The Impact of Structural Reforms on Electricity Market Performance: Empirical Evidence from Pakistan

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ABSTRACT

Pakistan started its electricity market reforms process in 1998 whereby WAPDA Act was passed with the objectives to achieve operational, financial and managerial efficiencies by reducing electricity price-cost margins, system losses and sectoral price differences with enhanced private sector investment in electricity generation, and better utilization of existing generation capacity. However, despite these reforms in place, Pakistan's electricity market is still marred with issues including widening demand and supply gap, high operational and financial losses, circular debt, lack of operational capacity and inadequate generation capacity. This study has thus empirically investigated the impact of structural reforms on electricity market outcomes in Pakistan. Five different models in static and dynamic settings have been estimated for the period of 1980 to 2016 under ARDL framework. The estimation results indicate that the electricity market reforms had limited success as the reforms largely remained ineffective at impacting the performance indicators except for IPPs, capacity utilization and transmission and distribution losses in selected dimensions of the market performance. We recommend the policymakers to introduce more reforms for enhancing the efficiency of the electricity market. The role of government in the decision-making process should be minimized by empowering the regulatory body for creating competition among different market players.

Keywords: *Structural reforms, unbundling, regulatory body, IPPs*

INTRODUCTION

Electricity market reforms have been widely put in place in many countries around the world since the late 1980's to improve the performance of their electricity markets. Although varied in substance from one country to another, a general reforms template for all countries consisted of components such as corporatization, unbundling, formation of regulatory authority, establishment of markets at wholesale and retail level and privatization (Bacon and Besant-Jones, 2001). In line with international practices, the WAPDA Act of 1998 laid the foundations for reforms in Pakistan's electricity market. Rooted in the background of a heavily state-regulated market with inefficiencies in production

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In line with international practices, the WAPDA Act of 1998 laid the foundations for reforms in Pakistan's electricity market. Rooted in the background of a heavily state-regulated market with inefficiencies in production, transmission, distribution[1], limited investments in generation[2], transmission and distribution, price discrimination between different sectors of the economy, different consumer groups and different geographical areas (Aziz & Ahmad, 2015), electricity prices below the marginal cost of production, and very high transmission and distribution losses, the objectives of introducing these reforms were:

1. To enhance the efficiency in electricity production, transmission and distribution and reduce transmission and distribution losses.
2. To devise a price mechanism by which prices reflect the marginal cost of production and provide right signals for efficient electricity consumption.
3. To keep investment at an economically efficient level and ensure energy supply security.
4. To improve the efficiency in electricity consumption by eliminating price differentials among different sectors of the economy.

The WAPDA Act not only provided the legal foundations for unbundling different segments of the electricity market, it also shaped the policy paradigm in which the electricity market was operating. During the pre-reform period, all the aspects of the electricity market were centrally planned. However, after the introduction of the reforms, the vertically integrated electricity utility, WAPDA, was unbundled into four electricity generation companies (GENCOs), one transmission company (NTDC) and eight distribution utilities (DISCOs). An independent regulatory body, the National Electric Power Regulatory Authority (NEPRA), was established in 1998 to regulate the overall electricity market. Despite putting these reforms in place, the performance of the electricity market has not improved and the market in Pakistan is marred with issues including worsening of financial indicators[3], widening demand and supply gap[4], lack of operational capacity[5] and inadequacy of generation capacity. Moreover, electricity generation in Pakistan is dominated by fossil fuels,[6] resulting in the deterioration in price cost

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[1] The average transmission and distribution losses from the financial year 2012–13 to financial year 2016–17 remained approximately 21%. The transmission and distribution losses for FY 2012–13 to 2016–17 were 21.64, 21.65, 21.62, 20.71, and 20.26%, respectively (NEPRA,2017).

[2] The demand–supply gap for electricity from FY 2012–13 to FY 2016–17 revealed that there was always a deficit in the system. This deficit was −4227, −4406, −5201, −5298, −6097 MW from the FY 2012–13 to FY 2016–17, respectively.

[3] After the reforms process took place in Pakistan's electricity market, a major emphasis was placed on thermal projects. Owing to political pressure, overstaffing, poor quality of service and system losses negatively affected the financial condition of the country (Malik., 2015).

[4] Pakistan's economy was growing at an average of 6% annually during the FY 2002–03 to 2006–07; therefore, electricity generation capacity was required to grow at 8.8% to meet the increased demand compared with only a 2% growth in its installed capacity during the same period. Unfortunately, growth in demand was not anticipated, which resulted in peak demand supply gap of up to 7000 MW at few instances (Aziz & Ahmad, 2015).

[5] A need for expansion of power infrastructure has been realized as the installed cables are too old or have less capacity to bear the load. Transformers were overloaded and were considered to have insufficient capacity to run the system (NEPRA, 2015).

[6] In all GENCOS, fossil fuel is used as a primary source of energy to run the plants and to produce electricity. Until 2015, a continuous surge in oil price was observed owing to the oil price hike in the

margins (NEPRA, 2014). Additionally, losses in the form of transmission and distributional losses cause circular debt to rise[7]. In Pakistan, governance and management flaws[8] and poor coordination among institutions[9] often generate inefficiencies in the electricity market (Ullah at el., 2017). Undeniably, the energy sector in Pakistan has been facing serious issues even after passing through the reforms process (Malik, 2012).

There are a number of studies that have empirically evaluated the reform process and the performance of the post-reforms electricity markets across the world, such as Besant-Jones, (2006), Kirkpatrick (2014), Jamasb and Pollitt, (2005), and Zhang et al., (2008). Differences exist in the literature regarding the success or failure of the reform process depending on the extent of the implemented reforms, the time since the reforms had remained in effect and the types of data and methodologies employed. Because structural reforms in the electricity market are expected to improve industry-related indicators as well as indicators relating to economic, social and environmental aspects, the evaluation of these reforms is a complicated task (Pollitt, 2004). However, there is a lack of evidence at single country level, particularly for developing countries, which face difficulty in choosing suitable measurement techniques owing to insufficient quantity and quality of data. Pollitt (2009), Saal and Parker (2000, 2001) and Joskow (2008) quantitatively evaluated the impact of reforms reforms followed by advanced countries, whereas Kirkpatrick et al. (2006), Pollitt (2004), Zhang *et al.*, (2008), Erdogdu (2013); Nepal and Jamab (2012) have examined the impact of reforms in developing countries in a more narrative manner.

