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Sectoral analysis of the causal relationship between electricity consumption and real output in Pakistan

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HIGHLIGHTS

- We assess the electricity-growth nexus in Pakistan at the aggregate and sectoral levels.
- The variables are cointegrated at both levels.
- We find causality from electricity to output at the aggregate level and services.
- We find neutral causality in the agricultural sector.
- We find bi-directional causality in the manufacturing sector.

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ABSTRACT

This study uses the annual data from 1972 to 2010 to assess the causal relationship between electricity consumption and real output at the aggregate and sectoral levels in Pakistan. This study covers three main economic sectors in Pakistan namely agricultural, manufacturing and services sectors. Our cointegration results reveal that the variables are cointegrated at the aggregate and sectoral levels. At the aggregate level, we find that there is uni-directional Granger causality running from electricity consumption to real output in Pakistan. At the sectoral level, we find that electricity consumption Granger-causes real output in the manufacturing and services sectors. However, there is no causal relationship between electricity consumption and real output in the agricultural sector. The policy implication of these results is that electricity conservation policies in general would deteriorate the process of economic growth as well as the real output in the manufacturing and services sectors in Pakistan. Nevertheless, we suggest the Pakistani government to implement the electricity conservation policies merely to the agricultural sector because such policies may have less or no adverse impact on its real output.

1. Background and motivations of study

More than three decades from the seminal work of Kraft and Kraft (1978) in validating the causal relationship between energy consumption and real output, the direction of causality between these variables remain controversial (Ozturk, 2010; Payne, 2010). Some empirical studies found that energy (electricity) consumption Granger-causes real output (e.g. Abosedra et al., 2009; Narayan and Singh, 2007; Shahbaz et al., 2011; Shiu and Lam, 2004; Stern, 2000; Tang, 2008, 2009; Tang and Tan, 2012); while other studies argued that energy (electricity) consumption does not Granger-causes real output (e.g. Abosedra and Baghestani, 1989; Binh, 2011; Cheng, 1995; Ghosh, 2002; Mahmoodi and Mahmoodi, 2011; Mozumder and Marathe, 2007; Narayan and Smyth, 2005; Yu and Jin, 1992). From policy standpoint, knowing the actual direction of causality between energy consumption and real output is essential in helping policymakers to enhance the process of economic growth and development of a country. On the one hand, if real output Granger-causes energy consumption or there is no causality between them, increase in energy consumption may not effectively promote real output, but it may increase the carbon dioxide (CO_2) emissions. On the other hand, if energy consumption Granger-causes real output, energy conservation policies to control environmental degradation would retard the process of economic growth and development. In light of this, most studies have taken piecemeal approach to replicate the subject. Earlier studies on energy-growth nexus have mainly

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concentrated on aggregate level but very few studies have focused on sectoral level, particularly in lower middle income countries such as Pakistan.

Pakistan is one of the impressive growth performance economies in the South Asia region and the average growth rate of gross domestic product (GDP) from 1972 to 1992 is approximately 6 per cent per annum (Ahmad, 1994). However, the internal political instability and the low influx of foreign capital investment (FCI) have significantly retarded the process of economic development in Pakistan. Evidently, the average growth rates of GDP from 2008 to 2010 dropped to approximately 3 per cent. The contribution of agricultural, manufacturing and services sectors to GDP in 1980 are about 30.9 per cent, 19.6 per cent and 49.5 per cent, respectively. However, the economic structure has shifted gradually from the agricultural to the manufacturing and services sectors. For example, from 2000 to 2010, the contribution of the agricultural sector to GDP in Pakistan dropped to approximately 21 per cent, whereas the contribution of manufacturing and services sectors increased to nearly 25 per cent and 53 per cent, respectively.

Table 1 reveals the electricity consumption by the key sectors in Pakistan. Generally, the electricity consumption shows an increasing pattern from 1980 to 2010. Moreover, the electricity consumption in the manufacturing sector is consistently greater than the electricity consumption in the agricultural and services sectors. In 1980, the manufacturing sector consumed 4108 million kilowatt hours (kW h), whereas the agricultural and services sectors consumed about 2066 million kW h and 883 million kW h, respectively. After two decades, the electricity consumption in these key sectors increased more than 200 per cent compared to the volume of electricity consumption in 1980. Specifically, the electricity consumption in the manufacturing, agricultural and services sectors in 2010 are 21922 million kW h, 8984 million kW h and 6485 million kW h, respectively. This increasing pattern indicates that electricity is an important input to production in the manufacturing, agricultural and services sectors in Pakistan. Therefore, it is essential to investigate the relationship between electricity (energy) consumption and real output at the aggregate and sectoral levels in Pakistan.

