Energy-GDP relationship for oil-exporting countries: Iran, Kuwait and Saudi Arabia

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Abstract

The purpose of this paper is to examine the causality issue between energy consumption and economic growth for three typical oil-exporting countries: Iran, Kuwait and Saudi Arabia. We use two different test methods to test for causality, namely, the error correction model and Toda-Yamamoto (1995) procedure. The results based on both approaches consistently show a unidirectional long-run causality from economic growth to energy consumption for Iran and Kuwait and unidirectional strong causality from energy consumption to economic growth for Saudi Arabia. So, the results support the neutrality hypothesis of energy consumption with respect to economic growth for Iran and Kuwait and *vice versa* for Saudi Arabia. The findings have practical policy implications for decision makers in the area of macroeconomic planning, as energy conservation is a feasible policy with no damaging repercussions on economic growth for Iran and Kuwait. However, increased GDP requires enormous energy consumption in Saudi Arabia. So, it seems misleading to recommend the same policy for different oil-exporting countries.

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IN RECENT YEARS, the growing concern about climatic change due to CO_2 emission has led to a debate about whether developing countries should be allowed to increase their emission of climatic gasses more than industrialised countries. Developing countries have argued in discussions that they should be able to increase their CO_2 emissions more than developed countries since they see energy use as a precondition for economic growth (Guttormsen, 2004).

The literature concerning the relationship between energy consumption and economic growth has led to the emergence of two opposite views. One point of view suggests that energy use is a limiting factor to economic growth. The other point of view suggests that energy is neutral to growth. This is known in the literature as the 'neutrality hypotheses' which proposes that the cost of energy is a small proportion of GDP, and so it should not have a significant impact on growth output. It has also been argued that the possible impact of energy use on growth will depend on the structure of the economy and the stage of economic growth of the country concerned. As the economy grows, its production structure is likely to shift towards services, which are not energy intensive activities (Solow, 1978; Brendt, 1980; Denison, 1985; Cheng, 1995).

There are a large number of papers examining the empirical relationships between energy use and economic growth. Based on the methodology used, the literature on the relationship between energy use and economic growth can be divided into three generations of "energy-use economic-growth relationship studies." First-generation studies are based on a traditional vector autoregression (VAR) methodology (Sims, 1972) and Granger's causality testing, which assumed that these data series were stationary (Kraft and Kraft, 1978; Yu and Wang, 1984; Erol and Yu, 1987; Abosedra and Baghestani, 1989). Second- and third-generation studies are based on the understanding that the variables in question are non-stationary and hence that cointegration is the appropriate tool for investigating these relationships. Second-generation studies, based on Engle-Granger (1987), two-stage procedure, tested pairs of variables for cointegrating relationships and estimated error correction models (ECM) to test for Granger causality (Nachane, Nadkarni and Karnik's research, 1988; Glasure and Lee,1997; Cheng and Lai,1997; Al-Iriani, 2005).

The third-generation literature uses multivariate estimators (Johansen, 1991), which facilitated estimations of systems, where restrictions on cointegrating relations can be tested and information on short-run adjustment, were investigated. The multivariate approach also allows for more than two variables in the cointegration relationship (Masih and Masih,1996, 1997, 1998; Yang, 2000; Stern, 2000; Asafu-Adjaye, 2000; Ghosh, 2002; Soytas and Sari, 2003; Ghali and El-Sakka, 2004; Oh and Lee, 2004). The review of literature states that a relationship exists between energy use and economic growth. However, when it comes to whether energy use is a result of, or a prerequisite for economic growth, there are no clear trends in the literature. Depending on the methodology used, and the country and time period studied, the direction of causality between energy consumption and economic variables has remained empirically elusive and controversial.

This paper examines the energy-income relationship for three typical oil-exporting countries: Iran, Kuwait and Saudi Arabia. We investigate the causal nexus between the two series based on two approaches, namely, the ECM and Toda-Yamamoto (1995) procedure. The direction of causation between energy consumption and economic growth has significant policy implications for these countries, enjoying implicit generous subsidies[1] (low domestic prices) for energy. If, for example, there exists unidirectional Granger causality running from income to energy, it may be implied that energy conservation policies, such as phasing out energy subsidies or elimination of energy price distortions, have little adverse or no effects on economic growth.

