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Do the electricity price shocks influence the Sectoral Production and KSE100 Index in Pakistan? An ARDL structural breaks approach

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ABSTRACT

This research investigates the long-term cointegration of electricity price with sectoral production and equity market in Pakistan. Fourteen major industrial sectors and the KSE100 index is taken into consideration to determine the relationship. Literature in this regard is available but this research is distinct from previous literature for it tests the sectoral production and equity market relationship with electricity price change in Pakistan. Monthly data from 1st Jan 2011 till 31st Dec 2019 is taken for fourteen sectors from the sources of Quantum Index Pakistan Bureau of Statistics (PBS) and for KSE100 index from (www.investing.com). An Auto Regressive Distributed Lag (ARDL) model and bound test for multiple structural breaks has been applied. It is found that almost the production of all industrial sectors and KSE100 index stock prices are adversely affected by the electricity price shocks both in long-term and short-term. The study suggests that management should implement a moderate monetary policy that is neither more expansionary nor contractionary. The government should provide incentives to those who successfully control energy wastage. A mixed kind of energy policy is recommended with higher weightage to the development of renewable energies to reduce foreign exchange outflow with imported furnace oil. This study is limited to the sectoral production and equity market of Pakistan. A cross-sectional research is encouraged to compare the connection between major energy costs and macroeconomic variables in different countries.

Keywords

Electricity Price Change, Sectoral Production, KSE100, Economic Growth, ARDL, Pakistan.

JEL

Classification

Q21, D13, E23, O4

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1. Introduction

The World Bank Enterprise Survey 2015 states that 45.3% of the total firms in Pakistan have identified electricity as the top obstacle for the business sector in Pakistan (Bank, 2015). Like other developing countries, the shortfall and higher cost of electricity will affect the economic activities. At average, in South Asia each firm is facing a load shedding of 5.3 hours out of 24 hours while in Pakistan the average load shedding faced by each firm is 13.2 hours out of 24 hours (Grainger & Zhang, 2017, 2019). Currently, 50 million people have no access to electricity while others in access are facing regular load shedding. About 75% of the firms in Pakistan have pointed out electricity as a major barrier to the production growth as shown in Figure 1. Pakistan is reckoned on 115 out of 137 countries for its reliable source of electricity in the world (Schwab, 2018). In Pakistan the distortion of power sector costs 7% of the total GDP, which equals to \$18 billion a year. The report analyzes the power supply cycle including power generation, and supply to the users. This distortion is caused by poor infrastructure, faulty metering and theft cases which increases load shedding and per unit cost. Consequently, the businesses collapse and the units of production are reduced (The World Bank, 2013). Therefore, electricity sector reform should be the top priority for the government of Pakistan to quickly yield major economic gains which will directly increase the firm's productivity and reliability. It also reduces the cost of production and CO_2 emissions (Grim et al., 2020).

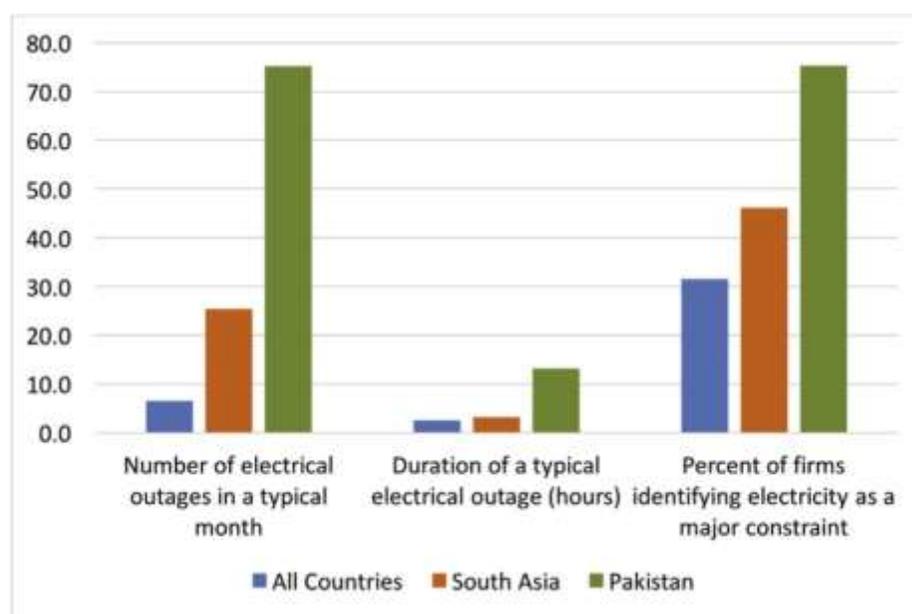


Figure 1 Proportion of industries recognizing electricity as a major obstacial to production.

The early classical study considered energy as the fundamental factor of industrial production. The study identified that the output cost varies with the cost of input. The classical theory proposed that additional to energy, the labor and capital are other major input costs of production (Kümmel, 1982). The concept of the classical theory is contradicted by stating that

the importance of energy as input is increased with technological advancement (Jorgenson, 1984; Rosenberg, 1983). The significance of energy consumption is increased with the technological advancement in the industrial production. The pollution taxes and environmental control system also discourages the consumption of oil and gas. Thus, the dependency of electricity as a major input source for production is increased (Ayres et al., 2013; Guo et al., 2019; Wu et al., 2019).

The link between the cost of energy and IP is one of the most important subjects for the economic policy makers. Most of the researchers and policy makers focused on the cause and effect of overall production, GDP and electricity consumption. Recently, the research aimed to investigate the electricity shortage effect on industrial production in Pakistan (Grainger & Zhang, 2019). According to the third quarterly report of the State Bank of Pakistan for the year 2018-2019, the inflation rate increased from 6% to 8.5% in the third quarter of 2019. The cost push factors of inflation in the energy sectors are petrol, gas and electricity. It has risen up the consumer price index and increased the cost of production (SBP, 2019).

In Pakistan, mostly the impact of electricity shortage is taken as a proxy with overall industrial production (A. Ali et al., 2019; Grainger & Zhang, 2017; Jamil & Ahmad, 2010; Yasmin & Qamar, 2013). Traditionally, crude oil price, natural gas price and CPI are used to quantify the aggregate output of Pakistan. Specifically, the researchers focused on aggregate industrial output rather than sectoral production. Furthermore, the Planning Commission of Pakistan (PCP) in 2019 reported 2/3 of the electricity generated from high cost thermal power plants which has negatively affected the economy (Government, 2020). Previous studies usually investigated the casual connection between energy costs and GDP. There is a gap to quantify the impact of electricity price shock and the output of different industrial sectors in Pakistan.

This research objective is to expand the understanding by investigating the short-run and long-run connection between electricity price change and production growth in different industrial sectors of Pakistan. The sector specific impact of electricity price change is significant for various reasons. Firstly, the impact of the electricity price change is not similar for all sectors. The sector sensitivity to electricity price changes should be asymmetric because all the sectors might not be exposed to the electricity price change. The sector sensitivity depends on utilization of electricity as a major or a minor input source. Secondly, by adding the electricity input cost to the final goods available in market may reduce production cut offs. Measuring sectoral production sensitivity to electricity price changes is more explanatory than GDP. Thirdly, the industries may switch from high cost to low cost energy input. This behavioral heterogeneity of the industries will identify the sensitivity to electricity price shocks.

This study analyzes various industrial sectors in Pakistan thus helping the policy makers and concerned reader and researcher to get comprehensive information about a relationship with electricity prices. It can help the government authorities to take well informed decisions for the betterment of effected industrial sectors by identifying cheaper sources of energies, power subsidies, awareness of energy savings and tax relief.

The paper consists of: Section-2 Review of Literature, Section-3 on Data Collection and Methodology, Section-4 as Empirical findings and discussion, Section-5 on Main findings lastly, Section-6 as Conclusion.

2. Review of Literature:

The study of the connection between energy prices and the sector specific industrial production is not common. Although, previous literature mainly focused on the casual connection between the consumption of energy and growth in the economy (Bildirici et al., 2012; Destek & Aslan, 2017; Dogan, 2015; Ghali & El-Sakka, 2004; Ozturk, 2010; Polemis & Dagoumas, 2013; Wolde-Rufael, 2014; Wu et al., 2019). A sector specific relationship with electricity consumption is carried out between 1993–2006 and 1993-2011. The findings proposed that the irregular upsurge in the consumption of electricity is due to the structural changes in the production line (Blignaut et al., 2015; Inglesi-Lotz & Blignaut, 2011). Electricity consumption is usually more reactive to GDP (Bildirici et al., 2012; Ciarreta & Zarraga, 2010b, 2010a; Ghali & El-Sakka, 2004). Using the panel data to analyze the connection between consumption of electricity and growth in the economy of 12 European countries, but still the sectoral investigation is not emphasized (Ciarreta & Zarraga, 2010a). The relationship between consumption of electricity, cost of electricity and aggregate production between 1960-2010 is investigated. The study found a unidirectional causal relationship between electricity prices and GDP (Jamil & Ahmad, 2010). The short-run and long-run effect of electricity consumption and its determinants is investigated. The results suggested a short-term price adjustment strategy adopted by Pakistan is not efficient. Rather, Pakistan should improve the utilization of power generation plants to reduce the cost of electricity available to the industries or to reuse the oil and gas resources for generating electricity. Otherwise, a shortage will widely increase the cost of electricity available to the industries (Alter & Syed, 2011).