One of the main reasons of analysing the causal relationship between energy consumption and real output at the sectoral level is that the causality results can be varied between aggregate and sectoral levels due to the aggregation bias problem. For example, Bowden and Payne (2009) and Zachariadis (2007) found neutral causality evidence at the aggregate level, while there are some causality evidences at the sectoral level. In contrast to the earlier studies, Abid and Sebri (2012) support the energy-led growth hypothesis at the aggregate level whereas the study rejects the hypothesis at the sectoral level. Apart from differences between aggregate and sectoral levels, Zaman et al. (2011), Bowden and Payne (2010) and Zachariadis and Pashourtidou (2007) observed that causality results can also be inconsistent among sectors. Therefore, sectoral analysis can provide more specific and useful results. Ultimately, more effective energy policies can be suggested based upon the results at the sectoral level.

Table 1
Electricity consumption by sectors in Pakistan.

Years	Million kilowatt hour (kW h)		
	Manufacturing	Agriculture	Services
1980	4,108	2066	883
1985	6,249	2798	1413
1990	10,324	5027	1963
1995	12,528	6251	2623
2000	13,202	4540	2544
2005	18,591	6989	4080
2010	21,922	8984	6485

Source: Hydrocarbon Development Institute of Pakistan.

Motivated by the importance of this subject to the existing literature and policymaking, the goal of this study is to investigate the relationship between electricity consumption and real output in Pakistan at the aggregate and sectoral levels from 1972 to 2010. At the time of writing this paper, fourteen studies have been conducted to analyse the relationship between energy (electricity) consumption and real output in Pakistan (see Table 2). Almost all of them are using a bivariate framework to test the long run as well as the causal relationships between energy consumption and real output at the aggregate level. From the summary of studies in Table 1, most of the earlier studies in Pakistan tend to suggest that energy consumption Granger-causes real output. Besides, only Mushtaq et al. (2007), Zaman et al. (2011) and Liew et al. (2012) examined the energy-growth nexus in Pakistan at the sectoral level. Specifically, Mushtaq et al. (2007) analysed the relationship between electricity consumption, the price of electricity and real output in the agricultural sector in Pakistan using the Johansen–Juselius cointegration and Granger causality tests. They found that the variables are cointegrated, but only uni-directional Granger causality running from electricity consumption to real output is detected.

Then, Zaman et al. (2011) used the Johansen–Juselius cointegration and Granger causality technique to investigate the role of sectoral oil consumption on real output in Pakistan. By and large, they found that the sectoral oil consumption and real output are cointegrated. In terms of causality, the study found that real output Granger-causes oil consumption at the power supply sector, while oil consumption in the manufacturing and transportation sectors do not Granger-cause real output in Pakistan and their causal relationship tend to be neutral. Recently, Liew et al. (2012) used a bivariate model to examine the causal relationship between energy consumption and the outputs of Pakistan economic sectors, namely agricultural, manufacturing and services sectors. They found that energy consumption and real output in the agricultural sector Granger-cause each other in Pakistan, while there is uni-directional causality running from real outputs in the manufacturing and services sectors to energy consumption.

This study contributes to the existing literature in at least three ways. First, most of the studies in Pakistan tested the direction of causality with a bivariate framework and also neglected the importance of sectoral information. Lütkepohl (1982) contended that the Granger causality test with two variables system is likely to produce biased causality results because of the omission of relevant variables such as capital and labour. Moreover, Gross (2012) revealed that empirical evidence at the aggregate level is necessary but insufficient for policymakers to formulate an appropriate policy, particularly at the sectoral level. To circumvent these problems, we use a multivariate framework derived from the neoclassical growth theory to analyse the relationship between electricity consumption and real output in Pakistan at the aggregate and sectoral levels—agricultural, manufacturing and services sectors. By doing so, we can avoid the omitted variables bias and also provide appropriate sectoral information to the policymakers. Second, none of the sectoral studies for Pakistan have taken into consideration the impact of structural breaks when testing the order of integration with unit root tests.[1] According to Perron (1989) and Zivot and Andrews (1992), the results produced by

[1] We are aware of the fact that some studies in Pakistan such as Shahbaz and Feridun (2012), Shahbaz and Lean (2012), and Shahbaz et al. (2012) have taken into account the effect of structural breaks in unit root test. However, all of them are studies in the aggregate level.