On the other hand, if unidirectional causality runs from energy consumption to income, reducing energy consumption, for example through bringing domestic energy prices in line with market prices, could lead to a fall in income or employment. Lastly, no causality in either direction would indicate that policies for increasing energy consumption do not affect economic growth.

The remainder of this paper is organised in the following fashion. Section 1 presents a brief overview of the economic and energy use profiles of the countries in the sample. Section 2 briefly describes the data sources and the methodology employed, respectively. Section 3 presents empirical results. Some concluding remarks are presented in the final section.

1. Economic and energy use profile

The three countries are heavily dependent on oil revenues and enjoying implicit generous subsidies for energy. Of the three, Iran is the least wealthy on a per capita income basis of comparison, with a per capita GDP of international $5,923.10 (1995 dollars). The others have per capita incomes of over international $11,000 (**table 1**). All three countries have recorded low annual output growth per capita (based on constant local currency), ranging from 1.5 for Iran to –3.11 for Kuwait. Although, economic performance has been influenced by oil revenue volatility and "stop-go" policies, resulting in boom and bust cycles, most mineral exporters, and in particular the oil exporters, have done far less well than resource-poor countries over the past few decades, particularly when considering the massive revenue gains to the oil-exporting countries since 1973. Many studies support the "paradox of plenty" or "natural resource curse" (recent examples include Auty, 2001, and Gylfason, 2000 and 2001).

To avoid lower rates of growth or stagnation in the non-oil sectors, these countries make high demands on energy resources with cheap domestic energy particularly in times of high world energy prices. Table 1 reports figures for annual percentage changes in average per capita GDP and energy use for the three countries in the sample. In all of the countries, energy use growth has been far more than economic growth (on a per capita basis). The gap between GDP and energy use growth is highest for Kuwait with 7.3 per cent followed by Saudi Arabia with 6.4 per cent. Carbon dioxide emissions per 1995 ppp $ of GDP are also implausibly high, ranging from 1.68 kilogram per dollar (kg/$) for Saudi Arabia to 0.91 kg/$, for Iran (compare these figures with 0.69 for middle income, 0.44 for south Asia, 0.35 for European union and 0.49

for high income economies). A similar pattern of results is obtained using the energy intensity (defined as the amount of energy consumption per GDP).

The above figures imply concerns about increasing energy consumption in oil-exporting countries. For example, in Iran, total oil consumption amounted to 1.5 million barrels per day in 2002–03, similar to Spain's, with a GDP six times higher than Iran's (IMF, Country Report, 2004). Implicit energy subsidies have given rise to misallocation of resources, waste and over consumption of energy products. As a result, they have become one of the most energy intensive countries in the world. So it seems that there is high energy saving potential in these countries.

Given implausibly high oil consumption in oil-exporting countries and the recent phenomenal growth in awareness of and concern for global warming, an examination of the energy income relationship has implications for energy policy in these countries. It is important to add that most of the studies referred to above, have dealt with countries relying on imports for their energy needs and it may be argued that the results are not applicable to net exporters of fuel.

Table 1
Selected economic indicators
(1971–2002)[a]

Indicator	Iran	Kuwait	Saudi Arabia
Population (end of periods, millions)	65.54	2.33	21.89
GDP per capita			
(end of periods, 1995 international $)	5,923.10	14,382.00	1,1207.00
GDP per capita (average growth rate, per cent)[b]	1.50	–3.75	–0.38
Energy use per capita			
(average growth rate, per cent)	3.82	3.57	6.02
CO_2 emissions per capita (2000, m ton)	4.87	21.87	18.06
CO_2 emissions			
(kg per 1995ppp $ of GDP, 2000)	0.91	1.34	1.68

[a]*Source: World Bank.*
[b]*GDP is at market prices based on constant local currency.*

2. Methodology and data

Data used in the analysis are annual time series on real GDP and energy use (both per capita) during the period 1971–2002. The data were obtained from World Development Indicators (WDI) 2005, published by the World Bank. The choice of the starting period was constrained by the availability of data on energy consumption. The variables' notations and definitions are as follows:

LEC: natural logarithm of commercial energy use in kilogram of oil equivalent per capita; and

LGDP: natural logarithm of real income, defined as GDP per capita in constant 2000 prices in local currency units.

