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Modeling economic policy issues

An assessment of power sector reforms and utility performance to strengthen consumer self-confidence towards private investment

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ABSTRACT

Pakistan's power sector has undergone significant reforms since 1994 to improve technical and financial performance. This study aims to measure the post-reform efficiency dynamics of electricity distribution utilities from 2015 to 2019 by taking Islamabad Electric Supply Company (IESCO) as a case study. The study also assesses the role of consumers' self-confidence in a particular business environment to participate as investors in the electric utility sector. The total factor productivity index and PLS-SEM approach were applied to validate the framework empirically. Results from the former show negative growth, as all index components remained negative except for efficiency change. It has been concluded that the standard of governance improves the business environment of the utility sector, which does not adequately describe the industrial performance of Pakistan's utility sector. Moreover, consumer self-confidence (e.g., information acquisition confidence and social outcome confidence) significantly mediates between the business environment and industrial output. Thus, consumer self-confidence is a prerequisite to maximizing industrial growth in the utility sector. Practitioners should launch a policy framework to enhance consumer self-confidence in the local context and, as a result, enhance the electric utility sector's industrial growth.

1. Introduction

The power sector of Pakistan has seen a major overhaul in the last 25 years. These changes were needed due to the insufficient power generation, poor structure, lack of private investors, and inadequate methods for the power sector's governance. One of the most important of these reforms was the correct division of the state-owned vertically integrated monopoly (Baloch et al., 2019). According to these reforms, WAPDA (Water and Power Development Authority) was divided into DENCOs, NTDC, and DISCOs (i.e., Generation Companies, National Transmission and Dispatch Company, and publicly owned distribution utilities, respectively). Similarly, the National Electric Power Regulatory Authority (NEPRA,

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2018) was formed as an independent regulating body in 1997. Although massive efforts have been made to improve the power sector, the country still faces challenges, such as severe distribution losses, inability to recover bill costs, lack of investments for the distribution structure, and lack of experience in the work force (Grainger and Zhang, 2019).

The private sector is not showing sufficient interest in investing in the power sector because of several risks and the long-term approach of the projects (Taghizadeh-Hesary and Yoshino, 2019, 2020). Governments for promoting the private sector's investment in these projects need to incentivize them by covering the risks and increasing the rate of return (Yoshino et al., 2019). Through power sector reforms, private investments in the electric utility sector aim at increasing energy efficiency through the post-reform agenda (Arowolo and Perez, 2020). This study aims to analyze the power sector reforms to achieve energy efficiency through private investments. The electric utility sector of Pakistan has a vital role in its economic development, both in terms of the business environment and industrial output. For instance, the utility sector's energy consumption rose from 75.2% (2001) to 99.65% (2019) in the last 18 years, reflecting almost a hundred percent energy consumption (Akber et al., 2017), which is many folds above the global average (∼31%) (Abdullah et al., 2020). Notably, with a rise of 0.8% from the previous year, the industrial growth in 2020 was 7.9% of the GDP, which implies a broader reliance of Pakistan's industry on the energy sector (Poudineh et al., 2020).

Moreover, the utility sector has a vital role in the development of the local business environment. Therefore, the electric utility sector is essential to developing the industrial sector and its sound economic growth. Pakistan produces most of its energy through traditional fossil fuels, which should be replaced by efficient green energy methods (Aized et al., 2018). This high dependence on a single source can trap the country's economic growth with serious challenges (Shabbir et al., 2020; Irfan et al., 2019). Hence, some researchers propose using green energy generation to enhance energy production to contribute to the country's growth (Zafar et al., 2018).

Energy efficiency is the most crucial aspect of the electric utility sector, having a vital role in the flexibility of prices, energy demand, and energy security (Malik et al., 2020). It can be argued that South Asia's private investment execution strategy for the electric utility sector influences energy efficiency positively. Electric power consumption indicates that the local electric utility price elasticity boosted to 7.80% in reaction to a 1% rise in electric utility consumption on average. Private power-producers promote competition in the power market, leading to a decline in the price of energy for industrial customers; however, some researchers advocate government subsidies as the primary cause for the negative GDP-to-industrial price relationship (Nagayama, 2009).

In the context of the above discussion, this work evaluates consumers' self-confidence towards private investment in the electric utility sector to encourage private investors in Pakistan's utility sector. A private investor's greatest concern is to manage the required electricity supply through the necessary infrastructure with minimum funds. To the best of the authors' knowledge, this is the first work evaluating consumers' willingness towards private investment in Pakistan's utility sector. A consumer-oriented approach was adopted, where post-reform electricity utility distribution efficiency was analyzed from 2015 to 2019 through the data from Islamabad Electric Supply Company (IESCO). The power sector utilities' efficiency has been determined through the directional distance function. Accurate analysis is established in the context of government, industry, and the consumer. The study aims to close the research gap by encouraging private investments to improve energy efficiency in the electric utility sector. Quoting Wüstenhagen and Menichetti (2012), "Thinking about ways to identify relevant private investment may increase the efficiency and effectiveness of public policies to leverage private capital for the growth of the renewable energy market". More precisely, the following research points should be considered: energy efficiency affected by private investment in the electric utility sector; and the interaction of private investment factors with utility sector heterogeneity in terms of the effect on energy efficiency in large utility energy projects.

The study highlights several important aspects of post energy reforms in Section 2, the research methodology in Section 3, results and discussion in Section 4, and conclusion and policies in Section 5.

