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Energy consumption and economic growth: The case of oil exporting countries

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Abstract

This paper examines the causal relationship between the per capita energy consumption and the per capita GDP in a panel of 11 selected oil exporting countries by using panel unit-root tests and panel cointegration analysis. The results show a unidirectional strong causality from economic growth to energy consumption for the oil exporting countries. The findings have practical policy implications for decision makers in the area of macroeconomic planning. In most major oil exporting countries, government policies keep domestic prices bellow free market level, resulting in high levels of domestic energy consumption. The results imply that the energy conservation through reforming energy price policies has no damaging repercussions on economic growth for this group of countries.

Keywords: Energy consumption; Causality; Panel cointegration

1. Introduction

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 output growth. 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 (see, e.g. 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 four generations of "energy-use–economic-growth relationship studies". First-generation studies are based on a traditional VAR methodology (Sims, 1972) and Granger's causality testing, which assumed that these data series were stationary (see, e.g. 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 Granger (1988) two-stage procedure, tested pairs of variables for cointegrating relationships and used estimated error correction models to test for Granger causality (see, e.g. Nachane et al., 1988; Glasure and Lee, 1997; Cheng and Lai, 1997).

The third-generation literature use multivariate estimators (Johansen, 1991), which facilitated estimations of systems where restrictions on cointegrating relations can be tested and informations on short-run adjustment are investigated. The multivariate approach also allows for

Abbreviations: ADF-stat: augmented Dickey–Fuller statistic; IPS: Im, Pesaran and Shin; PP-stat: Phillips–Perron *t*-statistic; rho-stat: ρ (autoregressive parameter) statistic; stat: statistic; *t*-Rho-stat: *t*-statistic for estimated ρ; *v*-stat: variance ratio statistic

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more than two variables in the cointegration relationship (see, e.g. Masih and Masih, 1996, 1997, 1998; Yang, 2000a, b; Stern, 2000; Asafu-Adjaye, 2000; Ghosh, 2002; Soytas and Sari, 2003; Ghali and El-Sakka, 2004; Oh and Lee, 2004). Fourth-generation studies employ panel cointegration and panel-based error correction models providing more powerful tests compared to time series approach (see, e.g. Lee, 2005; Al-Iriani, 2006). 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.

There are very few studies concerning the relationship between energy use and GDP for oil exporting countries. This paper examines the energy–income relationship by exploiting a heterogeneous panel cointegration framework developed by Pedroni (1995, 1999) for 11 oil exporting countries listed in Table 1. 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 and employment. And 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 organized in the following fashion. Section 2 presents a brief overview of the economic and energy use profiles of the countries in the sample. Section 3 describes the data sources and the econometric methods of estimation and reports the empirical results for cointegration and causality tests. Some concluding remarks are presented in the final section.

2. Economic and energy use profile

The panel used in this paper includes 11 oil exporting countries and the study period spans from 1971 to 2002. A sub-regional breakdown of these countries is given in Table 1. These 11 countries are heavily dependent on oil revenues and enjoying implicit generous subsidies for energy. Most of the oil exporting 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 (see Table 1). Although, economic performance has been influenced by oil revenue volatility and "stop-go" policies, but 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; Gylfason, 2000; 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 11 countries in the sample. In all of the countries, energy use growth has been far more than economic growth (on a per capita basis), while the inverse hold for the other countries and regions. The gap between GDP and energy use growth is highest for Kuwait with 7.3% followed by Saudi Arabia with 6.4%. Carbon dioxide emissions per 1995ppp $ of GDP are also implausibly high, ranging from 2.05 kg/$ for Bahrain to 0.62 kg/$ for Algeria (compare these figures with 0.63 for the low income, 0.49 for the high income, and 0.55 for the World). A similar pattern of results is obtained

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

Region/country	GDP per capita[b], average growth rate, percent	Energy use per capita, average growth rate, percent	CO_2 emissions, kg per 1995ppp $ of GDP, 2000
Middle East			
Iran	1.50	3.82	0.91
Kuwait	−3.75	3.57	1.34
Saudi Arabia	−0.38	6.02	1.68
United Arab Emirates	−2.57	3.85	1.07
Bahrain	0.18	1.51	2.05
Oman	2.37	14.12	0.72
Africa			
Algeria	1.17	4.72	0.62
Nigeria	−0.05	0.40	0.72
Central & South America			
Mexico	1.58	1.96	1.13
Venezuela	−1.05	0.92	1.98
Ecuador	1.24	2.11	1.20
Regional aggregates			
Low Income	1.98	0.88	0.63
High Income	2.18	0.89	0.49
East Asia & Pacific	5.51	2.19	0.58
World	1.40	0.43	0.55

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

[1]Implicit energy subsidies arise from the differential between domestic and border prices. For example, this figure amounted to $10\frac{1}{2}$ percent of GDP for Iran (IMF, Country Report, 2004).