Before conducting any econometric analysis, the time series properties of the data must be investigated. We used augmented Dickey_Fuller (ADF) and Phillips_Perron (PP) tests to assess the order of integration of the two series (Dickey and Fuller, 1979; Phillips and Perron,. 1988). If the series are non-stationary in levels and stationary when first differenced, then they are said to be integrated of order one. We can test for cointegration between integrated series of the same order.

Table 2
Unit root tests

	Augmented Dickey-Fuller (ADF)		Phillips-Perron (PP)	
Country/ variable	**Levels**	**First differences**	**Levels**	**First differences**
Iran				
LGDP	–2.51(0.32)	–3.62(0.01)	–2.31(0.42)	–3.54(0.01)
LEC	–3.14(0.11)	–7.03(0.00)	–3.06(0.13)	–7.03(0.00)
Kuwait				
LGDP	–1.38(0.85)	–4.30(0.00)	–1.45(0.83)	–4.31(0.00)
LEC	–3.19(0.11)	–5.51(0.00)	–2.92(0.17)	–7.32(0.00)
Saudi Arabia				
LGDP	–2.75(0.08)	–2.67(0.01)	–1.82(0.36)	–2.50(0.01)
LEC	–1.19(0.89)	–3.39(0.02)	–1.26(0.88)	–3.37(0.02)

Notes: The lag lengths for the ADF and PP tests are chosen by using Akaike's information criterion and Newey and West (1987) method, respectively. The numbers in parentheses are MacKinnon (1996) one-sided p-values.

The results of the PP and ADF unit root tests for levels and first differences in table 2, show that in all countries, LEC and LGDP appear to be non-stationary at five per cent level of significance and thus, any causal inferences from the two series in levels are invalid. However, non-stationarity can be rejected for first differences of these series at five per cent level of significance[2], suggesting that each variable is integrated of order one or I(1) for all three countries. As it was mentioned earlier, we apply two procedures to test for the causal relationship between the two variables discussed in the followings.

Cointegration and EC version of Granger causality:

The most popular method for Granger causality tests, is based on ECM, avoiding spurious regression problems. In this procedure, we first investigate whether the two non-stationary series are cointegrated, ie. whether a linear combination of the two series is stationary. Cointegration implies that causality exists between the two series, but it does not indicate the direction of the causal relationship. To test for cointegration between the two series, we use the Johansen test (Johansen 1988; Johansen and Juselius 1990) based on the maximum eigenvalue and trace statistics, as well as ADF cointegration tests developed by Engle-Granger (1987).

The dynamic Granger causality can be captured from the vector error correction model (VECM) derived from the long-run cointegrating relationship (Granger 1988). Engle and Granger (1987) showed that if the two series are cointegrated, the VECM for the LGDP and LEC series can be written as follows:

$$\Delta LGDP = \alpha_y + \beta_y ECT_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta LEC_{t-i} + \sum_{i=1}^{n} \delta_{yi} \Delta LGDP_{t-i} + \varepsilon_{yt} \quad (1)$$

$$\Delta LEC = \alpha_e + \beta e ECT_{t-1} + \sum_{i=1}^{n} \gamma_{ei} \Delta LEC_{t-i} + \sum_{i=1}^{n} \delta_{ei} \Delta LGDP_{t-i} + \varepsilon_{ei} \quad (2)$$

where Δ is a difference operator; ECT is the lagged error correction term derived from the long-run cointegrating relationship; The $\beta_i (i = y,e)$ are adjustment coefficients and the ε_{it}s are disturbance terms assumed to be uncorrelated and random with mean zero.

The optimal lag order in the above model is determined by Schwarz (1978) and Hannan and Quinn (1979) criteria (SC and HQ, respectively). If these criteria choose the same lag order, we use that order, but if they choose different lag orders, then we conduct the likelihood ratio test (LR) to select between these two lag orders. Finally, we carry out diagnostic tests to confirm that the underlying desirable statistical assumptions are fulfilled. If these assumptions are not satisfied, we increase the lag order in the VAR model until the diagnostic tests show improved.

Sources of causation can be identified by testing for significance of the coefficients on the lagged variables in equation 1 and 2. First, by testing $H_0:\gamma_{yi} = 0$ for all i in equation 1, or $H_0:\delta_{ei} = 0$ for all i in equation 2, we evaluate Granger weak causality. This can be implemented using a standard F-test. Masih and Masih (1996) and Asafu-Adjaye (2000) interpreted the weak Granger causality as 'short run' causality in the sense that the dependent variable responds only to short-term shocks to the stochastic environment.

