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Finding the cointegration and causal linkages between the electricity production and economic growth in Pakistan

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ABSTRACT

The present study reveals the impact of electricity production on economic growth in Pakistan. It covers the period of 1975–2010, and assumes a log-linear relationship between the variables. The bounds test for cointegration indicates a unique long-run relationship between the variables. Moreover, it finds that sub-optimal electricity production is eroding the private business investment in the short run. Based on these facts, this study advocates the promotion of hydropower plants that are beneficial for two reasons. First, it would produce clean power in the country. Second, the cost of production would also drop resulting in lower tariff rates. Finally, it finds bidirectional causal relationship between the variables in the long run whereas no causal relationship is found in the short run.

1. Introduction

Sustainable supply of electricity is crucial for balanced economic growth. Contemporaneous literature specifies that it is the driving force behind the development in many countries, the so-called growth hypothesis. This arena is important for policy relevance and is also central to conservation policies, the so-called conservation hypothesis (Ghosh, 2002). One can support the conservation policies if the electricity supplies bring no economic growth in the long run. In such a scenario, it would be better to utilize other available options for satiating energy needs. Nonetheless, if electricity supplies induce significant macroeconomic developments in an economy then conservation policies might be detrimental to the economic health of society.Any negative shock such as load-shedding, or higher electricity tariffs, or a combination of both would be damaging to the country (Narayan and Singh, 2007). Electricity supply has remained subject to frequent disruptions in Pakistan as well. The following lines are going to discuss the basic reasons for the failure of electrical system in Pakistan.

Generation, transmission and distribution of electricity are conducted by the Water and Power Development Authority (WAPDA), and Karachi Electric Supply Corporation (KESC). The former institution is liable to cater the electricity essentials of the whole country, with the exception of Karachi, while the latter one provides its services in Karachi (Jamil and Ahmad, 2010). Unfortunately, both of these institutions are unable to fulfill electricity demand in the country. To overcome the electricity deficit, government of Pakistan has committed two agreements with private power producers. The first formal agreement was initiated in a1994 (Ministry of Water and Power, 2002), and 15 IPPs registered themselves as private power producers in this initial phase. There was no further development in this program for a long period of time, but persistent electricity deficit reinitiated this program. In results, many IPPs were accessed for the production of 2500 MW of electricity (Ministry of Water and Power, 2002). This was the second phase of private electricity production which was completed with incumbent players and some new ones.

An effective tariff rate is the most important thing for optimal production and consumption of electricity. In this regard, power purchase agreement (PPA) between the government of Pakistan and private power producers preserve great prominence. There are two types of PPAs, formally known as the first generation PPA and second generation PPA, signed under Power Policy 1994 and 2002 respectively. Nonetheless, there is a significant difference between the two PPAs. The first PPA calculates tariff in real US dollar terms, while the second PPA deals in Pakistani Rupee. This makes average tariff rates higher in the first PPA as compared to the second PPA. In short, there are two reasons for the costly production of electricity in Pakistan. First, as the majority of the private power producers are operating under the first PPA, it makes every additional unit of electricity more expensive than the previous one[1]. Second, these IPPs are operating under thermal power plants which are much costly as compared to hydropower plants. For these reasons, IPPs charge higher tariff rates for their buyers. Owing to stagnant public sector electricity production in

[1] [The Pakistan Credit Rating Agency Limited(2009),http://www.pacra.com/RMethodology/IPP%20rating%20Methodology.pdf].

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Pakistan, any rise in the electricity consumption is supposed to encounter by IPPs.These private power producers generate almost 30 percent of the total electricity production in the country.

In the past, natural disasters such as earthquakes and floods have also caused huge damage to power sector infrastructure. Jinnha hydropower plant faced the most devastating destruction, most of its machines were damaged severely and it was unable to operate at its potential level. Moreover, many other electricity generating plants were closed as a result of these disasters. All these problems reared electricity deficit and it is projected that, up to the year 2020, per day electricity deficit would rise to 13,651 MW (see Table 1 for details). Khan and Ahmed (2009) claimed that per day electricity production was 11,500 MW in the year 2008 while its demand was 20,000 MW. Provision of sustained electricity at compatible rates plays the essential role in economic development but this is not the case in most of the developing countries. Incompatible electricity prices and underdeveloped electricity infrastructure are also curbing the economic growth in Pakistan. People experience the longest power outages which is making difficult to run the daily business.

