WP/02/201

IMF Working Paper

Testing the Relationship Between Government Spending and Revenue: Evidence from GCC Countries

Ugo Fasano and Qing Wang

INTERNATIONAL MONETARY FUND

 WP/02/201

IMF Working Paper

Middle Eastern Department
Policy and Development Review Department

Testing the Relationship Between Government Spending and Revenue: Evidence from GCC Countries

Prepared by Ugo Fasano and Qing Wang[1]

Authorized for distribution by Zubair Iqbal

November 2002

Abstract

The paper examines the direction of causality between total government expenditure and revenue in oil-dependent GCC countries by utilizing a cointegration and error-correction modeling framework, and by calculating a variance decomposition analysis. In addition, it presents impulse responses to shed light on the dynamic relation of expenditure to a revenue shock. The results confirm expectations that government spending follows oil revenue, suggesting a pro-cyclical expenditure policy to variations in oil revenue. To make budget expenditure less driven by revenue availability, the authorities could resort to a medium-term expenditure framework, so that expenditures can be planned and insulated from volatile short-term revenue availability.

JEL Classification Numbers: E62, H50, N15

Keywords: fiscal policy; GCC countries

Authors' E-Mail Addresses: ufasano@imf.org, qwang@imf.org

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[1] We are grateful to Edward Gardner, Peter Allum, Steven Barnett, and Javier Hamann for helpful comments.

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I. Introduction

Sound fiscal policy is crucial to promote price stability and sustainable growth in output and employment. Thus, understanding the relationship between government spending and revenue is important to evaluate how to address fiscal imbalances. Several hypotheses have resulted from the causal link of this relationship. A bi-directional causality between revenue and expenditure supports "the fiscal synchronization hypothesis," i.e., over time, expenditure decisions are not made in isolation from revenue decisions. In contrast, if causality runs from revenue to expenditure, "the revenue-spend hypothesis," the spending level adjusts to changes in revenue, while "the spend-revenue hypothesis" suggests the opposite in that changes in spending induce changes in revenue. Although this relationship has been extensively studied in industrial and some developing countries, with the exception of a paper by Ghamdi (1991), it has not been examined for the oil-dependent Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.[2] Some GCC countries have consistently recorded overall fiscal deficits since the early 1980s after oil prices peaked in 1979–81. In addition, with oil revenue accounting for about three-quarters of government revenue in most of these countries, fluctuations in crude oil prices have led to volatile revenue and swings in spending.

The focus of the paper is, therefore, to test the validity of these various hypotheses in the case of the GCC countries for the period from 1975–2000—a common available period of observations for all these countries. We examine the direction of causality between total government expenditure and revenue in these countries by utilizing a cointegration and error-correction modeling framework, which provides a more comprehensive test of causality than the standard Granger causality test, and by calculating a variance decomposition analysis to determine the stronger causality if results show a bi-directional causality (Appendix I). In addition, we present impulse responses to shed light on the dynamic relation of expenditure to a revenue shock.

The paper proceeds as follows. First, a brief review is presented of developments in government revenue and spending in GCC countries over the past three decades. Then, we report our empirical results of the testing of the causality between revenue and expenditure. The last section summarizes our findings and the policy implications.

II. Revenue and Spending Developments in GCC Countries

Over the past three decades, GCC countries have generally followed procyclical fiscal policies to changes in oil revenue (Table 1). Following the sharp increase in global oil prices in the 1970s and early 1980s, government spending in all these countries rose as fast as oil revenue through a massive public investment program in infrastructure, fiscal incentives to

[2] For empirical studies covering Latin American countries, see Ewing and Payne (1998); the United States, Miller and Russek (1989); industrial countries, Joulfaian and Mookerjee (1991); G-7 countries, Owoye (1995); and Canada, Payne (1997).

develop the industrial sector, and the adoption of a generous welfare system. Notwithstanding the increase in spending, sizable overall fiscal surpluses were recorded in all GCC countries during those years, leading to a sharp accumulation of official assets (Figures 1–6).

The existence of large foreign official assets facilitated a relatively low level of adjustment in spending in the period 1980–86, when crude oil prices declined significantly. Concerns for sustaining domestic demand in order to stave off a sharp reduction in non-oil growth has usually militated against significant fiscal adjustment in the face of falling oil prices in GCC countries.[3] Spending was only cut by the equivalent to about half the fall in total revenue in Saudi Arabia, 20 percent in the United Arab Emirates, and 10 percent in Qatar. Facilitated by the completion of major infrastructure investments, the cutbacks fell mostly on outlays for projects, while current expenditure rose in all these countries, except in Saudi Arabia. In Bahrain and Kuwait, spending continued to rise across the board. In contrast, in Oman, lower oil revenue was more than offset by higher investment income and fees and charges, leading to a further increase in expenditure in the period.

The boost in expenditure towards the end of the 1980s, particularly in Saudi Arabia and the United Arab Emirates, mainly reflected the emergency and higher external assistance requirements created by the 1990/91 regional conflict. However, this increase mainly resulted from higher current spending, since capital expenditure was cut further across the GCC area, particularly in Oman. Following the end of the conflict, oil prices declined and increased attention was devoted to fiscal adjustment, particularly in Saudi Arabia, where both current and capital expenditure was cut, with the overall fiscal deficit in nominal terms returning to the pre-conflict level by the mid-1990s. In the other GCC countries, except Bahrain, spending continued to rise during the first half of the 1990s, even though revenue declined, but the sharp rise in spending in Kuwait reflected the reconstruction period.

[3] However, Fasano and Wang (2001) showed that despite the important role of the government in the GCC countries, the empirical results do not strongly support that changes in government spending tend to slow or accelerate non-oil real growth in GCC countries.

Table 1. GCC Countries: Change in Total Government Spending and Revenue in Selected Periods, 1975-2000 1/

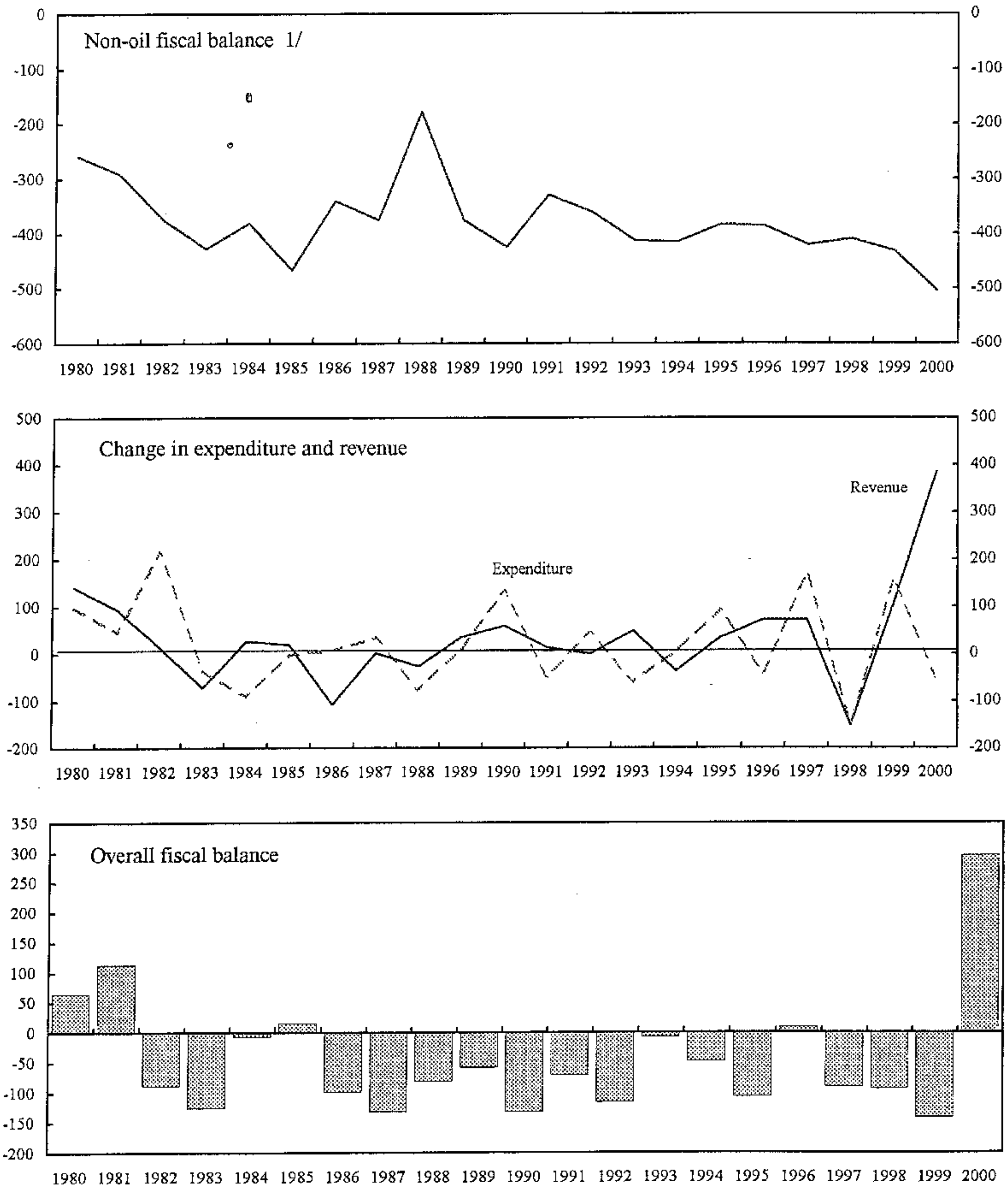
(In percent)

