Electricity Consumption, Financial Development and Economic Growth Nexus: A Revisit Study of Their Causality in Pakistan

Muhammad, Shahbaz

COMSATS Institute of Information Technology, Lahore, Pakistan

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Abstract: This study contributes to energy economic literature by incorporating financial development in neo-classical production function to investigate the electricity consumption and economic growth nexus in case of Pakistan. ARDL bounds testing approach has been applied to examine cointegration between the series over the period of 1971-2009. The direction of causal relationship between the variables is tested by applying VECM Granger causality approach and robustness of causality has been checked by innovative accounting approach (IAA).

Our findings confirm the existence of cointegration among the variables. The results indicate that financial development, electricity consumption, capital and labour contribute to economic growth. The VECM Granger causality analysis reveals that feedback hypothesis is found between electricity consumption and economic growth, financial development and electricity consumption, economic growth and financial development, capital and economic growth and, capital and financial development. This implies that energy (electricity) conservation policies will not be appreciated in case of Pakistan. Furthermore, government of Pakistan should encourage making investments on research and development to articulate new energy savings technology to sustain economic growth. In this manner, financial sector should launch new financial policy to encounter the rising demand for electricity and enhance the process of capitalization to raise economic growth by offering and distributing financial resources to efficient and profit oriented ventures.

Keywords: Electricity Consumption, Financial Development, Economic Growth

I. Introduction

The direction of causal relationship between electricity consumption and economic growth is very important for policy makers due to its importance in production function. The energy-growth nexus was pioneered by Kraft and Kraft (1978) dealing with the causality between energy consumption and gross national product. Their results indicated that GNP Granger causes energy consumption in case of United States. Wide ranging studies are available investigating the causality relation between energy consumption and economic growth (i.e. Yoo, 2006; Chen et al. 2007; Narayan and Prasad, 2008; Chandran et al. 2009; Payne, 2010; Shahbaz et al. 2011; Shahbaz and Feridun, 2012) using data of different countries and/or regions. The relationship between energy consumption and economic growth is based on four competing hypotheses. Adoption of energy (electricity) conservation polices would be counter-productive if energy (electricity) consumption Granger causes economic growth. The existence of bidirectional causal relationship between energy (electricity) consumption and economic growth (feedback effect) reveals that economic growth would be adversely affected by reductions in energy (electricity) consumption and decline in economic growth in resulting would lower energy (electricity) demand. This implies that policies regarding exploration of new energy sources should be encouraged in meeting the rising demand of energy (electricity) to sustain economic growth. The adoption of energy (electricity) conservation policies may not adversely effect economic growth if causality is running from economic growth to energy (electricity) consumption. Finally, neutral hypothesis implying no causal relationship between energy (electricity) consumption and economic growth focuses to adopt electricity conservation policies because energy (electricity) consumption has minor role to raise economic growth of an economy.

The study contributes in energy literature by investigating relationship between electricity consumption, economic growth, financial development, capital and labor using augmented neo-classical aggregate production model in case of Pakistan over the period 1971-2009. We have included financial development in production function to test the nexus of financial development and economic growth pioneered by Schumpeter (1911, 1934) and latter on Goldsmith (1969) and, financial development and energy (electricity) consumption[1]. The energy literature reveals that the easy access to cheaper loans induces the individuals to purchase big ticket items such as automobiles, household appliances, computers, mobiles, televisions which increase the demand for electricity and hence electricity consumption.

Financial development shows the actual amount of resources to be allocated to productive projects. This shows that financial development is a main rout of funds for investment projects through banks and stock markets (Minier, 2009; Sadorsky, 2010). Financial development contributes to economic growth by boosting investment through level effect as well as efficiency effect. The level effect implies that financial sector channelizes resources from inefficient projects to productive ventures. This transparency in financial markets and reporting system attracts foreign direct investment as well as local investment by enhancing confidence of investors (both local and foreign) (Sadorsky, 2010). The efficiency effect reveals that financial development is an appropriate way to increase liquidity and asset diversification which provides financial resources for high return projects. This implies that the effect of financial development on economic growth and thus the energy consumption should be positive. Furthermore, Sadorsky (2011) pointed out that financial development directly affects energy consumption by enhancing

[1] For detailed literature review, see Levine (1992, 1994, 1996, 1997, 1998, 2008) etc.

access of individuals to financial resources offering by banks to purchase consumer big items and indirectly boosting business activity. Overall, this raises energy demand in the country.

