DYNAMIC RELATIONSHIP BETWEEN ENERGY AND ECONOMIC GROWTH: EVIDENCE FROM D8 COUNTRIES

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ABSTRACT

The oil embargo of 1970's and its impact on major macroeconomic variables throughout the world attracted extensive research to examine the relationship between energy and economic prosperity. However, the researchers failed to establish a definitive direction of causality between the two variables. This study investigates the dynamic relationship between energy use and economic growth in the D8 countries. The evidence gathered through application of VAR Granger Causality, Johansen Cointegration and VECM proves existence of short-run and long-run correlation between energy use and economic development in all countries. The results supported either uni-directional or bi-directional causality in the long as well as short run for all the D8 countries except for Indonesia where non-causality was established between the two variables in the short run.

Keywords: Energy Use, Economic Growth, D8, VAR Granger Causality, Cointegration, VECM.

Introduction

Energy is vital to economic growth and its significance was best demonstrated during the 1973–1974 oil embargo. As oil-producing nations of the Middle East restricted the output, prices increased fourfold in a span of a few months, resulting in serious disruption in the industrialized countries as well as the supplies of raw material from the developing countries. The energy crisis

of the seventies attracted significant investigation into the relationship between energy consumption and economic growth. Overtime, numerous studies conducted to examine this relationship have produced conflicting results: some studies suggest that energy use is highly positively correlated with GDP growth [for example; Chebbi and Boujelbene (2008), Jumbe (2004), Siddiqui (2004) etc], others support a negative relationship [for example; Okonkwo and Gbadebo (2009), Noor and Siddiqi (2010) etc]. While some studies report non-causality [for example; Sarkar *et. al.*, (2010), Yusma and Wahilah (2010) etc], others have reported bi-directional causality [for example; Pradhan (2010), Loganathan *et. al.*, (2010), Omotor (2008) etc]. Thus, the empirical evidence is varying and conflicting about direction of causality.

The complexity of relationship and the presence of contradictory evidence between energy use and economic activity indicates the need for re-examination of long run and short run linkages between energy consumption and real output in the D8 because if the causality in these countries runs from energy to GDP, the energy constraints can have serious implications for the pace of development in these economies. The main objective of this study is to investigate the dynamic relationship between energy consumption and economic growth in the D8 countries.

Rest of the study is organized as follows; Chapter I reviews a few existing studies dealing with the investigation of link between energy use and economy in D8 countries; Chapter II provides an overview of the data collection techniques and time series diagnostics; Chapter III deals with the energy-growth linkage in the short-run; results of long-run estimation are presented and discussed in Chapter IV, Chapter V compares the inferences drawn and finally, Chapter VI concludes the inferences drawn and provides policy implications.

I. Energy and Economic Growth: Literature Review

Although business and financial economists pay significant attention to the impact of oil and other energy prices on economic activity, the neoclassical economists do not even implicitly include energy into their macro-economic framework (Stern, 2003). The argument is based on the rejection of land as a factor of production since the neoclassicals subsume land under capital. Energy from non-human sources e.g., coal, oil, electricity, food or fertilizer etc, enters the economy only as an intermediate input. The basic model of economic growth, the Nobel-prize winning work by Solow (1956), does not include resources at all in the basic framework. Also, the extensions of this model, that include energy in any form, are only applied in the context of debates about environmental sustainability, not in standard macro-economic functions (Stern, 2003).

Nicholas Georgescu-Roegen (1972, 1976) was one of the first to comment on the absence of energy in economic thinking of the Marxists and neoclassical economists as they take resources and energy flows for granted and ignore the economy's output of wastes. Roegen (1976) argued that standard economics does not recognize that *"terrestrial resources of energy and materials are irrevocably used up and the harmful effects of pollution on the environment accumulate."*

Overall there is a strong link between rising energy use and economic growth. However, the linkage between these two can be reduced by a number of factors including shifting to higher quality fuels and technological change aimed at general increases in economic productivity.

Quite a few country specific studies focusing on the economic growth- energy nexus have been conducted and presented in the recent economic literature. Khan and Qayyum (2007) found the evidence in favor of causation running from energy consumption to GDP for Pakistan, Bangladesh, India and Sri Lanka while utilizing Bound test and ARDL techniques. Rahman and Amin (2011) also found the same direction of causality for Bangladeshi data, by the application of cointegration and granger causality. On the other hand, Sarkar *et. al.,* (2010), by applying Granger causality test and cointegration, reported neutrality between the focus variables in case of Bangladesh.