	1975-80	1980-86	1986-90	1990-94	1994-96	1996-98	1998-2000
Bahrain							
Change in expenditure	201.4	35.5	23.1	-8.8	8.8	3.6	16.2
Current	...	85.0	17.2	27.4	-1.0	6.9	18.5
Capital	...	11.9	-13.7	5.3	-19.1	39.8	-14.8
Change in revenue	236.1	-4.6	17.1	5.8	20.2	-12.5	89.1
Ratio change in expenditure/revenue	0.9	-7.6	1.3	-1.5	0.4	-0.3	0.2
Kuwait							
Change in expenditure	108.6	28.0	-3.7	46.3	4.8	-9.6	0.7
Current	...	37.5	19.2	57.4	7.0	-11.7	5.0
Capital	...	38.3	-43.3	-3.0	-10.5	8.3	-29.8
Change in revenue	153.9	-31.6	0.2	-23.2	29.7	13.1	31.8
Ratio change in expenditure/revenue	0.7	-0.9	-15.8	-2.0	0.2	-0.7	0.0
Oman							
Change in expenditure	107.5	116.4	-2.0	19.4	0.4	-1.4	18.7
Current	...	112.5	25.3	13.2	3.1	-3.6	18.5
Capital	...	139.0	-60.1	66.7	-11.6	9.7	10.9
Change in revenue	201.2	16.2	46.5	-11.5	32.4	-22.1	87.5
Ratio change in expenditure/revenue	0.5	7.2	0.0	-1.7	0.0	0.1	0.2
Qatar							
Change in expenditure	106.8	-4.7	9.3	15.0	26.9	1.1	8.7
Current	...	13.9	15.5	6.4	27.1	6.6	9.2
Capital	...	-51.9	-27.6	66.9	35.5	-19.9	5.0
Change in revenue	166.4	-69.0	106.2	-15.9	31.9	-5.1	83.4
Ratio change in expenditure/revenue	0.6	0.1	0.1	-0.9	0.8	-0.2	0.1
Saudi Arabia							
Change in expenditure	223.9	-40.4	47.9	-17.9	15.7	-4.1	23.9
Current	...	-7.7	90.6	-26.2	16.4	-0.1	21.7
Capital	...	-70.4	-19.5	-18.0	12.0	-29.8	43.8
Change in revenue	261.4	-77.0	88.6	-14.7	38.7	-21.0	64.4
Ratio change in expenditure/revenue	0.9	0.5	0.5	1.2	0.4	0.2	0.4
United Arab Emirates 2/							
Change in expenditure	788.1	-9.0	49.8	6.3	40.2	-3.2	13.8
Current	...	21.8	72.9	-3.1	61.2	-11.9	33.4
Capital	...	-19.6	-5.6	103.5	-12.6	36.3	-19.7
Change in revenue 3/	821.5	-59.2	101.7	36.0	18.1	-2.2	54.5
Ratio change in expenditure/revenue	1.0	0.2	0.5	0.2	2.2	1.5	0.3
Memorandum item:							
Change in average crude oil prices 4/	234.8	-61.4	62.2	-30.6	27.7	-35.8	116.0

Source: Authors' calculations based on national statistics.

1/ Total expenditure includes net lending, and revenue, grants and investment income.
2/ Consolidated fiscal accounts (federal plus the three largest emirate governments).
3/ Includes investment income from 1991 onwards.
4/ Average nominal price of UK Brent, Dubai, and West Texas Intermediate.

Figure 1. Bahrain: Central Government Fiscal Indicators, 1980-2000
(In millions of Bahraini Dinars)