Another study analyses the connection between consumption of electricity and increase in economy. The study determines a positive bi-directional association among the two variables. It is further suggested to cover the increasing demand of electricity Pakistan needs an effective power generation policy and cost control (Shahbaz & Lean, 2012). The economy and firm's demand for electricity between 1998-2008 is investigated. The findings illustrates a negative relationship with 1% increase in the cost of electricity will lead to approximately -0.58% reduction in the electricity demand across the firms (Amjad Chaudhry, 2010).

Indeed, the Islamabad Chamber of commerce and industry in 2013 reported summer as the worst season for the public and commercial sectors of Pakistan with a maximum average of 16-18 hours load shedding all over the country (Magnet, 2013). The shortage of electricity causes a decrease in the production, increase unemployment and closure of the industries.

The study investigated Canada, Ecuador, Norway and South Africa (Fei et al., 2014), Bangladesh (Masduzzaman, 2013), Nigeria (Danmaraya & Hassan, 2016; Polemis & Dagoumas, 2013), South Africa (Amusa et al., 2009; Bildirici et al., 2012), China (Zhang et al., 2017) found a positive connection among consumption of electricity and growth in the economy. Another study in Brazil, China, Russia, India and South Africa (Khobai, 2018), Pakistan (Balcilar et al., 2019), USA (Alola & Yildirim, 2019) supports energy as a main driver of the economy. The literature has the opinion that the cost of electricity and consumption have a significant role in the industrial production. This implies that higher electricity prices have a negative impact on the consumption of electricity and production growth. Other studies by (Capros et al., 2016; Gonese et al., 2019) examined the effect of electricity and gas prices on sectoral production in the European Union (EU) and South Africa. The findings suggest that

electricity is an essential part of the production having a significant effect on the output growth of different sectors in both EU and South Africa.

The shortage of Electricity will increase the input cost by using diesel generators in producing electricity. It will reduce the capital available for productive use leading to decrease in the output. More critically, if the alternative source of electricity generation is not available during shortages it may lead to shut down industries, spoil of useful raw materials and labor productivity (Allcott et al., 2016). Continuous electricity shortage compels firms to outsource electricity which will increase the output cost (Fisher-Vanden et al., 2015). Due to higher electricity cost firms avoid using energy intensive technology. Adopting this strategy leads to decrease in the long term productivity growth (Abeberese, 2017).

Another research examines the casual connection between growth in GDP and demand of electricity. It concludes bi-directional association between change in GDP and consumption of electricity (Faisal et al., 2017). A comprehensive overview of various studies in China spanning from 1978 to 2016 concluded a significant relationship between electricity consumption and growth in the economy (Zhang et al., 2017). Another study investigates the casual relationship between electricity demand and GDP. A long-term bi-directional interdependency is found between both variables, but the relationship is insignificant in the short-run (Hasan et al., 2017).

The urbanization and electricity consumption are investigated in Pakistan considering technology and transformation. It is found that both variables have a unidirectional positive impact on electricity consumption (Shahbaz et al., 2017). The energy insecurity is explained as the unavailability of energy at reasonable prices. A study analyzed the energy security of Pakistan in four dimensions as accessibility, availability, affordability, and applicability. The results found that the Pakistan economy is continuously insecure over the last five years. It is recommended that Pakistan should move toward green energy and advance metering systems (S. Malik et al., 2020). The energy security is investigated between GDP growth and electricity consumption of the developing economy in South Asia. The results revealed there is no long-term connection between consumption of energy and aggregate output. A 1% increase in the population will increase the consumption of electricity by 4.16%. It is suggested to use large scale hydropower to improve energy efficiency and climate control in the developing country of South Asia like Nepal (Paija, 2019).

Additionally, there is a significant effect of energy costs on macro-economic variables (Taghizadeh-hesary et al., 2015), energy insecurity also has great effect on finish goods and food prices (Taghizadeh-hesary et al., 2019). Energy price shocks influencing different macroeconomic factors i.e., GDP, rate of interest, rate of inflation, foreign exchange rate, human development, stock and bond prices, portfolio optimization and business cycle (Ahmed et al., 2018; Marza & Daly, 2018; Naser, 2019; Nazlioglu et al., 2019; Pönkä & Zheng, 2019; S. Sarwar et al., 2019; Waheed et al., 2018; Wesseh & Lin, 2018). Historically, the industrial production considered to be positively correlated with stock market return. It is further concluded that the growth in the industrial production largely represent the price movement of the stock market (Fama, 1981, 1990). Recently, a large proportion of researches constituted a literature which investigates the relationship between stock market and industrial production in different countries and scenarios. A study examined the cointegration between the stock price and industrial production, supply of money and foreign exchange rate by using long-term cointegration bound test. The results found a long-term cointegration between the stock price

movement and all the macroeconomic variables (Bekhet & Matar, 2013). There are many studies investigating the causality between equity market return and macroeconomic variables but the causality in the context of non-linear situation is investigated in China. It is concluded that the causality still exists between the stock price and macroeconomic variable in non-linear condition (Borjigin et al., 2018). It is further concluded that industrial production and inflation rate performs a vital part in the equity return volatility during long-run and short-run prospects (Engle et al., 2013). It is further added that macroeconomic fundamentals are playing an important role in speculation of stock market return (Girardin & Joyeux, 2013). Another study has taken the industrial production and long-term interest rate as a factor that influences the European stock price movement. The finding revealed that the weight has clearly moved from interest rate to industrial production. It is concluded that IP has a greater impact of stock prices in comparison to interest rate (Peiro, 2016).

Pakistan Stock Exchange (PSE) is established in 2016 by merging three different stock markets i.e., Karachi, Lahore, and Islamabad. It is regulated by Security Exchange Commission of Pakistan (SECP). KSE100 includes the top 100 multiple sector companies enlisted in PSE based on higher market capitalization.

Like other countries, in Pakistan energy is the major driver of the economy. In Pakistan most electricity is generated using thermal power plant (Solangi et al., 2018; Zameer & Wang, 2018). Pakistan is facing a shortfall of 65000 Mega Watt (MW) due to load shedding. To fulfill the required demand of electricity in Pakistan by using imported oil from gulf countries. It is concluded that Pakistan's economy is exposed to energy price shocks like other developing countries (Wakeel et al., 2016).

In the context of Pakistan, previous literature found a negative connection of energy cost with economy. The relationship of individual sector contributing to the economy is not yet identified. All industrial sectors are individually contributing an important part in the economic development of a country. The study will provide new foresight by finding out the effect of electricity cost on sectoral production of Pakistan. This study will help energy policy makers to identify the most sensitive sectors to electricity price shocks. Further, it will grab the attention of policy makers to make a sophisticated energy policy for all affected industrial sectors. Additionally, the results will help the investors to identify the energy price relationship with stock market return in Pakistan. Further, the association between IP and equity market return will be cross validate.

3. Data Collection

This study considers 14 industrial sectors that are critically important for the GDP of Pakistan. These industrial sectors include automobiles (cars, cars parts and lubricants), chemicals (refineries, petrochemicals, metallurgical and mineral based products), food, beverages and tobacco (cigarettes, foods sub products), iron & steel products (construction materials), coke petroleum products (oil and gas products, distribution services, alternative energy resources), paper board (raw paper, packing, plastics and construction materials), pharmaceuticals (medicines and surgical products, health care and biotechnological products), rubber products (general use rubber products for home and commercial use), nonmetallic mineral products (cement, ceramics, glass, and lime), textile (animal wool and silk, cotton, flax and bamboo, glass fiber and synthetic materials), fertilizers (agricultural products), electronics (house hold equipment and heavy duty machinery), leather products (cloths, shoes, bags etc.),

wood products (furniture and fixtures), engineering products (construction and material, manufacturing equipment). Additionally, the KSE100 index that comprises of the top 100 companies from all the 14 industrial sectors of Pakistan.