Another possible source of causation is the ECT in equation 1 and 2. In other words, through the ECT, an ECM offers an alternative test of causality (or weak exogeneity of the dependent variable). The coefficients on the ECTs represent how fast deviations from the long run equilibrium are eliminated following changes in each variable. If, for example, β_y is zero, then LGDP does not respond to a deviation from the long-run equilibrium in the previous period. Indeed, $\beta_y = 0$ or $\beta_e = 0$ is equivalent to both the Granger non-causality in the long-run and the weak exogeneity (Hatanaka, 1996). This can be tested using a simple t-test.

It is also desirable to check whether the two sources of causation are jointly significant, in order to test Granger causality. This can be done by testing the joint hypotheses H_0:$\beta_y = 0$ and $\gamma_{yi} = 0$ for all i in equation 1 or H_0:$\beta_e = 0$ and $\delta_{ei} = 0$ for all i in equation 2. This is referred to as a strong Granger causality test. The joint test indicates which variable(s) bear the burden of short-run adjustment to re-establish long-run equilibrium, following a shock to the system (Asafu-Adjaye, 2000). A test of these restrictions can be done using F-tests. If there is no causality in either direction, the 'neutrality hypothesis' holds.

Toda and Yamamoto Version of Granger causality:

As pointed out by Toda and Yamamoto (1995), and Zapata and Rambaldi (1997), the power of unit roots and cointegration tests are very low against the alternative hypothesis of (trend) stationarity. Moreover, these tests are cumbersome and sensitive to the values of the nuisance parameters in finite samples and, therefore, their results may be are unreliable. Hence, the second method we apply in our empirical investigation to test for Granger causality is Toda and Yamamoto (1995) methodology. This procedure provides the possibility of testing for causality between integrated variables based on asymptotic theory. Toda and Yamamoto (1995) augmented Granger causality test method is based on the following equations:

$$LGDP = \alpha_y + \sum_{i=1}^{k+d} \theta_{yi} LEC_{t-i} + \sum_{i=1}^{k+d} \phi_{yi} LGDP_{t-i} + \varepsilon_{yt} \tag{3}$$

$$LEC = \alpha_e + \sum_{i=1}^{k+d} \theta_{ei} LEC_{t-i} + \sum_{i=1}^{k+d} \phi_{ei} LGDP_{t-i} + \varepsilon_{ei} \tag{4}$$

where d is the maximal order of integration order of the variables in the system, and are error terms that are assumed to be white noise with zero mean, constant variance and no autocorrelation. Indeed, all one needs to do is to determine the maximal order of integration d, which we expect to occur in the model and construct a VAR in their levels with a total of (k + d) lags. In equation 3, EC "does not Granger-causes" GDP if it is $\theta_{yi} = 0$ for $i \leq k$. Similarly, in equation 4, GDP "does not Granger-causes" EC if it is $\phi_{ei} = 0$ for $i \leq k$. Notice that the additional lags (d) are unrestricted. Their function is to ensure that the asymptotical critical values can be applied when test for causality between integrated variables are conducted, according to Toda and Yamamoto (1995). The zero restrictions are tested by computing the modified Wald (MWALD) test statistic. This method is applicable whether the VARs are stationary (around a deterministic trend), integrated of an arbitrary order or cointegrated of an arbitrary order.

3. Empirical results

Given that all of the variables are integrated of the same order, the next step was to test for cointegration, using Johansen's multivariate maximum likelihood procedure, as well as Engle-Granger (1987) approach. The test results from Johansen procedure are reported in **table 3**, where r presents the number of cointegrating vectors. It can be seen that for Iran, the null hypothesis of no cointegration relationships is rejected against the alternative of one cointegrating relationship at the ten per cent level. Moreover, the ADF cointegration test for residuals shows the value of –3.65, which is significant at the five per cent level. In the case of Kuwait and Saudi Arabia, the test results based on Johansen procedure suggest the presence of two cointegrating relationships which is in contradiction to existence of a unit root in the series of LGDP and LEC. Moreover, the ADF cointegrating test for the variables LGDP and LEC are rejected (the t-statistics for the null hypothesis of no cointegration relationships are –3.33 and –3.16, respectively for Kuwait and Saudi Arabia) and the estimated coefficients on lagged value of error term from cointegrated regressions are significant for the three countries. So, we prefer to maintain the null hypothesis $r = 1$ and apply the test of causality based on the first method, namely ECM for all these countries.