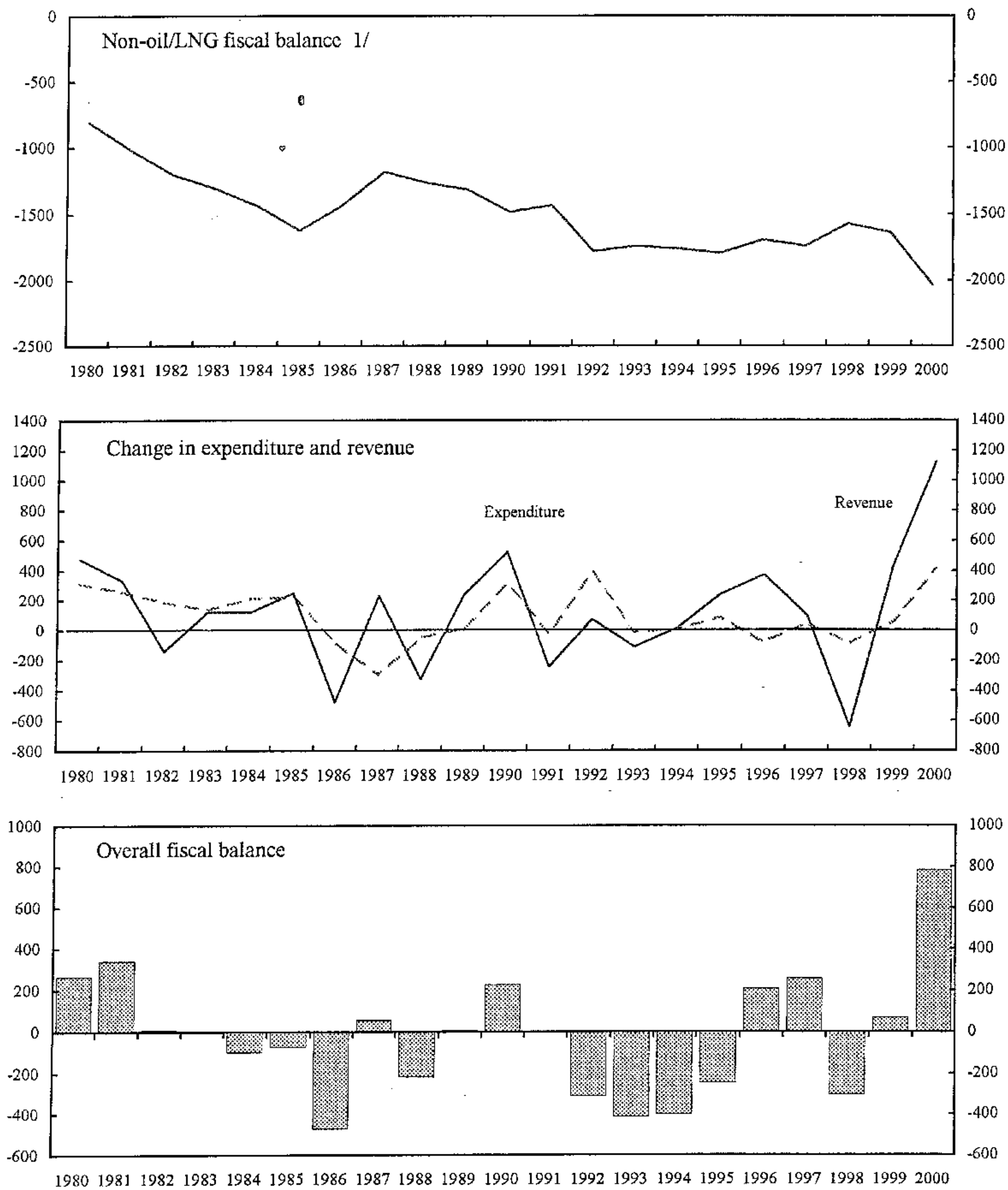


Sources: National authorities; and IMF staff estimates.
1/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

Figure 2. Kuwait: Central Government Fiscal Indicators, 1980-2000
(In millions of Kuwaiti dinars)

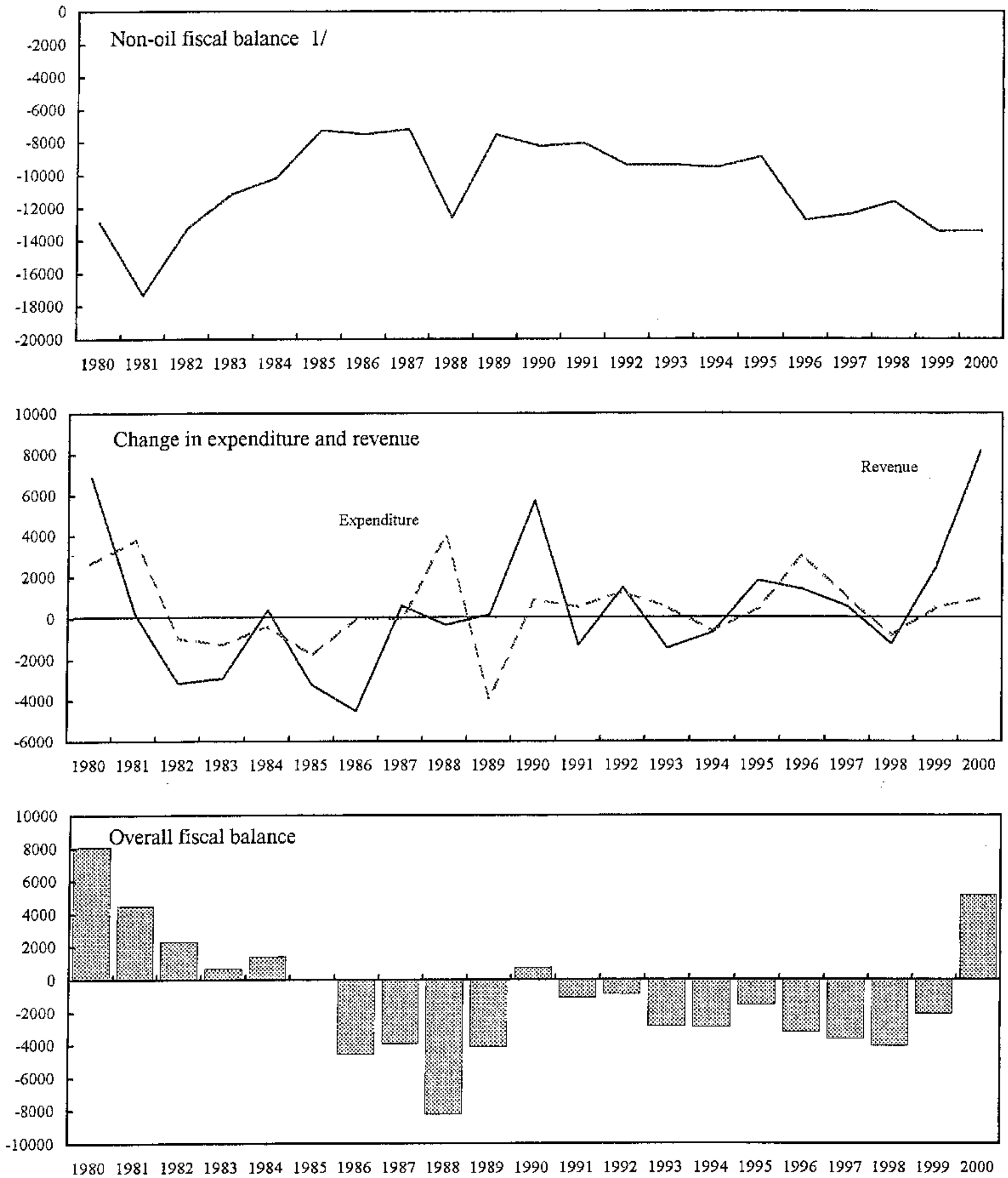
Sources: National authorities; and IMF staff estimates.
1/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

Figure 3. Oman: Central Government Fiscal Indicators, 1980-2000
(In millions of rials Omani)



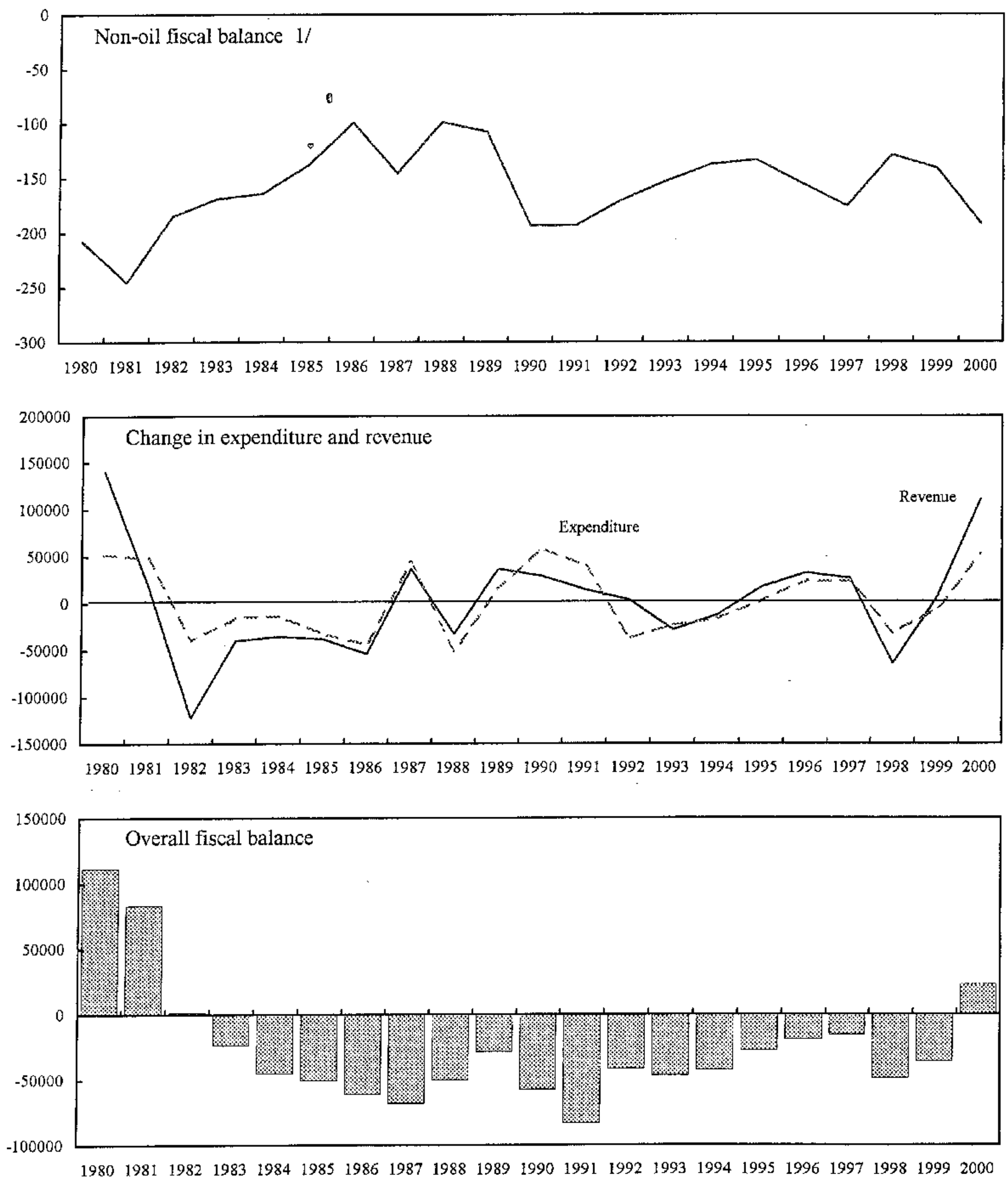
Sources: National authorities; and IMF staff estimates.
1/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

