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Are Sectoral Outputs in Pakistan Led by Energy Consumption?

Venus khim-sen Liew
Universiti Malaysia Sarawak

Thurai murugan Nathan
Universiti Malaysia Sarawak

Wing-keung Wong
Hong Kong Baptist University

Abstract

We investigate the relationships between energy consumption and the outputs of the main economic sectors in Pakistan, where energy shortage is a major challenge faced by the economy. It is found that services and industrial output, which make up of fourth-fifth of Pakistan gross domestic product, are not led by energy consumption in the country. Hence, the government of Pakistan could impose energy conservation measures on these two sectors with little or no adverse effect on the growth of these sectors.

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Contact: Venus khim-sen Liew - venusliew@yahoo.com, Thurai murugan Nathan - thurai86@gmail.com, Wing-keung Wong - awong@hkbu.edu.hk.
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1. Introduction

A voluminous literature on the interdependency of energy consumption and output has been developed in response to the few episodes of energy crisis since the first oil shock series that occurred in the 1970s[1]. In this respect, many researchers attempted to determine the causal linkages between energy consumption and output, as the direction of causality has important implications on energy conservation policies[2]. For instance, the presence of causal relationship running from energy consumption to output would indicate that energy is a stimulus to economic growth. As such, energy conservation policies such as the Kyoto protocol might possibly retard the economic development. In contrast, when causality runs from output to energy consumption for a country it denotes a less energy-dependent economy. Therefore, energy protection or conservation policies may be implemented with little unfavourable or no adverse effects on output. Empirically, most studies obtain consistent findings that energy consumption and output are related in the long run. However, there is no consensus on whether energy consumption contributes to output or the other way round (see, for instance, Ighodaro, 2010).

Noteworthy, previous empirical focus has concentrated on analyzing the energy-output relationship using data on aggregate output. Nonetheless, Chebbi and Boujelbene (2008) and few studies have attempted to investigate sectoral outputs in the analysis of the energy-output relationship. The advantage of this form of research is that we can identify the energy-dependent sectors in a country. We adopt this approach to investigate the dependency of sectoral outputs on energy in Pakistan in the current study. The specific aim of this study is to investigate the long-run relationship and the short-run causality directions between energy consumption and the outputs of the main economic sectors in Pakistan. These sectors are the industrial, services, and agriculture sectors[3].

Pakistan is experiencing a rapid growth in energy demand due to the accelerating pace of economic growth and industrialization. At present, the country is facing a critical energy shortage whereby nationwide power outages that can last for 6 to 8 hours a day frequently occur (British Broadcasting Corporation, 2010). In response to the growing energy shortage, the government of Pakistan announced the Pakistan National Energy Policy on April 22, 2010 to conserve energy.

[1] See Payne (2010) for an extensive survey on this issue.
[2] Bowden and Payne (2009, 2010), for instance, focus on such relationship using the U.S. data. Note that Aqeel and Butt (2001) study the causal relationship between aggregate output and with energy consumption at aggregated and disaggregated levels for Pakistan.
[3] According to the Central Intelligence Agency (2011), in 2010, the services sector contributed 54.6% to Pakistan's GDP, followed by the industrial sector (23.6%) and the agricultural sector (21.8%).

Meanwhile, the United States had also undertaken an initiative to cooperate with Pakistan to help the country overcome its energy shortfall and to improve the lives of the Pakistani people (Daily Times, 2010). Additionally, according to the State Bank of Pakistan energy shortage in Pakistan is projected to keep widening from 2010 to 2030. In view of this serious energy shortage, the proper allocation of energy among the country's main economic sectors is important to make sure that energy is used efficiently around the country.

2. Data, Methodology and Empirical Findings

We analyze the annual data ranging from 1980 to 2007 for Pakistan to examine the energy-growth relationship. Data on total energy consumption (ENE) and the outputs of Pakistan's three main economic sectors, namely, the agriculture (AGR), services(SER), and industrial (IND) sectors, are obtained from the Energy Information Administration (EIA) (2010) in its *International Energy Annual* and the World Bank's (2011) *World Development Indicators (WDI)*. Energy consumption is expressed in terms of kg of oil equivalent per capita, while sectoral outputs are the per capita value-added outputs for the corresponding sectors expressed in constant 2000 U.S. dollars. All data are transformed into logarithms before they are analyzed.