Large-scale manufacturing data is available on the Quantum Index (QI). QI measures output and structural changes of large-scale manufacturing industries. It provides data regarding production, raw material, contribution to GDP, fix assets and large-scale manufacturing taxes. It also provides data regarding new industrial development and production. In terms of data this study uses monthly data during 1st Jan 2011 and 31st Dec 2019 (Zhang et al., 2017). All the industrial sector data is available in Pakistan Bureau of Statistics (PBS). QI is calculated at constant factor cost of year 2005-2006 with help of Laspeyer's formula (Biggeri et al., 2017) as equation 1 base year 2005-2006.

$$QI(P_M) = \frac{M(n)}{M(0)} * 100 \quad \text{Eq 1}$$

Equation 2 calculates monthly growth rate electricity relative to base year CPI 2007-2008:

$$CPI(E_M) = \frac{M(n)}{M(0)} * 100 \quad \text{Eq 2}$$

Equation 3 calculates the log return of the closing prices.

$$KSE100(R_m) = Ln \left(\frac{p(n)}{p(0)} \right) \quad \text{Eq 3}$$

Where, in equation 1 the “ P_M ” represents a large-scale manufacturing industry, “ $M(n)$ ” is the real output for the current month and “ $M(0)$ ” is the real output of the base year 2005-2006 and in equation 2 “ E_M ” represents electricity prices, “ $M(n)$ ” is the current month CPI and “ $M(0)$ ” is the previous month CPI. The data for the control variables like government expenditure, money in circulation, foreign direct investment and wholesale prices are extracted from the Statistics of Pakistan's Economy report, 2018 available on website of State bank of Pakistan (SBP) (Yasmeen et al., 2019). KSE100 index monthly data is extracted from (www.investing.com). In Equation 3 the R_m is the log stock return, $p(n)$ is the current price, $p(0)$ is the previous month price, and Ln is a natural log (Hanif, 2020).

Further, adding the control variable like government expenditure, money in circulation, foreign direct investment and wholesale prices can improve the relationship between electricity price and sectoral production. Higher electricity prices lead to increase the production cost which has a direct impact of the whole sale prices of the unit produced which creates an inflationary situation in the country. It depresses the saving power of the public and increases the money supply in the country. Money supply has a positive effect on the growth of Industrial Production (IP). Foreign Direct Investment (FDI) also has a positive effect on the industrial production. But the increase in the energy prices may lead to decrease in the FDI due to increase in the cost of production. On other hand, Pakistan is generating electricity mostly form imported furnace oil but due to decrease in the Pakistani rupee comparatively with dollar the energy prices will increase which also leads to increase in the production cost and decrease the overall production of the industry.

Due to circular debts many industries are tax default which leads to decrease the government tax revenue and increase the budget deficit. It leads to shutdown the production of different industries in Pakistan (Yasmeen et al., 2019). The list of variables is mentioned in Table 1.

Table 1: Acronyms of the variables

Acro	Full Title
ELEP	Electricity Prices
FDI	Foreign Direct Investment
GXP	Government Expenditure
MC	Money in Circulation
WPI	Wholesale Price Index
AUT	Automobiles Chemicals (cars, cars parts and lubricants)
CHE	Chemicals
FOO	Food, Beverages Tobacco (cigarettes, foods sub products)
IRO	Iron Steel Products (construction Materials)
COK	Coke Petroleum Products (oil and gas products, distribution services, alternative energy resources)
PAP	Paper Board (raw paper, packing, plastics and construction materials)
PHA	Pharmaceuticals (medicines and surgical products, health care and bio technological products)
RUB	Rubber Products (general use rubber products for home and commercial use)
NON	Nonmetallic Mineral Products (cement, ceramics, glass, and lime)
TEX	Textile (animal wool and silk, cotton, flax and bamboo, glass fiber and synthetic materials)
FER	Fertilizers (agricultural products)
ELE	Electronics (household equipment and heavy-duty machinery)
LET	Leather Products (cloths, shoes, bags etc.)
WOO	Wood Products (furniture and fixture)
ENG	Engineering Products (construction and material, manufacturing equipment)
KSE100	Karachi Stock Exchange Top 100 firms
ARDL	Autoregressive Distributed Lag
ADF	Augmented Dickey–Fuller
PP	Phillips–Perron
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum of Squares

4. Methodology

This study investigates the effect of electricity price changes on industrial sector's production using multifactor nonlinear regression analysis considering the open economy industrial sector (IS) function for sectoral production. It determines the effect of electricity price changes in sectoral production. Each model includes electricity price as an explanatory variable. To increase the model goodness of fit the study considers other four explanatory variables i.e., government expenditure (GXP) on projects, money in circulation (MC) due to general public investment, Foreign Direct Investment (FDI) and Wholesale Prices (WPI) (Bohi, 2017; Jo, 2014; Yasmeen et al., 2019).

This research utilized Auto Regressive Distributed Lag (ARDL) model to investigate the impact of electricity prices on sectoral production in Pakistan (Akadiri et al., 2019; Shin & Smith, 2001). The ARDL model is gaining increasing popularity because of high potential and

less glitches connected with it in comparison with other cointegration models (M Hashem Pesaran, 1997; M Hashem Pesaran & Shin, 1998; Yasmeen et al., 2019). The Eagle Granger method is used to examine the connection between two variables and for more than two variables then the Johansen Cointegration is used (Econometrics, 2015; Engle et al., 1987; Johansen, 1988). Vector Auto Regressive (VAR) Model has certain shortcomings. It is applied only when there is a large sample size used in the study and the VAR model prerequisite is that all the variables must be stationary at the same level (Johansen & Juselius, 1990). In comparison to VAR the ARDL model has some additional benefits i.e., ARDL can be used for small sample size, if the variables are stationary at level or at first order difference or a mix of both while Johansen cointegration the variables must be in similar order difference (Mohammad Hashem Pesaran & Pesaran, 1997; Shin & Smith, 2001). ARDL allow variables with optimal lags while it is not allowed in other conventional cointegration models. By applying bound test the OLS model is transformed to Error Correction Model (ECM). ECM helps further in adjusting the long-run and short-run relationship without losing the long-run information (Laurenceson & Chai, 2003). As discussed, earlier ARDL approach cannot be functional if there are second order difference I (2) stationary variables. For testing the stationarity of the variables with I(0) and I(1), the ADF and PP tests are used to test H_0 of a unit root (Dickey & Fuller, 1979; Phillips & Perron, 1988). For testing the unit root most of the studies used ADF and PP tests. In time series data, due to structural breaks the ADF and PP have low power of finding unit root therefore the multiple structural break test is used (Bai & Perron, 2003; Balcilar et al., 2017; Smith et al., 2019a).

Further, ARDL approach has two steps. Firstly, to test the H_0 of no long run cointegration between the variables. By using the f-statistics value the existence of cointegration is confirmed than the study further interprets the coefficients for long-run and short-run. The ARDL model generates the lower bound I(0) and upper bound I(1) critical values. The f-value greater than upper bound I(1) it means long-run cointegration exists in the relationship and the H_0 is rejected. In contrast, if the f-statistics is lesser than lower bound I(0) we can accept the H_0 and ARDL approach cannot be applied. The results are inconclusive to apply ARDL in case the f-value is in between lower and upper bound. In 2017, the Bound test is found significant for small sample size (Ahmed et al., 2018; Garg & Prabheesh, 2020). The usefulness of small sample size i.e., 30 to 80 observations is supported (Narayan, 2007). This study uses the smaller sample size based on the methodology of (Yasmeen et al., 2019). By applying the ARDL model for different industries the ECMs are calculated as following.

$$\Delta AUT_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + \delta_1 \Delta ELEP_{t-1} + \delta_2 \Delta FDI_{t-1} + \delta_3 \Delta GXP_{t-1} + \delta_4 \Delta MC_{t-1} + \delta_5 \Delta WPI_{t-1} + dummy_{2018} + dummy_{2019} + \mu_t \tag{Eq 4}$$

$$\Delta FOO_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + \delta_1 \Delta ELEP_{t-1} + \delta_2 \Delta FDI_{t-1} + \delta_3 \Delta GXP_{t-1} + \delta_4 \Delta MC_{t-1} + \delta_5 \Delta WPI_{t-1} + dummy_{2017} + \mu_t \tag{Eq 5}$$

$$\Delta IRO_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + \delta_1 \Delta ELEP_{t-1} + \delta_2 \Delta FDI_{t-1} + \delta_3 \Delta GXP_{t-1} + \delta_4 \Delta MC_{t-1} + \delta_5 \Delta WPI_{t-1} + dummy_{2017} + dummy_{2018} + \mu_t \tag{Eq 6}$$

In Equation 4, " β_0 " is a constant and " β_1 to β_5 " are utilized for error correction in the model. The dummy variables are used after applying the structural break bound test (Bai & Perron, 2003; Yasmineen et al., 2019). The " Δ " and " μ_t " represent the white noise error term. The long run association among the variables is represented by " δ_1 to δ_5 ". The ARDL model estimates " $(n + 1)^k$ " times regression to get optimal lags length criteria. Where " n " is maximum number of lags and " k " is the number of variables under investigation. The ARDL model is applied to check the long-term cointegration among the variables by using Wald F-statistics. The null hypothesis is no long-term cointegration which is " $H_0 = \delta_1$ to " $\delta_5 = 0$ ". The alternative hypothesis " H_a " is long-term cointegration among the variables. Equation 5 to 17 follow the same explanation.