The objective of the present study is to explore the relationship between economic growth and electricity consumption in Pakistan. Energy, and in particular electricity, is crucial for economic growth. Thus understanding the dynamics in the sector is very relevant to run factories, boost factors productivity and achieve broader economic goals. Using augmented neo-classical aggregate production model, this study deals with three competing hypothesis i.e. electricity consumption and economic growth nexus, financial development and economic growth hypothesis and, relationship between financial development and electricity consumption. The short run and long run relationship between electricity consumption, economic growth, financial development, capital and labor is investigated by applying ARDL bounds testing approach to cointegration and VECM Granger causality approach to test the direction of causality among the series.

The rest of study is organized as follows: section-II briefs about electricity consumption section-III provides review of literature on energy (electricity) consumption and economic growth nexus, financial development and economic growth nexus, and financial development and energy consumption, section-IV describes model and methodological framework, section-V presents results and their discussion and finally conclusion and future research are draw in final section.

I.I Pakistani Context

Like most developing nations, the underdeveloped energy infrastructure in Pakistan is a major impediment to economic growth. The findings of the study can have important bearing on the economy of Pakistan in the context of developing viable energy policy. Pakistan has a population of 165 million and is strategically located in the Indian Sub-continent. Table-1 shows the projected demand-supply situation in Pakistan over the period 2008–2020. It is clear that there is serious demand supply gap in the power sector. To cope with excess demand, the power authorities frequently resort to load-shedding something which takes its toll on both the consumers and the business. As can be seen in Table-1, the electricity deficit is chronic. The projection also depicts a grim future as the trend is likely to deteriorate further in the days ahead. This gap in the energy sector indicates the severity of the challenges the economy is bound to face as it continues to pursue economic growth.

Table-1: Supply and Demand of Electricity in Pakistan

Supply and Demand Position: 2008-2020 (MW)													
Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Existing Generation	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903
Proposal / Committed Generation	530	4,235	7,226	10,115	10,556	13,307	13,520	14,607	16,134	18,448	18,448	18,448	18,448
Total Existing/Committed Generation	16,484	20,138	23,129	26,018	26,459	29,210	29,423	30,510	32,037	34,351	34,351	34,351	34,351
Expected Available Generation	13,146	16,110	18,503	20,814	21,167	23,368	23,538	24,408	25,630	27,481	27,481	27,481	27,481
Demand (Summer Peak)	16,484	17,868	19,352	20,874	22,460	24,126	25,919	28,029	30,223	35,504	34,918	37,907	41,132
Surplus/Deficit Generation*	-3,338	-1,758	-849	-60	-1,293	-758	-2,381	-3,621	-4,593	-8,023	-7,437	-10,426	-13,651
Source: *Private Power and Infrastructure Board - Govt. of Pakistan													

Natural disasters do happen and often cause damage to overall infrastructures. However, the destruction to the power sector–generating stations, distribution centers and the transmission lines–by the recent flood and the earth quake has been very high for the nation. In particular, the damage to the recently constructed Jinnah hydroelectric power plant will have adverse implication for the transmission and distribution network including installation centers. This will only aggravate the existing crisis further. The rising waters have caused shut down of many electricity generating plants. The output of natural gas has also been reduced due to recent flood in Pakistan. The natural disaster of 2005 affected nuclear activities at Chashma Nuclear Power Complex. This plant is along a geological fault. For these reasons, the gap between electricity demand and supply has worsened. The forecast reported in Table-1 reports that electricity gap would peak when the demand rises to 41, 132 MW per day. The forecast shows that electricity generation would remain 34, 351 MW per day and there would be no increase in electricity supply between 2017 and 2020.