The impact of electricity market reforms has also been studied from static as well as dynamic point of views (Finon & Menanteau, 2003). Prior studies have only used static approaches to analyze the impact of reforms on the efficiency, prices and distribution consequences (Schober, 2013). However, some countries can be slow at adapting to the reforms process or may even reverse the process with the passage of time; therefore, the true effect of reforms may not be accurately measured in a static model setting. Pakistan is an example of this reform reversibility. The Pakistan Electric Power Company Private Limited (PEPCO) was established for restructuring and privatizing the generation and distribution companies under the privatization commission of Pakistan (Khan, 2014). Hydroelectric power development and its operations are still under the control of WAPDA , whereas PEPCO was responsible for thermal power plants, NTDC and distribution companies. Owing to a severe power crisis in April 2012, PEPCO was dissolved and its functions were transferred to the Central Power Purchase Agency (Kessides, 2013). To the best of our knowledge, no work has been done to empirically investigate the impact of the electricity market reforms in Pakistan. In this work, we empirically analyze the impact of reforms on Pakistan's electricity market from static and

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international market. One of the objectives of the reforms was to supply electricity at a low rate (NEPRA, 2015).

[7]NEPRA has allowed only 2.5% T&D loss on the total delivered energy but the actual loss is above 20% annually, which contributes to the accumulation of circular debt. Moreover, poor revenue collection, delays in fuel price adjustments and electricity theft contribute to the rising of circular debt. (NEPRA, 2015)

[8]Stable political & economic conditions and an efficient environment are helpful in boosting investor confidence. A weak governance structure is one of the major reasons that reforms were not fully implemented in Pakistan (Ullah et al., 2017)

[9]Ershad (2017) argued that the poor coordination among the institutions resulted in energy inefficiency. NEPRA determines the tariff, which is overruled by the government for their political goals and this intervention results in pilling up of circular debt.

dynamic perspective and fill the existing gaps in the empirical literature. In the light of this discussion, the objectives of this study are:

- To assess the impact of structural reform in electricity market on sectoral price difference in Pakistan's electricity market.
- To assess the impact of structural reform in electricity market on price cost margins in Pakistan's electricity market.
- To assess the impact of structural reform in electricity market on per-capita electricity generation capacity in Pakistan.
- To assess the impact of structural reform in electricity market on transmission and distribution losses in Pakistan.

The rest of the paper is organized as follows. Section 2 discusses theory and conceptual framework. Section 3 explains data and methodology whereas section 4 discusses empirical findings in detail. Section 5 concludes the paper with appropriate policy recommendations.

THEORY AND CONCEPTUAL FRAMEWORK

The motivation behind the electricity market reforms has traditionally been different in developed and developing economies. In developed economies, the motives were to increase economic efficiency, regional trade and transferring of financial risk to the private sector. In developing countries, the motivation behind the electricity reforms were the poor performance of the state owned utilities, financial inadequacy of the state for further investment in maintaining plants and provision of electricity supply, low service quality and bills collection and the need for capital for further investment (Zhang et al. 2008 and Besant-Jones, 2006).

Three types of regulation theories namely, public interest theory, Chicago theory of regulation and public choice theory explain the working of the markets (Den Hertog, 1999,2010) but this study only considers the public choice theory as it is more relevant to this work. The Economic justification based on public choice theory favors the structural reforms to limit the size and specify the operations of natural monopolies. The theory suggests that although monopolists usually enjoy economies of scale but these economies of scale lead to inefficient allocation of resources and distort the price mechanism.

The public choice theory thus propagates that structural reforms in the state regulated market are important for optimal utilization of resources through market means of action (Arrow,1985). The optimal utilization of resources can be achieved by assigning property rights and powers of doing agreements to industries to minimize the cost of production (Pejovich, 1979). The freedom of contracts gives operational and financial rights to the firms and keeps the prices at marginal cost of production to minimize inefficiencies in the system. By reducing the size of natural monopolies through disintegration and introducing competition, efficiency gains can be materialized.

According to reforms model introduced around the globe, some of the preliminary steps of the reforms included commercialization, corporatization, privatization, the establishment of the regulatory body and the introduction of energy laws. Privatization and free competition were applied in generation and distribution companies along with the unbundling of electricity generation, transmission and distribution (Victor & Heller, 2007). The purpose of these reforms was to improve the efficiency of the electricity market by ensuring the credibility of policies by adopting the cost-effective practice and reducing the unnecessary political interference (Stigler,1968)

Independent regulatory bodies were established to ensure the credibility of government policies, to oversee market operations and to regulate the monopoly-prone segment of the market (Heller & McCubbins, 1996). Thus, the regulatory bodies were aimed to promote unbundling through coordination among three segments (generation, transmission and distribution) and overseeing changes in electricity prices. Similarly, regulatory bodies were aimed to promote privatization and create distance between government and private generation companies to avoid the negative implications of political interference (Shleifer & Vishny, 1997). The issuance of Independent power producers (IPPs) allowed the private investors to independently perform their operations without the direct approval of the government. The induction of IPPs not only facilitates private investors but also enables the government to take benefits from private investment without losing their authority (Szakonyi & Urpelainen, 2013).

We have developed the following hypotheses to test the effect of structural reforms in the power sector on electricity generation per capita, capacity utilization, transmission and distribution losses, price-cost margins and sectoral price differences.

Generation Capacity Per Capita

Electricity shortages have been one of the major drivers of reforms in developing countries. The rising gap between supply and demand of electricity started to affect the economic growth of Pakistan in the 1970s. When international donors conditioned financial aid to reforms in the power sector, governments faced a looming financial crunch to meet the investment needs for new power generation. This necessitated the structural reforms in the power sector to involve the private sector in electricity generation. We hypothesized that structural reforms that are composed of a number of inter-related steps may increase the electricity generation capacity. Therefore, to increase the electricity installed capacity and electricity generation, the government of Pakistan (early 1990s) permitted international power producers (IPPs) to invest in the generation sector in a very early phase of reforms in the country. In the post-reforms market, stakeholders including the regulatory body were responsible for making decisions regarding the operational and financial activities, whereas hard budget constraints imposed by reforms forced the utilities to recover their costs. The successful implementation of reforms helps to increase generation capacity (Victor & Heller, 2007; Zhang et al., 2008; Nagayama, 2010). Likewise, competition and privatization help to improve the generation capacity because lower costs of production improves the technical efficiency and decrease the price, consequently increasing the demand for electricity (Zhang et al., 2008). Furthermore, independent power producers facilitate private investment, which results in an increased generation capacity (Urpelainen & Yang, 2017).

On the basis of above arguments, we deduced the following hypotheses relating to the impact of structural reforms on electricity generation performance.

Hypothesis 1: Electricity market reforms significantly improve the generation capacity per capita

The existing literature supports our hypothesis as Joskow (2008) and Jamasb et al. (2005) found lower productivity levels in the state-owned utilities, which result in electricity shortages in rural areas. Khana and Zilberman, (2001) explored the Indian electricity sector and concluded that compared with state-owned generation plants, private plants exhibit more generation capacity by using better management practices. Other studies including Cubbin & Stern (2006); Zhang et al. (2008) and Erdogdu (2014) examined the impact of reforms and found a positive change in electricity generation capacity.

Capacity Utilization

According to Newberry (1997), capacity utilization refers to the increase in system efficiency that does not depend on the transfer of ownership but on the reforms. In the beginning, many countries forcefully disintegrated the vertical monopoly structure of the electricity market with the objective to increase competition, which results in optimum utilization of existing resources.