2. Literature review and background

2.1. Electricity infrastructure

Electric distribution utilities carry electricity from medium voltage grids to low-voltage grids and consumption nodes. The distribution network in Pakistan consists of 10 distribution utilities and K-Electric. Under the single buyer model, the Central Power Purchase Agency (CPPA) takes electricity from all available resources, including WAPDA hydro, independent power producers, public sector generation companies (GENCO's), nuclear plants, and imports. According to the National Electric Power Regulatory Authority (NEPRA, 2018), the total installed capacity of electricity generation in Pakistan is 25,100 MW with a 63.96% share of thermal, 26.70% hydel, 4.54% nuclear %, 3.03% wind, 1.23% solar, and 0.94% bagasse (Ahmed et al., 2019). Due to the excess use of fossil fuels, Pakistan's natural reserves are significantly decreasing, and a recent report predicts that natural gas reserves will be at 25%–30% by the year 2027–28. Moreover, the recovery of electricity bills from end-consumers declined to 85% compared to 94% in March 2019. The remittance to CPPA dropped 11.3% from the power distribution companies, and industrial and commercial electricity consumption fell 25% and 27%, respectively (Ullah et al., 2019).

Fig. 1 shows Pakistan's national energy mix. Pakistan's average electricity demand is 17,000 MW; however, the actual power generation in any season is 14,000 MW, leaving an average deficit of 3000 MW that can increase to 5200 MW in the summer.

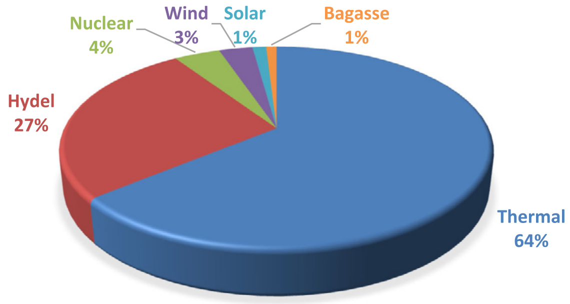

Fig. 1. National energy mix.

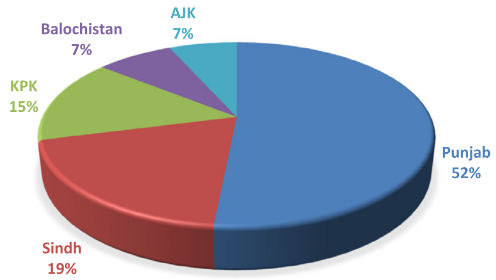

Fig. 2. Province wise installation of the energy mix.

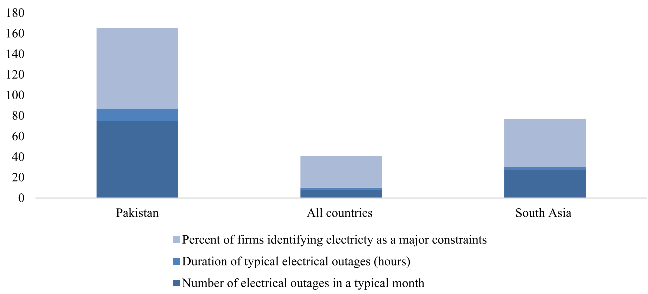

Fig. 3. Comparison of electric outages.

Fig. 2 shows the province-wise installation of the energy mix. The installed capacity of electricity production is dominated by Punjab province, at 52%, followed by Sindh (19%), KPK (15%), Baluchistan, and Azad Jammu Kashmir (7%), respectively. In many developing countries, a significant barrier to economic growth is an unreliable electricity supply. Electricity shortages in South Asia are prevalent, with the average firm experiencing nearly an outage per day, lasting roughly 5.3 h each. Within South Asia, Pakistan has the most severe power shortages, with the average firm reporting 2.5 outages each day for an average total daily duration of 13.2 h. More than 75 percent of the country's firms identified a lack of reliable electricity as a primary constraint to their operation and growth (Shahid et al., 2020).

Fig. 3 shows the comparison of electricity outages. Additional hours per day of expected outages (scheduled blackouts) and unexpected outages decrease revenues by nearly 1.3% and 10%, respectively. Similarly, an increase in unexpected outages by an hour per day decreases value added at the firm level by roughly 20% and increases the labor share of output. The impact for a similar amount of expected outages is significantly smaller, likely due to predictability and firm adaptation (Jamil, 2020).

2.2. Governance quality, business environment, consumer self-confidence, and utility sector reforms

By the early 1980s, the poor performance of vertically integrated electricity sectors motivated many countries (developed and developing) to implement reforms towards market-oriented institutional frameworks (Nagayama, 2007). Before reforms, developed countries had surplus capacity, expensive generation mix, high prices, and inefficient production. In contrast, developing countries suffered from capacity shortage, inefficient production, subsidies, and poor governance of utilities (Urpelainen and Yang, 2019). Weak governance and utility sector reforms in the region can be traced to government ideologies about the state's role in the economy. Studies have indicated that higher potency of governance quality (GC) promotes security and reduces corruption (Brewer and Walker, 2011), accounting practices (Abdu and Debajie, 2019), public-service quality (Ilhaamie, 2010), internal capabilities, and performance.

Business environment (BE) is stipulated on the grounded realities of organizational strategic focus, which leads an organization to the growth or decline stage. The business environment has multiple growth constraints, including access to funds, business conditions and market fundamentals, environmental paradigms, gender, firm employment, and incubation plans (Mohamed Badawy, 2015). However, Sujatha and Devi (2016) pioneered developing the relationship between the business environment and consumer confidence. This relationship is identified by following the submissions that were inadequate in justifying this relationship in general (Peña Martel et al., 2018; Cormier et al., 2017; Shang et al., 2018; Głodowska and Pera, 2019).