By evaluating long run cointegration by using f-Statistics value and applying the bound test for structural breaks and finding long term coefficients in the above model the study further finds the short-term coefficients using the model below.

$$\Delta AUT_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + n_1 ECT_{t-i} + dummy_{2018} + dummy_{2019} + \mu_t \tag{Eq 18}$$

$$\Delta FOO_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_2 ECT_{t-i} + dummy_{2017} + \mu_t \tag{Eq 19}$$

$$\Delta IRO_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_3 ECT_{t-i} + dummy_{2017} + dummy_{2018} + \mu_t \tag{Eq 20}$$

$$\Delta COK_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_4 ECT_{t-i} + dummy_{2013} + dummy_{2019} + \mu_t \tag{Eq 21}$$

$$\Delta PAP_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_5 ECT_{t-i} + dummy_{2017} + dummy_{2019} + \mu_t \tag{Eq 22}$$

$$\Delta PHA_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_6 ECT_{t-i} + dummy_{2017} + dummy_{2019} + \mu_t \tag{Eq 23}$$

$$\Delta RUB_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + \delta_1 \Delta ELEP_{t-1} + n_7 ECT_{t-i} + dummy_{2016} + dummy_{2018} + \mu_t \tag{Eq 24}$$

$$\Delta NON_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_8 ECT_{t-i} + dummy_{2011} + dummy_{2018} + \mu_t \tag{Eq 25}$$

$$\Delta TEX_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_9 ECT_{t-i} + dummy_{2015} + dummy_{2018} + \mu_t \tag{Eq 26}$$

$$\Delta FER_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_{10} ECT_{t-i} + dummy_{2013} + dummy_{2019} + \mu_t \tag{Eq 27}$$

$$\Delta ELE_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_{11} ECT_{t-i} + dummy_{2013} + \mu_t \tag{Eq 28}$$

$$\Delta LET_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_{12} ECT_{t-i} + dummy_{2016} + dummy_{2019} + \mu_t \tag{Eq 29}$$

$$\Delta ENG_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_{13} ECT_{t-i} + dummy_{2013} + dummy_{2019} + \mu_t \tag{Eq 30}$$

$$\Delta KSE100_t = \beta_0 + \sum_{i=1}^n \beta_{1i} \Delta ELEP_{t-1} + \sum_{i=1}^n \beta_{2i} \Delta FDI_{t-1} + \sum_{i=1}^n \beta_{3i} \Delta GXP_{t-1} + \sum_{i=1}^n \beta_{4i} \Delta MC_{t-1} + \sum_{i=1}^n \beta_{5i} \Delta WPI_{t-1} + n_{14} ECT_{t-i} + \mu_t \tag{Eq 30}$$

Equation 18 represents the short run cointegration among the IVs and DVs. The “ECT” is the Error Correction Term. ECT is used when there is abnormality in the data, showing how long it will take to get back into its normal position in the long-term. “n₁” is the coefficient of the ECT. The dummy variables are used due to structural breaks in the data. The same explanation is followed by Equation 19 to 31. The model stability of both short-term and long-term cointegration is tested by using CUSUM and CUSUMQ (Evans, 1974).

5. Results:

This portion of the study explains the unit root testing, structural breaks in the data, model fitting, auto correlation and heteroscedasticity of the data. In Table 2 provides the results of ADF and PP unit root test to investigate the stationarity at I(0) and I(1). The results confirmed that all the variables are stationary at level and first order difference and a mix of both. The prerequisite of the ARDL has been accepted which means all the variables are stationary at level or first difference.

Table 2: Unit Root Test

Variables	ADF		PP	
	I(0)	I(1)	I(0)	I(1)
ELE	-6.1652*** (1)	-10.6589*** (1)	-6.1516*** (1)	-36.2876*** (1)
ELEP	-10.5650*** (1)	-9.8471*** (1)	-10.5716*** (1)	-104.0480*** (1)
ENG	-2.3713	-11.1627*** (2)	-3.6598	-23.1542*** (2)
FER	-3.3128	-6.7570*** (2)	-2.5401	-6.5013*** (2)
IRO	-3.0672	-10.2214*** (2)	-3.0758	-10.2287*** (2)
LET	-3.9652*** (1)	-10.3248*** (1)	-3.9652	-23.2421*** (1)
NON	-3.6235*** (1)	-13.8405*** (1)	-3.3212*** (1)	-16.3095*** (1)
RUB	-3.5172*** (1)	-13.5994*** (1)	-3.4465*** (1)	-13.6553*** (1)
TEX	-3.6453*** (1)	-13.4525*** (1)	-3.5125*** (1)	-14.0943*** (1)
AUT	-0.4199	-10.2469*** (1)	-0.41998 (1)	-10.2469*** (1)
CHE	-2.4073	-14.0132*** (1)	-3.0274*** (1)	-16.261*** (1)
COK	-4.6401*** (2)	-10.4101*** (2)	-4.6198*** (2)	-16.2024*** (2)
FOO	-1.7829*** (2)	-13.9188*** (2)	-2.2189	-13.9077*** (2)

PAP	-3.2660*** (0)	-12.3287*** (0)	-3.0935*** (0)	-13.3710*** (0)
PHA	-3.5810***(0)	-7.4020***(0)	-6.9604***(0)	-31.9163***(0)
FDI	-12.2934*** (0)	-11.0515*** (0)	-12.4329*** (0)	-61.1246*** (0)
MC	-2.5674	-4.6406*** (0)	-2.4973	-4.7361*** (0)
WPI	-2.5731	-9.0003*** (0)	-2.8641	-8.9984*** (0)
GXP	-2.8790	-3.7623*** (0)	-2.3481	-5.6263*** (0)
KSE100	-11.0121***(0)	-9.1917***(0)	-11.0387***(0)	-72.8086***(0)
Test Critical Value				
1% level	-3.494378	-3.494378	-3.493129	-3.493747
5% level	-2.889474	-2.889474	-2.888932	-2.8892
10% level	-2.581741	-2.581741	-2.581453	-2.581596

Note: All the regressions are based on trend and intercept, the optimal lags are selected using Schwarz Bayesian Criterion (SCI), () is used for optimal lags, *** is P-value less than 0.05 means the null hypothesis of unit root is rejected. Critical Value at 1%.

As discussed previously, the findings of unite root testing are ambiguous due to structural changes in the time series data. Following the procedure used previously by applying Bai–Perron multi structural breaks test (Bai & Perron, 2003; Balcilar et al., 2017; Smith et al., 2019b; Yasmeen et al., 2019). Before exploring the short-term and long-term cointegration it is important to find structural changes in the data. Table 3 is providing the summary of multiple structural breaks in the data under study. It is observed that all the variables include structural breaks. For AUT, CHE, COK, ELE, ENG, FER, FOO, NON, PAP and PHA with one structural break, one dummy variable is added. For IRO, LET, RUB and TEX with more than one structural break, multiple dummy variables are added. Lastly the KSE100 index has no structural breaks in the time series data. Structural breaks improve the model stability and provide more significant results for interpretation.

Table 3: Bai–Perron structural breaks in the data

Variables	Schwarz* Criterion	LWZ* Criterion
AUT	2018M06	2018M06
CHE	2015M09	2015M09
COK	2013M10	2013M10
ELE	2013M09	2013M09
ENG	2013M12	2013M12
FER	2012M10	2012M10
FOO	2017M10	2017M10
IRO	2012M07, 2017M05, 2018M08	2012M07, 2017M05, 2018M08
LET	2012M04, 2013M07, 2016M08	2016M08
NON	2013M07, 2014M11, 2016M03, 2018M07	2015M11, 2018M07
PAP	2017M08	2017M08
PHA	2017M08	2017M08
RUB	2012M06, 2013M10	2012M06
TEX	2012M04, 2018M07	2012M04, 2018M08
ELEP	2013M12	2013M12
FDI	2014M10	2018M06
MC	2013M09	2013M09
WPI	2017M10	2017M10
GXP	2017M08	2017M08
KSE100	N/A	N/A

** Bai–Perron critical values.

In table 4 interpreting the F-value of bound test to validate the presence of long-term cointegration against the H_0 of no long-term cointegration. Different structural breaks are noticed in 2013, 2015, 2016 and 2017. The reasons are Pakistan is producing 64% of electricity from thermal power plant but in 2013 due to shortage of oil and gas the country lost a potential of 3000MW of electricity generation. Pakistan is using imported furnace oil and gas imported from other countries (Ministry of Finance, 2013). In 2015-2016 circular debt is the main reason of structural breaks when the power generating companies get defaulted and failed to pay dues to the oil and gas suppliers. The power generating companies are unable to generate enough sales due to inefficient power distributing companies like (DISCOs). Power distributing companies have no control on electricity theft cases, power distribution losses and low-cost tariffs. During 2015 and 2016 the circular debt has increased from 05 billion to 06 billion (Tauhidi & Chohan, 2020). In 2017 onward there is a 20% depreciation in the Pakistan rupees against the U.S. dollar which made the import of furnace oil more expensive and result in decrease of foreign exchange reserves from \$9.9 bn to \$8.1 bn within four months (Simon Nicholas & Buckley, 2018).