Asafu-Adjaye (2000), Fatai *et. al.,* (2004) and Chiou-Wei *et. al.,* (2008) found evidence of causality from energy to income for different countries including Indonesia as they used granger causality tests on their respective samples. Mehrara (2007), from the results of ECM and Toda Yamamoto procedure, concluded that in Iran, Kuwait and Saudi Arabia, economic growth leads to energy consumption. Moradi (2009) established a significant long-run relationship between economic growth and oil abundance in Iran from the results of cointegration tests and ARDL. Abbasian *et. al.,* (2010), using VAR, granger causality and also Toda-Yamamoto causality tests concluded that in Iran, natural gas consumption leads to economic growth.

For Malaysia, Loganathan *et. al.,* (2010), Yusma and Wahilah (2010) and Islam *et. al.,* (2011) all established uni-directional or bi-directional causality between different proxies of the energy sector and economic growth. Their methodologies varied from Ordinary Least Square Engel-Granger, Dynamic Ordinary Least Square, ARDL, bounds test, ECM, Engle-Granger cointegration and standard granger causality test.

Omotor (2008), using Nigerian data found existence of bi-directional causality while Adeniran (2009) established cointegration between the focus variables but concluded that there exists uni-direction causality where energy causes economic growth without a feedback in Nigeria. Okonkwo and Gbadebo (2009) also found the variables to be cointegrated and having positive relationship between current growth and energy.

Siddiqui (2004) estimated the standard production function for Pakistan and included different proxies for energy from different energy sources applying granger causality and ARDL. She found the evidence in favor of the notion that energy causes economic growth. Pradhan (2010) also found same direction of causality for Pakistan as he applied cointegration and ECM. Abosedra and Ghosh (2007), on the other hand, did not find a cointegration relationship between energy and economic growth in Pakistan while oil prices were found to be effective, only in short-run.

Soytas *et. al.*, (2001) and Altinay and Karagol (2005) found evidence in favor of uni-directional causality where energy causes economic prosperity in case of Turkey. Lise and Montfort (2005), however, concluded that the causality runs in the opposite direction for Turkey i.e., from GDP to energy consumption.

Many studies using Panel estimation techniques on the same relationship have also provided differing and contradicting evidences. Studies such as Chontanawat *et. al.*, (2006) and Nondo *et. al*., (2010) concluded that there is a bi-directional causality between GDP and energy consumption. On the other hand, Joyeux and Ripple (2007) did not find evidence in favor of any cointegration relationship between energy and economic growth for their panel. Imran and Siddiqui (2010) could not reject neutrality of relationship in short-run, while in the long-run, the

variables were found to be cointegrated and energy consumption caused economic growth. Noor and Siddiqi (2010) and Joyeux and Ripple (2011) established uni-directional relationship between proxies of energy and economic growth where causality from income/ economic growth to energy was prevalent.

II. Data Collection and Diagnostics

Apergis and Payne (2009) synthesized the often conflicting results obtained by the literature into four hypothesis. According to the "growth hypothesis", energy consumption is a complement of labor and capital in producing output and, as a consequence, it contributes to growth. The "conservation hypothesis" implies that real GDP is not affected by energy conservation policies aiming at curtailing energy consumption and waste and improving energy efficiency. If the "neutrality" hypothesis holds energy consumption and real output will not have a significant connection. Finally, the "feedback" hypothesis suggests that more energy consumption results in increases in real GDP, and vice versa

The annual data for the D8 countries; Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey from the year 1980 to 2007 is used. The data for energy consumption, measured by energy use (kg of oil equivalent per-capita) and GDP in million US dollars at year 2000 constant prices is collected from 'The World Development Indicators (2010)' by the World Bank. The data for total population is also gathered to convert the energy use (kg of oil equivalent per-capita) to total energy use (kg of oil equivalent).

Following Soytas *et. al.,* (2001) this analysis consisted of three key steps. The first step was checking for the stationarity of the series, the second step was testing for cointegration, and

the third step was testing for causality in long and short run by developing a VECM and VAR Granger Causality respectively.