In Pakistan the Water and Power Development Authority (WAPDA) and the Karachi Electric Supply Corporation (KESC) are incharge of generating, transmitting and distributing electricity to the end-users. WAPDA produces electricity for whole country except Karachi. Late in the 1990s, electricity generation competition was established among 16 independent power producers (IPPs). One third of electricity is produced by these IPPs (Jamil and Ahmad, 2010). Electricity demand is more than electricity generation (Table-1). Poor transmission and distribution network, huge losses, electricity theft and inefficient electricity consumption (Jamil and Ahmad, 2010) are the reasons for the loss of social welfare. The rising electricity demand will attract both domestic and foreign investors to the sector. This will help meet the demand and raise social welfare.

II. Literature Review

Literature review portrays three possible relations i) electricity consumption and economic growth, ii) financial development and economic growth and iii) financial development and energy consumption as following:

II.1. Electricity consumption and economic growth

The energy literature provides two strands of studies on the electricity consumption and economic growth nexus. The first strand shows empirical evidence on multi-countries and other is about single-country studies. The empirical energy literature shows mixed results on the direction of causality between electricity consumption and economic growth.

Following multi-countries studies, Yoo (2006) considered the relationship between electricity consumption and economic growth in case of ASEAN countries[2]. The results indicated that bidirectional causality exists between electricity consumption and economic growth in case of Malaysia and Singapore and unidirectional causality also exits running from economic growth to electricity consumption in case of Indonesia and Thailand. In case of 17 African countries, Wolde-Rufael (2006) investigated the cointegration and causal relation between electricity consumption and economic growth. The ARDL bounds testing approach to cointegration developed by Pesaran et al. (2001) and Toda and Yamamoto (1995) causality approaches were applied respectively. The empirical evidence reveals that cointegration exists in nine out of seventeen countries. Though, causality analysis considers electricity-led-growth hypothesis in Benin, the Democratic Republic of Congo, and Tunisia, while electricity conversation hypothesis exists in Cameroon, Ghana, Nigeria, Senegal, and Zimbabwe. Further, feedback hypothesis is found between both the variables in case of Egypt, Gabon, and Morocco[3]. In case of China, Hong Kong, Indonesia, India, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand, Chen et al. (2007) re-examined the causal relation between both variables. Their empirical exercise confirms the existence of cointegration between electricity consumption and

[2] Indonesia, Malaysia, Singapore, and Thailand

[3] Unfortunately, there exists no causal relationship between both variables for the case of Algeria, Congo Republic, Kenya, South Africa and Sudan over the period.

economic growth except in China and Malaysia. The Panel Granger causality analysis reports that electricity consumption and economic growth Granger-cause each other in long run while in short run unidirectional causal relationship is found running from economic growth to electricity consumption.

Apart from that Narayan and Prasad (2008) investigated the direction of causal relation between both variables in case of 38 OECD countries by applying bootstrapping causality test. They found unidirectional causality running from electricity consumption to economic growth in case of Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK. The growth-led electricity consumption hypothesis is valid for case of Finland, Hungry, Korea, Netherlands and UK[4]. Similarly, Narayan and Smyth (2009) considered the relationship between income, electricity consumption and exports in Middle Eastern Countries[5]. Their panel granger causality analysis shows unidirectional causality running from electricity consumption to economic growth and economic growth to exports.

Recently, in South American countries namely Argentina, Brazil, Chile, Columbia, Ecuador, Peru, and Venezuela, Yoo and Kwak (2010) investigated the relationship between both variables. Their results showed that electricity consumption Granger-causes economic growth in Argentina, Brazil, Columbia and Ecuador and growth led electricity hypothesis is valid for Venezuela[6]. In case of European countries, Ciarreta and Zarraga (2010) applied panel cointegration and

[4] There was no causal link between electricity consumption and economic growth in Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Japan, Luxembourg, New Zealand, Norway, Poland, Spain, Sweden, Switzerland, Turkey, Mexico, and the USA.
[5] Iran, Israel, Kuwait, Oman, Saudi Arabia, and Syria
[6] There was no causal relation was between both variables in case of Peru.

causality approaches to examine long-run and causality between both variables[7]. Their results confirmed the existence of long run equilibrium relationship among electricity consumption, electricity prices and real GDP. Further, feedback hypothesis is valid between electricity prices and real GDP and electricity consumption Granger-causes real GDP[8]. Finally, Ozturk and Acaravci (2011) considered issue of causality between electricity consumption and economic growth in 11 Middle East and North Africa (MENA) countries. They used ARDL bounds testing for long run and VECM for causality analysis. Overall, their empirical analysis showed no relationship between both variables.

