a time trend. Finally, Westerlund [54] derived a pair of variance ratio (VR) test statistics for the null hypothesis of no cointegration.

In general, we have a majority of tests for which the null hypothesis of the absence of cointegration can be rejected (especially in the specification with the intercept only). For both pairs of variables, the results indicate that cointegration clearly emerges when only the constant enters the deterministic specification. Instead, if also a trend is included in the deterministic part, the evidence is mixed. Therefore, we can consider *GGR* and *GGTE* cointegrated. While, for the variables *GGNPL* and *GGGD* this is less clear, as, according to the Kao and Westerlund tests, there would be cointegration, while for the Pedroni test, the cointegration is not so evident.

Assuming that government revenues and expenditures—as well as government debt and primary balance—are cointegrated, we estimate the cointegrating

Table 2 Panel cross-section dependence tests

Test	GGR	GGTE	GGNPL	GGGD
1. Pesaran [49]	5.716*** (0.0000)	7.006*** (0.0000)	10.150*** (0.0000)	8.408*** (0.0000)
2. Friedman [27]	58.215*** (0.0000)	64.622*** (0.0000)	87.797*** (0.0000)	51.490*** (0.0000)
3. Frees [26]	1.209*** (0.0000)	0.629*** (0.0000)	1.723*** (0.0000)	1.049*** (0.0000)
4. Chudik and Pesaran [15]	5.597*** (0.0000)	6.952*** (0.0000)	10.003*** (0.0000)	8.040*** (0.0000)
5. Pesaran [49] CD	6.47*** (0.0000)	11.36*** (0.0000)	10.63*** (0.0000)	1.58 (0.1150)
6. Breusch-Pagan (1980)	79.9359*** (0.0000)	135.7351*** (0.0000)	134.9113*** (0.0000)	123.2946*** (0.0000)
7. Pesaran [49] LM	11.8556*** (0.0000)	22.0431*** (0.0000)	21.8927*** (0.0000)	19.7718*** (0.0000)
8. Baltagi et al. [6]	11.7445*** (0.0000)	21.9320*** (0.0000)	21.7816*** (0.0000)	19.6607*** (0.0000)

1: Pesaran [49] cross-sectional dependence in panel data models test

2: Friedman [27] test for cross-sectional dependence using Friedman's χ^2 distributed statistic

3: Frees [26] for cross-sectional dependence using Frees' Q distribution (T-asymptotically distributed)

4: Chudik and Pesaran [15] test for weak cross-sectional dependence

5: Pesaran [49] CD test for cross-section dependence in panel time-series data

6: Breusch and Pagan [13] LM test of independence

7: Pesaran [49] scaled LM test

8 Baltagi et al. [6] bias-corrected scaled LM test

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Sources: our calculations on IMF data

Table 3 Panel unit root tests in the presence of cross-section dependence

Variable	Specification	
	Constant	Constant and trend
Pesaran's CADF test		
GGR	– 0.840 (0.201)	0.742 (0.771)
GGTE	– 1.889** (0.029)	– 0.961 (0.168)
GGNPL	– 2.272** (0.012)	– 2.005** (0.022)
GGGD	– 0.788 (0.215)	2.173 (0.985)
Pesaran [48] test		
GGR	– 2.645***	– 2.938**
GGTE	– 3.609***	– 4.118***
GGNPL	– 4.871***	– 5.293***
GGGD	– 2.251**	– 1.492

For Pesaran [47] test, *Z*-*t*-bar or *t*-bar statistics are reported; *P* values in parentheses. For Pesaran [48] test, deterministics chosen: constant: critical values: – 2.10 (10%), – 2.22 (5%), – 2.44 (1%), deterministics chosen: constant and trend: critical values: – 2.67 (10%), – 2.82 (5%), – 3.10 (1%)

***$p<0.01$, **$p<0.05$, *$p<0.10$

coefficients to investigate the long-run relationships. In general, the results point to a positive long-run co-movement between the levels of government revenues and expenditures (Table 5). As we can see, for the two countries, the coefficient is not statistically significant (Bahrain and Qatar). While the remaining four countries show a positive significant coefficient between 0.25 (Kuwait) and 0.97 (Saudi Arabia). In addition, two countries present a coefficient value near 1: Saudi Arabia (0.97) and Oman (0.91). Since β is very close to 1, Saudi Arabia is in a condition of risk, having to keep the debt under control, which measures national policymakers have already begun to implement. On the second relationship, a country-by-country inspection shows that two countries (Kuwait and Saudi Arabia) present significant positive coefficient estimates for the improvement of the primary balance after past debt increases. In general, four countries exhibit almost one significant cointegrating relationship (Kuwait, Oman, Saudi Arabia, and UAE), while for Bahrain and Qatar, none of them is statistically significant.