The Augmented Dickey-Fuller (1979) (ADF) unit root test was utilized to check for the stationarity of natural log of Energy Use (Lneu) and natural log of Real GDP (Lngdpc) series. The results of ADF test are summarized in table 1. For all countries, evidence was found in favor of the null hypothesis that both series contain unit roots at level, as t-statistics for all variables are less than the critical values at, respectively, 1%, 5% and 10% levels from ADF test. However, we reject the null hypothesis for the first differences of all series i-e the results of the first differenced variables show that the ADF test statistics for all the series are greater than the critical values at 5% and 10% levels. Therefore, it is concluded that both series are integrated of the order 1 i.e. I (1) for all the countries. Thus cointegration tests can be applied for all countries.

Table 1 ***Results of ADF Test***

Country	**Variables**	**ADF test**		**Order of integration**
		Level	**First diff.**	
	Lngdpc	0.26	-5.68*	**I(1)**
Bangladesh	**Lneu**	0.34	-3.51*	**I (1)**
	Lngdpc	-0.89	-2.66*	**I (1)**
Egypt	**Lneu**	-2.15	-5.07*	**I (1)**
	Lngdpc	-1.27	-3.77*	**I (1)**
Indonesia	**Lneu**	-1.00	-5.50*	**I (1)**
	Lngdpc	0.75	-3.86*	**I (1)**
Iran	**Lneu**	-0.21	-7.21*	**I (1)**
	Lngdpc	-0.51	-4.01*	**I (1)**
Malaysia	**Lneu**	-0.65	-7.45*	**I (1)**
	Lngdpc	1.75	-4.91*	**I (1)**
Nigeria	**Lneu**	-1.18	-4.91*	**I (1)**
Pakistan	**Lngdpc**	-0.75	-3.31*	**I (1)**

	Lneu	-2.14	-4.31*	**I (1)**
	Lngdpc	-0.31	-5.94*	**I (1)**
Turkey	**Lneu**	-0.43	-5.89*	**I (1)**

* Statistically Significant , 5% critical value=-2.981038, 10% critical value 2.629906

The appropriate lag length was selected on the basis of Akaike Information Criteria (AIC) and Schwarz Criteria (SC).

Table 2 ***VAR Lag Order Selection Criteria***

Country	**Lags**	**0**	**1**	**2**
	AIC	-3.26	-10.98	**-11.04***
Bangladesh	**SC**	-3.16	**-10.69***	-10.56
	AIC	-2.97	-8.99	**-9.03***
Egypt	**SC**	-2.88	**-8.70***	-8.55
	AIC	-2.36	**-7.16***	-7.15
Indonesia	**SC**	-2.27	**-6.87***	-6.67
	AIC	-1.12	-5.59	**-5.99***
Iran	**SC**	-1.02	-5.30	**-5.51***
	AIC	-1.86	**-6.67***	-6.62
Malaysia	**SC**	-1.77	**-6.38***	-6.13
	AIC	-3.60	**-8.94***	-8.66
Nigeria	**SC**	-3.51	**-8.65***	-8.18
	AIC	-4.09	**-10.84***	-10.68
Pakistan	**SC**	-3.99	**-10.55***	-10.20
	AIC	-3.84	-8.24	**-8.34***
Turkey	**SC**	-3.74	**-7.95***	-7.85

* indicates lag order selected by the criterion

Although for most of the countries, the selected number of lags to be included was same by both criteria like in the case of Indonesia, Iran, Malaysia, Nigeria and Pakistan, but under circumstances where there was a discrepancy between the appropriate lag order, for example in

case of Bangladesh, Egypt and Turkey, the selected lag order for the respective country was chosen on the basis of the results of SC as it is more accurate and thus is preferred by most of the economists including Geweke and Messe (1981).

III. Energy Use and Growth Linkage in the Short Run

The results of investigation of short-run relationship between energy use and GDP by application of VAR Granger Causality/Block Exogeneity Wald Tests are presented in table 3.