The single-country studies provide four types of competing hypothesis between electricity consumption and economic growth namely (a) *electricity consumption-led growth hypothesis*, (b) *Feedback hypothesis (c) growth-led electricity consumption hypothesis* and (d) *Neutrality hypothesis*.

A huge number of studies confirm the validation of electricity-led growth hypothesis as electricity consumption Granger-causes economic growth. For instance, Aqeel and Butt (2001) for Pakistan, Altinay and Karagol (2005) for Turkey, Lee and Chang (2005) for Taiwan, Shiu and Lam (2004) for China, Yoo (2005) for Korea, Narayan and Singh (2007) for Fiji Islands, Yuan et al. (2007) for China, Abosedra et al. (2009) for Lebanon, Gupta and Chandra (2009) for India, Chandran et al. (2009) for Malaysia, Odhiambo (2009b) for Tanzania, Yong (2010) for

[7] Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands and Sweden, and two non-EU countries: Norway and Switzerland.

[8] Acaravci and Ozturk (2010) examined the long-run relationship and causality between electricity consumption and economic growth in Transition countries namely Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands and Sweden, and two non-EU countries: Norway and Switzerland. Their results found no cointegration between electricity consumption and real GDP. This could not lead them to pursuance in investigating causality between both variables.

China, Solarin (2011) for Botswana and Kouakou (2011) for Cote d'Ivoire. Similarly, studies also show the validation of feedback hypothesis supported by the existence of bidirectional Granger causality between electricity consumption and economic growth using the cointegration and Granger causality approaches. The findings of Yang (2000), Jumbe (2004), Zachariadis and Pashouortidou (2007), Tang (2008), Aktas and Yilmaz (2008), Odhiambo (2009a), Tang (2009), Lean and Smyth (2010), Ouédraogo (2010), Lorde et al. (2010), Acaravci (2010), Shahbaz et al. (2011) and Gurgul and Lach (2012) for Taiwan, Malawi, Cyprus, Malaysia, Turkey, South Africa, Burkina Faso, Barbados, Turkey, Portugal and Poland provide support to discourage energy (electricity) conservation policies.

On contrary, in case of India, Australia, Indonesia, Hong Kong, Bangladesh, Pakistan, Spain, Japan and Ghana, findings by Nigeria, Ghosh (2002), Narayan and Smyth (2005), Yoo and Kim (2006), Ho and Siu (2007), Mozumder and Marathe (2007), Jamil and Ahmad (2010), Ciarreta and Zarraga (2010), Sami (2011) and Adom (2011), Kwakwa (2012), Shahbaz and Feridun (2012) indicated unidirectional causal relation running from economic growth to electricity consumption supporting the growth-led electricity hypothesis. Finally, Yusof and Latif (2007) in case of Malaysia support the neutrality hypothesis. These findings imply that implementation of energy (electricity) conservation polices would not adversely effect economic growth.

II.2. Financial Development and Economic Growth

The relationship between financial development and economic growth has received wide rage of academic attention in the contemporary economics literature. Research has been undertaken using both time series and cross-country data[9]. A developed financial system is credited with adding to the efficiency of financial institutions, promoting financial innovations, helping in adoption of advanced technology, reducing information cost, and allocating funds from low to high return investment ventures [Townsend (1979), Levine (1996), Bairer et al. (2004), Abu-Bader and Abu-Qarn(2008), Shahbaz et al. (2008b), Shahbaz (2009) and Shahbaz et al. (2010a)]. Financial sector may stimulate economic growth by mobilizing savings which raises the supply of funds for productive projects. As well as, financial sector monitors and screens the investment ventures and enhances the efficiency of investment projects (Greenwood and Jovanovic, 1990 and Levine, 1991). However, developed financial markets play an important role in reducing transaction cost, insuring and enhancing the efficiency of allocated resources in high yielding projects that in turn, increases the rate of economic growth (Levine, 1997).

