Renewable and Sustainable Energy Reviews 65 (2016) 1159–1178

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

The dynamics of electricity demand in Pakistan: A panel cointegration analysis

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ARTICLE INFO

Article history:
Received 19 July 2015
Received in revised form
21 June 2016
Accepted 26 June 2016

JEL classification:
C32
C52
Q43

Keywords:
Electricity demand
Panel cointegration
Agriculture sector
Industrial sector
Residential sector
Pakistan

ABSTRACT

This paper examines the dynamics of electricity demand in Pakistan at the aggregate and sectoral levels over the period 1978–2012. Panel cointegration test and Fully Modified Ordinary Least Squares method is employed to determine the long run relationship between electricity consumption, real income, real price of electricity and domestic price of non-energy products. The results reveal that electricity demand is more responsive to changes in income than changes in prices at the aggregate and disaggregate levels. Short run and long run income elasticities are positive and statistically significant, supporting the conservation hypothesis. It appears from the results that long run price elasticities are negative and significant at the aggregate level and for the agriculture, commercial, residential sectors and public utilities. The short run price elasticities are significant but low in magnitude, which implies that changes in electricity price exert minimal effect on the electricity consumption in Pakistan. The domestic price of non-energy products is positive and significant for aggregate sample in the short run, the domestic price of non-energy products exert significant negative (positive) impact on electricity demand in the agriculture (industrial) sectors. The results, thus, provide important information to the agents operating in the electricity market regarding the income and pricing policies and helps in planning the future strategy of electricity demand management.

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http://dx.doi.org/10.1016/j.rser.2016.06.054
1364-0321/

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1. Introduction

Electricity is considered an engine of economic growth and constitutes one of the crucial inputs in the socio-economic development of a country. Provision of adequate and affordable electricity is essential for sustainable human development. Electricity helps on facilitating economic development and poverty reduction by underpinning industrial development and productivity growth. It enhances socio-economic development by fulfilling the basic human needs of nutrition, warmth and lighting in addition to education and public health [1]. Onakoya et al. [2] recognize electricity as a pillar of wealth creation. Medlock and Soligo [3] indicated that lack of access to electricity is a principal cause for the low levels of socio-economic development in developing countries. Like many developing countries, Pakistan's economic growth heavily relies on the different uses of electricity which plays a significant role in driving its economy. Statistics show that electricity consumption in Pakistan has been increasing steadily for the past 25 years, while the growth in power supply has not been able to keep the pace with rising demand.[1] This increase in electricity demand was due to various economic, social and climate changes. High population growth rate, industrialization, extensive urbanization, rural electrification, and increasing use of electrical appliances have resulted in a phenomenal rise in demand for electricity in the country. Statistics show that growth of electricity consumption rose from 4% in the 1990s to 7% in the first seven years of 2000s. However, growth in electricity generation rose from 5.2% to 5.06% during the same period. As a result, electricity balance deteriorated and it turns out from surplus of 435 MW in 2002 to a deficit of 7078 MW in 2013.

Currently, Pakistan is suffering from perennial power crisis, and widespread outages of electricity have severely hampered economic growth and caused unemployment. Inefficient allocation of electricity among various sectors and low generation over the years, however, has widened the gap in the demand for and supply of electricity.[2] Among other factors, underdeveloped T&D infrastructure, electricity theft, weak governance, price distortions, under-utilization of installed capacity, poor performance of utilities, lack of investment in power sector and high costs of generation are the primary causes of the current power crisis in Pakistan. Consequently, the supply of grid electricity to the industrial and agriculture sectors was significantly curtailed.

The GoP has taken a number of important steps to expand electricity generation capacity in order to bridge the gap in the demand for and supply of electricity.[3] Despite the lucrative incentive-based policy measures, the electricity supply has been lagging the demand. As a result, the gap in the demand for and supply of electricity peaked at 7078 MW in 2013 that posed formidable challenges to sustainable socioeconomic development in Pakistan. According to the PES (2013–14), the contribution of electricity sub-sector to the GDP declined from 2.4% in 2012 to 1.9% in 2013, while its share in industrial sector was reduced from 11.3% in 2012 to 9.2% in 2013.

The most important reason of power shortages in Pakistan is inaccurate information with respect to future market demand which is of vital importance to electricity producers, consumers and policymakers. Effective planning of electricity demand requires accurate information with regard to the consumption patterns of electricity, existing infrastructure and future challenges. Gyamfi [4] and Adom et al. [5] asserted that electricity problem could be solved easily if attention is given to the demand management of the electricity. Underestimation of electricity demand would lead to potential outages, while overestimation would cause unnecessary idle capacity and waste of financial resources [6]. It is, therefore, pertinent to investigate the demand for electricity in Pakistan. Non-availability of adequate, uninterrupted, and affordable supply of electricity is one of the critical bottlenecks for Pakistan's future economic development. To this end, short run and long run income and price elasticities of electricity demand are essential to determine welfare implications for income and price changes, helpful to plan future capacity building, and formulate investment policies in the power sector. Furthermore, a better understanding the dynamic relationships among per capita electricity consumption, real income, electricity prices and domestic price of non-energy products is significant not only to formulate effective policies, but also useful for long-term sustainable development of the country. This study is, therefore, intended to focus on aggregate and disaggregate analyses of electricity consumption, electricity prices, real income and domestic price of non-energy products in the case of Pakistan.

Numerous studies are available that have estimated the electricity demand function in Pakistan [8–19]. These studies employed linear and non-linear functional form for analyzing the electricity demand at the aggregate and disaggregate levels. The results of these studies demonstrate that real income, real price of electricity, real price of substitutes, temperature and stochastic trend appears to be an important determinant of electricity demand at the aggregate and sectoral levels in Pakistan. One problem with these studies is that they are impaired by a short data span that lowers the power of the unit root and cointegration tests. The present study uses panel unit root and panel cointegration tests which combine cross-sectional and time series data, and provides more powerful inferences.

The objective of this study are two-folds: first, to examine the existence of long run relationship between electricity consumption, real income, average real price of electricity and domestic price of non-energy foreign products for aggregate and disaggregate electricity consumption using the dynamic panel cointegration approach for the period 1978–2012. This modeling approach allows for controlling unobserved heterogeneity across cross-sectional units, which could otherwise remain undetected in simple time series or cross sectional data [20]. For the aggregate analysis, the present study uses total electricity consumption per capita as dependent variable, while real income per capita, real price of electricity and domestic price of non-energy products as independent variables. To examine the separate effect of real income and electricity price on electricity consumption, total electricity consumption was disaggregated into six major subsectors of electricity users namely, agriculture, government, residential, commercial and industrial, and public utilities. The second objective is to examine the short-term dynamic relationships

[1] For example, from 1991 to 2013, electricity consumption significantly increased from 31,534 GWh to 76,789 GWh, registering a growth rate of 143.51%, while its supply increased from 40,042 GWh to 96,494 GWh during the same period and showing a growth rate of 135.11%.

[2] In this study we used electricity demand and electricity consumption interchangeably.

[3] For example, 1995 Energy Policy, 1998 Energy Policy, 2006 Renewable Energy Policy for power generation and 2013 National Power Policy. Detailed discussions on various energy policies can be seen in Rauf et al. [7].