Table 3 ***VAR Granger Causality/Block Exogeneity Wald Tests***

	Dependent Variable						
	Lneu			**Lngdpc**			
Country	**Excluded**	**Chi-sq**	**Prob.**	**Excluded**	**Chi-sq**	**Prob.**	**Causality**
Bangladesh	**Lngdpc**	5.26*	0.02	**Lneu**	0.25	0.61	**GDP→Eu**
Egypt	**Lngdpc**	13.14*	0.00	**Lneu**	0.03	0.86	**GDP→Eu**
Indonesia	**Lngdpc**	0.53	0.46	**Lneu**	1.53	0.22	**Neutrality**
Iran	**Lngdpc**	2.21	0.33	**Lneu**	10.38*	0.00	**Eu→GDP**
Malaysia	**Lngdpc**	15.50*	0.00	**Lneu**	0.16	0.68	**GDP→Eu**
Nigeria	**Lngdpc**	1.62	0.20	**Lneu**	25.33*	0.00	**Eu→GDP**
Pakistan	**Lngdpc**	9.02*	0.00	**Lneu**	0.97	0.32	**GDP→Eu**
Turkey	**Lngdpc**	2.95*	0.08	**Lneu**	0.21	0.65	**GDP→Eu**

*indicates statistically significant

From the results of granger causality test above, it is concluded that there is a uni-directional short-run causality from real GDP to energy use in Bangladesh, Egypt, Malaysia, Pakistan and Turkey, as the null hypothesis of non-causality is rejected at 5% level of

significance. However, this is not the case for test of causality from energy use to real GDP as the null hypothesis cannot be rejected for these countries. Thus higher rates of energy use do not have an effect on the economic development in the short-run for the afore-mentioned countries. For the energy exporters Iran and Nigeria, the opposite direction of causality can be observed as energy use significantly causes the economic growth even in the short-run as the null hypothesis of non-causality is rejected at 5% or 10% level of significance in both states without a feedback affect. In Indonesia, however, the neutrality hypothesis could not be rejected in the short-run i.e. neither energy use nor the economic growth caused each other in the short-run in Indonesia as the null hypothesis of non-causality could not be rejected at 5% level of significance.

IV. Energy Use and Growth Linkage in the Long-Run

Johansen Cointegration test was used to determine the number of cointegrating vectors (Table 4). The results of Johansen Cointegration test are summed up in the table 5. The Johansen cointegration technique has been used because of its ability to capture the properties of time series, to produce estimates of all possible cointegrating vectors along with the test statistics.

Table 4 Results of Johansen's Cointegration Test (between lngdpc and lneu)

Country	**No. of CE's**	**Trace Statistic**	**Critical Value**	**Max-Eigen statistic**	**Critical Value**	**Conclusion**
Bangladesh	H_0: None*	39.27	20.26	33.15	15.89	**Cointegrated**
	H_0:At most 1	6.12	9.16	6.12	9.16	
Egypt	H_0: None*	24.69	23.34	17.11	17.23	**Cointegrated**
	H_0:At most 1	7.58	10.67	7.58	10.67	
Indonesia	H_0: None*	21.16	20.26	14.01	15.89	**Cointegrated**
	H_0:At most 1	7.15	9.16	7.15	9.16	
Iran	H_0: None*	27.05	20.26	19.55	15.89	**Cointegrated**
	H_0:At most 1	7.51	9.16	7.51	9.16	
Malaysia	H_0: None*	13.18	12.32	13.18	11.22	**Cointegrated**

	H_0:At most 1	0.00	4.13	0.00	4.13	
Nigeria	H_0: None*	24.87	20.26	15.79	15.89	**Cointegrated**
	H_0:At most 1	9.08	9.16	9.08	9.16	
Pakistan	H_0: None*	18.74	20.26	16.30	15.89	**Cointegrated**
	H_0:At most 1	2.43	9.16	2.43	9.16	
Turkey	H_0: None*	33.70	20.26	27.85	15.89	**Cointegrated**
	H_0:At most 1	5.85	9.16	5.85	9.16	

* denotes rejection of the hypothesis at the 0.05 or 0.1 level

The estimated cointegration results between energy use and real GDP for all countries indicate that the two series have at least one cointegrating relationship in all countries. This is because the null hypothesis of H_0: $r = 0$ against $r \leq 1$ is rejected at 5% or 10 % level by either one or both of the criteria i.e. Trace and Maximum Eigen value. One cointegrating equation means that there exists either a uni-directional or bi-directional long run relationship between energy use and GDP in these countries, and any change in one or both variables would most likely have implications on each other in the long term.