Patrick, (1966) pointed out the direction of relationship between financial development and economic growth. Demand-following hypothesis implies that real economic activity Granger-causes financial development by generating the demand of financial services as economy grows and in resulting, efficiency of financial sector is improved. Similarly, Robinson, (1952); Lucas, (1988) and Stern, (1989) argued that financial development follows economic growth. Financial development leads economic growth by raising savings and capital enhancing effect is supply-leading hypothesis. In broader prospective, financial markets also contribute to economic growth by raising resources through internal and external sources to finance the better investment projects (Greenwood and Jovanovic 1990 and Bencivenga and Smith 1991).

[9] See for more details and literature Wachtel et al. (2006), Gruyay et al. (2007), Maswana (2008), Wolde-Rufael (2009b), and Shahbaz (2009).

In recent wave of economic growth literature, Shahbaz (2009) considered relationship between financial development and economic growth in Pakistan concluding that financial development stimulates economic growth by enhancing domestic production through offering cheaper loans to entrepreneurs. Ibrahim (2007) investigated the relationship between financial development and economic development in case of Malaysia. The results postulated that financial market development has favorable effect on economic growth by controlling financial instability. In case of Pakistan and China, Jalil and Ma, (2008) found that financial development contributes to economic growth by raising capital formation. Odhiambo (2010) considered the relationship between financial development and economic growth by incorporating investment as an additional variable for South Africa. The results indicated that financial development boosts investment activities which raises domestic production and hence triggers economic growth. For Tunisian economy, Odhiambo (2011) investigated causal relationship between financial development, foreign capital inflows and economic growth. The results indicated that financial development follows economic growth and financial development and foreign capital inflows are interdependent.

Financial development as part of financial liberalization activates equity markets, introduces greater level of transparency in transactions, allows easy access to financial capital for investment across nations, facilitates inflow of foreign direct investment (FDI), and lowers financial risk and borrowing costs. Broadly, financial development improves monetary transmission mechanism, boosts savings and investment and promotes economic growth. Fung, (2009) argued that the growth augmenting effect of financial development is also facilitated through an enhancement of business productivity. The growth inducing effect of financial development and energy demand have been documented by a number of authors [Bekaert and Harvey (2000) and Bekaert et al. (2001, 2002, 2005)].

II.3. Financial development and Energy Consumption

The impact of financial development on energy consumption can work in different ways. For instance, Love and Zicchino (2006) considered that financial development has impact on energy consumption through real variables i.e. real interest rate and investment level or capitalization. Financial development is associated with less borrowing cost which increases investment activities and hence generates employment opportunities both for skilled and unskilled labor that increases demand for energy. The rise in investment enhances domestic production and hence economic growth. An increase in economic growth further raises demand for energy. This shows that financial development indirectly enhances energy demand through investment and growth enhancing effect. Directly, financial development offers loans to consumers at cheaper rates to buy consumer items such as automobiles, houses, refrigerators, air-conditions, washing machines, mobiles, cooking utensils etc. (Sadorsky, 2010, 2011, Mankiw and Scarth, 2008)[10].

Similarly, Karanfil (2009) argued that any search for a causal link between energy use and economic growth need to go beyond the framework of a simple bivariate case. Among the financial variables he suggested, are stock market capitalization as share of GDP, liquid liabilities as share of GDP and domestic credit to the private sector as share of GDP. Further, he suggested that exchange and interest rates may influence energy demand through the price channel. For example, demand for big ticket items depends upon the borrowing cost on loans

[10] Mielnik and Goldemberg (2002) find a relationship between foreign direct investment and energy intensity while Tamazian et al. (2009) results conclude that financial development lessens CO_2 emissions.

offered by banks. The borrowing cost by banks is highly sensitive to interest rates. If banks charge high interest rates against loans they offer then use of non-essential items become very expensive which in resulting lowers demand for energy and vice versa. That is why, Stern (2000) warns about model misspecification due to omitted variables.