Figure 4. Qatar: Central Government Fiscal Indicators, 1980-2000
(In millions of Qatari riyals)



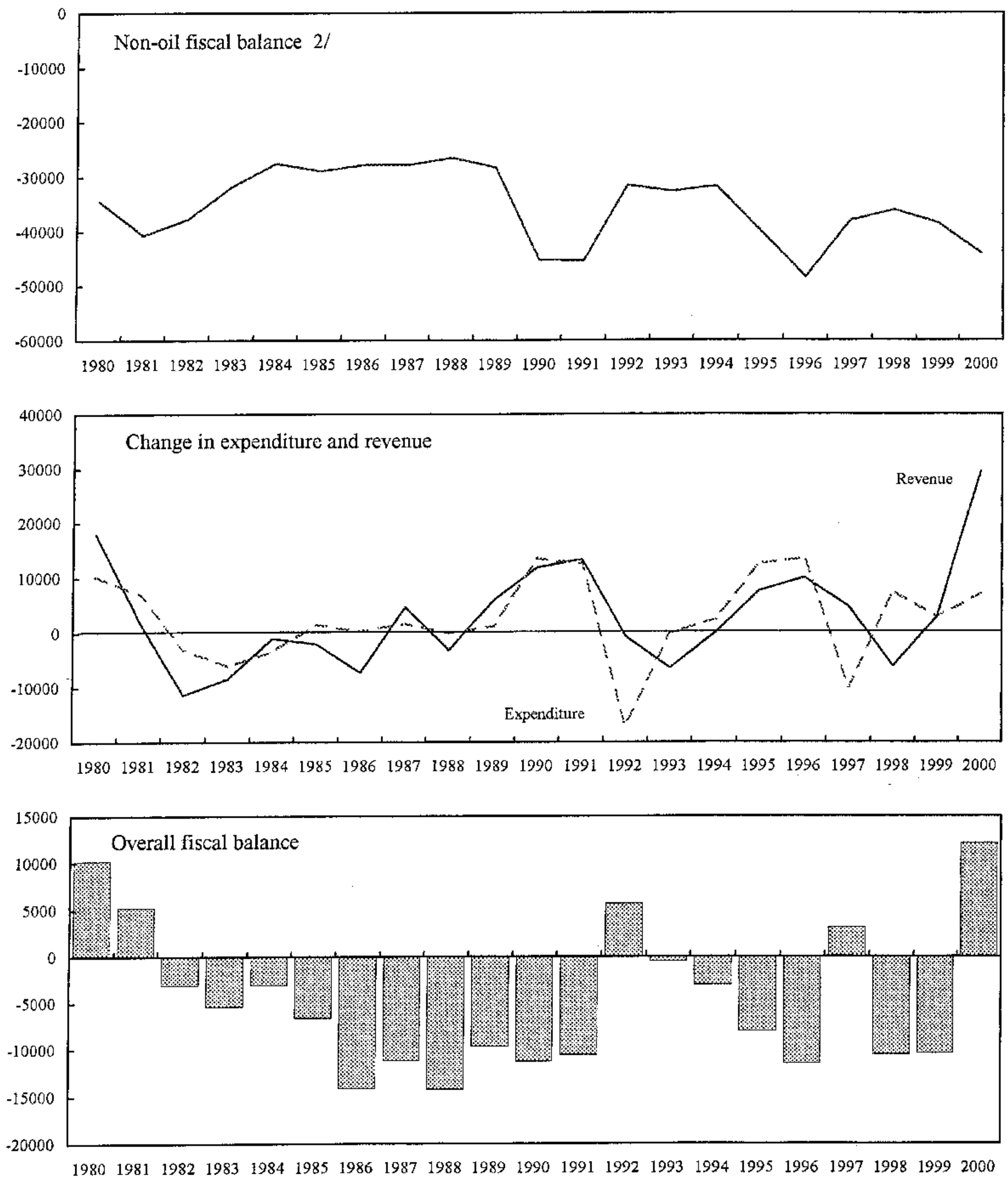
Sources: National authorities; and IMF staff estimates.
1/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

Figure 5. Saudi Arabia: Central Government Fiscal Indicators, 1980-2000
(In millions of Saudi riyals)



Sources: National authorities; and IMF staff estimates.
1/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

Figure 6. United Arab Emirates: Central Government Fiscal Indicators, 1980-2000 1/
(In millions of U.A.E. dirhams)



Sources: National authorities; and IMF staff estimates.

1/ Consolidated fiscal accounts of the federal government and the three largest emirates.

2/ Non-oil fiscal balance defined as overall fiscal balance excluding oil revenue.

The second half of the 1990s witnessed renewed volatility in government expenditure in some GCC countries. The recovery in oil prices during 1994–96 was accompanied by an increase in spending, particularly in Qatar, though this was related to the country's liquefied natural gas projects, and in the United Arab Emirates. In Oman, spending remained stable despite the increase in revenue. In response to the 1998 oil price collapse, all GCC countries, except Bahrain and Qatar, cut spending—albeit modestly. However, for the first time, in some GCC countries (Kuwait, Oman, and the United Arab Emirates), current spending bore much of the adjustment. Some GCC countries also mobilized non-oil revenue to dampen the decline in oil prices. More recently, most GCC countries made progress in decoupling public expenditure decisions from the evolution of oil revenue. In fact, total spending rose moderately in most of these countries despite the sharp recovery in global oil prices through end-2000.

III. Econometric Methodology and Empirical Results

Our empirical analysis employs annual total real government expenditures and revenues for the GCC countries. The choice is for total revenue since oil accounts for the majority of government revenue in these countries.[4] The variables are in logarithmic form (let R_t and E_t denote the natural logarithm of real government revenues and government expenditures, respectively), and are converted to real terms using the consumer price index. The cointegration and error-correction modeling approach is well suited to study the causality between government revenue and government expenditure. It is quite conceivable that the levels of revenue and expenditure are cointegrated, namely, they move on a common trend as long as the intertemporal budget constraint is binding over the long run. This important information is incorporated through the error-correction model in examining the causality between the changes in government expenditure and revenue.