A low level of power generation was mainly associated with a low level of investment so the reforms were implemented to achieve optimal utilization of existing plants with improved technology. As far as developing countries are concerned, the availability of resources was restricted because of the poor allocation and utilization of these resources owing to poor operational and technological progress. Furthermore, because the losses were subsidized by the government, no proper attention was given to maintaining and overhauling of the installed plants and utilization of the existing generation capacity. Therefore, we argue that if these plants are utilized optimally, more energy could be produced from existing resources, which further helps in the continuous provision of electricity for economic activities.

Electricity demand depends on cyclical and seasonal variation, whereas consumers require a reliable and continuous supply of electricity with sustained voltage,[10] which implies that producers must ensure "black start capacity" and "spinning reserve"[11]. This pairing of demand and supply requires the electricity suppliers to maintain excess capacity to meet peak demands. Therefore, reforms are expected to increase the market participation by the producers for the purpose of ensuring optimal utilization of existing resources and sustaining the reliable provision of electricity. These arguments led us to the following hypothesis:

Hypothesis 2: Electricity market reforms have a statistically significant impact on capacity utilization.

Capacity utilization determines the rate at which input can be converted into output. This process of conversion plays an important role in determining the price of electricity and price, which, in turn, determines the consumption of electricity. The smooth and continuous provision of electricity leads to efficient allocation of resources, which further improves the technological advancement and economies of scale (Zhang et al; 2016). Steiner (2000) found a significant effect of reforms including privatization and unbundling on the capacity utilization of electricity markets of OECD countries. Hattori & Tsutsui (2004) re-examined the analysis of Steiner and found a similar effect of reforms on capacity utilization of electricity markets. Other empirical findings that confirmed this hypothesis include Cubbin & Stern (2006); Zhang et al. (2008); Joskow (2008); Erdogdu (2014).

Transmission and Distribution Losses

One of the aims of reforms is to curtail the production cost and price through competition under the supervision of a regulatory body. These reforms also enhance the efficiency of the electricity market by reducing transmission and distribution losses. These losses refer to the units of electricity that are generated but are lost before they reach the end user. Electricity reforms are designed in such a way that they minimize both technical and nontechnical losses (Victor & Heller, 2008; Zhang et al., 2008; Nagayama, 2010). Regulation improves the efficiency by removing the political intervention in the collection of payments. Similarly, regulatory support for competitive pricing minimizes the financial losses, thereby improving the performance of the transmission and distribution segment. On the same note, privatization and competition provide incentives for reducing losses because, in the long run, only efficient and loss-minimizing utilities are allowed to operate in the market because none of the utilities can earn profit from the electricity that is lost during transmission and distribution. Reliable and smooth provision of electricity in the country is not possible without controlling these losses. Moreover, the focus on T&D losses helps us to capture the ability of the market to distribute electricity without losses. These arguments help us to develop the following hypothesis:

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[10] According to IEA, continuity implies the confidence of consumer in the supply of electricity in the long-term instead of the duration of the contract. Contrary to this, reliability refers to the confidence of consumer in day-to-day supply. A stable voltage of electricity is essential for avoiding black-outs (complete loss of electricity) and brown-outs (drops in the voltage).

[11] Black start capability is defined as the ability of an electricity generation unit to restart the system when the power is lost whereas spinning reserve refers to the capacity to instantly provide electricity. More specifically, the plants in the spinning reserves create operating costs but do not supply electricity to the distribution network.

Hypothesis 3: Electricity market reforms have a statistically significant impact on transmission and distribution losses.

Evidence shows that privatization improves operational efficiency as well as financial efficiency by reducing both technical and nontechnical losses, which further result in better service quality (Jamasb, 2006). Similar to privatization, unbundling helps to reduce the total losses of electricity utilities (Bhatia & Gulati, 2004; Nagayama 2010; Zhang et al, 2008) found that reforms had a positive role in reducing transmission and distribution losses. Similarly, a regulatory body ensures electricity utilities to reduce transmission and distribution losses (Urpelainen & Yang, 2017; Besant-Jones, 2006).

Price-Average Cost Margin

The price–cost margin is a traditional method for measuring competition between firms (Aghion et al., 2005; Nickell, 1996) and industrial performance (Setiawan et al., 2016). Thereby, price–cost margins allows estimation of the allocative efficiency (Görg & Warzynski, 2006). It is argued that when the actual market prices diverge from the competitive price, this leads toward welfare implications for the economy because output produced at this level remains lower than its potential while high prices are charged, leading toward welfare loss to consumers (Aziz et al., 2016). The aim of electricity reforms is to reduce the price–cost margins so that they can converge toward the optimal output level. Reforms such as privatization lead toward cost saving whereas competition leads to cost reduction in the short-term and long-term. Therefore, the reforms improve the economic efficiency by increasing their generation capacity and improving their savings by reducing the financial and physical losses of distribution utilities.

More specifically, reforms in the electricity market introduce cost-reflective pricing, which improves the efficiency of the market by reducing the price–cost margins and by reducing the cross-subsidies among different consumer groups. However, the change in prices depends mainly on the initial level of prices, i.e., if the prices in the pre-reform period were "too low" (below long-term marginal cost), reforms in such a situation may increase the prices (Nagayama, 2007; Erdogdu, 2013). But prices decrease if prices are determined to be above the long-term marginal cost in the pre-reform period (Joskow, 1998).

Electricity prices in Pakistan are administratively determined under the NEPRA tariff standards, 1998. The regulatory process allows the sector to determine the prudent cost including cost of capital, fuel, administration and financing for generation, transmission and distribution whereas the regulator determines the prices. However, the government determines the final price of electricity, which is set below the price determined by NEPRA. The poor performance of the state-owned electricity market was mainly because of the inability of the government to finance their maintenance and operational costs (Joskow, 1997, 2006, 2008; Bacon & Besant-Jones, 2001; Babatunde,2011;Victor & Heller,2007; Jamasb et al., 2007; Eberhard et al., 2008). On the basis of this discussion, we have developed the following hypothesis.

Hypothesis 4: Reforms significantly reduce the price-average cost margins as the market moves from a monopoly market to a competitive market.

Erdogdu (2013;2014) found a significant impact of reforms on the price–cost margins and cross-subsidies in the electricity market of 63 countries. Steiner, (2001) found that unbundling of the electricity market tends to lower the reserve margins. Similarly, Nagayama, (2009) found that electricity reforms tend to reduce the cross-subsidization in Asian electricity markets whereas in Latin American countries they do not have a significant effect on price–cost margins.