As Engel and Granger (1987) suggest, if cointegration exists between two variables in the long run, then, there must be either unidirectional or bi-directional causality between these variables, thus Vector Error Correction Model (VECM) can be applied to study the direction of long-run relationship between the selected variables as cointegration test does not specify the direction of causality. The VECM for this study can take the following form:

$$\Delta \mathrm{LNGDPC}_t = \beta_0 + \sum_{j=1}^{M} \beta_{1j} \Delta LNEU_{t-j} + \sum_{j=1}^{N} \beta_{2j} \Delta LNGDPC_{t-j} + \alpha E_{t-1} + u_{1t} \ldots\ldots\ldots (4)$$

$$\Delta LNEU_t = \delta_0 + \sum_{j=1}^{K} \delta_{1j} \Delta LNEU_{t-j} + \sum_{j=1}^{L} \delta_{2j} \Delta LNGDPC_{t-j} + \lambda C_{t-1} + u_{2t} \ldots\ldots\ldots\ldots (5)$$

where LNGDPC is the natural log of real GDP and LNEU is the natural log of energy consumption. E_{t-1} and C_{t-1} are the error correction terms, Δ is the first difference and *u*'s are serially uncorrelated random error terms with mean zero. (M and N), and (K and L) are the optimal lag lengths. C_{t-1} is the lagged value of the residuals from the cointegration regression of LNGDPC on LNEU, and E_{t-1} is the lagged value of the residuals from the cointegration regression of LNEU on LNGDPC. Equation (4) can be used to test the causality running from energy use to economic growth while to test the causation from economic growth to energy use, equation (5) can be used.

VECM approach allows us to determine the direction of causality in long run. Significant error correction terms (α and λ) implies long-run causal relationship. Error correction term contains the long-run information since it is derived from the long-run cointegrating relationship. It should be noted that the coefficient of error correction term is a short-run adjustment coefficient correcting long run disequilibrium in dependent variables in each short period. Thus the stability of long-run equilibrium can also be judged from the sign and significance of the error correction term as if it is negatively significant, it shows convergence towards the equilibrium i.e., a stable long-run equilibrium.

The VECM results for long-run causality and stability of the long run equilibrium relationship between energy use and economic prosperity are displayed in the table below:

Table 5 ***Summary of VECM Results (Dependent Variable= LNGDPC)***

Country	**Dependent Variable=LNGDPC**	**ECT**		**Causality**
		D(LNGDPC)	**D(LNEU)**	
Bangladesh	0.55*** (5.72)	0.05*** (5.30)	0.11*** (3.83)	**GDP↔Eu**

Egypt	0.11 (1.57)	-0.60*** (-4.51)	-0.47 (-1.06)	**GDP→Eu**
Indonesia	1.15*** (12.60)	0.13** (1.97)	0.249*** (3.92)	**GDP↔Eu**
Iran	0.71*** (10.28)	-0.15*** (-2.22)	-0.30*** (-4.34)	**GDP↔Eu**
Malaysia	0.55*** (23.67)	-0.02*** (-3.58)	-0.02*** (-2.49)	**GDP↔Eu**
Nigeria	1.69*** (7.40)	0.05 (1.09)	0.09*** (4.36)	**Eu→GDP**
Pakistan	1.11*** (50.20)	0.27*** (2.21)	0.45*** (4.48)	**GDP↔Eu**
Turkey	1.04*** (52.52)	0.82*** (3.73)	1.06*** (5.94)	**GDP↔Eu**

*, **, *** indicates significant at 10%, 5% and 1% respectively
t-values in parenthesis

IV-1. *Bangladesh*

For Bangladesh in the long run, there exists a bi-directional causality between the focus variables, as indicated by the significant error correction terms. The results also indicate that there is a positive relationship between energy and economic growth and one time relative increase in energy use will lead to 0.55 times relative increase in real GDP, as is indicated by the high level of significance and positive sign of the coefficient of LNEU.

Both the error correction terms for Bangladesh are highly significant. The error correction terms are positive which means that any exogenous shock in one of the variables will lead to divergence from equilibrium. An exogenous shock in the energy use will lead to 11% movement away from the original equilibrium every year while in case of a shock in the GDP, there will be 5% divergence from equilibrium per year. Thus the equilibrium is unstable in case of Bangladesh. Thus it can be concluded that in the net energy importer Bangladesh, energy use

drives the economic development and the economic progress also has an influence on the energy use in the long-run.

IV-2. *Egypt*

The VECM results, reported in table, provide evidence of weak long-run relationship between the two variables for Egypt as the coefficient of energy use is not significant. The weak relationship can be attributed to the fact that Egypt's main exports consist of non-petroleum products such as ready-made clothes, cotton textiles, medical and petrochemical products, citrus fruits, rice and dried onion, and more recently cement, steel, and ceramics along with natural gas. Egypt's main imports consist of pharmaceuticals and non-petroleum products such as wheat, maize, cars and car spare parts (Metz).