A. Empirical Results

Test results for unit root

Each time series in our sample are first tested for their orders of integration by using Augmented Dickey-Fuller (ADF) test (Table 2). The test shows that R_t and E_t are integrated of order one, or I (1), for all GCC countries in our sample.[5]

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[4] No time-series, detailed data are available for all GCC countries on the composition of expenditure to examine econometrically the possibility of a different dynamic response by type of expenditure to oil revenue variations.

[5] See Appendix I for a presentation of more detailed test results.

Table 2. ADF Test Results for Unit Roots

Variables	Bahrain	Oman	Qatar	Kuwait	Saudi Arabia	U.A.E.
R_t	I(1) **	I(1) **	I(1) **	I(1) **	I(1) **	I(1) **
E_t	I(1) **	I(1) *	I(1) **	I(1) **	I(1) *	I(1) *
Note: * and ** denotes significance at 5 and 1 percent, respectively.						

Test results for cointegration

Since the time series of R_t and E_t are found to be integrated of the same order (i.e, order one), a cointegration test can be conducted to determine whether a long-run equilibriating relationship exists between them. Johanson cointegration test is performed, assuming a cointegrating relationship as specified by equation (1):

$$E_t + a * R_t + c = \varepsilon_t \qquad (1)$$

Cointegration relationships are found for all GCC countries in our sample (Table 3).[6] The results indicate that, not surprisingly, government expenditure and government revenue are subject to an equilibrating relationship and positively related to each other over the long run.[7],[8] However, the degree of their association differed across countries. To maintain the long-run equilibrium, for Bahrain, Oman, and Kuwait, when government revenue increased by 1 percent, government expenditure also increased by about 1 percent during the period under analysis; for the United Arab Emirates and Saudi Arabia, when government revenue increased by 1 percent, government expenditure rose by less than 0.5 percent; for Qatar, when government revenue increased by 1 percent, government expenditure increased by more than 1 percent. It should be noted that these different degrees of association are negatively related to the levels of fiscal deficits for each country, i.e., starting from a position of a higher deficit, when government revenue increases, maintaining long-run equilibrium would require government expenditure to increase by less in percentage term.

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[6] For Bahrain, Qatar, and the United Arab Emirates, the tests weakly point to the existence of two cointegrating vectors. However, economic theory informed the choice of the long-run relationship presented in Table 3.

[7] Note that from the perspective of a typical structural equation, such as equation (1), the signs of the constant and R_t are reversed because they are on the left-hand side of the equation.

[8] Dummy variables are used in the regression equations for Qatar and Kuwait, since for the former, data show an apparent structural change during the period of 1986–89, when world oil prices experienced a sustained slump, and for the latter, the dummy reflects the impact of the regional crisis in the early 1990s. The relatively short time series in our data set prevents fully addressing the issue of data instability through more sophisticated tests.

Correspondingly, during the period under analysis, Saudi Arabia and the United Arab Emirates registered the highest average level of overall fiscal deficits.

Table 3. Johanson Cointegration Test: Estimated Cointegration Vectors

Variables	Bahrain	Oman	Qatar	Kuwait	Saudi Arabia	U.A.E.
E_t	1	1	1	1	1	1
R_t	-0.90 (-13.08)	-1.02 (-23.59)	-1.36 (-3.89)	-1.24 (-5.36)	-0.42 (-4.73)	-0.42 (-1.79)
Constant	-0.01	-0.004	0.34	0.23	-1.35	-0.95
Likelihood Ratio	20.60	18.80	20.56	27.66	21.14	22.17
Eigenvalue	0.48	0.50	0.45	0.70	0.52	0.39
No. of CE(s)	1**, 2*	1 *	1** , 2*	1**, 2**	1**	1**, 2*
Dummy	No	No	Yes	Yes	No	No

Note: 1. The cointegration coefficients are normalized on E_t.

2. t-ratios are in parentheses.

3. *(**) indicates the significance level at which the number of cointegration equation(s) (CE) is identified is 5% (1%).

4. The length of the lag is estimated with Schwartz's criterion and chosen, with an view to balancing between ensuring approximately white-noise errors and allowing for enough degrees of freedom in estimation.

Test results for causality

Since the series for all the countries in our sample are found to be cointegrated, the Granger causality test is conducted in the context of an error correction model by estimating a vector auto regressive (VAR) model as follows:

$$\Delta E_t = \vartheta_0 + \alpha_0 \Delta E_{t-1} + \beta_0 \Delta R_{t-1} + \lambda_0 ECT_{t-1} + \mu_t \qquad (2)$$

$$\Delta R_t = \vartheta_1 + \alpha_1 \Delta E_{t-1} + \beta_1 \Delta R_{t-1} + \lambda_1 ECT_{t-1} + \nu_t \qquad (3)$$

where, θ, α, β, and λ are the coefficients, and μ and ν are the error terms. ECT_t is equivalent to ε_t in equation (1), representing the disequilibrium residuals of the cointegration equation identified above.

As discussed in more detail in Appendix I, by examining the t-statistics on β_0 and λ_0 in equation (2) and β_1 and λ_1 in equation (3), one can infer the direction of causality either from revenue to expenditure or from expenditure to revenue, respectively.[9] For instance, from equation (2), a statistically significant coefficient on either ΔR_{t-1} or ECT_{t-1} or both, suggests that revenues cause expenditures thereby supporting the spent-revenue hypothesis. Likewise, from equation (3), a statistically significant coefficient on either ΔE_{t-1} or ECT_{t-1} or both suggests that expenditure causes revenue thereby supporting the revenue-spend hypothesis. If the relevant coffecients from equations (2) and (3) are both statistically significant, then the fiscal synchronization hypothesis is supported.

The results from estimating the error-correction model show a unidirectional causality from revenue to expenditure for Bahrain, the United Arab Emirates, and Oman, supporting the revenue-spend hypothesis (Table 4). A bi-directional causality between revenue and expenditure was found for Qatar, Saudi Arabia, and Kuwait, supporting the fiscal synchronization hypothesis. Nevertheless, for Kuwait and Saudi Arabia, the causality from revenue to expenditure shows higher significance than the reversal direction.

Moreover, the estimated parameter on λ gives an indication of how fast, in the short run, expenditure growth adjusts itself toward the long-run equilibrium level. For Oman, the United Arab Emirates, and Kuwait, the adjustments were made at a speed of around 2.5 years (a coefficient of around 0.4 on annual data). For Bahrain and Saudi Arabia, the adjustments were close to one year, while Qatar's adjustment was very slow—more than 7 years. These estimated speeds of adjustment are in general slower than those estimated for other countries in the literature. This, however, could be partly explained by the relatively sizable foreign assets held by the GCC governments, which serve as a cushion and allow the government to adjust at a relatively slow pace.[10]

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[9] Note that in the case where there is only one lagged value, a standard t-test replaces the joint significance tests such as F-test or Wald test.

[10] Ewing and Payne (1998) estimated that the adjustment speeds for Colombia and Ecuador were about two-three years, and those for Chile and Paraguay were about four months and one year, respectively. According to Miller and Russek (1989), the adjustment speed for the U.S. federal government was less than one quarter.

