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Oil Revenues and Economic Growth in Saudi Arabia

Moayad H. Al Rasasi*
Economic Research Department Saudi Arabian Monetary Authority, Saudi Arabia

John H. Qualls
Economic Research Department Saudi Arabian Monetary Authority, Saudi Arabia

Bander K. Algamdi
Economic Research Department Saudi Arabian Monetary Authority, Saudi Arabia

Abstract

This paper examines the relationship between Saudi oil revenues and the Kingdom's economic growth over the past 47 years. In analyzing the data that are needed for this analysis, problems were encountered with the basic real GDP and government oil revenue data that are typically used. The most widely-used measure of non-oil private sector activity that is available, the Non-Oil Private Institutional Sector GDP, does not include the Gross Value Added of all of the private activities, omitting over SAR 80 billion of real activity (in 2010 prices). A new series was constructed, consisting of all of the non-oil private activities, including the recently corporatized/privatized companies. In addition, the oil revenue data prior to 1987 were found to be unsatisfactory for use as published, due to their being based on the 354-355 day Hijra calendar. A new conversion methodology, based on a recently published paper by Qualls *et al.* (2017), was applied, and the pre-1987 data were converted to a consistent Gregorian basis with good results. The two series were determined to have a unit root of order one, with a highly significant long-run relationship. An error-correction model was then estimated, and highly significant short- and long-run relationships were found. A Ganger Causality test was performed, with the results confirming the ECM's results, with real government oil revenue growth "Granger-causing" real private-sector GDP growth. Finally, the new non-oil activity GDP measure produced better results than did the traditionally-used Non-Oil Private Sector GDP.

Keywords: Economic growth, oil revenues; Cointegration; Error correction model; Granger causality.
JEL: C13; C22; C32; Q43.

1. Introduction and Discussion of Key Data Problems

Although the literature is replete with studies on the impact of oil prices on developed and emerging/developing country growth (particularly the shock of higher oil prices), less has been written about the impact of oil prices and revenues on oil exporting countries. This is particularly the case for Saudi Arabia, whose role as the world's largest exporter of crude oil and as a member of the G-20 is not matched by the attention given to the impact of the government's oil revenue receipts on the Saudi non-oil private sector economy.

The studies that have been done have focused on oil price shocks, rather than government oil revenues, and have included Saudi Arabia in a group of countries. These studies, as well as internal studies by various government bodies, also apparently use measures of real GDP that 1) either include both government and oil activities, or 2) exclude large amounts of what is normally considered to be private sector activity.

There also appears to be a problem with the government oil revenue data used in these analysis. The only publically-available source of data going back far enough to give a sufficient number of observations is SAMA's *Annual Statistics* Excel workbook.[1] This dataset purports to go back to 1969, but the 1969-1986 data are based on the Hijra lunar calendar, which has a 354-355 day year and was used by the Ministry of Finance in publishing its fiscal year data until 1987. To illustrate the problem in using these data, consider that the "1969" government oil revenue data was actually received for the period between September 12, 1969 and September 1, 1970. Thus, there were only 110 days of 1969's revenues, versus 255 days of 1970's.

This paper deals with all of these problems and shortfalls. It focuses on the entire 47 year period to determine both the short- and long-run relationship between oil revenue and real economic growth, uses an innovative approach which deals with the Hijra-Gregorian data problem, and uses an expanded measure of real GDP that includes the total of all of the Kingdom's non-oil private activities, including the recently corporatized/privatized enterprises.

The rest of the paper is organized as follows. Section 2 provides a brief review of the existing empirical studies, while Section 3 describes the dataset that was used. Section 4 covers the applied econometric methodolgy alongside the discussion of the results, while Section 5 contains the conclusion.

[1] This document is available on the SAMA website at:
http://www.sama.gov.sa/_layouts/15/images/xlsx.png,
Section 5 (Public Finance Statistics), Table 2 (Annual Government Revenues and Expenditures - Actual)

*Corresponding Author

2. Literature Review

In general, there has been a growing literature analyzing the consequences of global oil market volatility on various macroeconomic, microeconomic, and financial sectors of the world's economies. It is important to note that Hamilton (1983) is one of the most prominent pioneers investigating the impacts of historical oil price shocks on the US economy. In particular, Hamilton explores the response of key US macroeconomic variables to oil shocks since World War II and concludes that oil shocks were responsible for seven out of eight US recessions, in which higher oil prices led to lower economic growth.