The adjustment coefficient for GDP is significantly negative as it should be, suggesting that the speed of adjustment of energy use towards the equilibrium in the long run in case of an exogenous shock is very high at 60% per year. On the other hand the error correction term for energy use, although negative, is insignificant indicating that all the adjustment towards the equilibrium is being done by the GDP. Thus it can be concluded that there is uni-directional causality between the focus variables in the short as well as long run where causality runs from GDP to energy consumption in the short-run as well as the long run. The long run findings are consistent with the findings of Costantini and Martini (2010) who also found the direction of causality running from GDP to energy use in the long run for their panel of OECD and non-OECD countries.

IV-3. *Indonesia*

In Indonesia, long run causality runs from the real GDP to energy use with a feedback affect and one time relative increase in energy use will lead to 1.15 times relative increase in the GDP. The error correction terms for GDP and energy use in Indonesia are highly significant.

The adjustment coefficient for energy use is positive and the speed of divergence from equilibrium as a result of an exogenous shock is of 25% a year. Also the adjustment coefficient for energy use is positive and significant. An external shock in GDP in Indonesia will lead to divergence of 13% per year so it can be concluded that in Indonesia there is bi-directional long run causality between economic growth and energy use but the equilibrium is unstable. Therefore, in Indonesia the energy use causes real GDP in the long run with a feedback affect. The findings for Indonesia are similar to the findings of Asafu-Adjaye (2000).

IV-4. ***Iran***

The results provide a positive link between energy use and economic growth in case of Iran i.e. one time relative increase in energy use will lead to a relative increase of 0.71 times in GDP. Iran is the second largest oil and natural gas producer in the world. High oil prices in recent years have enabled Iran to increase its export revenue and amass $100 billion in foreign exchange reserves through its exports. Thus an increase in energy use in the economy would lead to higher exports revenues (CIA Factbook).

The adjustment coefficients are negative in both cases, suggesting that the speed of adjustment of energy use, in case of an exogenous shock, towards the equilibrium in the long run is 30% every year. Thus the equilibrium is stable. The error correction term for GDP is also

negative indicating that in case of disequilibrium due to an exogenous shock, GDP will lead to convergence towards equilibrium at the rate of 15% every year. Thus there is uni-directional causality between the focus variables where energy use leads to economic growth in the short-run but bi-directional causality exists in the long run in Iran.

IV-5. ***Malaysia***

The VECM results for Malaysia provide evidence in favor of a significant bi-directional causality between economic development and energy consumption. The adjustment coefficients are highly significant advocating the long run bi-directional causality from energy use to real GDP in Malaysia. Moreover the relationship between the two is positive. The error correction term for a shock in GDP is highly significant and negative, therefore suggesting there is a long-run causal correlation from economic growth to energy use and the per year speed of adjustment towards equilibrium is slow at 2% in case of a disequilibrium caused by an external shock in GDP. The adjustment coefficient for energy use is also negatively significant.

Thus the long run equilibrium in Malaysia is stable and any disequilibrium due to an external shock will be corrected at the speed of 2% adjustment every year. Thus it can be concluded that energy consumption is influenced by economic growth in Malaysia with a feedback affect. These results are similar to inferences drawn by Loganathan *et al.* (2010).

IV-6. ***Nigeria***

In the long run, as suggested by the VECM results, there is uni-directional causality between the energy use and real GDP where there is a positive correlation between energy use

and GDP and one time relative increase in energy use leads to a relative increase of 1.69 times in economic development.

The adjustment coefficient for energy use is highly significant, therefore suggesting there is a long run causal correlation from energy use to economic growth with no feedback and the per year speed of divergence from equilibrium is 9% in case of a shock in energy use because the sign of the error correction term for energy use is positive. Thus the equilibrium is an unstable one for Nigeria as it shows divergence from equilibrium in the long-run. The adjustment coefficient of GDP, although insignificant, also has a positive sign.

This can be attributed to the heavy dependence on oil as a source of revenue. This fact exposes the vulnerability of the Nigerian economy to global energy dynamics. Thus it can be concluded that energy use influences economic growth in Nigeria but the equilibrium in the long run is unstable. Adeniran (2009) also established long-run causality from energy to economic growth in Nigeria.