Sectorial Price Difference

The economic theory of regulation states that the policy makers can provide a benefit to any interest group on behalf of another. Cross-subsidization is an important example in this regard, as it allows the utility to finance one consumer group at the cost of another. Rather than transferring the cost of electricity services to all consumer groups, electricity utilities subsidize the electricity rates for one group at the expense of others. Theoretically, electricity tariffs benefit low-income groups by offering them lower prices. Similarly, it allows the specification of a price structure that enables the lower consumption group to pay an electricity price below the cost of production because of high correlation between electricity consumption and income (Joskow,1998). In Pakistan, residential consumers have been subsidized against commercial and industrial customers. Tariff differential subsidies (TDS) equalize the differences in the cost of electricity services across different provinces.

The relevant hypothesis to determine the impact of reforms on electricity price ratios is as follows:

Hypothesis 5: Electricity market reforms have a statistically significant impact on the sectoral price difference.

Nagayama, (2009) found that reforms introduced in the electricity markets of Latin American countries tend to increase the energy prices in different sectors. Victor and Heller (2007) and Kridel. et al., (1996) examined the impact of reforms on the electricity market and found that an independent regulator enhances the productivity of the sector and creates stability in electricity prices. Steiner (2001) in a cross-country analysis found that unbundling tends to lower electricity prices only for residential customers in the electricity markets of OECD countries. Contrary to this,

Therefore we expect that the reforms should have had a positive impact on electricity generation and capacity utilization, whereas transmission and distribution losses, price ratios and price-average cost margins should decrease owing to the reforms process.

DATA AND METHODOLOGY

Model Specification

The selection of relevant performance indicators is an important step in evaluating the impact of structural reforms. The performance indicators used in this study as dependent variables include electricity installed generation capacity per capita, capacity utilization, price-average cost margins, transmission and distribution losses and ratios between sectoral electricity prices. These indicators explain the degree of production capacity in the electricity market and the level of cross-subsidization among different economic groups.

The impact of structural reforms has been captured through the introduction of a dummy variable for each of the reform's variables. Independent variables for particular reforms' steps were taken as dummy variables, with 1 indicating the existence of a particular reform's step and 0 indicating its non-existence in a specific year. In total, 4 reform steps including entry of independent power producers (IPPs), unbundling (UNB), a separate regulatory body (RB) and privatization (PVT) were used as independent variables. A baseline model based on the work of Erdogdu, (2013) and Nworie (2017) was established as follows:

$$MP_t = a_0 + b_1 UNB_t + b_2 IPP\text{t} + b_3 RB_t + b_4 PVT_t + b_5 Z_t + \mu_i \quad (1)$$

In which MPt is the notation for market performance, which is described with five different indicators and five different models were estimated. UNB_t reflects unbundling, IPP_t corresponds to the induction of independent power producers, PVT_t represents privatization and RB_t stands for the existence of an independent regulatory body, Z_t corresponds to other control variables introduced in the model and 't' is the time series operator.

By following the existing literature (Erdogdu, 2013; Nworie, 2017), we incorporated some important control variables that determine the electricity market performance including urbanization, i.e., total population living in urban areas, industrial electricity consumption, i.e., number of units consumed by the industry, industrial value added, i.e., industrial contribution in GDP and the number of industrial customers.

$$MP_t = a + b_1UNB_t + b_2IPP + b_3RB_t + b_4PVT_t + b_5LCUST_t + b_6LINDV_t + b_7LINDC_t + b_8LURB_t + \mu_t \quad (2)$$

The dependent and control variables were transformed by taking their logarithm for interpreting the estimated coefficients as elasticities.

Stationarity properties of data

Because we used time series data to assess the impact of structural reforms on electricity market performance, it was imperative to test for the unit root properties of the data. A standard augmented Dickey-Fuller (ADF) unit root test was employed to study the unit root properties of the variables. The ADF test estimates the following equation:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \delta Y_{t-1} + \beta_1 \Delta Y_{t-1} + \beta_2 Y \Delta_{t-2} \ldots \ldots \beta_n \Delta Y_{t-n} + \varepsilon_t \quad (3)$$

The null hypothesis and alternate hypothesis are written as:

H_0: $\delta = 0$ (There is a unit root or the time series is nonstationary or it has a stochastic trend)

H_1: $\delta < 0$ (The time series is stationary) (Gujrati and Porter, 2011)

in which Y_t is the time series under discussion and ε_t is the residual term and "t" represents the time trend. The major difference between DF and ADF is that in ADF, lags of the dependent variables are included as independent variables to take care of the serial correlation problem. In ADF, we still test the null hypothesis whether δ=0 and the ADF test also follows the same asymptotic distribution as the DF test. Therefore, the same critical values can be used for hypothesis testing. The lag length in the ADF test is determined using an appropriate lag-selection criterion. The results of the ADF test indicate that the variables of interest follow a mixed order of integration, i.e., I (0) and I(1); therefore, we resorted to the ARDL approach to cointegration for estimating the static and dynamic models.

Model specification and Estimation Technique

On the basis of the unit root results, we used an autoregressive distributed lag (ARDL) model approach to cointegration to test for the existence of long-run static relationships among variables used in the models. In the first step of the ARDL approach to cointegration, there is a need to check for the optimal lag length for the further analysis. The study applied an unrestricted VAR model and followed AIC to select the optimal number of lags to be introduced in the ARDL model.

In the second step, we estimated the following model for bound testing to check cointegration among the variables. The standard model for the test is as follows:

$$\Delta MP_t = \beta_1 + \sum_{i=0}^{n} \beta_{2i} \Delta MP_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta LCUST_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta LINDV_{t-i} + \sum_{i=0}^{n} \beta_{5i} \Delta LINDC_{t-i} + \sum_{i=0}^{n} \beta_{6i} \Delta LURB_{t-\mathrm{i}} + \beta_7 MP_{t-1} + \beta_{.8} LCUST_{t-1} + \beta_9 LINDV_{t-1} + \beta_{10} LINDC_{t-1} + \beta_{11} IPP_t + \beta_{12} PVT_t + \beta_{13} RB_t + \beta_{14} UNB_t + \mu_t \ldots \ldots \quad (4)$$

The following Wald test was used to test for the existence of cointegration among the variables:

$H_0: \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$ (No evidence of long-run relationship)

$H_1: \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq 0$ (Existence of long-run relationship)

The decision for the existence of co-integration was made on the basis of a comparison of the estimated F-test with bounds provided by Pasran et al. (2001). If the F-value (Bounds) appear to be greater than the upper bound, co-integration in autoregressive distributed lag sense existed and the variables form a static long-run relationship with each other. The error correction model to separate short-run dynamic adjustments from the long-run static relationship was also estimated in the following form.

$$\Delta MP_t = \beta_1 + \sum_{i=1}^{n} \beta_{2i}\Delta MP_{t-i} + \sum_{i=0}^{n} \beta_{3i}\Delta LCUST_{t-i} + \sum_{i=0}^{n} \beta_{4i}\Delta LINDV_{t-i} + \sum_{i=0}^{n} \beta_{5i}LINDC_{t-i} + \sum_{i=0}^{n} \beta_{6i}LURB_{t-1} + \beta_7\Delta \mathrm{IP}P_t + \ +\beta_8\Delta PVT_t + \beta_9\Delta RB_t + \beta_{10}\Delta UNB_t + \beta_{11}ECM_{t-1} + \xi_t \ldots \ldots \quad (5)$$

The residuals from the long-run static estimates were obtained and used as error correction terms with first lag in the dynamic error correction model, as given in Equation 5. In the short-run dynamic models, the lagged error correction term estimates the speed of adjustment. The value of the error correction term should be negative and statistically significant for the models to converge to the long-run static model.