Since the groundbreaking work of Hamilton (1983), the literature linking oil shocks to the economic and financial markets becomes richer over time. In other words, Hamilton's seminal work has encouraged other economists to initiate new measures for oil price shocks. For instance, Mork (1989) develops asymmetric measures for oil shocks, distingushing between positive and negative shocks. This in turn motivates (Hamilton, 1996;2003) to initiate a new measure for oil shock, known as the "net oil price increase", capturing oil price rises by comparing the current oil price to past prices one or three years earlier. Over the past decade, Kilian (2009) introduced new measures for oil shocks, differentiating between oil supply and demand shocks.

With these existing measures of oil price shocks, there are hundreds of studies probing the consequences of oil fluctuations on key macro, micro, and financial variables for both advanced and less advanced economies. For example, some of the prevalling empirical studies assess how changes in oil prices affect economic growth (i.e. (Al Rasasi and Yilmaz, 2016; Hooker, 1996; Kilian, 2008), inflation (i.e. (Bachmeier and Cha, 2011), exchange rates (Al Rasasi, 2018; Chen and Chen, 2007), trade (Le and Chang, 2013), fiscal policy (i.e. (El Anshasy and Bradley, 2012), stock markets (i.e. (Alali, 2017; Bachmeier, 2008; Naser and Alali, 2017), monetary policy (i.e. (Hamilton and Herrera, 2004), and employment (e.g., (Davis and Haltiwanger, 2001).

Additional effort by researchers, economists, and policymakers has focused on analyzing the macroeconmic consequnces of shocks to global oil market by relying on oil revenue shocks rather than oil price shocks. This usually applies to oil exporting countries, in order to evaluate how these economies are influenced by oil market fluctuations. For instance, Mehrara and Oskoui (2007) show that the volatility of key macroeconomic variables in oil exporting economies (including Saudi Arabia) is related to oil shocks. Mehrara (2008), who assesses the consequences of oil revenues on the economic growth on 13 oil-exporting countries based on panel data econometric techniques, confirms the presence of a positive relstionship between oil revuene and the growth of the non-oil GDP at the threshold of 18 percent of oil revenues. However, this relationship becomes negative when the threshold exceeds 18 percent.

Another study by Emami and Adibpour (2012) examines the effects of asymmetric oil revenue shocks on the growth of the Iranian economy, considering various key macroeconomic variables. They conclude that the oil shocks and output in the cases that they studied move together in the same direction, suggesting the positive (negative) impact of rising (declining) oil prices on economic growth. They found that negative oil shocks severely impact output growth. Hamdi and Siba (2013), investigate the short and long run impacts of oil revenue shocks on government expenditures and economic growth in the case of Bahrain. Their evidence shows that both output growth and government spending are impacted by variations in oil revenue in the short and long run. Further evidence is provided by Dizagi (2014), who examines the economy of Iran to evaluate how key macroeconomic variables respond to changes in oil revenues. The empirical evidence that has been gathered suggests the essential role of oil revenues on government expenditures as well as other macroeconomic variables. In addition, Farzangegan (2011) analyzes the interaction between oil shocks and government expenditures in Iran over the time horizon 1959-2007. His empirical evidence reveals that oil revenue shocks (or oil price shocks) have significant impacts only on government expenditures on military and security and do not affect expenditures on social services.

Unfortunately, despite the large share of literature appraising the impacts of oil shocks on developed and less developed economies, it is surprising to observe that Saudi Arabia's share of mention in this literature is not proportional to its major role as the most prolific exporter in the world's oil markets, as well as the size of its economy, which is one of the 20 largest in the world. The prevailing literature on the Saudi Arabian economy tends to analyze the consequences of oil price shocks on economic growth i.e. (Al Rasasi and Banafea, 2015; Alkhathlan, 2013), inflation (i.e. (Al Rasasi, 2017; Nazer, 2016), exchange rates (i.e. (Al Rasasi, 2017; Mohammadi and Jahan-Parvar, 2012), and the Saudi stock market (i.e. (Arouri *et al.*, 2011).

Regarding the impact of oil revenue shocks on the Saudi Arabian economy, there are only a few studies. Mehrara and Oskoui (2007), for example, confirm the essential role of oil revenues in influencing economic activity and government expenditure in several oil exporting countries including Saudi Arabia. Another study by Mehrara (2009) also emphasizes the essential role of oil revenues on various oil producing countries, including Saudi Arabia.

3. Data

In order to achieve the main objective of this paper, this study uses annual data for real output, measured by the total of real non-oil private (NOP) production (gross value added) activities and government oil revenue, for which data exist from 1970 to 2017. It is essential to stress that this real output measure is higher than the Kingdom's Non-Oil Private Institutional Sector data that is typically used in research papers, since the General Authority for Statistics (GASTAT) includes a substantial portion of NOP activity in its Government Institutional Sector total.[2] Furtheremore, empirical evidence obtained from working with the SAMA econometric model reveals that the non-oil private activity total usually gives a better equation statistical fit than does the non-oil private institutional sector total.