IV-7. *Pakistan*

In the long-run, as suggested by the VECM results, there is bi-directional causality between the energy use and real GDP where there is a positive correlation between energy use and GDP and one time relative increase in energy use leads to a relative increase of 1.11 times in economic development as indicated by the positive sign of energy use coefficient.

The adjustment coefficients are highly significant for energy use and GDP, therefore suggesting there is a long-run causal correlation from economic growth to energy use with

feedback. The per year speed of divergence of adjustment coefficient of real GDP from equilibrium is 27% in case of an external shock. Thus the equilibrium is an unstable one for Pakistan as it shows divergence from equilibrium in the long-run. The adjustment coefficient of energy use is also positively significant indicating an unstable relationship between the two in long-run. Any external shock in the energy use will disturb the equilibrium and will lead to 45% divergence every year. These results are in consistent with the findings of Pradhan (2010).

This can be attributed to the fact Pakistan is net importer of oil and virtually imports most of its fuel from other countries. The heavy dependence on oil imports to keep the production afloat makes the country susceptible to damage from fluctuations in international production and pricing of energy. Thus it can be concluded that energy consumption and economic growth are influenced by each other in Pakistan where increased energy use boosts GDP but the equilibrium in the long run is very unstable.

IV-8. ***Turkey***

In the long-run there is evidence of bi-directional causality from the VECM results for Turkey, where causality runs from real GDP to energy consumption with a feedback affect. The same direction of causality was found by Aktas and Yilmaz (2008). The relationship is also positive and highly significant.

The error correction terms are highly significant and both are positive. These results indicate that there is a long run bi-directional causality between energy use and economic growth but the long run equilibrium is not stable as suggested by the positive sign of the error correction

terms. Thus any external shock will lead to a divergence in GDP of 82% every year and even higher in energy use. In the long run the economic situation of Turkey and energy use both affect each other. Moreover, for the period of 1980-2007, Turkey's long run equilibrium is very unstable.

V. *Comparison*

From the gathered evidence, in the short run, the "growth hypothesis" is true for Iran and Nigeria, both energy exporters, where support for the hypothesis that energy use contributes to growth has been established. Thus energy use is an important determinant of economic development in both of these countries in the short-run and a shortage of energy would have serious repercussions for the pace of development and prosperity.

The "conservation hypothesis" where GDP is not affected by the energy use but itself has implications for energy use has been proved for Bangladesh, Egypt, Malaysia, Pakistan and Turkey in the short-run. In these countries, energy use does not have an influence on the growth process while GDP has an effect on energy use. Therefore, in these five countries, energy conservation may be viable without being detrimental to economic growth in short-run.

The estimation results support a "neutrality hypothesis" for Indonesia in the short-run pointing out that for the selected sample, the energy use and real GDP did not have significant implications for each other at least in the short-run. While in no case a support of the "feedback hypothesis" was established in the short-run.

Table 6 ***Direction of Short-Run Causality in D8 Countries***

Feedback hypothesis	**Growth hypothesis**	**Conservation hypothesis**	**Neutrality hypothesis**

-	Iran	Bangladesh	Indonesia
-	Nigeria	Egypt	-
-	-	Malaysia	-
-	-	Pakistan	-
-	-	Turkey	-

In the long run, the results confirm that the "growth hypothesis" is true for the sample period in Nigeria. Therefore in Nigeria energy consumption has important insinuations for the growth and prosperity of the economy. Nigerian economy, as explained in the situation analysis, is overwhelmingly dependant on the exports of oil. Despite its huge energy reserves, the country faces acute shortage of financial resources and infrastructure to fully utilize them and as a result is still an under-developed economy. The Nigerian government heavily relies on the oil exports as they form the principal contributor in the total national revenue. The results of estimation suggest that in Nigeria, energy conservation policies may hinder economic growth in the long-run. Thus it is not a superior choice for Nigerian government to adopt energy conservation policies without diversifying the manufacturing and export base.