Data and Data Sources

We used annual time series data from 1971 to 2016 to perform the analysis and the descriptive statistics are presented in table 1. This time period covers a sufficient number of years before and after the reforms, which were initiated in the 1990s. The data has been collected from the economic survey of Pakistan (various issues), state of industry reports by NEPRA (various reports), power system statistics, NTDC (various reports), annual reports of the State Bank of Pakistan and world development indicators (WDI) to conduct the analysis. The data on electricity generation, installed capacity and capacity utilization was acquired from the reports of the NTDC, the system operator in Pakistan. The data on the sectoral electricity prices was obtained from annual reports of NTDC (2017).

Table 1: Descriptive statistics

Variables	Mean	Maximum	Minimum	SD
No. of customers	9329881	22587870	1377789	6489565
Industrial value Added	888	2000	196	578
Urban population	31.12814	37.86	25.12	3.492776
Electricity Generation per capita	306.714	535.83	94.35	146.8593
Capacity utilization	45.42371	58.52492	30.7538	6.688536
Agri. to Industrial Price ratio	0.543276	0.852721	0.322767	0.160677
Commercial to Agri. Price ratio	3.095911	5.104167	1.572574	0.966133
Industrial consumption	9.054651	18.01	1.69	5.458529
Transmission & distribution loss	10.95047	22.77	1.99	7.005059
Price average cost margins	0.737674	2.85	-3.31	1.208864

RESULTS AND DISCUSSION

Impact of Electricity Market Reforms and Market Outcomes

The empirical analysis was performed following the standard time series analysis procedure. In the first step, an augmented Dickey-Fuller (ADF) test for checking the order of integration for each series was applied and the results are given in Table 2.

The results of the ADF unit root test indicate that the variables of interest follow a mixed order of integration. On the basis of the unit root results presented in table 2, we employed an ARDL bounds' testing approach to cointegration for estimating the static and dynamic effects of structural reforms in the electricity market on market performance indicators including electricity generation per capita, capacity utilization, transmission and distribution losses, price-average cost margins and electricity price ratios between different sectors respectively. Another reason for applying ARDL is that Johansen cointergration is based on VAR methodology which considers all variables as endogenous. However, the reform variables in our study are determined exogenously and ARDL approach to co-integration allows us to treat these variables as exogenous.

Table 2: Unit Root Test

Variable	**At Level**		**At First Difference**		**Decision**
	Intercept	**Trend and intercept**	**Intercept**	**Trend and intercept**	
LEGPC	-0.0255[0] (-2.6657)*	-0.0222[1] (-0.5074)	-0.8349[0] (-5.4332)***	-0.9965[0] (-6.3511)***	I_0
CUC	-0.2405[0] (-2.0747)	-0.2569[1] (-1.7029)	-1.1280[0] (-6.1440)***	-1.1333[0] (-6.1335)***	I_1
TDL	-0.02751[0] (-0.9127)	-0.1114[4] (-1.4318)	-1.0462[0] (-6.6928)***	-1.0529[0] (-6.6504)***	I_1
PACM	1.3781[5] (-3.3885)***	1.3842[6] (-4.4862)**	1.4027[6] (-2.1721)	-1.4856[1] (-5.9805)***	I_0
AIR	-0.0016[0] (-0.0314)	-0.0700[0] (-1.3242)	-0.9056[0] (-5.8357)***	-1.0388[0] (-6.5523)***	I_1
IDR	0.4766[2] (-2.4728)	0.3895[2] (2.6933)	-0.7885[0] (-5.09)***	-0.9564[0] (-5.9139)***	I_1
CAR	-0.0426[0] (-0.7393)	-0.0702[0] (-1.2022)	-0.9927[0] (-6.3252)***	-1.0580[0] (-6.7246)***	I_1
LINDC	-0.0317[0] (-2.9415)**	0.3723[1] (-0.6239)	-0.5820[0] (-4.6862)***	-0.6466[0] (-4.7968)***	I_0
LINDV	0.0299[0] (2.6387)	-0.0599[0] (-1.2673)	-0.7567[0] (-4.9746)***	-0.9067[0] (-5.7497)***	I_1
LCUST	0.2388[1] (-3.7354)**	0.2465[1] (-0.9572)	-0.4093[0] (-3.0738)**	-0.7668[0] (-4.988)***	I_0
LURBPO P	-0.5999[2] (-2.9753)**	0.9219[1] (-7.62)***	0.6607[1] (-0.9442)	-0.0863[0] (-1.9115)	I_0

***, **, * indicate the level of significance of test statistics at 1%, 5% and 10%, respectively, against the null hypothesis of unit root. Values in [ ] represents lag length criteria on Akaike information criterion (AIC)whereas values in ( ) represent t-test statistics of unit root.

The bound test results presented in table 3 clearly indicate that in all models, co-integration exists as critical bound value is greater than upper bound values. The results of the static model are discussed below.

Table 3: ARDL Bound Test Analysis

Variable	**Lower bound**	**Upper bond**	**Critical values**
LEPGC	4.01	5.07	5.86

PACM	2.86	4.01	4.62
CUC	3.47	4.45	4.48
TDL	3.23	4.35	7.50
AIR	2.62	3.79	6.55
ADR	2.45	3.52	3.64

Impact of Reforms Using Static Analysis

The results in section 4.1.1 and 4.1.2 are based on estimation of equation 3.4 and 3.5. Model 1 in Table 4[12] in represents the static impact of reforms in the electricity market on electricity generation per capita. The results indicate that all the control variables were statistically significant and their coefficients carry signs according to prior expectations. However, except for IPPs, all the reform variables showed an insignificant impact on electricity generation per capita. As far as reforms variables are concerned, IPPs showed a statistically significant and positive impact on energy generation per capita. The purpose of IPPs was to enhance the electricity generation and generation capacity in the electricity market to meet the increasing demand. To enhance the growth in electricity generation, the Government of Pakistan introduced a free-market approach in 1994 by establishing the laws for the induction of IPPs. The establishment of these IPPs was encouraged through two policy regimes, namely Power policy 1994, in which IPPs were allowed to develop thermal power projects, and Power policy of 2015, in which these power producers were also allowed to invest in hydro power plants. To attract investors, IPPs were exempted from withholding and income tax while they were initially allowed to charge higher tariffs, which was later changed in Power policy 2015 (Saeed et al., 2017). Our results show that the Government of Pakistan remained successful in inviting private investment in electricity generation in thermal power projects. However other reform variables including the enactment of a regulatory body, privatization and virtual unbundling appeared to be statistically insignificant in this model because the role of the regulatory body and privatization was limited in the electricity market in Pakistan.