A psychological trait that maximizes a consumer's confidence and constructs consumer attitude towards buying intentions is Consumer Self-Confidence (CSC). In other words, consumer confidence is a divergent antecedent of consumer decision making due to self-confidence. There is a dire need to measure the relationship between consumer self-confidence and the amount of private investment in the utility sector. Thus, with its dimensions, CSC improves knowledge, the psychological state, and the consumer's cognitive rationale with the potency to maximize industrial output. Moreover, the business environment enhances consumer confidence, develops a positive image of the organization, and collectively enhances corporate and industrial output (Webb and Shu, 2013). Similar findings are observed in the Chinese context. However, endorsing the above-cited review, governance quality has a significant association with the business environment (H1), the business environment has a significant association with consumer self-confidence (H2), the business environment significantly mediates the association between governance quality and consumer self-confidence (H3), consumer self-confidence has a significant association with industrial output (H4), and consumer self-confidence significantly mediates the association between the business environment and industrial output (H5). By reviewing the above-cited literature and developing a conceptual framework, the consumer confidence theory (CCT) is used as a theoretical base for this research. CCT elaborates on consumers' psychological status about their financial satisfaction and understanding of the overall state of the provided services.

3. Methodology

3.1. Data collection and sampling

A two-fold data collection technique was used, where the data was collected from the databases of the World Development Indicators (WDI), World Bank privatization in infrastructure, and Pakistan Bureau of Statistics, and our adapted scale of consumer-self confidence from Bearden et al. (2001). This scale is already used in the context of information sharing and knowldge intention in Pakistani context Zubair et al. (2019) which was used to collect consumer self-confidence data. Secondary sources for data collection were used because of data availability, reliability, and sufficiency (World Bank, 2017). The sample range starts from July 2019 to April 2020, while for the multifactor productivity index, data from the annual reports of IESCO from 2015 to 2019 were used. Moreover, in primary data collection via a questionnaire, the authors used simple random sampling for response acquisition, and a brief questionnaire on consumer self-confidence was shared with electricity consumers in highly populated areas of southern Punjab, Pakistan (i.e., Multan, Bahawalpur, Rahim Yar Khan, Muzaffar Garh, D.G. Khan, and Layyah). The questionnaire is shared with 1500 electricity-consuming households, out of which feedback from 800 households was received (i.e., response rate = 53.33%). Economic conditions, demand for legacy fossil fuels, and geopolitics are the major challenges. Active and innovative financial recovery and energy efficiency are the key factors that contribute to fast economic development. Some investments, such as subsidizing energy savings in residential buildings, help speed the recovery in the construction sector, and mitigate CO_2 emissions. Still, some investments may be at odds with these objectives. Accelerating the transition should not take place at the expense of a slower recovery, as this could create supply and demand imbalances undermining both conventional and green energy.

3.2. Study instruments and analysis

Government quality is measured by taking government quality antecedents developed by Kauffman et al. (2010) and a governance quality datasheet. Loading values above 0.70 indicate that the construct explains more than 50% of the indicator's variance, demonstrating a satisfactory degree of reliability. The next step involves the assessment of the constructs' internal consistency reliability. When using PLS-SEM, internal consistency reliability is generally evaluated using (Jöreskog and Wold, 1982) composite reliability ρ_c, which is defined as follows (for standardized data):

$$\rho_c = \frac{\left(\sum_{k=1}^{K} I_k\right)^2}{\left(\sum_{k=1}^{K} I_k\right) + \sum_{k=1}^{K} Var(ek)} \tag{1}$$

Where k symbolizes the standardized outer loading of the indicator variable k of a specific construct measured with K indicators, *ek* is the measurement error of indicator variable k, and Var(*ek*) denotes the measurement error variance. For the composite reliability criterion, higher values indicate higher levels of reliability. For instance, researchers can consider values between 0.60 and 0.70 as "acceptable in exploratory research", whereas results between 0.70 and 0.95 represent "satisfactory to good" reliability levels (Sun et al., 2019). However, values that are too high (e.g., higher than 0.95) are problematic, as they suggest that the items are almost identical and redundant. The reason may be the same or similar item questions in a survey or undesirable response patterns such as straight-lining (Krasker, 1986).

$$\alpha = \frac{K.\bar{r}}{[1 + (K-1).\bar{r}]} \tag{2}$$

The next step in assessing reflective measurement models addresses convergent validity, which is the extent to which a construct converges in its indicators by explaining the items' variance. Convergent validity is assessed by the Average Variance Extracted (AVE) across all items associated with a particular construct and is referred to as a communality. The AVE is calculated as the mean of the squared loadings of each indicator associated with a construct.

$$AVE = \frac{\left(\sum_{k=1}^{K} I_k\right)^2}{K} \tag{3}$$

Where l_k and K are explained above. An acceptable threshold for the AVE is 0.50 or higher. Thus, three main dimensions measure and represent governance quality included here (i.e., political indicators of stability, the rule of law dimensions, control over corruption, and effectiveness indicators of the Pakistan government). The business environment is computed by taking two instruments (Agboyi and Ackah, 2015), the globalization index and the economic freedom index. Industrial output is measured by taking WDI indicators (World Bank, 2018). Moreover, consumer self-confidence is scaled on a five-point Likert scale (1=strongly disagree to 5=strongly agree) (Anaza and Rutherford, 2014), having the reliability value $\alpha = 0.876$. Moreover, contractual risk willingness is scaled by using the mean liberalization index (Chang et al., 2017).