The existence of cointegrating relationships among LGDP and LEC suggests that there must be Granger causality in at least one direction. However, it does not indicate

Table 3
Results of Johansen's maximum likelihood tests for multiple cointegrating relationships

	Trace		Maximum eigenvalue	
Country/ null hypothesis	**Statistics**	**p-value**	**Statistics**	**p-value**
Iran				
$r = 0$	22.69	0.12	18.33	0.07
$r \leq 1$	4.36	0.69	4.36	0.69
Kuwait				
$r = 0$	37.93	0.00	33.45	0.00
$r \leq 1$	4.47	0.03	4.47	0.03
Saudi Arabia				
$r = 0$	56.20	0.00	44.35	0.00
$r \leq 1$	11.85	0.00	11.85	0.00

the direction of temporal causality between the variables. To determine the direction of causation, we must examine the ECM results. In addition, the ECM enables us to distinguish between 'short-run' and 'long-run' Granger causality. The results of the tests on causality are presented in table 3.

The results for Iran and Kuwait are qualitatively the same: the coefficient of the ECT is significant in the energy equation which indicates that long-run causality runs from GDP to energy consumption. However, none of the lagged explanatory variables in the GDP equation are statistically significant. Moreover, the interaction term (ECT and GDP) in the LEC equation for Kuwait is significant at five per cent level. These results imply that, there is unidirectional Granger causality running from GDP to energy consumption in the long-run, while energy has a neutral effect on GDP in both the short- and long-run. In other words, GDP is strongly exogenous and whenever a shock occurs in the system, energy consumption would make short-run adjustments to restore long-run equilibrium. Hence, bringing domestic energy prices in line with (international) market prices or any well-designed conservation policy can play an effective role in managing the energy sector.

The results for Saudi Arabia are much different from those of Iran and Kuwait, so that the causality relationship is reversed. In the case of Saudi Arabia, it can be seen from the GDP equation that energy strongly Granger-causes GDP. The results for the other equation suggest that GDP has no effect on energy consumption in short- and long-run. Therefore, there is unidirectional Granger causality running from energy consumption to GDP. The results imply that, unlike the case of Iran and Kuwait, energy is strongly exogenous and GDP interact in the short-term to restore long-run equilibrium after a change in GDP.[3] The energy consumption is the initial receptor of an exogenous impact and the equilibrium is restored through adjustment in the GDP. Hence, energy can be considered as a limiting factor to economic growth so that phasing out energy subsidies may adversely affect GDP growth or cause a fall in the GDP in Saudi Arabia. The ECMs displayed reasonable goodness-of-fit based on the R^2 and F statistics (not reported here) and passed most of the diagnostic tests including CUSUM and CUSUMSQ tests for structural break, the Godfrey LM test for serial correlation, the Engle test for first-order autoregressive heteroscedasticity [ARCH (1)], the Jarque and Bera (1980) test for normality and the Ramsey (RESET) test for model misspecification. (**table 4**)

To apply the second method, namely, the Toda-Yamamoto procedure, the equations (3) and (4) are estimated and MWALD test statistic is computed. The MWALD statistic is asymptotically distributed as a Chi Square, with degrees of freedom equal to the number of "zero restrictions", irrespective of whether LEC and LGDP are I(0), I(1) or I(2), non-cointegrated or cointegrated of an arbitrary order. The results of the MWALD test statistic, as well as its p-values are presented in **table 5**. These results match the ones obtained by ECM. Again, in Iran and Kuwait, there is a unidirectional causality running from GDP to energy consumption, while the opposite is right for Saudi Arabia.