Model 2 estimates the static impact of structural reforms in the electricity market on capacity utilization. The results indicate that industrial consumption, number of customers and the urban population have a statistically significant impact on capacity utilization. With the exception of privatization, all reforms variables had a positive and statistically significant effect on capacity utilization. Our results indicated that the implementation of reforms elements of IPP, UNB and RB lead to an increase in capacity utilization by approximately 4.56%, 7.12% and 14.08%, respectively. These results confirmed our earlier conjecture that reforms have remained successful in this regard because one of the objectives of the reforms was to optimally utilize the existing resources. Unlike Nagayama (2010), we found a positive and significant effect of unbundling on capacity utilization in Pakistan. Our static analysis showed that privatization of state-owned electricity utilities had an insignificant impact on capacity utilization, which was owing to the fact that privatization was limited only to a couple of companies, namely, Kot-Addu Power Company (KAPCO) and Karachi Electric Supply Co. (KESC), who have shown the least interest in enhancing their generation capacity (Saeed, 2013).

Model 3 showed the static impact of reforms on transmission and distribution losses. The independent power producers and unbundling had a negative impact on T&D losses whereas privatization and the regulatory body contributed to transmission and distribution losses. Unbundling resulted a significant reduction in T&D losses, indicating that reforms played an

[12] We also tried to use the cross products of individual reforms' steps following many cross-country studies (Erdogdu, 2011, Nagayama, 2010, Zhang et al., 2008); however, they were omitted during analysis owing to a collinearity problem.

important role in reducing such losses. Furthermore, a decline of 3.09% in distribution losses was observed after privatization of the electricity market. However, this variable was not statistically significant in our static analysis, which was consistent with Nagayama (2010). Moreover, our results indicated that independent power producers play an important role in reducing losses. As indicated in the literature, independent power producers inject investment in the sector, which results in an increase in operational and administrative expenditures, which further reduce T&D losses (Bhatia & Gulati, 2004). The regulatory body makes a significant contribution on the T&D losses, indicating a limited implementation of electricity reforms because an autonomous regulatory body in Pakistan is not properly enacted, which leads to an increase in T&D losses. These results were consistent with Nagayama (2010).

The static analysis of reforms on the price average cost margin (Model 4) showed that all our economic variables were negatively associated with the price-average cost margin except for the number of customers. Our result indicated that owing to 1% increase in the number of customers, the price-average cost margin increases by 31.48 units. This seems to be a policy issue associated with government's subsidy reforms, reflecting in increasing price–cost margins. Reforms variables negatively affected the price-average cost margin, but this relationship was statistically insignificant. The sign of the coefficients of the reform variables were in line with those reported by Erdogdu (2011). However, Erdogdu (2011) found a negative significant effect of IPPs, unbundling, regulatory body and privatization on cross-subsidies. The theory states that when reforms are implemented, prices are adjusted to their equilibrium level and if prices are high in the pre-reform period, they move downward and vice-versa (Nagayama, 2007; Erdogdu, 2013). The sign of the reform's variables was in line with theory but their insignificance indicated that reforms had no statistically significant impact on price-average cost margin. This insignificance of reforms can be attributed to the fact that even after disintegration of a vertically integrated industry, the distribution companies were not independent in setting the prices for electricity and they had to rely on the government for the price setting. The government, keeping in view its fiscal space and policy to subsidize different sectors of the economy, determined the electricity price levels.

To estimate the static impact of reforms variables on price ratios between different sectors of the economy, two separate models were estimated. Model 5 estimated the static impact of reforms on the agricultural to industrial electricity price ratio, whereas model 6 measured the impact of reforms on the industrial to domestic price ratio. The literature indicates that these price ratios should decrease with the implementation of reforms (Joskow, 1998; Nagayama, 2007; Victor and Heller, 2007; Steiner, 2001). The results of the static analysis indicated that independent power producers and the regularity body remained insignificant in these models. However, unbundling and privatization reflected a negative and statistically significant effect on the industrial to domestic price ratio and the agricultural to industrial electricity price ratio, respectively. These results were consistent with (Nagayama,2009; Victor & Heller (2007); Kridel et al., 1996). These results showed a mixed impact of reforms on sectoral prices, which led us to the overall conclusion that electricity reforms in terms of price adjustment in different sectors were not completely effective.

Table-4: Static Model Results

Ind. Variables.	LEPGC (Model 1)	CUC (Model 2)	TDL (Model 3)	PACM (Model 4)	AIR (Model 5)	IDR (Model 6)
LINDC	0.31*** (0.08)	52.07*** (21.55)		-12.23** (5.01)	-0.39 (0.56)	-0.51 (1.19)
LURBPOP	1.39** (0.67)	-403.95** (169.13)	61.78 (38.81)	-30.17*** (10.49)	-8.44** (3.78)	-0.97 (3.28)
LINDV	0.30** (0.13)	17.14 (21.55)	-62.45** (24.88)	-10.31 (6.55)	-75.05*** (25.36)	49.31** (24.70)
LINDV2					1.29*** (0.43)	-0.91** (0.46)
LCUST		83.83** (36.50)	21.14** (9.94)	31.48*** (8.63)	8.76*** (3.45)	1.48 (2.02)
IPP	0.06** (0.03)	4.56** (2.29)	-0.71 (1.89)	-0.92 (0.83)	0.11 (0.09)	-0.24 (0.19)
UNB	-0.02 (0.02)	7.12*** (2.46)	-6.60* (3.71)	-1.69 (1.13)	-0.05 (0.12)	-0.54** (0.22)
PVT	0.008 (0.044)	1.98 (4.15)	3.09 (1.98)	-1.33 (1.27)	-0.32* (0.18)	0.61 (0.67)
RB	0.03 (0.02)	14.08*** (3.68)	2.28* (1.26)	-0.21 (0.79)	0.07 (0.09)	-0.24 (0.20)
C	-26.5*** (9.45)	5045.92** (2127.91)	369.98* (206.98)	373.50* (138.51)	1092.1*** (376.4)	667.9* (360)
TREND	-0.05** (0.021)	4.39 (2.99)				

Note: *** ,** and * represents significant level of 1% and 5% and 10%, respectively, whereas standard errors are shown in parenthesis

Impact of Reforms Using Dynamic Analysis

Compared with static analysis, for estimating the dynamic impact of electricity reforms, the dynamic distributed lag model was employed in line with the work by Schober (2013). These results are presented in Table 5.