Literature provides the information about residential demand of electricity (Nasir et al., 2008), and impact of electricity consumption on economic growth (Aqeel and Butt, 2001; Jamil and Ahmad, 2010; Zahid, 2008) in Pakistan. Two points are notable here. First, all these empirical studies have focused on electricity demand or consumption while the role of electricity production in growth is missing. Second, all of them take GDP as the indicator of economic growth, whereas GDP entails consumption which has very little to do with the long-term growth. Nonetheless, it is the investment, especially private business investment, which contributes to long-term growth. As compared to the stable GDP, owing to stable consumption, private business investment is much volatile and needs individual attention. Up to this time, no attention has been paid to the private business investment that is vital for long-term growth. These facts provide the motivation for discovering the influence of electricity production on private business investment in Pakistan.

A concrete analysis is prerequisite for better policy implications, it would be important to have the knowledge of both the short-run and the long-run scenarios in the model. The ultimate objective of the present study would be to analyze the impact of electricity production on the private business investment in the short run and long run. For this purpose, in the first stage, it establishes a log-linear model to identify the long-run relationship between the private business investment and electricity production. In the second stage, it analyzes the stationarity of all the variables to be employed in regression. Unit root tests do not provide enough information so that it could choose between the bounds test and Johansen test for the analysis of cointegration. For the sake of efficiency and a comprehensive analysis and without losing the long-run information in the data, the present study employs both of these estimation techniques to find a stable long-run relationship between the two variables and this is conducted in the third stage. In the fourth stage, it discusses long-run and short-run relationships and their causal linkages.

The remaining study has been organized as follows. Section 2 reviews the literature, for a compact analysis it presents the tabulated review of literature. Section 3 presents data, sources of data and econometric methodology for empirical analysis. Section 4 describes the long-run and short-run results along with the causal linkage between the variables. Finally, Section 5 concludes the study and also provides some policy implications.

Table 1
Electricity demand and supply position in Pakistan 2011–2020 (In MW).

Year	2011	2020	Growth rate
Existing generation	15,903	15,903	0.00
Proposed generation	10,115	18,448	45.17
Total existing generation	26,018	34,351	24.26
Available generation	20,814	27,481	24.26
Summer peak demand	20,874	41,132	49.25
Deficit	60	13,651	99.56

Source: Private Power and Infrastructure Board — Government of Pakistan.

2. Review of literature

On the basis of the direction of causality, literature is classified under four hypotheses which are discussed one by one. If causality runs from electricity to economic growth, and the opposite is not true, this unidirectional causality specifies the presence of Growth hypothesis.On the other hand, it there is unidirectional causal relationship between the electricity and economic growth, while causality is running from economic growth in electricity, it is known as Conservation hypothesis. In some cases, there is also the evidence of an interdependent relationship between electricity and economic growth, it is known as Feedback hypothesis. Finally, Neutrality hypothesis assumes no causal relationship between the variable. cReview of literature has been enclosed in the following Table 2. Although it covers both types of cases (country specific and multi-county cases) but owing to the nature of the study, it emphasizes more on the former category.

3. Data and methodology

Previously, literature has used real gross domestic product (GDP) as a development indicator and electricity consumption as the energy indicator. However, given the abovementioned objective of the study, private business investment has been employed as a development indicator and electricity production as energy indicators. For the choice of a better functional form, it takes the help of the prevailing literature. Log-linear functional form produces robust results as compared to linear specification (Nasir et al., 2008; Noor and Siddiqi, 2010; Shahbaz and Lean, 2012a, 2012b). It is as follows:

$$I_t = \alpha_0 + \alpha_1 E_t + \mu_t \tag{1}$$

Private business investment has been denoted with I_t and is denominated in million rupees, while electricity production has been denoted with E_t and measured in kWh, and μ_t denotes a white noised error term. Annual data are used for the period of 1975 to 2010. Both the variables are taken from the World Bank database and are converted in natural logarithms. After specifying the data and variables, it would be important to know the order of integration of the variables. For this purpose, it takes the help of Augmented Ducky Fuller (ADF) test and Phillips–Perron (PP) test. Both of these tests proceed with Eq. (2) for their operations. It is as follows:

$$\nabla x_t = \alpha_0 + \alpha_1 x_{t-1} + \sum_{i=1}^{n} \beta_i \nabla x_{t-i} + \mu_t \tag{2}$$

Where ∇, x_t *and* μ_t denote difference operator, a given variable, and white noised error term respectively (Dickey and Fuller, 1979). Eq. (2) is estimated under the null of unit root against the alternative of stationarity. Additional lags of the differenced variable can also be utilized to make the error term white noised.

Standard econometric techniques require stationary data for integrated date might provide spurious estimates. Nonetheless; differencing eliminates the long-run information in the data, it would be misleading if there is a long-run relationship among the variables. Fortunately, the contemporaneous econometric literature has made it possible to operate with integrated data. Hence, if all the variables are integrated of the same order, then one must find a unique cointegrating vector among the variables in the level form (Johansen, 1991; Johansen and Juselius, 1990).