In order to convert the nominal government oil revenue into real terms, we rely on the implicit price deflator for the Non-Oil Private Activity in order to deflate the government oil revenue, since it is a better measure of overall inflation in the private sector. Under no circumstances should oil prices, the Oil Institutional Sector GDP deflator, or either of the oil activity deflators (for oil extraction and refining) be used, since they have little or no bearing on the overall internal inflation in the Kingdom.

Data on the non-oil private activities and government oil revenue are obtained from GASTAT and the Ministry of Finance respectively. It is important to emphasize that the 1970-1986 data are converted from the Hijra data to a Gregorian basis following the proposed methodology of Qualls *et al.* (2017). This is particularly important, since all of the equations are expressed in error correction format, with the dependent variables (and many of the independent variables) expressed in log first difference (delta log) form. The use of Hijra data in the earlier years would severely distort the actual annual growth rates.

4. Empirical Methods and Results

4.1. Testing for Stationarity, Cointegration, and Causality

In time series analysis, it is common to detect the nonstationarity of various financial and economic variables; in other words, these variables tend to have trending behavior. Thus, determining whether time series are stationary or not is an essential task to avoid spurious regressions and inaccurate forecasts, and to determine whether there exists a cointegration relationship among multiple time series or not. For the purpose of this paper, it is critical to check for stationarity prior to testing for cointegration.[3]

To do so, this paper utilizes the most common procedures to ensure the stationarity of the employed economic variables. Specifically, we apply the Augmented Dicky Fuller test developed by Said and Dickey (1984), who extend the well-known test of Dickey and Fuller (1979), to take into account ARMA (p,q) models. We also apply another implemented unit root test developed by Phillips and Perron (1988). The correction for heteroskedasticity and serial correlation in the error term is what differentiates this test from other unit root tests. Lastly, both tests share the null hypothesis that a time series is integrated of order one against the alternative hypothesis that it is integrated of order zero.

In case the employed economic variables are integrated of order one, then there is a possibility of observing a cointegration relationship among these variables as suggested by Engle and Granger (1987). By this means, we rely on the trace cointegration test, which is one of the most popular cointegration tests originated by Johansen and Juselius (1990). Within the scope of this paper, finding evidence in support of cointegration would enable us to evaluate the appropriateness of modeling real economic growth as a function of real government oil revenues.

Furthermore, the presence of a cointegrated relationship would enable us to compute both the short- and long-term elasticities via the estimation of the error correction model (ECM), as recommended by Engle and Yoo (1987). The existence of an error correction mechanism shows the suitability of modeling changes in the dependent variables as a function of the error correction term, measuring the deviation from the long run equilibrium, in addition to changes in other explanatory variables assessing the short term relationship among all variables.

Furthermore, the presence of a cointegration relationship indicates the existence of Granger causality among the the cointegtated economic variables in at least one way as documented by Engle and Yoo (1987). Therefore, we apply the causality procedure developed by Granger (1969) to assess whether changes in real government oil revenues cause the changes in real non-oil private activities. It is essential to bear in mind that the Granger causality test determines whether the past values of real government oil revenues would be able to predict the changes in the current values of real non-oil private activities. If the paramter estimates of real non-oil private activities are related to the past values real government oil revenues with statistical significance, then we can conclude that real government oil revenues Granger-cause real non-oil private activities. It is also worthy to highlight the possibility of observing either unidirectional or bidirectional causality. In last, to verify whether there exists Granger Causality or not, we need to estimate a simple bivariate vector autoregression model with the first difference of the real government oil revenues and real non-oil private activities as given below:

$$\Delta GDP_t = \beta_0 + \sum_{i=1}^{k} \beta_{1,i} \Delta GDP_{t-i} + \sum_{i=1}^{k} \beta_{2,i} \Delta Rev_{t-i} + \varepsilon_{1,t} \quad (1)$$

$$\Delta Rev_t = \alpha_0 + \sum_{i=1}^{k} \alpha_{1,i} \Delta GDP_{t-i} + \sum_{i=1}^{k} \alpha_{2,i} \Delta Rev_{t-i} + \varepsilon_{2,t} \quad (2)$$

where ΔGDP_t and ΔRev_t are the first difference of real output measured by non-oil private activities and real government oil revenue at time t, respectivly. In addition, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the error terms, while $\beta's$ and $\alpha's$ are the