The findings of the dynamic impact of reforms on electricity generation per capita indicated that only industrial value added had a positive and significant effect on electricity generation whereas all other control variables remained insignificant in this analysis. As far as reforms variables are concerned, independent power producers positively and significantly contributed to energy generation per capita. All other reform variables in Model 7 had insignificant impact whereas the negative sign of unbundling contradicted the theory because the theory states that unbundling encouraged private investment in the sector, which further increased the generation capacity (Cropper et al., 2012). Overall, our dynamic nature of reforms on energy generation per capita indicated the ineffectiveness and poor implementation of reforms in the short-term. The negative coefficient of the ECM term indicated that the model converged toward long-run static behavior with a speed of adjustment of 71%.

The dynamic impact of reforms on capacity utilization (Model 8) showed that industrial consumption at its optimal lag had a significant impact on capacity utilization, indicating that owing to an increase in industrial consumption, electricity generation companies efficiently utilize their existing resource, which results in an increase in capacity utilization. The size of the urban population has a significant effect on the capacity utilization of the electricity market in dynamic analysis; an increasing urban population results in a decrease in the capacity utilization of electricity, which is contrary to economic theory. The industrial value added and the number of customers both had a significant and positive effect on capacity utilization. The dynamic analysis of the impact of reforms on the capacity utilization model showed that with the exception of privatization, all reform variables were positive and statistically significant. The model showed the convergence of the dynamic nature of the reforms toward static behavior at a speed of adjustment of 93%.

The dynamic analysis of transmission and distribution losses (Model 9) showed that transmission and distribution losses decreased owing to an increase in industrial consumption. In contrast, an increase in urban population, industrial value added and number of customers significantly contribute to transmission and distribution losses. These results were substantiated by the findings of Mirza et al., (2015), who found a positive relationship between number of customers and electricity theft (non-technical cause of T&D loss). The analysis of reforms variables showed that only unbundling had a significant effect on T&D losses whereas the other reforms were insignificant. The coefficient of unbundling showed that with the implementation of these reforms, transmission and distribution losses decreased. These results were in line with (Bhatia & Gulati, 2004; Nagayama, 2010; Zhang et al.,2008). Conversely, the positive sign of privatization revealed that private entities contributed to T&D losses, which indicates the presence of hurdles in the privatization policy created by bureaucrats and insufficient measures taken by private investors, owing to which they were unable to improve their operational and financial efficiency, which results in further increase in transmission and distribution losses. The negative and significant coefficient of the ECM term indicates the convergence of dynamics toward static behavior with a speed of adjustment of 66%.

The results of Model 10 showed that the urban population and industrial value added at their optimal lag have significant and positive impact on price-average cost margins. The positive coefficients of the urban population and industrial value added indicate that these factors are creating demand pressure and have forced the authorities to provide electricity at even higher prices in the presence of government subsidies. As a result, inappropriate price agreements take place, which increase the price–cost margins rather reducing them. The dynamic nature of reforms on the price-average cost margin showed that only unbundling had a negative and statistically significant effect on the price–cost margin. These results indicate that the reforms have not played any role in improving this performance indicator. These results were consistent with Steiner (2001), who found restricted association of unbundling with lower prices. This means that high prices are charged by government, i.e., electricity is provided at the cost of consumer welfare loss. Erdogdu, (2011) argued that the rate of return regulation for tariff determination contributed to the accumulation of deadweight welfare loss owing to a monopoly price. Therefore, electricity reforms provide an incentive to DISCOs for cost reduction. The ECM term showed the convergence of the dynamic model towards the long run static nature of reforms with a speed of adjustment of 62%.

The results of Model 11 showed that the size of the urban population had a negative impact on the agricultural to industrial electricity price ratio, indicating the dynamic relationship between the urban population and the price ratio. Therefore, an increase in urban population initially increases the agricultural to industrial electricity price ratio, whereas after two periods the ratio decreases. In contrast, the industrial value added verified the dynamic nature of this variable on the agricultural to industrial electricity price ratio. The square term of the industrial value added was included in the model to capture the nonlinear relationship between the variables. The negative sign of the squared term in the industrial to domestic electricity price ratio showed that the relationship between industrial production and the price ratio changes in the same year, whereas in the agricultural to industrial electricity price ratio, the turning point is achieved after three years. Similarly, the number of customers had a negative and significant impact on the agricultural to industrial electricity price ratio at different lags showing the dynamic effect of the number of customers on the price ratios. An increase in the number of customers increases the agricultural to industrial electricity price ratio in the same year, whereas after a year passes, a further increase in the number of customers decreases the price ratio. Model 12 captures the dynamic analysis of the reforms on the industrial to residential electricity price ratio. The coefficient of industrial consumption and industrial value added showed a negative and significant effect on the industrial to residential electricity price, which indicated that owing to an increase in industrial consumption and industrial value added, the price ratio for industrial to residential electricity consumption decreases. The dynamic analysis of reforms on the price ratio of two sector showed that privatization is negatively and significantly affecting the agricultural to industrial electricity price ratio. All other reform variables are insignificant showing that reforms had limited effect on price setting mechanism of the sector. The dynamic analysis of the reforms on the industrial to domestic electricity price ratio showed an insignificant impact of reforms on the price ratio in the sector. Unbundling was the only reform variable that had a negative and significant impact on the performance indicator in the sector. Steiner, (2001) found the same effect of unbundling on the price ratios, whereas Hattori and Tsutsui, (2004) found that initially, reforms lowered the commercial prices but increased the sectoral price difference between industrial and residential consumers. The price ratio models also showed the convergence from dynamic behavior to static behavior with a speed of adjustment of 45% and 43% in agricultural to industrial and industrial to domestic electricity price ratio, respectively. Privatization had no impact on the price ratios whatsoever, IPPs had a statistically significant impact on generation capacity and capacity utilization and unbundling had a statistically significant impact on capacity and T&D losses. The remaining reform variables played no role.

Table-5: Dynamics Analysis Short Run ECM Model

Variables	ΔLEPGC (Model 7)	ΔCUC (Model 8)	TDL (Model 9)	PACM (Model 10)	AIR (Model 11)	IDR (Model 12)
Δ(TDL)t-1			-0.45** (0.23)			
Δ(IDR)t-1						-0.37*** (0.11)
Δ(TDL)t-2			-0.45*** (0.13)			
Δ(TDL)t-3			-0.38*** (-2.88)			
Δ(PACM)t-1				-0.36 (0.22)		
Δ(PACM)t-2				-0.88*** (0.26)		
Δ (LINDC)	0.22 (0.15)	48.74*** (8.26)	-7.73* (4.17)	-1.31 (2.27)	0.27 (0.27)	-1.68*** (0.45)
Δ (LINDC)t-1			-11.09* (5.95)		0.24 (0.30)	
Δ (LINDC)t-2			8.80** (4.24)			
Δ (LURBPOP)	0.98 (0.68)	-378.07*** (138.03)	1096.04*** (216.01)	496.34*** (172.05)	9.30 (16.37)	-0.42 (1.41)
Δ (LURBPOP)t-1				232.48 (141.47)	79.72*** (24.12)	
Δ (LURBPOP)t-2					-47.03*** (11.68)	
Δ (LINDV)	0.212* (0.08)	30.86 (21.46)	-5.45 (7.11)	2.86 (2.80)	-40.48*** (14.40)	20.94 (12.79)
Δ (LINDV)t-1		64.03*** (21.04)	6.68 (6.21)	-1.22 (2.54)	-17.59 (11.51)	-1.61*** (0.31)
Δ (LINDV)t-2		-14.30 (21.57)	19.04*** (6.12)	10.13*** (3.44)	-18.81*** (6.17)	
Δ (LINDV)t-3		-38.75 (24.26)	7.62* (4.36)		17.79*** (6.00)	
Δ (LINDV2)					0.72*** (0.23)	-0.39* (0.23)
Δ (LINDV2)t-1					0.32 (0.20)	