In each model sectoral output, KSE100 index is taken as a dependent variable and electricity prices, FDI, WPI, MC and GXP as IV. The dummy variables are also added because of structural breaks. The f-statistics of bound test are interpreted to verify the long-term cointegration in the data. In table 4 the F-value of all variables are higher than upper bound which means the long-term cointegration among the variables.

Variables	Bound test cointegration F-Value	I(0)	I(1)	remarks
AUT	9.5155	3.79	4.85	long term cointegration
CHE	27.1777	3.79	4.85	long term cointegration
COK	58.7201	3.79	4.85	long term cointegration
ELE	35.1667	3.79	4.85	long term cointegration
ENG	22.2469	3.79	4.85	long term cointegration
FER	46.9500	3.79	4.85	long term cointegration
FOO	20.0303	3.62	4.16	long term cointegration
IRO	61.3658	3.62	4.16	long term cointegration
LET	5.00531	3.62	4.16	long term cointegration
NON	6.90343	3.62	4.16	long term cointegration
PAP	65.4195	3.62	4.16	long term cointegration

PHA				long term
	49.3819	3.62	4.16	cointegration
RUB				long term
	117.4260	3.62	4.16	cointegration
TEX				long term
	07.7853	3.62	4.16	cointegration
ELEP				long term
	06.3514	3.62	4.16	cointegration
FDI				long term
	35.1667	3.62	4.16	cointegration
MC				long term
	61.3658	3.62	4.16	cointegration
WPI				long term
	65.4195	3.62	4.16	cointegration
GXP				long term
	117.4260	3.62	4.16	cointegration
KSE100				long term
	24.0643	2.56	3.49	cointegration

Note: If the value of F-Stat is > than 4.16 the Long-Term Cointegration exist, If the F-Stat value is < 3.62 Short-Term Cointegration exists and if the value is between 3.62 and 4.16, the model is inconclusive.

This study has taken the sectoral production to check the long-term and short-term relationship with electricity price change in Pakistan. The table 5 provides the results of long-term and short-term cointegration for all industrial sectors. In the context of Pakistan, electricity is one of the major input source to produce output (Yasmeen et al., 2019). It is very important to investigate the fluctuation of energy prices and its impact on the economy. The study investigated the impact using ARDL models.

The result in table 5 indicates that all the IVs have significant and long-term negative relationship with electricity cost. The negative relationship indicates that all the sectoral productions are exposed to the electricity price shocks. These negative results have some serious consequences. On the supply side all sectors are highly dependent on electricity price shocks. The operations of all industrial sectors are highly dependent on energy prices and negatively affect the production growth and profitability (Zameer & Wang, 2018). On demand side, the industries and households also affect the electricity price shocks. It increases the expenditure and reduces the purchasing power of the public which leads to reduce the unnecessary purchases and increase savings. As a result, it decreases the aggregate demand of the finished products and cutoff on the productions of the industries. Electricity price is playing one of the vital positions in the growth of Pakistan's economy. In Pakistan electricity generation is extremely in need of imported furnace oil (Zameer & Wang, 2018). Preceding researches focused on the impact of oil price in industrial sectors of Pakistan (Yasmeen et al., 2019). Another study examines the impact of oil price variation on monetary policy (A. Malik, 2008). Other economic variable like inflation and interest rates are checked with oil price shocks and found a positive long run association between rate of inflation and interest rate (K. Malik et al., 2017). The impact of oil price shocks on the stock exchange is also investigated (Najaf & Najaf, 2016; Waheed et al., 2018). Recently, the connection between oil price shocks and trade deficits is investigated and found a positive relationship between increase in oil price and trade deficit (Ahad & Anwer, 2020). Additionally, the electricity prices are extremely in need of oil prices

and suffering from a severe crisis in the last two periods. This study focuses on electricity prices and sectoral production growth in Pakistan. The study on individual industrial sector is rare. All the industrial sectors have a negative significant connection with electricity price shocks in long run and short run except coke petroleum products (oil and gas products, distribution services, alternative energy resources), engineering products (construction and material, manufacturing equipment), nonmetallic mineral products (cement, ceramics, glass, and lime) and paper board (raw paper, packing, plastics and construction materials) that have an insignificant short-term relationship with electricity price shocks.

Table 4: Long-run and Short-run Coefficients using ARDL Models.

Variable	ARDL Long-Term (P-value)	ARDL Short-Term (P-value)
AUT	-0.9467(0.0000)	-0.2494(0.0391)
CHE	-1.2416(0.0000)	-0.4307(0.0000)
COK	-1.6416(0.0000)	-0.3935(0.0779)
ELE	-1.8475(0.0000)	-0.3802(0.0024)
ENG	-0.9827(0.0000)	0.0172(0.7167)
FER	-0.6732(0.0000)	0.3267(0.0013)
FOO	-1.3687(0.0000)	-0.3687(0.0075)
IRO	-0.0757(0.0041)	0.9242(0.0000)
LET	-0.3193(0.0000)	0.6727(0.0000)
NON	-1.3263(0.0000)	-0.3263(0.0619)
PAP	-1.1882(0.0000)	-0.1882(0.1975)
PHA	-1.5588(0.0000)	-0.5588(0.0007)
RUB	-0.1220(0.0021)	0.5762(0.0000)
TEX	-0.2362(0.0002)	0.6423(0.0000)
KSE100	-1.0829(0.0000)	-0.0018(0.0100)

Note: () is the p-value which is significant at 1%, 5% and 10%.

6. Robustness test of the Models:

The diagnostic investigation is applied to check the stability of the estimated models. Following tests are used: Breauch–Godfrey LM test to check serial correlation with the H_0 of no serial correlation, Jarque-Bera test to check the validity of H_0 is normally distributed, Breusch-Pagan-Godfrey test for heteroskedasticity in the model. In table 5, the findings of the LM test provide the information about the serial correlation. It is determined that the p-value is greater than 5%, which accept the H_0 of no serial correlation in all the variables. The value of R^2 is very high which confirms the appropriateness of the models. The results of Breusch–Pagan–Godfrey heteroscedasticity test accepts the null hypothesis of homoscedastic for all the residuals. The results of Jarque–Bera test are insignificant which accept the null hypothesis of normality. After applying the diagnostic test for model’s stability. The CUSUM and CUSUMQ tests are applied to test the coefficient’s constancy (Brown et al., 1975; Khan et al., 2020; Yasmeen et al., 2019). The results of CUSUM and CUSUMQ in figure 1 to 14 demonstrates all the coefficients are stable and within the boundaries of 5% significance level. Summing-up all the results the models used in the study are stable, residual normally distributes and homoscedastic, having no auto correlation and free of errors. It is derived that the association between sectoral production growth and price of electricity is justified which can be interpreted and used for future policy implications.

Table 5: Diagnostic Test Results for All Models

Variables	LM Test:	R^2	(F-Stat)	Heteroscedasticity	Normality
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AUT	0.067951(0.7943)	0.92	10.00663(0.0008)	0.131973(0.3884)	65.7885(0.3210)
CHE	0.022234(0.1428)	0.81	0.991776(0.0000)	6.011307(0.4219)	92.1418(0.1641)
COK	3.36237(0.1862)	0.96	2.722422(0.0000)	1.127679(0.0614)	56.272(0.1821)
ELE	7.981973(0.0568)	0.95	1.856718(0.0000)	10.69740(0.0982)	41.6351(0.1321)
ENG	1.813207(0.6121)	0.82	10.34549(0.0000)	0.007015(0.1486)	31.0100(0.1131)
FER	0.879715(0.6441)	0.81	2.962061(0.0106)	0.001733(0.9677)	85.7640(0.0841)
FOO	3.171740(0.2048)	0.87	3.429027(0.0025)	2.156707(0.9507)	46.6993(0.0731)
IRO	0.128622(0.7199)	0.94	326.4993(0.0000)	12.41041(0.0596)	219.7135(0.1531)
LET	1.240154(0.5379)	0.89	24.11097(0.0000)	23.46367(0.3818)	44.9160(0.32110)
NON	2.632324(0.2682)	0.95	2.694657(0.0136)	11.25665(0.1278)	60.7815(0.2001)
PAP	2.353056(0.3083)	0.79	1.364547(0.0000)	1.714686(0.6337)	44.9160(0.1321)
PHA	7.092175(0.2880)	0.88	15.15688(0.0000)	15.96735(0.1200)	81.2668(0.1231)
RUB	0.079018(0.9613)	0.90	66.39520(0.0000)	67.75367(0.8654)	44.3294(0.3214)
TEX	0.156421(0.1564)	0.73	28.08270(0.0000)	8.548380(0.2006)	37.4473(0.2131)
KSE100	0.4261(0.5155)	0.80	03.1029(0.0037)	0.003415 (0.6848)	0.0413(0.9795)

Note: The p-values are in closed in (), LM test for Serial Correlation, If the p-value > 0.05 the H_0 of no serial correlation is accepted. Jarque–Bera test if p-value > 0.05 the H_0 of normality is accepted, Breusch–Pagan–Godfrey heteroscedasticity test. If critical value > 0.05 the H_0 is the data is homoscedastic.