3.3. Multifactor productivity

The directional distance function (DDF) DEA introduced by Chambers et al. (1996, 1998) is defined as

$$\vec{D_T} = \left(X, Y, g^X, g^Y\right) = Sup\{\theta | \left(X - \theta g^x, Y - \theta g^y\right) \varepsilon T\} \tag{4}$$

Where $(g^X, g^Y)\varepsilon R_+^{m+s}$ is a direction vector. The DDF is a general functional representation of the technology: assuming g-disposability (see Färe et al. 2005), the production possibility set T is,

$$T = \left\{(X, Y)\, \varepsilon R_+^{m+s} | \vec{D_T}\left(X, Y, g^X, g^Y\right) \geq 0\right\} \text{For any } (g^X, g^Y)\varepsilon R_+^{m+s} \tag{5}$$

while the DDF is commonly used as a measure of technical inefficiency. In this study, the DDF was used as a functional representation of production possibilities. DDF contains the conventional radial input or output distance functions as its special cases. Specifying the direction vector as $(g^X, g^Y) = (X, 0)$, DDF is equal to one minus the input distance function. Similarly, the output distance function is obtained by setting $(g^X, g^Y) = (0, Y)$. DDF inherits the axiomatic properties of the production set T (Chambers et al. 1998, Lemma 2.2). The production probability set of the multifactor productivity model is as follows,

$$T = \left\{ (X, Y) \middle| \sum_{j=1}^{n} X_j\lambda_j \leq X, \sum_{j=1}^{n} Y_j\lambda_j \geq 0,\ j = 1, 2, 3, \ldots, n \right\} \tag{6}$$

Based on the above assumptions and production probability set, a CCR model can be obtained as follows:

$$\theta^* = \min\left[0 - \epsilon\left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_i^+\right)\right] \tag{7}$$

$$\text{st.}\ \sum_{j=1}^{n} X_{ij}\lambda_j + S_i^- = \theta X_{ij},\ i = 1, 2, 3, \ldots, m\}$$

$$\sum_{j=1}^{n} Y_{rj}\lambda_j - S_r^+ = Y_{rj},\ i = 1, 2, 3, \ldots, s$$

$$\theta, \lambda, S_i^-, S_r^+ \geq 0;\ j = 1, 2, 3, \ldots, n,$$

In formula (4), S_r^+ and S_i^- are loose variables, ε is infinite without Archimedes and is usually in the range 10–6. The formula's economic meaning is determined by λj, a variable that associates efficient DMUs to form an effective boundary. Excessive variable S_i^-, insufficient variable S_r^+, and non-zero loose variables enable effective boundaries to expand in horizontal or vertical directions to create the envelope (Mohsin et al., 2018b; Shah et al., 2019).

Table 1
R^2 and adjusted R^2.

	R^2	R^2 adjusted
BE	0.015	0.013
CSC	0.016	0.014
IO	0.768	0.767

Table 2
Reliability and validity.

	Cronbach's alpha	ρ_c	Composite reliability	Average Variance Extracted (AVE)
BE	0.932	0.957	0.948	0.648
CSC	0.932	0.946	0.941	0.507
IG	0.190	0.203	0.705	0.550
IO	0.919	0.920	0.932	0.558

Table 3
Discriminant validity (Fornell Lacker Criterion).

	BE	CSC	IG	IO
BE	0.805			
CSC	0.916	0.712		
IG	0.122	0.126	0.741	
IO	0.771	0.873	0.081	0.747

Table 4
Model fit (Fit summary).

	Saturated model	Estimated model
SRMR	0.089	0.340
dULS	6.558	94.965
dG	6.681	7.229
Chi-Square	10989.657	14595.024
NFI	0.541	0.390

4. Results and discussions

4.1. Measurement model

The factor loadings are obtained to assess convergent validity, AVE, and convergent validity uniformly. Thus, threshold criteria are standardized by the following factor loading values=0.7, and the average variance extracted should be equal to 0.5. These two fundamental criteria are the declaring factor and variance acceptance range (Blekher et al., 2019). Likewise, a value of 0.6 is also acceptable in factor scores. Following this criterion, the results indicated that the items: Governance Quality (GQ1, GQ2, GQ3, GQ4), Business Environment (BE1, BE2, BE3), and Industrial Output (IND1) explain their loading. Moreover, Consumer self-confidence is measured using two dimensions (i.e., information acquisition confidence and social outcome confidence).

Thus, items of Information Acquisition Confidence (IAC1, IAC2, IAC3, IAC4, IAC5) and Social Outcome Confidence (SOC1, SOC2, SOC3, SOC4, SOC5) sufficiently covered the criteria and explained factor loading as per set standards of explanation. However, the value of governance quality is 0.854, the business environment is 0.811, consumer self-confidence (i.e., information acquisition confidence is 0.888, social outcome confidence is 0.961), and industrial output is 0.898. The study is consistent with Sun et al. (2020a,b) in consumer preference. This criterion is used to discourage duplication among the findings, specifically in factor loadings and inter-item correlation. However, a Fornell and Lacker criterion was used (Table 2), which indicates the reliability and validity of the measurement model comprehensively.

Tables 1–5 show the empirical characteristics of PLS-SEM. VIF was also used to estimate multicollinearity in structural equation modeling. The threshold value was set at 10.0, while a higher value may lead to problems in analysis. In the present work, all construct values of VIF are below 0.5, indicating that there is no multicollinearity issue. For this, commonalities R^2 and geometric averages are incorporated for model fit prediction. R^2 belongs to endogens constructs, and the value of the study model fit is 0.015, 0.016, and 0.768 for BE, CSC, and IO, respectively, indicating a sound fitness in the following table (see Tables 6–11).

Based on the above fitness analysis, the structural modeling results confirm that governance quality has a positive relationship with the business environment (H_1: $\beta = 0.349$ with *P value<0.01), business environment positively predicts consumer self-confidence with both of its dimensions (H_2: $\beta = 0.232$ with *p. value <0.01). The business environment significantly mediates between governance quality and consumer self-confidence (H_3: with $\beta = 0.331$ *P value<0.01).