Table 4. Causality Test Based on Error-Correction Model

	Bahrain		Oman	
	ΔE_t	ΔR_t	ΔE_t	ΔR_t
ECT_{t-1}	-0.98 (-3.49)	0.07 (0.19)	-0.39 (-1.70)	0.60 (1.25)
ΔE_{t-1}	0.07 (0.32)	-0.18 (-0.69)	0.18 (0.83)	0.34 (0.78)
ΔR_{t-1}	-0.25 (-0.79)	0.42 (1.12)	0.01 (0.04)	0.20 (0.54)
Constant	0.03 (2.06)	0.02 (1.42)	0.02 (2.00)	0.02 (0.84)
Dummy	—	—	—	—

	Qatar		Saudi Arabia	
	ΔE_t	ΔR_t	ΔE_t	ΔR_t
ECT_{t-1}	-0.13 (-1.36)	0.38 (2.44)	-0.86 (-4.13)	-0.81 (-2.04)
ΔE_{t-1}	-0.33 (-1.63)	-0.25 (-0.76)	-0.19 (-0.72)	-0.70 (-1.37)
ΔR_{t-1}	0.37 (2.54)	0.27 (1.14)	0.13 (0.70)	0.32 (0.89)
Constant	0.01 (0.55)	0.04 (1.87)	0.01 (1.10)	0.02 (0.75)
Dummy	0.06 (1.39)	-0.016 (-2.24)	—	—

	U.A.E.		Kuwait	
	ΔE_t	ΔR_t	ΔE_t	ΔR_t
ECT_{t-1}	-0.40 (-2.86)	-0.24 (-1.13)	-0.42 (-6.22)	0.48 (3.39)
ΔE_{t-1}	-0.09 (-0.31)	0.38 (0.87)	-0.09 (-0.23)	0.24 (0.30)
ΔR_{t-1}	0.22 (0.94)	-0.13 (-0.36)	-0.11 (-0.91)	0.20 (0.78)
Constant	0.035 (1.96)	0.03 (0.10)	0.001 (0.06)	0.05 (1.71)
Dummy	—	—	0.22 (4.96)	-0.29 (-3.12)

Note: t- ratios are in parentheses.

Given that a bi-directional causality was initially observed for Kuwait, Qatar, and Saudi Arabia, variance decomposition was calculated to further determine which direction of causality is the strongest.[11,12] The results show that the causality from revenue to expenditure tends to be stronger (Table 5). In Saudi Arabia, over 80 percent of the variation of expenditures was accounted for by past revenues, while 20 percent was accounted for by past expenditures. This pattern seems to be largely consistent throughout the whole period examined, except for the first period, when the corresponding ratio was 64 percent and 36 percent. For Kuwait and Qatar, while innovations in expenditures account for most of the variations in future expenditures in the first or second periods, the reverse is consistently the case in periods beyond. That is, variation in revenues is of increasing importance in explaining future variation in expenditures. Therefore, the results from variance decomposition analysis together with the test for causality tend to support the conclusion that the revenue-spend hypothesis has prevailed in all GCC countries since the mid-1970s.

Table 5. Proportion in Percent of Forecast Error Variance K-Periods Ahead Produced by Each Innovation

Error in:	No. of periods	Kuwait		Qatar		Saudi Arabia	
		Innovation in:		Innovation in:		Innovation in:	
		E_t	R_t	E_t	R_t	E_t	R_t
E_t	1	98.4	1.6	71.6	28.3	35.7	64.3
	2	65.2	34.8	35.9	64.1	19.7	80.3
	3	46.6	53.4	33.8	66.2	17.8	82.2
	4	39.9	60.1	34.0	66.0	18.1	81.9
	5	36.3	63.7	34.4	65.6	18.3	81.7
R_t	1	0.0	100.0	0.0	100.0	0.0	100.0
	2	8.2	91.8	0.3	99.7	9.6	90.4
	3	11.0	89.0	2.7	97.3	14.6	85.4
	4	12.7	87.3	5.6	94.4	16.3	83.7
	5	14.1	85.9	8.3	91.7	17.0	83.0

[11] Variance decomposition exhibits the contribution of each source of innovation to the variance of the k-year ahead forecast error for each of the variables included in the system. In other words, variance decomposition refers to a breakdown of the change in the value of the variable in a given period arising from changes in the same variable as well as other variables in the previous periods.

[12] In order to compute variance decompositions, the innovations are orthogonalized by Choleski decomposition method (Eview 4 User's Guide, 2001). Such decomposition is not unique as it depends on the order which the variable enter the VAR system. In all three cases, we ordered the variables by considering first R_t and second E_t. The decision was based on the fact that, the t-statistics associated with causality were higher in the direction from R_t to E_t than vice versa.

B. Impulse Response Analysis

Taking the causality from revenue to expenditure as given, we then examine how a shock to revenue is transmitted to expenditure by examining the impulse responses. Impulse responses give the dynamic response of each variable to innovations of this variable as well as of the other variables included in the VAR system.[13]

Figures 7 and 8 depict intertemporal and accumulated responses from a one-standard deviation shock on revenue to expenditure over time, respectively.[14] As shown in Figure 7, increases in revenue lead to increases in expenditure in the first period in all the GCC countries. However, the patterns differ across countries thereafter. For Oman and Kuwait, expenditure growth rates remain positive throughout the period but decelerate gradually until reaching zero. For Saudi Arabia, the United Arab Emirates, and Qatar, expenditure growth turns negative in the second period and the rate of decline gradually slows down to zero. For Bahrain, expenditure growth does not turn negative until the fourth period, after when the rate of decline gradually slows down to zero. Figure 8 shows the corresponding cumulated responses. For Oman and Kuwait, expenditure level will rise gradually and monotonically before reaching the equilibrium; for Saudi Arabia, the United Arab Emirates, and Qatar, expenditure level will rise sharply and overshoot the equilibrium within two periods following the shock, after which it will go down gradually and reach the equilibrium. Bahrain displays a similar pattern, but it takes four years for expenditure level to rise before going down somewhat and reaching the equilibrium. It is not clear the reasons behind the smoother reaction of expenditure to revenue changes observed in Kuwait and Oman. However, it is important to note that these two countries generally articulate their fiscal priorities in a medium term framework, and have adopted formal oil savings/stabilization funds for more than two decades.[15]

IV. Conclusion and Policy Implications

Not surprisingly, our results—based on a cointegration and error-correction model and a variance decomposition analysis—support the revenue-spend hypothesis for all GCC countries. Thus, government spending follows revenue, suggesting a pro-cyclical expenditure policy to variations in oil revenue—the largest budgetary revenue component. In this context, GCC countries could enhance the effectiveness of fiscal policy by making budget expenditure less driven by revenue availability. This would avoid the costs and instability that variations in public spending generate, compounding the boost-bust economic cycle