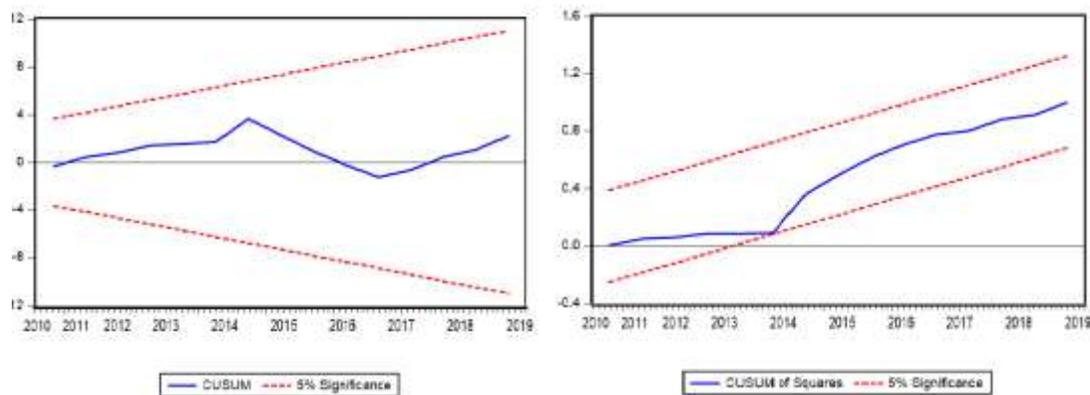


Figure 2 CUSUM and CUSUMQ for Automobiles Industry Model

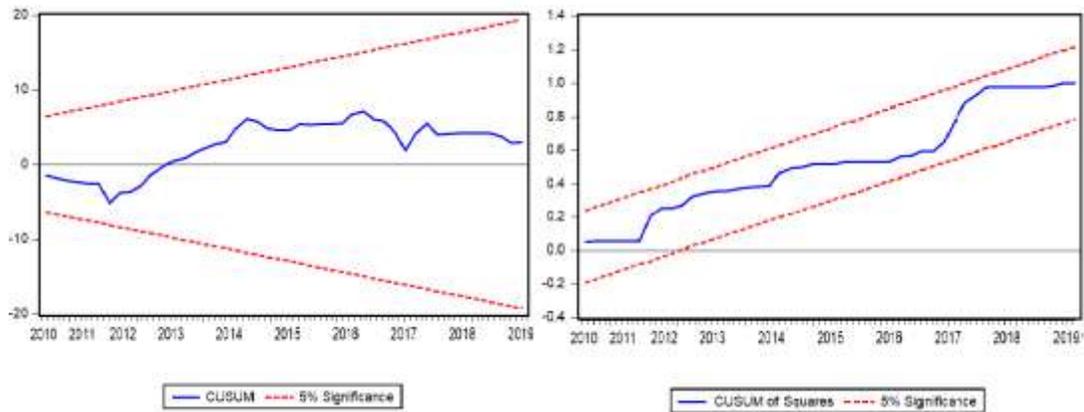


Figure 3 CUSUM and CUSUMQ for Chemical Industry Model.

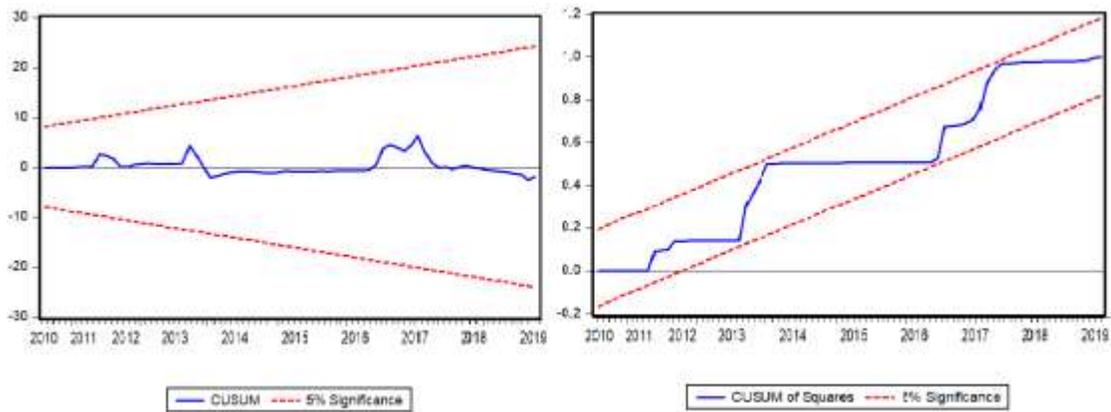


Figure 4 CUSUM and CUSUMQ for Coke Petroleum Products Industry Model.

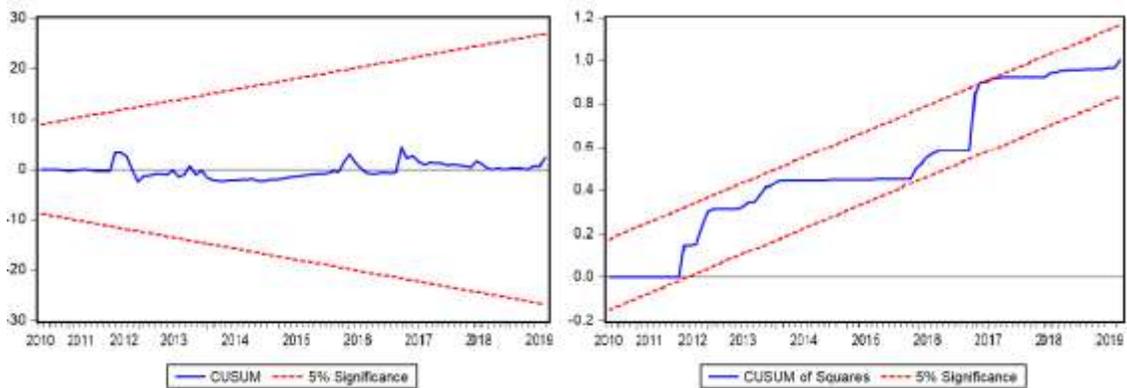


Figure 5 CUSUM and CUSUMQ for Electronics Industry Model.

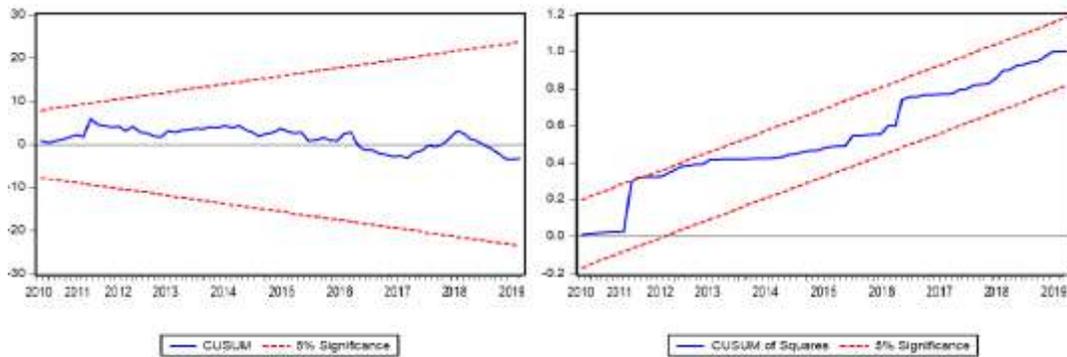


Figure 6 CUSUM and CUSUMQ for Engineering Products Industry Model.

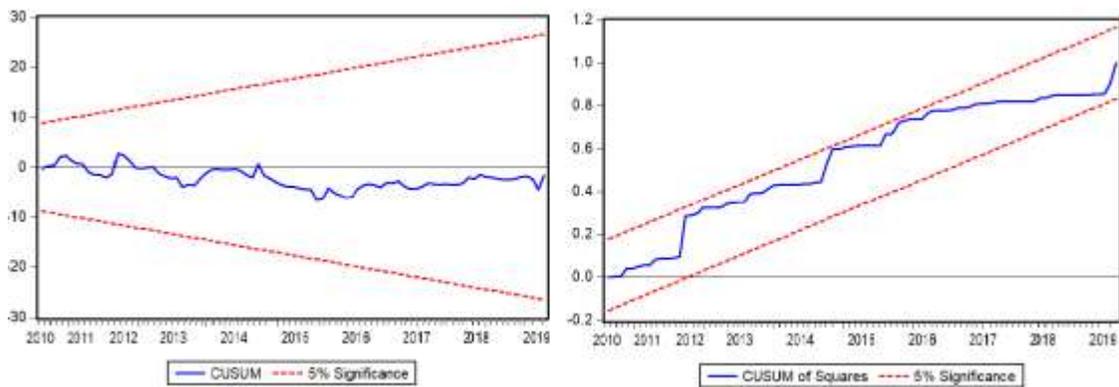


Figure 7 CUSUM and CUSUMQ for Fertilizers Industry Model.