Table 7 Direction of Long-Run Causality in D8 Countries

Feedback hypothesis	Growth hypothesis	Conservation hypothesis	Neutrality hypothesis
Bangladesh	Nigeria	Egypt	-
Indonesia	-	-	-
Malaysia	-	-	-
Pakistan	-	-	-
Turkey	-	-	-
Iran	-	-	-

The "conservation hypothesis" is true for Egypt according to the long run investigation of the correlation between energy and economic growth for the selected years. Thus, it implies that in Egypt energy use does not determine pace of economic development and growth. The rationale of such result is that Egypt's main exports consist of non-petroleum products such as ready-made clothes, cotton textiles, medical and petrochemical products, citrus fruits, rice and dried onion, and more recently cement, steel, and ceramics along with natural gas. The exports of petroleum products are minimal as compared to other exports. Egypt's main imports consist of pharmaceuticals and non-petroleum products such as wheat, maize, cars and car spare parts (CIA Factbook). Therefore energy sector does not play the leading role in Egyptian economy and thus, energy conservation policies will not harm pace of economic development in Egypt.

The "feedback hypothesis" was established by the results of estimation of long run causality for Bangladesh, Indonesia, Iran, Malaysia, Pakistan and Turkey. This finding leads to the conclusion that energy sector is a major player in these economies and it has huge impact on the national income and development of the economies. Both of the variables have dynamic effect on each other. These findings are appropriate for these countries as Iran and Indonesia are major energy exporters and are prominent members of OPEC[3] while Malaysia and Turkey are among the fastest growing energy markets. The economies of these countries are, thus, massively dependent on their energy export revenues and thus there is a bi-directional causality between the real GDP and energy use as more energy production (i.e., a part of energy use) results in more national income with a feedback affect i.e., increased economic prosperity results in increased energy production and use. The economies of Pakistan and Bangladesh are facing

[3] For the sample period i.e. 1980-2007. Indonesian membership of OPEC was suspended in 2008.

energy shortages but are in developing phase where economies rely heavily on the energy use to ensure economic development. Both countries are net importers of energy. Therefore import payments have significant implications for the national income and any change in energy use will lead to a change in GDP and *vice versa.*

The evidence of "neutrality hypothesis" was not found in case of any of the D8 countries in the long-run. Thus the outcomes of estimation support the evidence that energy sector is an important part of the economies of the developing countries and it has dynamic affect on the economic standing of these countries. The energy sector thus needs proper attention of the governments of these countries as flawed, defective and misguided policies can injure the economy gravely for a long period of time.

VI. Conclusion

Keeping in mind the vital and critical role of energy in the process of development, this study aimed at analyzing the link between energy consumption and real output for the D8 countries namely, Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan and Turkey, in both short as well as the long-run.

The evidence gathered through application of VAR Granger Causality, Johansen Cointegration and VECM proves existence of short-run and long-run correlation between energy use and economic development in all countries. The results supported either uni-directional or bi-directional causality in the long as well as short run for all the D8 countries except for Indonesia where non-causality was established between the two variables in the short run.

The important policy implications drawn from this study are that in order to achieve rapid economic growth, members of the D8 should adopt a policy of energy sector development on priority basis. Therefore, there is need to build new dams, installation of wind power plant and tidal energy projects to expand the energy production capacity especially in the countries facing energy crunch such as Bangladesh, Pakistan and Turkey.

Bangladesh, Pakistan and Turkey should try to avoid or minimize the import of crude oil at massive costs which are resulting in depletion of foreign currency reserves. For the achievement of this objective, the masses in these countries should be educated about the use of renewable energy to decrease dependence on fossil and traditional sources of energy. Moreover, policy orientation needs a drastic modification to focus on utilization of indigenous resources. Finally these countries should pursue energy conservation policies in such a way that is not detrimental to economic growth.

As for the energy exporting countries, the results show that energy consumption plays an important role in these economies in short as well as long-run. These countries need to reduce their over-dependence on the energy sector for the economic growth and development and diversify their economies. The countries such as Iran and Nigeria need to broaden their industrial and export base from only natural resources to varying energy intensive industrial products. Furthermore, Nigeria should develop the domestic infrastructure and make sure of an environment conducive for foreign investment.

As for Malaysia and Indonesia, two of the fastest growing economies in East Asia, the demand of energy is growing at very fast pace in these countries. These countries, it is feared, will have to face energy crunch in near future. As it has been established by the outcomes of the

estimation, energy has long-run insinuations in both economies therefore, the respective governments should plan ahead to avoid possible chaos due to energy crisis. For that purpose, there is a dire need of popularizing the use of renewable energy, which might be the only solution to problems related to energy demand and supply.

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