Δ (LINDV2)t-2					0.35*** (0.11)	
Δ (LINDV2)t-3					-0.31*** (0.10)	
Δ (LCUST)		78.46*** (29.10)	14.06** (7.62)	8.41 (4.99)	1.53*** (0.41)	0.68 (0.83)
Δ (LCUST)t-1					-1.12*** (0.39)	
Δ (LCUST)t-2					-0.55* (0.30)	
Δ (LCUST)t-3					-0.94** (0.40)	
Δ (IPP)	0.04** (0.02)	4.27** (1.95)	-0.47 (1.16)	-0.57 (0.46)	0.05 (0.04)	-0.11 (0.06)
Δ (UNB)	-0.02 (0.02)	6.67*** (2.17)	-4.39*** (1.43)	-1.05** (0.43)	-0.02 (0.05)	-0.23** (0.11)
Δ (PVT)	0.005 (0.03)	1.85 (3.83)	2.05 (1.38)	-0.83 (0.62)	-0.14** (0.06)	0.26 (0.24)
Δ (RB)	0.02 (0.02)	13.18*** (2.51)	0.51 (1.08)	-0.13 (0.47)	0.03 (0.04)	-0.10 (0.09)
Δ (TREND)	-0.03 (0.02)	4.11 (2.66)				
CointEq(-1)	-0.71*** (0.16)	-0.93*** (0.11)	-0.66*** (0.20)	-0.62*** (0.22)	-0.45** (0.10)	-0.43*** (0.14)
Diagnostic Tests						
R square	0.99	0.89	0.99	0.96	0.99	0.97
Probability	0.00	0.00	0.00	0.000	0.000	0.000
F. Statistic	1806.7	14.18	106.24	30.38	54.66	82.40
Serial correlation LM test	0.08 [0.92]	2.97 [0.07]	13.96 [0.12]	5.05 [0.23]	12.75 [0.09]	1.06 [0.36]
Normality Test Jorque-Bera	0.017 [0.99]	0.61 [0.73]	3.54 [0.17]	0.97 [0.61]	0.74 [0.69]	0.26 [0.26]
Heteroskedasticity Test (BG)	0.75 [0.66]	0.82 [0.64]	3.18 [0.00]	0.91 [0.56]	0.73 [0.75]	1.49 [0.18]

Note: *** ,** and * represent significant level of 1% and 5% and 10%, respectively, whereas standard errors are shown in parenthesis. F-value for test statistics are given in the table and probability values to reject null hypothesis of the correct specification are given in brackets

CONCLUSION

This work is an attempt to empirically analyze the impact of structural reforms in the electricity market of Pakistan on its operational and financial performance from an economic perspective by developing econometric models. Electricity market reforms have been adopted by many developing countries with the ambition to improve the performance of the electricity markets to benefit the end users by ensuring continuous and reliable supply of electricity for commercial and domestic economic activities.

We have analyzed the impact of structural reforms in the electricity market on capacity utilization, electricity generation per capita, transmission and distribution losses, price-average cost margins and electricity price ratios between different sectors of the economy using time series data from 1971 to 2016. The impact of the reforms was studied under static and dynamic model settings to capture long run and short run impacts of the reforms. The results were supported with standard diagnostics, which validated the findings and signified appropriate policy recommendations.

The estimation results indicated that the electricity market reforms in Pakistan had limited success because electricity reforms have largely remained ineffective at impacting the performance indicators except for IPPs, capacity utilization and transmission and distribution losses in selected dimensions of the market performance. IPPs significantly contribute to increasing electricity generation per capita whereas other reform variables have not shown any significant contribution to this indicator. This leads us to the conclusions that because IPPs are governed by independent private investor entities, these entities contribute to improving the performance of generation companies. The electricity reforms, including the introduction of IPPs, unbundling of the monopoly and the introduction of a regulatory body, significantly contribute to the enhancement of the capacity utilization of the sector and play a significant role in reducing the losses incurred during electricity provision. Similarly, electricity reforms made no significant contribution in determining the price-average cost margins and sectoral price ratios. The reason for this failure lies in the fact that electricity prices in Pakistan are administratively determined owing to which reforms have remained unsuccessful in adjusting electricity prices in different sectors.

Given the above-mentioned conclusions, in this section of the study the policy recommendations have been presented as a consequence of the estimated results to improve the operational and financial performance of the electricity market of Pakistan.

First, it is suggested to policymakers to introduce more reforms for enhancing the efficiency of the electricity market. The role of government in the decision-making process should be minimized for enhancing the competition in different segments of the market. In this regard, one possible reform is to empower the regulatory body by reducing the control of government and allowing the regulatory body to take autonomous decisions for creating competition among different market players. Policy makers need to ensure the autonomy of NEPRA in the decision-making process. These policy actions should focus on designing separate authorities for the generation, transmission and distribution network to remove the overlay of authorities.

Second, competition in the electricity generation market should be increased by creating a day-ahead market, balancing market and intraday market, which allow bilateral trading outside the pool. These fundamental changes in the electricity market can enhance the efficiency of generation companies because their contracts are based on supply contracts that allow them to meet electricity demand by independently determining their output target (Learner, 2000; Blok,2005) and market-determined electricity prices.

Third, more competition is essential to enhance the operational activities of distribution companies, which is only possible by privatizing these distribution companies. Another possible reform is separation of the distribution channel from retailing. The electricity market in Pakistan is operating in the wholesale market, in which distribution companies purchase electricity from generation companies and sell it directly to the consumers (only the largest consumers are allowed to directly buy electricity from generation companies). Conversely, in the retail market, consumers may be allowed to choose their suppliers, whereas in the wholesale market only the largest consumers may be allowed to purchase from generators. Disentangling the distribution channels from the retail market would allow each consumer to purchase electricity from a retailer. This structure also minimizes the local monopoly of distribution companies and raises competition among them while a monopoly function remains only in the transmission and distribution network. In this competitive market, retail prices are not regulated because consumers have the power to change the retailer when they charge high prices (CPPA, 2018).

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