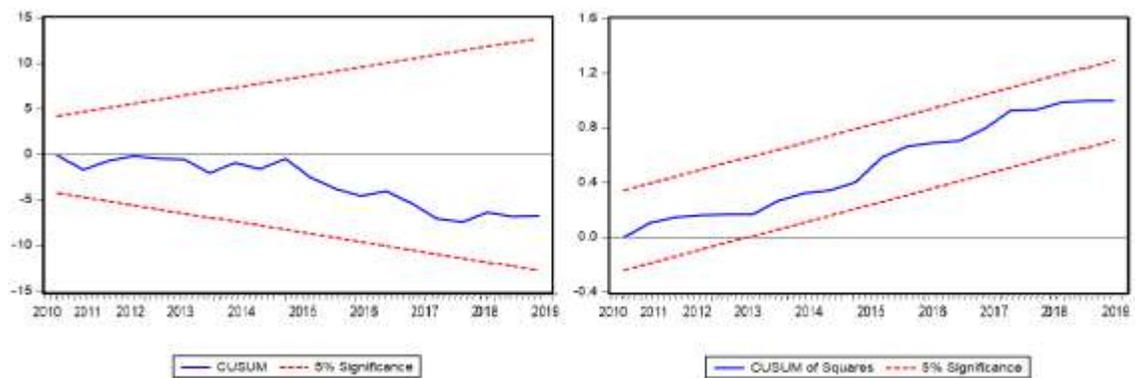


Figure 8 CUSUM and CUSUMQ for Food, Beverages Tobacco Industry Model.

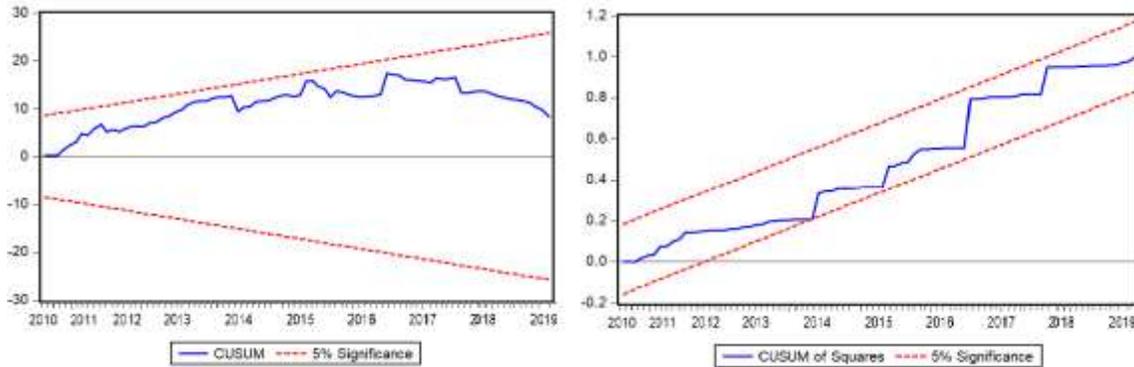


Figure 9 CUSUM and CUSUMQ for Iron Steel Products Industry Model.

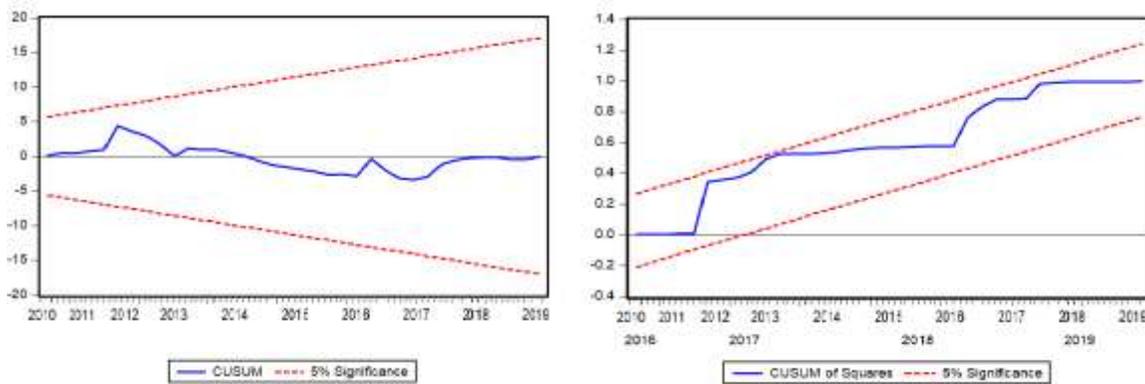


Figure 10 CUSUM and CUSUMQ for Leather Products Industry Model.

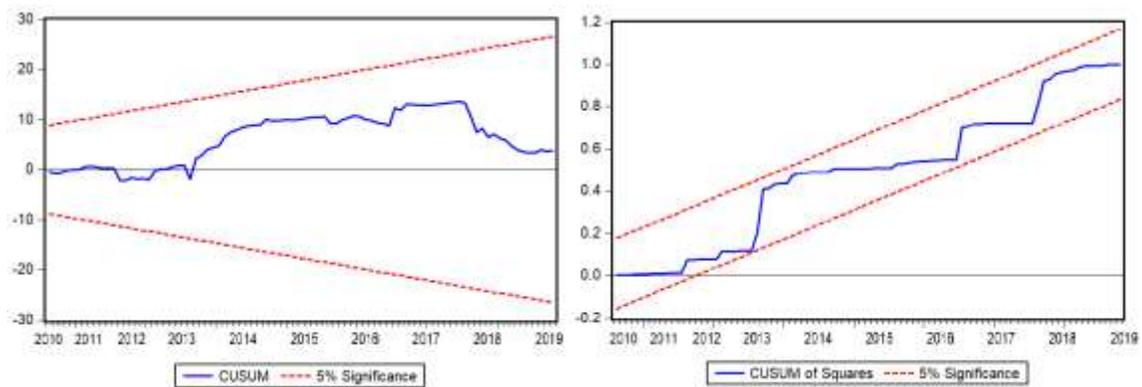


Figure 11 CUSUM and CUSUMQ for Nonmetallic Mineral Products Industry Model.

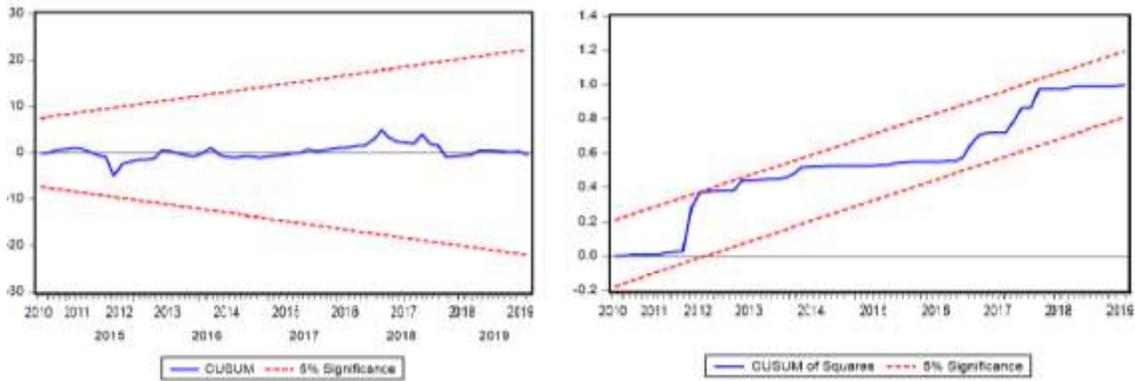


Figure 12 CUSUM and CUSUMQ for Paper Board Industry Model.

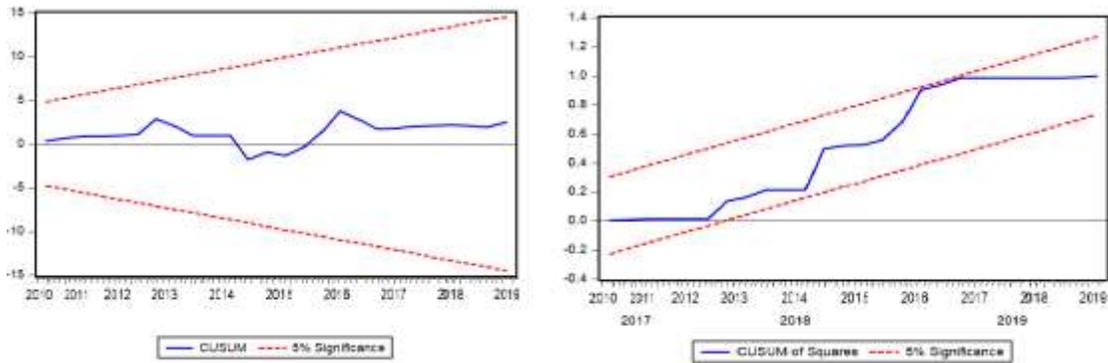


Figure 13 CUSUM and CUSUMQ for Pharmaceuticals Industry Model.