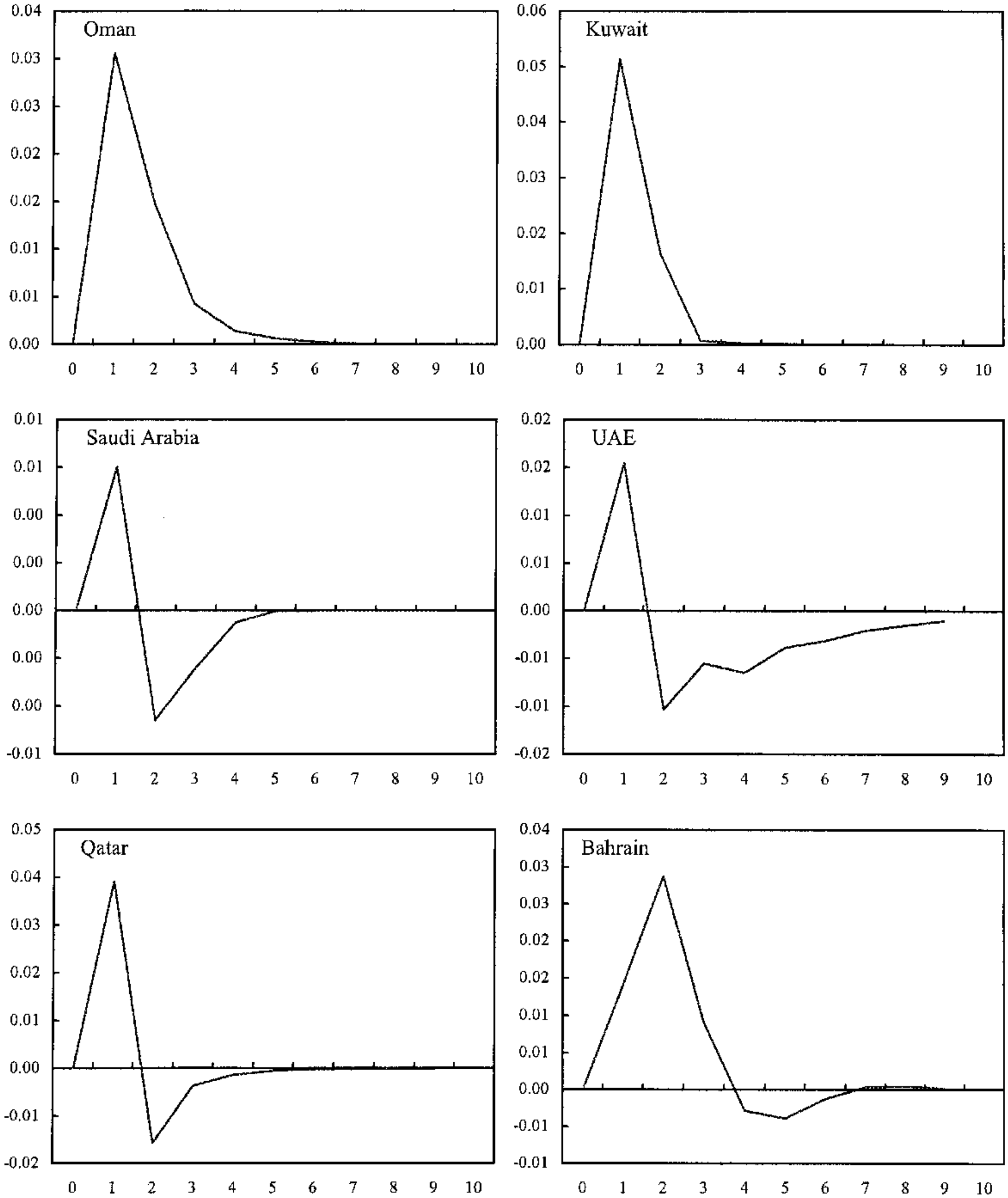
[13] Impulse response analysis amounts to dynamic simulation from an initial value of zero, where a shock at t=1 in a variable is traced through.

[14] The shocks, or the errors in more technical terms, are orthogonalized by Cholesky decomposition with degree of freedom adjusted for small sample (Eview 4 User's Guide, 2001). As regards ordering the variables, revenue precedes expenditure to be consistent with the direction of causality.

[15] For a detailed analysis of these funds see Fasano (2000a) and Davis and others (2001).

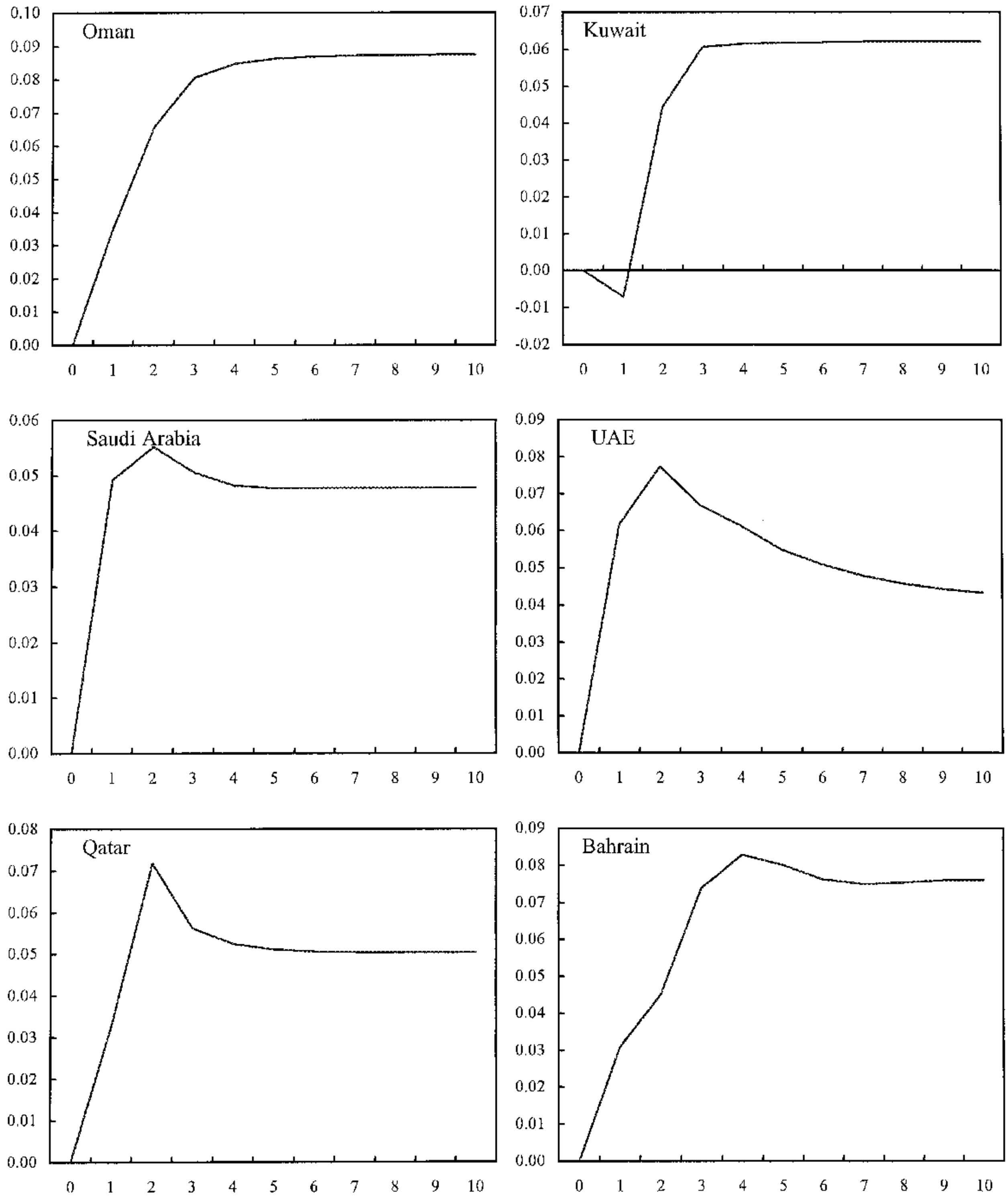
associated with oil price shocks. The authorities could resort to a medium-term expenditure framework, so that expenditures can be planned and insulated from volatile short-term revenue availability. Fiscal rules could be also adopted to constrain expenditure, the non-oil fiscal imbalance, and/or borrowing by the government. As a complement, the GCC authorities could adopt formal oil stabilization funds—as some have already done—to mitigate the pressure on government to overspend in periods of rising revenue by channeling a significant portion of the increase in oil revenue away from the budget. Additionally, GCC countries could also strengthen their budget preparation and execution process.

Figure 7. GCC Countries: Intertemporal Response of Government Expenditure to Cholesky One Standard Deviation Innovation in Government Revenue



Source: Authors' estimates.

Figure 8. GCC Countries: Accumulated Responses of Government Expenditure to Cholesky One Standard Deviation Innovation in Government Revenue



Source: Authors' estimates.

APPENDIX I

Econometric Methodology

Test for unit roots

We consider the causality relationship with the aid of cointegration and error-correction modeling. The standard Granger causality test examines whether past changes in one variable, Y, help to explain current changes in another variable, X, over and above the explanations provided by past changes in X. If not, then one concludes that Y does not Granger cause X. To determine whether causality runs in the other direction, from X to Y, one simply repeats the experiment, but with Y and X interchanged. Four findings are possible: 1) neither variable Granger causes the other; 2) Y causes X, but not vice versa; 3) X causes Y, but not vice versa; 4) Y and X Granger causes each other.