[2] In 2017, the real GDP for all non-oil private activities was SAR 1,094,541 million, but the real GDP for GASTAT's Non-Oil Private Institutional Sector was only SAR 1,012,249 million, a difference of SAR 82,292 million. Conversely, GASTAT's Government Institutional Sector real GDP was SAR 431,417 million, whereas the Government Services activity was only SAR 355,600 million, a difference of SAR 75,817 million. The missing amount (SAR 6,475 million) is accounted for by the difference between the Oil Sector real GDP (SAR 1,103,168 million) and the sum of the Oil Extraction and Oil Refining activities (SAR 1,000,160+96,533 = SAR 1,096,693 million), which also amounts to SAR 6,475 million. Clearly, a substantial amount of private activity is included in the Government Institutional Sector total, with a smaller amount going to the Oil Institutional Sector. A more sophisticated regression and statistical inference analysis shows exactly which private activity amounts go into which institutional sector. This topic will be examined in more detail in an upcoming SAMA paper.

[3] It is important to remember that all data were converted to natural logarithms before any statistical procedure.

parameter need to be estimated, and k is the optimal lag length determind by AIC criteria. Once we estimate the VAR model, we need to test the null hypothesis that ΔGDP_t does not Granger-cause ΔRev_t; in other words, $\beta_{1,i} = \beta_{2,i} = 0$. The same applies if we want to test whether changes in real oil revenues predict changes in real output.

4.2. Empirical Results

4.2.1. Unit Root and Cointegration Tests

The applied unit root tests confirm that all economic variables (expressed as natural logarithms) are integrated of order one as shown in Table (1). Likewise, the result of both trace and maximum eigenvalue tests of Johansen and Juselius (1990), as summarized in Table (2), validate the presence of a long run relationship. In other words, it seems appropriate to model real output as a function of real government oil revenues.

Table-1. Unit Root Tests

	ADF Test						PP Test			
	Level Data			First Difference			Level Data		First Difference	
	None	Trend	Drift	None	Trend	Drift	Constant	Trend	Constant	Trend
Oil Rev.	0.41	-2.76	-2.62	-4.60*	-4.61*	-4.61*	-2.02	-2.61	-2.71*	-2.86*
Output	1.44	-3.69*	-2.02	-2.64*	-3.33*	-3.29*	-2.67	-2.59	-5.43*	-5.44*

* denote the rejection of the null hypothesis at 5% significance level.

Table-2. (Johansen and Juselius, 1990) Cointegration Test

Trace Test		
H_0	$r = 0$	$r \leq 1$
Test statistics	21.94*	7.47
Maximum Eigenvalue Test		
H_0	$r = 0$	$r \leq 1$
Test statistics	14.47 *	7.47
$(*)$ denotes the failure to reject the null hypothesis of no cointegration at 5% significance level.		

4.2.2. Cointegration and Causality Analysis

Since the obtained cointegration results imply the presence of at least one long-run relationship among the employed variables, we need to understand the dynamics of the long-run relationship prior to interpreting the short-term dynamics based on the error correction model. To reach such an objective, we first estimate the long run relationship between real output and real oil revenue as given by equation (3):

$$GDP_t = \beta_1 + \beta_2 Rev_t + \varepsilon_t \quad (3)$$

where $GDP_t, Rev_t, and\ \varepsilon_t$ are real output, real government oil revenues, and the error term respectively at time period t. The estimated coefficients of equation (1), based on the ordinary least squares (OLS) estimation method, are presented in Table (3).

Table-3. OLS Regression Equation – Long Run Relationship

	β_1	β_2	**Adj. R-squared**
Parameter Estimates	4.73	0.65	57.24
t-statistics	(4.73)	(7.99)	

It appears that the estimated parameter of oil revenues is associated positively and significantly with real output growth. This finding shows the significant role of oil revenues on promoting non-oil economic growth in Saudi Arabia. In other words, an increase in oil revenues by 10 percent results in a rise of the non-oil private activities by 6.5 percent.

On the other hand, investigating the short turn relationship between real output and real government oil revenue is an additional objective of this paper. To achieve this and to attain insight concerning the restoration of long-run equilibrium, we estimate the following error correction model (ECM) as given by equation (4):

$$\Delta GDP_t = \beta_0 + \beta_1 \Delta Rev_t - \phi[GDP_{t-1} - \beta_2 Rev_{t-1}] + e_t \quad (4)$$

where the variables are as defined in equation (3), β_1 is the short-run elasticity of real output with respect to oil revenues, ϕ is the magnitude of error correction (speed of adjustment), which should have a value between 0 and -1. It is important to emphasize that the expression in brackets is the previous period's deviation from the equilibrium value. β_2 and e_t *are* the long-run elasticity of real output with respect to oil revenues, and the current period's error term respectively.