Table 5
Loading and cross loading.

Items	GQ	BE	IAC	SOC	IND
Governance Quality					
GQ1	0.728	0.845	0.661	0.783	0.788
GQ2	0.717	0.727	0.645	0.788	0.654
GQ3	0.777	0.509	0.784	0.754	0.789
GQ4	0.753	0.764	0.772	0.763	0.762
Business Environment					
BE1	0.766	0.471	0.431	0.538	0.715
BE2	0.782	0.731	0.706	0.741	0.778
BE3	0.797	0.754	0.782	0.787	0.764
BE4	0.821	0.736	0.971	0.887	0.719
Information Acquisition Confidence					
IAC1	0.784	0.701	0.708	0.766	0.763
IAC2	0.883	0.892	0.855	0.752	0.793
IAC3	0.828	0.952	0.752	0.759	0.753
IAC4	0.781	0.832	0.734	0.753	0.762
IAC5	0.776	0.821	0.717	0.762	0.719
Social Outcome Confidence					
SOC1	0.767	0.816	0.753	0.761	0.798
SOC2	0.644	0.843	0.789	0.714	0.843
SOC3	0.881	0.841	0.731	0.719	0.818
SOC4	0.504	0.881	0.761	0.914	0.837
SOC5	0.717	0.832	0.783	0.519	0.808
Industrial Output					
IND1	0.777	0.788	0.755	0.556	0.934

Table 6
Path coefficient.

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	*P* values
BE –> IO	−0.178	−0.182	0.058	3.089	0.002
CSC –> IO	1.037	1.041	0.049	21.011	0.000
IG –> BE	0.122	0.131	0.040	3.069	0.002
IG –> CSC	0.126	0.134	0.042	2.986	0.003

Table 7
Total effect.

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	*T* statistics (|O/STDEV|)	*P* values
BE –> IO	−0.178	−0.182	0.058	3.089	0.002
CSC –> IO	1.037	1.041	0.049	21.011	0.000
IG –> BE	0.122	0.131	0.040	3.069	0.002
IG –> CSC	0.126	0.134	0.042	2.986	0.003
IG –> IO	0.109	0.116	0.037	2.912	0.004

Table 8
Specific indirect effect.

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	*T* statistics (|O/STDEV|)	*P* values
IG –> BE –> IO	−0.022	−0.024	0.011	2.046	0.041
IG –> CSC –> IO	0.130	0.140	0.044	2.964	0.003

Moreover, consumer self-confidence is a significant positive antecedent of industrial output (H_4: with $\beta = 0.331$ *P value<0.01). The findings are also shown in Fig. 2. Therefore, consumer self-confidence is another mediator in this model leading to the mediation of the business environment. However, consumer self-confidence is significantly associated and mediated between the business environment and industrial output (H_5: with $\beta = 0.241$ *P value<0.01). Fig. 4 shows the industrial output.

Fig. 5 shows the business environmental index. The first type of utility considered by most investors is electricity. The concept of regulation is vital in the utility sector, as it provides both protection from competition and restrictions on unlimited pricing power. However, not all utilities and sectors within utilities are regulated. For example, many power companies have both regulated and unregulated (or commercial power) businesses. Regulated companies typically manufacture and sell electricity to individual customers and businesses and have a monopoly in a given service area. In exchange for this monopoly, utility companies must respond to regulators that approve (or reject) any request for a rate

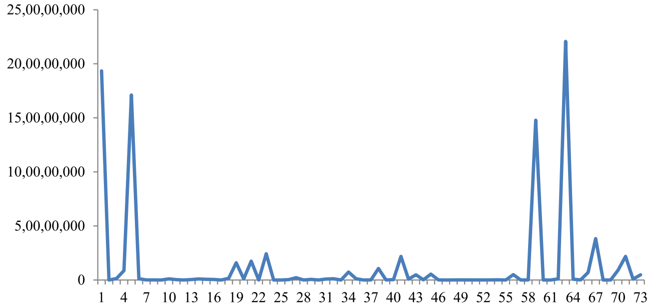

Fig. 4. Industrial output.

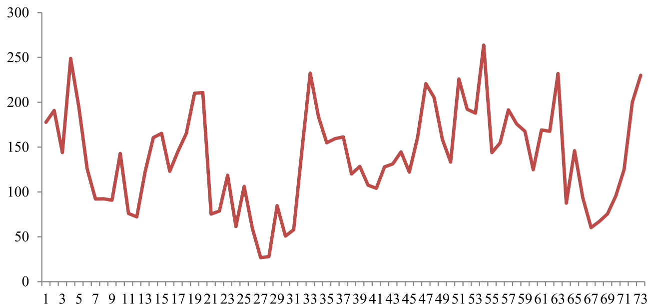

Fig. 5. Business Evi index.

Table 9
Total factor productivity growth of IESCO.

Year	Productivity growth
2015	0.92
2016	0.89
2017	1.00
2018	1.00
2019	0.83

Table 10
New license installation in 2018–19.

Licenses/Source	Capacity (MW)
Coal	336.50
Hydel	11.80
Wind	50.00
Solar	66.24
Bagasse	148.00
Solid waste	40.00
Total	652.54

hike. These requests are usually supported by the expense requirements of maintaining and upgrading the utility system. Unregulated operations often generate electricity and then sell it to other utilities. The electricity price is determined using spot exchange rates set by electricity demand or long-term contracts. The latter business is much more unstable, as the electricity demand fluctuates over time of day, time of year, and weather patterns (which are entirely unpredictable).