The results of the Dumitrescu and Hurlin causality tests show the presence of a bidirectional causal link between government expenditures and revenues with a feedback mechanism (Table 6). This result supports the hypothesis of fiscal synchronization, implying that the GCC governments take decisions on their revenues and expenditures simultaneously. On the other hand, it shows that the expenditures assigned decide the number of revenues, which in turn affects the number of expenditures for the present as well as the future. Therefore, policymakers should focus on the two-way causal flow between government expenditures and revenues, which could complicate the efforts made by the government itself to control the budget deficit, and could even help explain the dynamic of the national debt.

Table 4 Panel cointegration tests

	Relation	GGR, GGTE		GGNPL, GGGD	
		Individual intercept	Individual intercept and trend	Intercept	Intercept and trend
Pedroni's residual cointegration test					
Within-dimension	Panel v	2.1928** (0.0142)	− 0.2077 (0.5823)	1.5344* (0.0625)	− 0.5479 (0.7081)
	Panel ρ	− 2.9884*** (0.0014)	− 1.1038 (0.1348)	− 1.6416* (0.0503)	− 0.0801 (0.4681)
	Panel PP	− 2.4775*** (0.0066)	− 1.3684* (0.0856)	− 1.8298** (0.0336)	− 0.8753 (0.1907)
	Panel ADF	− 2.6711*** (0.0038)	− 1.5680* (0.0584)	− 1.6599** (0.0485)	− 0.7324 (0.2320)
Between-dimension	Group ρ	− 1.8403** (0.0329)	− 0.1165 (0.4536)	− 0.4396 (0.3301)	1.0318 (0.8489)
	Group PP	− 2.2929** (0.0109)	− 1.0294 (0.1516)	− 1.4489* (0.0737)	− 0.2829 (0.3886)
	Group ADF	− 3.0460*** (0.0012)	− 1.4663* (0.0713)	− 1.2859* (0.0992)	− 0.2323 (0.4082)
Kao's residual cointegration test					
	ADF	− 2.1484** (0.0158)		− 4.0211*** (0.0000)	

Westerlund error-correction-based cointegration tests

Statistic	GGR, GGTE		GGNPL, GGGD	
	Constant	Constant and trend	Constant	Constant and trend
Gt	− 3.977*** (0.000)	− 3.031*** (0.001)	− 0.414 (0.340)	0.396 (0.654)
Ga	− 4.963*** (0.000)	− 3.348*** (0.000)	− 2.056** (0.020)	− 0.952 (0.170)
Pt	− 3.991*** (0.000)	− 3.592*** (0.000)	− 1.735** (0.041)	− 0.440 (0.330)
Pa	− 6.966*** (0.000)	− 5.283*** (0.000)	− 4.882*** (0.000)	− 3.199*** (0.001)

For Westerlund's tests, the Z values are reported. P values in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.10$

Table 5 Panel estimates of the cointegrating relationship (FMOLS)

Country	GGR, GGTE	GGNPL, GGGD
Bahrain	0.4867 (0.3285)	0.4204 (0.3935)
Kuwait	0.2470*** (0.0950)	0.5896*** (0.0884)
Oman	0.9097*** (0.2492)	0.5061 (0.3397)
Qatar	0.0573 (0.1268)	0.2112 (0.2641)
Saudi Arabia	0.9688*** (0.3141)	0.2416** (0.1018)
UAE	0.3704*** (0.1433)	0.2720 (0.9882)

Robust standard errors in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.10$

Table 6 Panel pairwise causality tests

Test	$GGTE_{it} \rightarrow GGR_{it}$	$GGGD_{it} \rightarrow GGNPL_{it}$
Dumitrescu–Hurlin	2.6904*** (0.0071)	0.8039 (0.4214)
Granger	5.4182*** (0.0054)	3.8874** (0.0228)
	$GGR_{it} \rightarrow GGTE_{it}$	$GGNPL_{it} \rightarrow GGGD_{it}$
Dumitrescu–Hurlin	3.2729*** (0.0011)	14.6346*** (0.0000)
Granger	12.5691*** (0.0000)	27.4735*** (0.0000)