Dan and Lijun (2009) followed Karanfil (2009) model to investigate the effect of financial development on primary energy consumption in Guangdong province, China. Using Granger-causality test, they found unidirectional causality running from energy consumption to financial development. Sadorsky (2010) studied 22 emerging economies (1990-2006) using different indicators[11] of financial development and found energy consumption to be linked with economic growth. However, the impact of financial development on energy demand is positive but small. Similarly, Shahbaz and Lean (2012) investigated the impact of financial development on energy consumption applying energy demand function in case of Tunisia. Their results indicated that financial development increases energy demand by boosting stock market development and boosting real economic activity. The causality analysis showed that financial development and energy consumption Granger-cause each other while dominate effect is running from financial development to energy consumption.

III. Modeling and Data Collection

We apply neoclassical augmented production function to examine causal relationship between electricity consumption, financial development, economic growth, capital and labor in case of Pakistan. The general form of aggregate production function is given below where financial development, electricity consumption, capital and labor are considered as factors of production:

[11] FDI, bank deposits as share of GDP, stock market capitalization as share of GDP, stock market turnover ratio and total stock market value traded over GDP.

$$G_t = f(E_t, F_t, K_t, L_t) \qquad (1)$$

We converted all the series into logarithms i.e. log-linear specification to avoid spuriousness of results. It is pointed by Bowers and Pierce (1975), Ehrlich (1977), Layson (1983), Cameron (1994) and latter on Ehrlich (1996) that log-linear specification solves the problem of spuriousness and provides consistent results as compared to simple linear modeling[12]. Following above discussion, we consider the empirical equation following the neoclassical production function multivariate framework as given below:

$$\ln G_t = \alpha_1 + \alpha_E \ln E_t + \alpha_F \ln F_t + \alpha_K \ln K_t + \alpha_L \ln L_t + \mu_t \qquad (2)$$

where $\ln G_t$, $\ln E_t$, $\ln F_t$, $\ln K_t$ and $\ln L_t$ are log of real GDP per capita, per capita electricity consumption in KWH, real domestic credit to private sector per capita proxy for financial development[13], real capita use per capita and labor respectively, and μ_t is the error term and

[12] The empirical investigation is based on Cobb-Douglas production function and we have to covert the functional form of model into log-linear specification. The use log-linear specification may be helpful in attaining consistent and efficient results as logarithm transformation vanishes the variation in times series data. The simple linear specification provided inappropriate and unreliable results.

[13] There are many indicators that had been used for financial development such as M1, M2, M3 are considered poor proxies for financial development because they just show size of financial sector (Khan and Sinhadji, 2000). Similarly, currency to GDP ratio shows the size of money in circulation in an economy. Furthermore, stock market capitalization implies the promotion of trading activities which is another indicator of developed financial sector. These indicators of financial development indicate the actual size of financial markets. But we need a variable which shows the ability of financial sector to allocate funds in potential investment ventures rather than collecting money from savers. Considering this, domestic credit to private sector is a very good proxy of financial development. It shows actual amount of funds collected from savers and distributed by banks to investors for investing in high return projects. It does not include credit allocated to public sector. This implies that domestic credit to private sector works better for financial development as compared to other indicators of financial deepening (Levine, 2003).

assumed to be normally distributed[14,15]. We have combed economic survey of Pakistan (various issues) to attain the data on real GDP, electricity consumption, domestic credit to private sector, capital and labor over the period of 1971 to 2009.