Our results contradict the findings of Masih and Masih (1997), Hwang and Gum (1991), Glasure and Lee (1997), Yang(2000), Asafu-Adjaye(2000) Ghali and El-

Sakka (2004) and Yoo (2005) who found evidence of bidirectional causality for some Asian developing countries. However, they refute the neutrality hypothesis advanced

Table 4
Result of causality tests for Iran, Kuwait and Saudi Arabia

	Source of causation				
	Short-run		Long-run	Joint (short-run/long-run)	
	ΔLEC	ΔLGDP	ECT(–1)	ΔLEC, ECT(–1)	ΔLGDP, ECT(–1)
Country/ null hypothesis	**F-statistics**		**t-statistics**	**F-statistics**	
Iran					
LEC does not LGDP	1.36	–	–0.13	1.31	–
p-value	(0.290)		(0.897)	(0.307)	
LGDP does not cause LEC	–	0.42	–2.51	–	1.43
p-value		(0.789)	(0.023)		(0.262)
Kuwait					
LEC does not LGDP	0.11	–	0.42	0.08	–
p value	(0.956)		(0.680)	(0.987)	
LGDP does not cause LEC	–	1.40	–2.77		3.14
p-value		(0.273)	(0.012)		(0.0.39)
Saudi Arabia					
LEC does not LGDP	3.11		–4.03	6.86	–
p-value	(0.049)		(0.001)	(0.001)	
LGDP does not cause LEC		0.62	–0.74		0.57
p-value		(0.611)	(0.466)		(0.690)

Table 5
Results of long run causality due to Toda-Yamamoto (1995)

Null hypothesis	MWALD statistics	p-value
Iran		
LEC does not cause LGD	1.12	0.57
LGDP does not cause LEC	8.31	0.02
Kuwait		
LEC does not cause LGDP	1.93	0.38
LGDP does not cause LEC	6.44	0.04
Saudi Arabia		
LEC does not cause LGDP	11.04	0.00
LGDP does not cause LEC	0.92	0.63

in respect of the United States for the energy-income relationship (Erol and Yu, 1989; Yu and Jin, 1992).

4. Conclusion

The purpose of this study was to test for Granger causality between energy consumption and income for three typical oil-exporting developing countries: Iran, Kuwait and Saudi Arabia. This article uses a new non-causality testing procedure developed by Toda and Yamamoto (1995), as well as ECM to examine the dynamic relation between two economic series. Our findings suggest different directions of causalities for these countries. From results of the co-integration and Granger's causality test based on ECM, we conclude that there is unidirectional long-run causality running from GDP to energy consumption with no feedback effects for Iran and Kuwait, so that it is the GDP that drives the energy consumption, not *vice versa*. Moreover, the neutrality between energy and GDP is observed in the short-run. However, in the case of Saudi Arabia, energy consumption is strongly exogenous, suggesting one-way strong causality running from energy consumption to GDP, possibly due to heavily high dependency of economic growth on energy. The results support the neutrality hypothesis of energy consumption, with respect to economic growth for Iran and Kuwait and *vice versa* for Saudi Arabia.

The causality tests based on the Toda-Yamamoto tests reveal the same results: The GDP unidirectionally cause energy use without any feedback in the case of Iran and Kuwait, while in Saudi Arabia there is a unidirectional causality running from energy use to GDP. Moreover, in both methodologies, the strength of the causality from energy use to GDP for Saudi Arabia is highly significant at all levels, while causality from GDP to energy consumption for Iran and Kuwait was shown to be rather significant.

Thus, in the case of Iran and Kuwait, given the generous subsidies for energy, there is relatively more scope for more drastic energy conservation measures without severe impacts on economic growth. However, Saudi Arabia's economy is more dependent on energy and the link between GDP and energy appears to be strong, so that the elimination of energy price distortions may restrain the economic growth in this country. So, each country, even in group of oil-exporting countries, should follow its own policy in energy use and it is misleading to recommend the same policy for all these countries.

While this analysis conclusively demonstrates causal linkages between energy consumption and economic growth, it should be stressed that the usual production function also includes capital and labour. Hence, in future work, the techniques employed in this study can be readily extended to other multivariate systems, where energy consumption and real income are exposed to be determined by other economic factors such as capital stock and employment to improve the model. Furthermore, such an analysis could reveal the structural channels by which real income and energy consumption are inherently causal.

Footnotes

1. *Implicit energy subsidies (amounted to 10.5 per cent of GDP for Iran) arise from the differential between domestic and border prices.*

2. *We have mixed results at the ten per cent level for Iran GDP. Moreover, the ADF test statistic for Kuwait energy variable is marginally significant. So, we estimate Granger-causality models with level, as well as first-differenced data and examine the sensitivity of results.*

3. *A similar pattern of results was obtained when the Granger-causality models were estimated with level variables for the three countries.*

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