For Dumitrescu–Hurlin's tests the *Z*-*t*-bar statistics are reported; for Granger's tests, the *F* statistics are reported. *P* values in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.10$

Table 7 Penalized likelihood criteria

K	1	2
ll	− 652.7473	− 629.4663
AIC	1311.495	1272.933
BIC	1320.831	1294.716

K: number of components; ll: log-likelihood

Finally, we estimated a finite mixture model (FMM) using government expenditures and revenues as variables of interest. The model selection criteria suggest the choice of two clusters. In fact, the information criteria (AIC and adjusted BIC) assume the lowest values with two components, and the log-likelihood (ll) is maximized with a two-group clusterization (Table 7).

The regression mixture analysis resulted in subgroups with specific patterns of regression function (Table 8).

It can be observed that individuals in the population fall into the two different classes in proportions of 0.94 and 0.06. Notice that we specified the nose option above. We have estimated that 93.52% of observations are in group 1, while 6.48%

Table 8 Finite-mixture model

Dependent variable: GGR	Coefficient (SE)	
Component 1		
GGTE	0.4890*** (0.0897)	
Constant	0.1966*** (0.0314)	
Component 2		
GGTE	0.1033*** (0.0064)	
Constant	0.7411*** (0.0121)	
N	166	
Latent class marginal probabilities		
Group 1	0.9352	[0.8830; 0.9650]
Group 2	0.0648	[0.0350; 0.1170]
Latent class marginal means		
Group 1	37.5212*** (0.8176)	[35.9187; 39.1237]
Group 2	70.3420*** (0.9850)	[68.4114; 72.2726]

Robust SE in parentheses

***$p<0.01$, **$p<0.05$, *$p<0.10$

are located in the second group. However, we can calculate the level of government expenditures for each group, as well as the marginal means for each class.

In essence, the first cluster is formed by all GCC countries except Kuwait, which, obviously, is the only member of the remaining group 2. In the first group—which includes Bahrain, Oman, Qatar, Saudi Arabia, and UAE—the estimated coefficient is 0.49 ($p<0.01$). Instead, the second group shows a $\beta=0.10$ ($p<0.01$) (Table 8).

In the six countries belonging to the GCC, the conditions of sustainability differ according to the individual countries analyzed. Bahrain and Qatar are among the most problematic countries, as we have already demonstrated. Starting from a simple graphical inspection, the deterioration of the trend for the aggregate income, government expenditures, and debt is evident. In fact, Bahrain has witnessed over time an explosion of government debt that has doubled in the last 3 years, going from a value of 44% in 2014 to reaching over 90% in 2017, and a worsening of the primary deficit, from − 1.6 in 2014 to − 11.3 in 2016.

Kuwait, on the other hand, is the country that presents the most favorable financial conditions among GCC members. Government expenditures and revenues show a statistically significant cointegrating relationship; in addition, government debt, although doubled in just 1 year (from 9.9% in 2016 to 20.6% in 2017), it remains at a low and sustainable level.

Oman is in an intermediate condition, with government revenues and expenditures that even though cointegrated, exhibit a coefficient close to 1. This implies government accounts sustainability, but limited to the case in which the government deficit and debt are monitored and limited. In this regard, Oman has undermined its financial stability, given the fact that it has shifted from a 4.7% budget surplus in 2013 to a deficit of 11.4% in 2017. As a result, over the same period, the government debt-to-GDP ratio is grown from 5.0 to 44.2%.

For Qatar, as for Bahrain, the situation is more critical. Also in this case, the cointegrating relationship is not statistically significant neither for government revenues and expenditures nor for primary balance and government debt. Indeed, government debt has doubled in the last 3 years, going from 24.9% in 2014 to 54.0% in 2017.

Saudi Arabia is, as in the case of Oman, in an intermediate situation, in which the coefficient of the cointegrating relation between revenues and expenditures approaches 1, but in this case, there is at least a statistically significant relationship between deficit and debt, even if the debt rose from 1.6% in 2014 to 17.3% in 2017.

Finally, the UAE shows a cointegrating relationship only between government revenues and expenditures. Nevertheless, government debt is quite stable, hovering around 20% since 2009, with a moderate primary deficit in the last 3 years.