4.2. Total factor productivity growth

Private investors in the utility sector expect a clear pricing signal to ensure return on investment. Especially for geothermal energy, the exploration stage bears high risks, which should be compensated in the electricity price. Experience in countries successfully reforming the power sector shows the importance of private sector participation (Tian, 2018). Reforms in the power sector require changes in policies and regulations, and the participation of the private sector is an important aspect of the ideal reform structure. Well-designed pricing and tax policies also provide the potential for effective emission reduction.

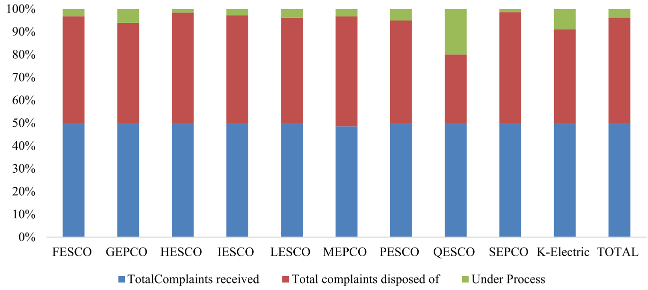

Fig. 6. Complaints record after post reforms in the electricity utility.

Table 11
NEPRA complaints redressed during the period of July 1, 2016–June 30, 2017.

DISCO	Total complaints received	Total complaints redressed	Under process
FESCO	202	189	13
GEPCO	90	79	11
HESCO	520	503	17
IESCO	172	162	10
LESCO	243	224	19
MEPCO	576	573	39
PESCO	177	159	18
QESCO	5	3	2
SEPCO	427	415	12
K-Electric	403	331	72
TOTAL	2815	2601	214

Values greater than one indicate improvement in the efficiency, whereas values less than one indicate deterioration in the efficiency. Average values of 0.40 to 0.60 indicate average efficiency levels. On average, change in total factor productivity has suggested a 10 percent decrease over the five years. The findings show that the sector is not utilizing its operation optimally, which is the major reason for its poor electricity production, distribution, and transmission performance. An additional hour per day of expected outages (scheduled blackouts) and unexpected outages decreases revenues by nearly 1.3% and 10%, respectively.

Similarly, an increase in unexpected outages by an hour per day decreases value-added at the firm level by roughly 20% and increases the labor share of output. In Pakistan, accumulated arrears of distribution companies to suppliers, commonly known as circular debt, reached about PRs 414 billion by March 2017 (Business Recorder, 2017). Circular debt has caused up to 5 GW (GW) of capacity to lie idle, accounting for almost 22 percent of Pakistan's total installed capacity (World Bank, 2015). One of the reasons is substantially inefficient power capacity; for example, the average efficiency of gas power plants in Pakistan is 30%, compared to the average efficiency of 43% for gas power plants in the United States. During 2018–19, 12 generation licenses, with a cumulative installed capacity of 652.54 MW, were issued for the following post reforms technologies.

Post reform agenda safeguarding consumers' interests and protecting them from discriminatory treatment or victimization is a vital objective of NEPRA (Fig. 8, Table 12). Hydel, thermal, and nuclear power plants consume electricity as auxiliary consumption. Total auxiliary consumption of hydel, thermal, and nuclear power plants was noted as 0.296 GWh, 3.577 GWh, and 0.6298 GWh, respectively. The dominance of thermal capacity in power generation infers that slippage of one rupee against the US dollar will increase the import bill up to 4 billion rupees annually (NEPRA, 2018). The fuel cost associated with electricity generation from coal is 4.27 R/KWh, high-speed diesel 13.67 R/KWh, furnace oil 8.73 R/KWh, gas 5.35 R/KWh, nuclear 1.01 R/KWh, and bagasse 5.47 R/KWh. Renewables (hydel, solar, and wind) contain no fuel cost, which is why the share from these resources must be increased to save billions of rupees on an annual basis (see Fig. 6).

Table 12 shows the annual compound growth rate. The extrapolated demand growth is a consequence of a rise in population and electricity consumers, improving living standards, rapid urbanization, rural electrification, and GDP growth. Pakistan's total projected electricity consumption in 2040 is 623.1 TWh, compared to 99.0 TWh in 2016. It indicates 6.3 times higher demand than the base year's value. Consumption will be highest in the domestic sector and the lowest in the public lighting sector in 2040 (Shahid et al., 2020). NTDC's official consumption forecast for 2040 is 370 TWh from four major sectors (domestic, commercial, industry, agriculture). The demand forecast for 2040 was not available from other works of literature. On the other hand, other researchers indicate the demand forecast for 2030 as 330.1 TWh (Mirjat et al. 2018), 312 TWh, and 303.7 TWh (Tareen et al., 2020).

Table 12
Annual compound growth rates.
Source: (Shahid et al., 2020).

Sectors	Annual compound growth rate %
Domestic	6.50%
Commercial	6.40%
Industry	1.90%
Agriculture	1.50%
Public lighting	0.30%
Bulk supply	2.20%
Other Govt.	22.50%
Hydel power plants	1.00%
Thermal power plants	13.80%
Nuclear power plants	22.30%

4.3. Enactment of electric utility reforms

The sector's obstruction and the investor needs remained primary triggers for altering and introducing reforms in the electric utility sector worldwide. However, South Asia adopted a different approach to electric utility sector reforms due to variation and contextual reasons. Electrification was limited only to some major industries before the second world war. State-owned vertically integrated utilities were responsible for the electricity provision in a major part of Asia before the power sector reforms. All electricity supply segments (i.e., generation, transmission, distribution, and retailing) were under the control of these state-owned utilities. Electric utility reform characteristics in selected Asian countries have been studied extensively in the literature (Ahmed and Bhatti, 2019; Singh et al., 2015; Dertinger and Hirth, 2020). Various Asian countries implemented regulatory changes in their electricity sectors in the 1980s and 1990s. The main reform measures were the unbundling of transmission and distribution generation, independent power producers (hereinafter IPPs), privatization, deregulation, and restructuring. These studies also highlight these countries' reform initiatives for a chronological transformation of their power sector.