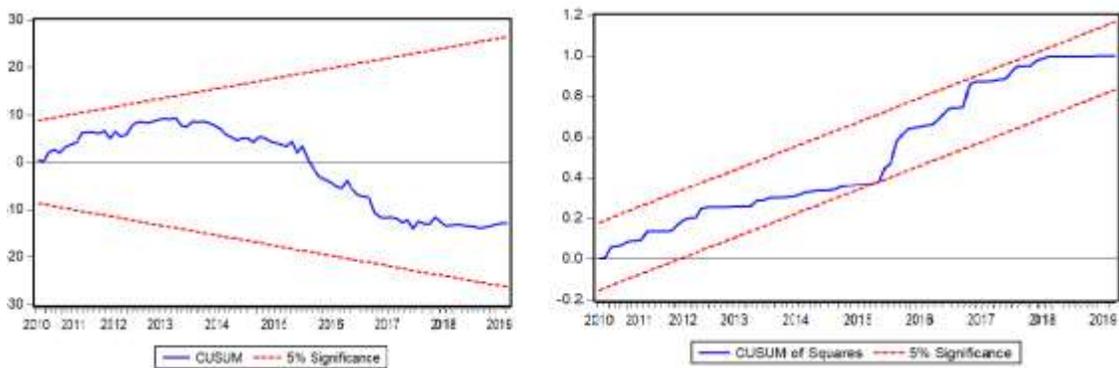


Figure 14 CUSUM and CUSUMQ for Rubber Products Industry Model.

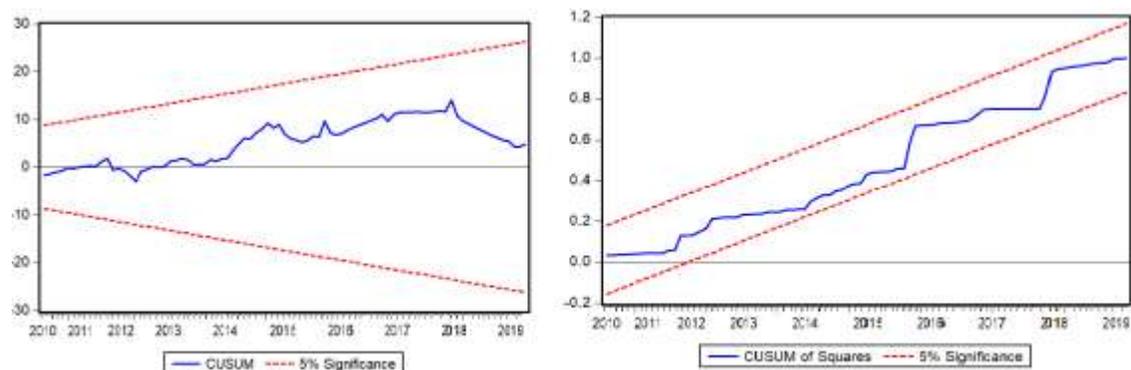


Figure 15 CUSUM and CUSUMQ for textile industry model.

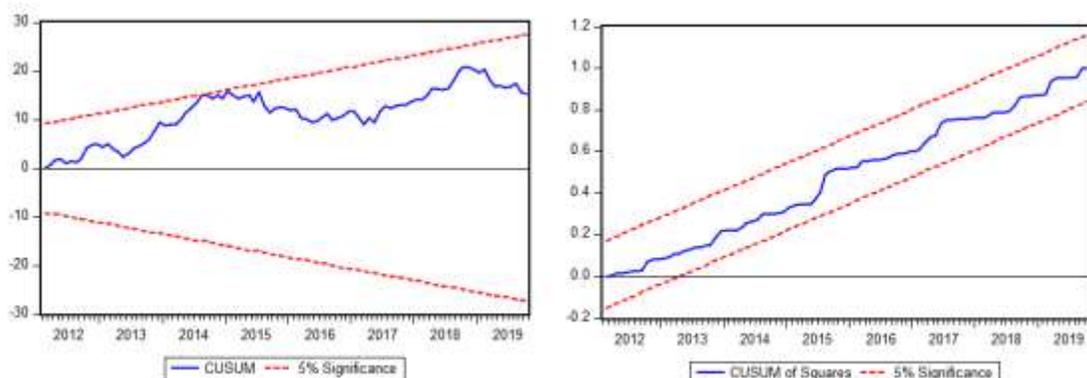


Figure 16 CUSUM and CUSUMQ for KSE100 model.

7. Conclusion:

The growth of sectoral production and electricity price fluctuation is investigated in the context of Pakistan. The single sector investigation is insufficient to provide full knowledge about the economy. The impact of electricity prices on sectoral production is more beneficial than the aggregate level of production. The study utilized the multifactor ARDL approach to investigate the long-term connection between cost of electricity and growth in sectoral production. The results found all the sectors have a long-term negative relationship with electricity price shocks. However, two of the sectors have an insignificant short-term relationship with electricity prices. The electricity prices affect all the economic sectors both on supply and demand side. The electricity price shocks increase the production cost and decrease production of goods supply. The increase in electricity prices reduces the income level and reduce the overall demand for consumption of goods produced. The coke, petroleum products and electronics industries are most negatively affected by electricity price shocks. The coke, petroleum industry produces the alternative sources of energies in Pakistan and mostly the electricity generated is dependent on fossil fuels and the price relationship go parallel (Rehman & Deyuan, 2018). Source of energy is the main driver behind every industry and if production

hampers consequently the whole economy is disturbed. The electronics industry production is affected due to demand driven link with higher electricity prices. If the electricity prices go up the demand of heavy-duty machinery and household equipment goes down which will lead to decrease in the production of this industry (Yasmeen et al., 2019). The production of pharmaceutical industry, chemical industry, textile industry and leather industry have decreased due to higher cost and unavailability of power supply (M. S. Ali et al., 2017). The agriculture sector of production has decreased due to increase in irrigation cost that ultimately affect the production of fertilizer industries (Shahbaz, 2015). The findings are consistent with previous study as the KSE100 index has a significant negative relationship with electricity price shocks (S. Sarwar et al., 2018). In Pakistan mostly electricity is generated by using furnace oil but due to increase in the cost of oil leads to increase in the cost of electricity which is utilized by machineries to produce food items and non-food item rubber, automobile parts, non-metallic and paper products industries. It enforces the industries to cutoff on production (M. N. Sarwar et al., 2020). Various factors are investigated in relationship with the production of cement and steel industries in Pakistan. Increase in the electricity price is weighted 70% in relationship with cement and steel production (AHMAD et al., 2018). The results of the study match the current state of Pakistan's economy. It is inferred that additional to oil price the electricity price is another barrier to the industrial production growth and higher returns on equity.

The study proposed different policy implications for government of Pakistan. The results revealed the upsurge in electricity prices disturb the growth of sectoral production which also have a negative impact on equity market return. The study suggests a moderate monetary policy to overcome the negative impact of high electricity price. Monetary policy should be neither higher expansionary (leading to inflationary situation) nor higher contractionary (causing growth reduction). The solution is temporary for the short-term in case the electricity prices are persistently high. In long-term the involvement of the government is increased.

The following strategies may be taken by the government to overcome the negative impact of electricity price on sectoral production and equity market growth. Save energy programs may be initiated by the government to bring awareness in the general public on how to reduce energy wastage and the government should provide incentives to the general public who successfully manage to reduce electricity wastages. (Hille et al., 2019). Private sectors should be encouraged to invest in renewable energy projects and government should offering tax reliefs to boost the usages of biofuels and renewable energies. To minimize electricity losses government should upgrade electricity transmission lines and power grids. Strict custom duties shall be applied on the import of heavy electronic appliances and the import duties on solar cells and other equipment shall be reduces.

Further, the government should use a mix kind of energy policy with greater weightage to renewable energies. Government should invest in exploring new reservoirs of crude oil and natural gas. It will reduce the cost of oil import and the outflow of foreign currency for generating electricity (Hanif, 2020). Consequently, increasing the supply of energy to the industries and protects from electricity price shocks (Simon Nicholas & Buckley, 2018). It is proposed that government should increase investment in electricity generation projects to provide lower cost electricity input to the industries. Considering the findings, the study provides some suggestions to policy maker to control negative impact of electricity price shocks on sectoral production. The study is limited to electricity prices which can be further extended

in relationship with other major energy prices i.e., crude oil and natural gas. A cross-sectional study may be encouraged to identify the generalized impact of energy prices on macroeconomic variable in developed and developing countries with advanced renewable energy and shale gas production like U.S.

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