A cointegration and error-correction modeling framework provides a more comprehensive test of causality, which specifically allows for a causal linkage between two variables stemming from a common trend or equilibrium relationship. This framework considers the possibility that lagged *level* of a variable, Y, may help to explain the current *change* in another variable, X, even if past changes in Y do not. The intuition is that if Y and X have a common trend, then the current change in X partly is the result of X moving into alignment with the trend value of Y. Such causality may not be detected by the standard Granger causality test, which only explains whether past changes in a variable help to explain current changes in another variable.

To avoid the potential problem of estimating spurious relationships, it is necessary to test the time-series properties of the variables under investigation for unit roots. If a variable is stationary, i.e., it does not have a unit root, it is said to be I(0) (i.e., integrated of order zero). If a variable is not stationary in its level form but stationary in its first-differenced form, it is said to be integrated of order one, or I(1). More generally, the series X_t will be integrated of order d, that is, $X_t \sim I(d)$, if it is stationary after differencing d times, so X_t containts d unit roots. A popular unit roots test is the Augumented Dickey Fuller (ADF) test,[16] which is based on estimating the following regression:

$$\Delta X_t = a_0 + a_1 t + a_2 X_{t-1} + \sum_{i=1}^{k} c_i \Delta X_{t-i} + e_t \qquad (A.1)$$

The null hypothesis for unit roots is H_0: $a_2 = 0$. We apply this test to each of the variables and determine the stationarity property in their levels as well as in their first differences. The results are presented in Table 1.

[16] Dickey and Fuller (1981), and Fuller (1976).

Table 1. ADF Unit Root Test Statistics

	Bahrain		Oman	
	R_t	E_t	R_t	E_t
Level	$-1.71^{c,**}$	$-2.98^{c,t**}$	-1.85^{c**}	-2.62^{c**}
Lag	3	1	0	2
First Differences	$-3.79^{c,**}$	-4.36^{c**}	-3.95^{**}	-3.25^{c*}
Lag	0	1	0	0

	Qatar		Saudi Arabia	
	R_t	E_t	R_t	E_t
Level	0.69^{**}	-2.50^{c**}	-2.23^{c**}	-2.81^{c*}
Lag	0	0	0	2
First Differences	-3.85^{**}	$-4.98^{c,**}$	-4.29^{c**}	-4.19^{**}
Lag	0	0	0	0

	U.A.E.		Kuwait	
	R_t	E_t	R_t	E_t
Level	$-3.17^{c,t**}$	-2.86^{c*}	-2.48^{c**}	-2.30^{c**}
Lag	1	1	0	2
First Differences	-3.54^{**}	-6.11^{**}	-5.61^{**}	-4.75^{**}
Lag	0	1	0	0

Note: * and ** denote significance at 5 percent and 1 percent, respectively.
c indicates the constant term is significant
t indicates the time trend is significant.

Test for cointegration vectors

If the time-series variables are found to be nonstationary and integrated of the same order, tests can be performed to see if the variables are cointegrated. An identified cointegrating relationship among variables implies there exists a long-term equilibriating relationship (at least in statistical sense) among those variables. Generally, a set of varibles are said to be cointegrated if a linear combination of their individual integrated series, which are I(d), is stationary. Intuitively, if Xt ~ I(d) and Yt ~ I(d), a regression is run, such as:

$$Y_t = \beta * X_t + \varepsilon_t \qquad (A.2)$$

If the residuals (ϵ_t) from the regression are I(0), then X_t and Y_t are said to be cointegrated. Clearly, the series need to be integrated of the same order for cointegration to be possible. Note, if ϵ_t are stationary, differences among the variables tend to die out, and therefore the variables are thought to exist in a long-run equilibriating balance. The constant and trend values can be included in equation (A.2) as needed.

Test for causality

The pattern of causality between the two stationary variables ΔX and ΔY can be identified by estimating a regression on ΔY and ΔX using current and past values of ΔX and ΔY and by testing appropriate hypotheses. For example, causality between two variables can be tested as follows:

$$\Delta Y_t = C_0 + \alpha_0 \Delta X_t + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \sum_{i=1}^{m} \beta_j \Delta Y_{t-j} + \mu_t \qquad (A.3)$$

$$\Delta X_t = C_1 + \delta_0 \Delta Y_t + \sum_{i=1}^{m} \gamma_i \Delta X_{t-i} + \sum_{i=1}^{m} \delta_j \Delta Y_{t-j} + \nu_t \qquad (A.4)$$

where α_i and β_i are coefficients that describe the effects of m current and past vaules of ΔXt and ΔYt on ΔYt, where γ_i and δ_i describe the effects of m current and past values of ΔXt and ΔYt on ΔXt. The μ_t and ν_t are mutually uncorrelated white noise series. The Granger causality can be tested through the null hypotheses that α_i =0 in equation (A.3) and δ_i =0 in equation (A.4) for all i and j, which can be done using standard tests, such as the t-test, F-test, or Wald-test. If α_i =0 and δ_i =0 for all i and j, then there is no causality, and the current value of each variables is solely affected by its own past history. Also, if some $\alpha_i \neq 0$, then ΔY is said to be caused by ΔX, while if some $\delta_i \neq 0$, ΔX is caused by ΔY. If both $\alpha_i \neq 0$ and $\delta_i \neq 0$, then there is bi-directional causality, and both variables are related to current and/or past effects of the other variable.

Engle and Granger (1987) provide a more comprehensive procedure for causality test for variables that are found to be cointegrated. This procedure, known as 'error-correction model' (ECM), incorporates information from the cointegrated properties of time series and allows for—in addition to the causal linkage from the short-run adjustment of individual variables *per se*—a causal linkage between two (or more) variables stemming from an equilibriating (or cointegrated) relationship.

Suppose that there exists a cointegrated relationsip as represented by equation (A.2), with Xt ~ I(1) and Yt ~ I(1). An ECM can be formulated to test causality as following,

$$\Delta Y_t = C_0 + \alpha_0 \Delta X_t + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \sum_{i=1}^{m} \beta_j \Delta Y_{t-j} + \lambda_1 ECT_{t-1} + \mu_t \qquad (A.5)$$

$$\Delta X_t = C_1 + \delta_0 \Delta Y_t + \sum_{i=1}^{m} \gamma_i \Delta X_{t-i} + \sum_{i=1}^{m} \delta_j \Delta Y_{t-j} + \lambda_2 ECT_{t-1} + \nu_t \qquad (A.6)$$

where the ECT_{t-1} is the error correction term lagged one period. The other variables are defined as equations (A.3) and (A.4). The ECT_{t-1}, which is stationary, is the fitted value of ϵ_t from equation (A.2), and thus represents the disequilibrium residuals of a cointegrating equation. Note that the only difference between the specifications of equations (A.5) and (A.6) and equations (A.3) and (A.4) lies in the term ECT_{t-1}. Causality test should be based on equations (A.5) and (A.6) if the series are found to be cointegrated. While causality tests were originally designed for stationary variables, Engel and Granger (1991) extended the idea to be used with cointegration models.

The inclusion of ECT_{t-1} in the ECM gives an extra avenue through which the effects of causality can occur. This additional channel of causality effect functions through the relevant variables' gradual correction of deviation from long-run equilibrium through a series of partial short-run adjustments.The tests are first done on the null hypotheses that $\alpha_i = \lambda_1 = 0$ in equation (5) and $\delta_i = \lambda_2 = 0$ in equation (6) for all i and j. If the null hypotheses cannot be rejected, there is no further tesing and there is no causality from either lagged values of the variables or the ECT_{t-1}. If the null hypothesis is rejected, causality is inferred.

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