Various aspects of this subject have been covered in the previous research; particularly, Ali et al. (2017) addressed it at the single-nation sector, while Ghosh and Kathuria (2016) discussed Indian thermal power plants' context of institutional quality. Similarly, Clark et al. (2005) analyzed the impact of power-sector reforms on African countries' economic cycle, while Ajayi et al. (2017) did the same for OECD countries Energy Statistics of OECD Countries (2015). The power sector reform is strongly interdependent in other economic sectors (Nepal and Jamasb, 2012). Regional increase in capacity-generation, transmission, and distribution losses is justified through the reform variables, such as independent players in the power sector, generation–transmission links, regulatory agencies, and the rise of wholesale spot markets (Nagayama, 2010). These studies address this relationship as a hypothesis and demonstrate the relationship between the power sector reforms and other initiatives. Studies proposing models for emerging economies to assess the power sector efficacy in developed countries are rare.

Most studies use different econometric techniques to analyze time series or panel data. Particularly, Nepal and Jamasb (2012) analyzed the macroeconomic and power-sector reform panel data through the bio-scale dynamic fixed-effects analysis (LSDVC). Simultaneously, the same was achieved in China's case through the difference-and-difference approach (Cheng et al., 2015). A similar study (Ajayi et al., 2017) used a short-term cost function to analyze the cost-effectiveness of electricity generation output by treating the capital stock as a quasi-fixed input factor.

4.4. Post-reform electricity utility sector

Since the rise of the electric utility sector, Pakistan has had a single purchaser under the regulatory supervision of the National Transmission and Distribution Company (NTDC), which gets most of the electric utilities and supplies it to 10 different distribution companies with a KESC–PEPCO collaboration. Therefore, the reforms of the electricity utility sector are inefficient and in the primary stages of implementation. The South Asian electric utility sector has achieved only one milestone in the electricity generation and electric utility market, the Independent Power Plant (IPP) project. However, the electric utility sector is still progressing slowly. Despite many federal government attempts, corporatization of unbundled services has not been achieved as the taxpayers bear these institutions' heavy financial burden (in the form of circular debt). The electric regulator's failure to develop its independence in deciding all stakeholders' rights is another unfinished agenda of the reforms. The regulator (NEPRA) is also challenged to independently carry out its assigned tasks, such as deciding tariffs for generators, transmitters, distributors, and consumers.

Unless the regulator acts independently and all state-owned entities, including generation and distribution, are privatized, the introduction of markets at the wholesale and retail level remains challenging. Notably, the pre-reform performance of the electric utility sector is similar to post-reform conditions. The South Asian electric utility sector faces high distribution and transmission losses, capacity shortages, poor pricing structure, expensive utility supply system, and inefficient subsidy framework (Malik, 2012; Malik et al. 2009; Munir and Khalid, 2012). Such issues have a strong historical background since the 1990s when South Asia reformed the electric utility sector to solve electric-utility issues. These problems already existed before the 1990s, when Pakistan reformed its power sector to solve these problems. However, the problems were not solved by institutional reforms. With the motivation to solve such issues, a recent study presented the argument to unlock private investment in the electric utility sector to boost energy efficiency.

The implementation policy of private investment will entice positive ties, boosting energy efficiency at large, and cause a reduction in electricity prices for industrial consumers by independent and private power producers. Similarly, the electricity industry's restructuring and deregulation are the main driving forces in reducing the industrial price of electricity in Pakistan and the Asian region. One of the two possible sources, (i) private investment or (ii) public–private investment, boosts energy efficiency in the electric utility sector by around 30 to 32% (Peng and Poudineh, 2017; Urpelainen and Yang, 2017). The local energy production sources, such as hydro sources, may be cost-effective, efficient, and sufficient, injected through private investment for efficient electricity utility generation, distribution, and consumption. This injection of sources would provide an efficient supply and build competition among the Asian electric utility companies in a free and competitive market. More so, this is not just a matter of competition in a free elastic market. For a better and efficient energy transition, private financing and investment act as the catalyst enhancing efficiency through different clean and green electric energy sources like renewable energy (OECD 2015).

In order to generate efficient electric utilities and power, advanced and innovative technology is required, which can lift the capacity of energy efficiency to 41.8%, indicating private investment maximization in the electric utility sector to boost energy efficiency through reforming the electricity reforms (Peng and Poudineh, 2017; Urpelainen and Yang, 2017). The prevalence of energy efficiency can be maximized through private investment. It emerges from the analysis that energy efficiency prevails in South Asia in varying degrees across geographies. The importance of electric utility industry services can be noted in the role of energy efficiency through electric and other energy generation and consumption sources in Pakistan, particularly in South Asia (Mohsin et al., 2018a; Alemzero et al., 2020b,a).