Concluding remarks and policy implications

This study explores the fiscal sustainability of six GCC member countries, using yearly data covering the 1990–2017 period. Bahrain and Qatar seem to face the toughest challenges. As already evident from a simple graphical analysis of the data, the deterioration of the public finance framework of the two countries is clear. Moreover, for both countries, government revenues and expenditures are not cointegrated, as well as primary balance and government debt. Never the less, single country econometric results indicate that Saudi Arabia and Oman should pay attention to the stability of their public finances. Furthermore, using panel causality tests, we found evidence in line with the fiscal synchronization hypothesis, which suggests that governments of the area take decisions on their revenues and expenditures simultaneously.

As oil price fluctuations are beyond the control of the authorities, their domestic impact must be attenuated through some combination of a primary expenditure rule and an oil stabilization fund. That said, three general considerations apply to the GCC region. First, faster economic diversification will not resolve the fiscal challenge on its own: countries will also need to increase their non-oil fiscal revenue. Second, governments will likely need to downsize. Additional non-oil revenues could help alleviate future fiscal pressures, but this alone will not be sufficient. Third, countries should re-evaluate their approach to saving.

In general, the GCC countries should seriously consider the repercussions that oil prices have on their public finances, trying to distance themselves from this sort of "dictatorship" in the medium to long-term, and diversifying their economies.

Future research might analyze the fiscal solvency of this area using different empirical methodologies, such as machine learning (ML) or artificial neural networks (ANNs) [40].

Appendix

See Table 9.

Table 9 Descriptive statistics

Country	Mean	Median	Std. Dev	Skewness	Kurtosis	Range	IQR	CV
GGR								
Bahrain	24.5777	24.9875	3.3258	-0.5424	2.6248	13.1440	4.2115	0.1353
Kuwait	60.8493	60.4445	8.5599	-0.3405	2.3481	31.0980	14.5920	0.1407
Oman	42.5046	44.1165	5.7658	-0.7246	2.7054	20.2230	8.5880	0.1357
Qatar	39.9615	39.2910	5.2339	0.3763	2.2565	20.3120	8.1175	0.1310
S. Arabia	34.5505	33.0440	8.6335	0.6136	2.7887	35.0040	13.8760	0.2499
UAE	30.4723	29.7355	5.7056	-0.3602	2.9107	23.0550	7.1805	0.1872
GGTE								
Bahrain	28.6667	28.0240	3.8824	0.3734	2.1419	13.4670	6.0515	0.1354
Kuwait	52.6725	43.9795	33.2729	3.6143	16.6910	176.0510	15.1070	0.6317
Oman	40.5811	39.22	5.1618	0.1316	2.6234	21.5600	7.0125	0.1272
Qatar	36.0578	32.6070	7.9191	0.3516	1.7328	27.9270	14.3165	0.2196
S. Arabia	34.2740	33.5875	3.8921	-0.0744	2.4521	14.4850	4.3745	0.1136
UAE	26.6253	28.3280	6.0020	-0.3968	1.9612	19.9600	10.4740	0.2254
GGNPL								
Bahrain	-2.8893	-3.2705	5.6006	-0.3724	3.3895	25.1230	6.1040	-1.9384
Kuwait	-4.2184	10.1145	42.1281	-3.1396	13.8382	213.3100	27.5725	-9.9868
Oman	1.3410	3.1320	9.1151	-0.6480	3.0188	37.3560	11.6815	6.7973
Qatar	6.0687	8.8850	8.4069	0.0729	2.2242	32.8130	12.1550	1.3853
S. Arabia	1.1506	-0.6000	11.4042	0.4506	2.9683	48.7350	17.8180	9.9119
UAE	4.5247	2.3560	6.9288	0.8045	2.7724	26.1010	10.0100	1.5313
GGGD								
Bahrain	28.0289	24.9550	21.2747	1.5495	5.0050	84.4740	18.6905	0.7590
Kuwait	36.0199	20.6410	39.2375	1.3779	4.1990	148.0460	48.9780	1.0893
Oman	19.9088	20.7240	11.9771	0.1057	1.8242	39.5090	21.4975	0.6016
Qatar	35.8079	34.1970	17.0187	0.2186	2.4058	65.4710	25.7655	0.4753
S. Arabia	45.4844	39.3520	35.8350	0.2093	1.5074	101.4300	64.6480	0.7879
UAE	12.0360	12.5320	7.3081	0.1262	1.4785	21.3940	13.8850	0.6072

Sources: our calculations on IMF data

Std. Dev. standard deviation, *IQR* inter-quartile range, *CV* coefficient of variation

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