We first examine if there is any long-run relationship between energy consumption and each of the sectoral outputs. If such a relationship is present, a Granger causality relationship should exist in at least one direction. We will then determine the direction of Granger causality between energy consumption and each of the sectoral outputs. This will provide information about the energy-output relationship. Before testing for cointegration, it is necessary to ascertain the order of integration for each variable. This can be identified by applying a unit root test. We employ the KPSS test (Kwiatkowski *et al.,* 1992) in this study. The results obtained (not shown to conserve space, but are available upon request) suggest that all variables under studied are integrated of order one. As such, the commonly used Johansen-Juselisus cointegration approach can be adopted to find out if the energy consumption and sectoral outputs are related in the long-run.

Table 1 shows the results of the cointegration test for Pakistan. Based on Table 1, we find that energy consumption exhibits long-run relationship with the agriculture as well as with services outputs of Pakistan. However, there is no evidence of long run relationship between energy consumption and industrial output.

Table 1: Cointegration Test Results

Variables	Null Hypothesis	Alternative Hypothesis	Trace Statistic	Decision
Energy consumption & Agriculture output	r = 0	r ≥ 1	39.54*	
	r ≤ 1	r = 2	6.16	r=1
Energy consumption & Services output	r = 0	r ≥ 1	25.26*	
	r ≤ 1	r = 2	6.18	r=1
Energy consumption & Industrial output	r = 0	r ≥ 1	29.00*	
	r ≤ 1	r = 2	9.29*	r=2
	5% Critical Values			
	r = 0	r ≥ 1	20.26	
	r ≤ 1	r = 2	9.16	

Notes: r denotes the number of cointegration equation. The lag parameters are selected based on the AIC. All the figures are rounded to two decimal places. Asterisks (*) indicate rejection of the null hypothesis at the 5% significance level. In the current study, if r=1, it means there is a long-run relationship between the variables. Otherwise, there is no evidence of long-run relationship.

The cointegration test measures the long-run relationship between the variables. This study further examines the short-run relationship based on the Granger causality test. The results of bivariate Granger causality test are summarized in Table 2. The results show that there is a bi-direction causal relationship between agriculture output and energy. On the other hand, there exists a one-way causal direction that runs separately from services and industrial output to energy consumption.

Table 2: Granger Causality Test Results

Null Hypothesis	F Statistics [Marginal Significance Value]	Direction
AGR does not Granger-cause ENE	2.59 [0.09]**	AGR → ENE
ENE does not Granger-cause AGR	6.69 [0.01]*	ENE → AGR
SER does not Granger-cause ENE	5.07 [0.02]*	SER → ENE
ENE does not Granger-cause SER	1.26 [0.30]	
IND does not Granger-cause ENE	9.62 [0.00]*	IND → ENE
ENE does not Granger-cause IND	0.51 [0.61]	

Notes: ENE stands for energy consumption; AGR, SER, and IND represent agriculture, services and industrial outputs respectively. The lag lengths are chosen by using AIC (Loganathan and Subramaniam, 2010). All the figures are rounded to two decimal places. * and ** denote rejection of the null hypothesis at the 10 and 5 % levels of significance respectively. → denotes direction of Granger causality.

3. Concluding Remarks

In this study, we aim to determine the interdependence relationship between energy consumption and sectoral outputs in Pakistan, a country where energy shortage is of great concern. The sectors under study are the industrial, services, and agriculture sectors. There are two major findings in this study. First, there is a bi-directional causal relationship between energy consumption and agriculture output. Second, services and industrial output separately Granger cause energy consumption. Notably, Masih and Masih (1996) find that aggregate output leads to energy consumption for data from Pakistan that covers the sample period of 1955 to 1990. Conversely, we find that energy consumption in Pakistan has driven the growth of agriculture sector. In contrast, neither the services sector nor the industrial sector is driven by energy consumption. This implies that any energy-saving policy will not hurt the services and industrial sectors, which contributes to nearly four-fifth of the country's GDP. However, it will have negative impact on agriculture outputs, the minor sector in Pakistan.

Pakistan is facing a critical energy shortage recently. If the problem of energy shortage is not tackled appropriately, it will hamper socio-economic development of Pakistan. Proper allocation of energy among the main economic sectors is therefore important to make sure that energy is used efficiently around the country. In this respect, we suggest that the government of Pakistan could impose energy conservation measures on the services, and industrial sectors with little or no adverse effect on the growth of these sectors.

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