For a few decades, energy efficiency has remained important for policymakers since this industrial unit has shown a significant contribution to global electric utility consumption and carbon emission. Energy efficiency remained the utmost priority for the key stakeholders and policymakers to motivate private investment in the electric utility sector. Hence, the application of the post-reform agenda is indispensable (European Parliament, 2018). Notably, the electric utility sector upholds a big contest in allocating investment management techniques to enhance the enactment of the post-reform agenda. These agenda reforms aim to achieve climate change goals by upholding the tight financial and monetary position (Marques et al., 2019). After the wake of the post-reform agenda, emerging economies have been in a diminishing state of economic progress, which could only be achieved at the outlay of higher energy consumption, and this is a daring task for emerging economies like Pakistan for least carbon diffusion and green change. China has been the world's largest energy growth market for 18 consecutive years (BP, 2018). As the world's largest energy consumer, China has accounted for 23.6% of global energy consumption and has contributed to 34% of its energy consumption growth in 2018. It needs about 24,834 tons of oil equivalents (TOE) to produce one GDP unit (measured by 100 million USD) in 2016 (World Bank, 2019). Specifically, China's emerging intensity is 1.81 times that of Japan, and 1.86 times that of Germany, indicating a huge gap between China and less energy-intensive countries.

5. Conclusion and policy implications

Results show that governance quality has a positive relationship with the business environment, and the business environment predicts consumer self-confidence positively with both of its dimensions. Similarly, the business environment significantly mediates between governance quality and consumer self-confidence. Though consumer self-confidence is significantly associated and mediated between the business environment and industrial output, the business environment is a dynamic attribute in Pakistan's electric utility sector. In contrast, consumer confidence in the electric utility sector is a neglected aspect that needs to refocus and address industrial output maximization, which is a monopoly of WAPDA. This lack of consumer confidence can be revamped single-handedly. However, the value of governance quality, business environment, consumer self-confidence, information acquisition confidence, social outcome confidence, and industrial output has shown that standard reliability belongs to the internal consistency of items.

Eventually, WAPDA is a monopolistic utility provision corporation that supplies electricity to all households of Pakistan. However, the operational framework of WAPDA in client services is traditional, obsolete, and full of flaws that need improvement categorically. Moreover, the electric utility sector controls WAPDA, a single producer doing business and inefficient to serve the consumer. So, there is a dire need and potential for a private investor to invest, sustain, and maximize business and economic growth. Thus, this analysis contributed to the literature as a pioneering study with this framework: (a) to diversify the monopolistic position, (b) to enhance public awareness, (c) to empower WAPDA consumers socially, and (d) to develop a policy framework according to the operational framework of this study.

Based on the above outcomes, we have put forward the following polices:

I. The distribution utilities should reduce their scales of production by moving to the most productive scale size. One possible way of improving productivity is to privatize these state-owned utilities and improve the effectiveness of regulations. Private owners may be keen to invest in new technologies that can help electric utilities optimize scale, reduce losses, and increase productivity. The private sector may also be more likely to appoint more competent and experienced managers. An alternative to privatization would be to consider rewards for managers that better operate their respective utilities. NEPRA, the regulator, should also be strengthened as an autonomous regulatory body, as it is presently under the government's influence. Finally, technical and non-technical losses of electric utilities, due to their network's length, and adding more distributors to the sector could lower costs and improve productivity (Mirza et al., 2017).

II. Governments should lean towards selecting pieces of the standard model of full merchandizing competition while the competitive markets regulate prices, investment, and consumption.

III. Governments and other decision-makers should create awareness about utilities' long-term sustainability, including psychological trust and the general public's investment opportunities.

IV. The government should ensure effective targeting, accumulate investment plans through subsidies, and ensure taxes on commercial bank investment. Administrative simplicity plans should be implemented to encourage lower-middle-class families. Financial costs, administrative charges, and payment channels should be well-defined and open to public investigation.

V. Project- and network-based collaborations between scientists, government partners, industry participants, and financial institutions are essential to addressing global challenges of private investment in the utility sectors, especially in Asian countries. Government research institutions should be aware of public opinion about public–private partnerships. There should be a risk-free and risk incentive-based return portfolio for different investors in the utility sector.

VI. Transparency should be considered part of the investor's required return rate so that private investment can be enticing in the utility sector. A transparent process with an independent review is a crucial element of such programs.

VII. Private and the utility sector board of directors should express public value propositions. Investors' expectations or commitments should be ensured to achieve economic and social goals, creating direct benefits for those who can show serious concerns in investing in the utility sector to a greater extent.

VIII. In order to promote the development of cooperation between the public and private sectors, the government should follow the following recommendations: (i) Reform its structure and working system to improve agility, reduce redundant committees and conflicting institutions, and establish single database reform laws and regulations for cooperation with various departments, and earnestly strengthen cooperation between partners; (ii) There should be an integration of multidisciplinary science into private sector decision-making, which can integrate sustainability considerations into supply chain management and capital allocation strategies. Promising entry points include quantitative indicators of risk-return and resilience (Yoshino et al., 2020).

IX. Consistent use of collaboratively developed, evidence-based indicators, and other decision-making tools in the utility sector can enable large-scale sustainable investment. Project- and network-based collaborations among various stakeholders require overcoming structural and cultural barriers and developing new incentives and agreements within research institutions and private sector organizations.

X. There is a dire need to provide a business environment that encourages private infrastructure investment that is more attractive to entrepreneurs and that could provide growing companies with the resources and capabilities to take their business to new levels in the utility sectors (i.e., WAPDA and Sui Gas in Pakistan). More emphasis should be placed on portfolio companies' profitability, which describes frequent investments, profit trends, and overall growth rate in the country's utility sector.

XI. However, resolving the debate about the importance and strategy of power sector reform is difficult because energy policy scholars still know very little about the power sector reform mode. Earlier research, for example (Gratwick and Eberhard, 2008) pointed out that many developing countries did not implement privatization and liberalization but established a "hybrid" power market, which corporatized state-owned power companies and regulatory agencies, and independent power manufacturers combined. We should formulate a policy to report the global progress of the eight key reform-liberalization laws, corporatization, independent power producers, independent regulation, spin-offs, privatization, wholesale market, and retail supplier selection.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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