The estimated coefficients of equation (4), based on OLS methodology, are presented in Table (4).

Table-4. OLS Regression Equation – Error Correction Model

	β_1	$\frac{\beta_2}{\phi}$	ϕ	**Adj. R-squared**
Parameter Estimates	0.120	0.082	-0.097	60.30
t-statistics	(5.82)	(5.93)	(5.91)	

The reported results in Table (4) can be interpreted as follows. The coefficient on the ΔRev_t term ($\beta_1$in equation 4) is the short-run elasticity of the oil revenue term. This is considerably lower (0.12) than the long-run elasticity in Table (3). This is to be expected, in accord with economic theory. The coefficient on the GDP_{t-1} term (ϕ in equation 4) is the speed of adjustment toward the long-run equilibrium real GDP value. Its value of -0.097 indicates a relatively slow pace of adjustment – only about 10 percent per year. The coefficient on the Rev_{t-1} term is related to the β_2 term (the long-term elasticity), but must be converted from its stated value of 0.082 by dividing it by the absolute value of the speed of adjustment (ϕ) term (0.097), if we wish to obtain the long-term elasticity. The result is a long-run elasticity of 0.84, considerably higher than the short-run elasticity of 0.12 and somewhat higher than the long-run elasticity of 0.65 estimated in equation 3. This is in line with the cointegration tests' results indicating the presence of a long run relation between real ouptut and real government oil revenues as Engle and Granger (1987) suggest.

With the exception of the constant term, all of the t-statistics are highly significant at the 5-6 sigma level (99.99+ percent). The adjusted R-squared statistic suggests that over 60% of the Kingdom's real non-oil private activity is related to real oil revenues.

In order to buttress this conclusion, a Granger Causality test to determine the presence and direction of causality was performed. Table (5) shows the results of this test.

Table-5. Results of Granger Causality Test

Period		# of	probability of null hypothesis[4]		confidence		conclusion at 95%
From	To	lags	log(GDP)→log(OILR)	log(OILR)→log(GDP)	log(GDP)→log(OILR)	log(OILR)→log(GDP)	
1970	2017	1	0.4116	0.0000	59%	99.99+%	OILR "causes" GDP
1970	2017	2	0.7112	0.0470	29%	95%	OILR "causes" GDP
1970	2017	3	0.7201	0.3951	28%	60%	no causality
1970	2017	4	0.4399	0.5880	56%	41%	no causality

The results of the Granger Causality test confirm the Error Correction Model's conclusion. Basically, the results say that changes in real oil revenues "Granger-cause" the changes in real non-oil private sector GDP. Furthermore, the test establishes the fact that the structure of this relationship is primarily a one period lag.

In order to test the appropriateness of using the expanded Non-Oil Private Activity (NOPA) measure of real GDP growth, the Non-Oil Private Sector (NOPS) measure was substituted and the regressions were rerun. In both the long-run relationship estimation shown in Table 3 and the ECM model in Table 4, the use of the NOPA measure resulted in a higher R-bar squared value and a lower standard error. The differences were small and probably not significant, but using the broadest and best measure of private sector activity would seem to make common sense.

5. Conclusion

The above results would indicate that there exists a strong relationship, both short- and long-run, between government oil revenue receipts and the growth and development of the broadly-definied measure of non-oil private activity. Of course, the major channel of this relationship is via government spending of the oil wealth in a prudent and effective fashion. The evidence of this strong relationship and the development of the non-oil private sector is testimony to the fact that this was money well-spent.

However, the government's main role will be changing, in line with the Vision 2030 initiatives. Rather than being the distributor of oil largesse, the government's role will be that of investing in the infrastructure that is critical to private sector development, setting the rules and regulations that will promote a strong and vibrant private sector, overseeing the conversion of oil wealth into financial investments whose monetary return will replace oil revenues, and providing those vital government services to its citizens in an efficient and effective manner.

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[4] The null hypothesis referred to here is the hypothesis that the log of the first variable x (e.g., real oil revenue) does not Granger-cause the log of the second variable y (e.g., real non-oil private activity GDP). A number smaller than 0.05 means that we can reject the null hypothesis for that particular variable combination – i.e., the first variable x **does** Granger-cause the second variable y. The numbers in the "confidence" column are simply the results of subtracting the probability of the null hypothesis from 1 and converting them to percentages. Following is an excellent explanation of Granger causality, excerpted from the EViews 9.5 Help File section on the subject.

"The Granger approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant…. It is important to note that the statement "x Granger-causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term."

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