The electricity-growth relationship has three competing hypotheses, electricity consumption-economic growth nexus, financial development-electricity consumption nexus and, financial development and economic growth nexus etc. The first hypothesis is concerned about electricity consumption-economic growth relationship. The causal relation between electricity consumption and economic growth which reveals that (i) unidirectional causality runs from electricity consumption to economic growth; (ii) economic growth granger causes electricity consumption; (iii) electricity consumption and economic growth granger cause each other or (iv) no causality is found between both the variables. Electricity consumption might granger cause economic growth because electricity consumption is considered as an important stimulus in production process like capital and labour etc. The causality from economic growth to electricity consumption reveals an expansion in output and hence economic growth will create demand for more electricity through investment enhancing effect. The existence of these hypotheses is very important regarding economic policy point of view. If unidirectional causality is found running from electricity consumption to economic growth or bidirectional causal relationship exists between both the variables then energy conservation policies may impede economic growth. A reduction in electricity consumption through energy conservation policies will not have adverse effect on

[14] The data on gross capital formation is available in world development indicators (WDI, CD-ROM, 2010). We have computed capital stock using the perpetual inventory method with an annual depreciation of 4%.

[15] The empirical investigation is based on Cobb-Douglas production function and we have to covert the functional form of model into log-linear specification. The use log-linear specification may be helpful in attaining consistent and efficient results as logarithm transformation vanishes the variation in times series data. The simple linear specification provided inappropriate and unreliable results.

economic growth if economic growth granger-causes electricity consumption or no causality is found between both the variables.

Sadorsky (2010, 2011) explored numerous ways that how financial development can affect energy (electricity) consumption and vice versa. The development of financial system will provide more facilities for consumers to purchase electronic and electrical appliances (i.e. televisions, computers, refrigerators, washing machines, mobiles and air conditioners) that lead electricity demand. Similarly, financial development also benefits the producers by offering loans at cheaper cost to purchase advanced machinery and equipment for production enhancement. It may be noted that the demand for electricity is expected to be positively related to financial development. Further, the availability of funds to both consumers and producer at cheaper cost (interest rate) will increase the profitability of banks and hence financial development. A tight monetary policy will decline the demand for electricity which in turn, lowers economic growth if financial development granger-causes electricity consumption or feedback hypothesis exists between financial development and electricity consumption. The unidirectional causality runs from electricity consumption to financial development or neutral hypotheses between both variables implies that the availability of funds at cheaper cost or loose monetary policy will not have beneficial effect on electricity demand.

Thirdly, the debate on the relationship between financial development and economic growth is not new. The relationship between financial development and economic growth also presents four competing hypotheses. For instance, supply-side hypothesis implies that financial development is considered as an important factor to determine the speed of economic growth.

Financial sector provides easy access to financial resources to generate investment opportunities that raises domestic production and in turn economic growth is stimulated. In this way, financial development may granger cause economic growth (McKinnon, 1973; Shaw, 1973 and, King and Levine (1993). The demand-side hypothesis considers that economic growth also promotes financial development by rising demand for financial services offering by banking sector. The third is possibility of bidirectional relationship between financial development and economic growth. The fourth hypothesis reveals no causal relation is found between both the variables (Robinson, 1952; Patrick, 1966; Chuah and Thai, 2004).

IV. Methodological Framework

This study applies the autoregressive distributed lag (ARDL) bounds testing approach to cointegration advanced by Pesaran et al. (2001) to examine the long run relationship between electricity consumption, financial development, economic growth, capital and labour in case of Pakistan over the period of 1971-2009. The ARDL bounds testing approach to cointegration is superior over traditional cointegration techniques due to its numerous merits. For example, if the variables are integrated at I(1) or I(0) or I(1)/I(0) then ARDL bounds testing approach is applicable to investigate the cointegration between the variables. Moreover, a dynamic unrestricted error correction model can also be derived from the ARDL bounds testing through a simple linear transformation. The ARDL approach is much suitable for small sample like in case of Pakistan. An unrestricted error correction model (UECM) combines the short-run dynamics with the long-run equilibrium without losing any long-run information. The UECM is expressed as follows:

$$\Delta \ln G_t = \vartheta_1 + \vartheta_T T + \vartheta_C \ln G_{t-1} + \vartheta_G \ln E_{t-1} + \vartheta_F \ln F_{t-1} + \vartheta_K \ln K_{t-1} + \vartheta_L \ln L_{t-1} + \sum_{i=1}^{p} \vartheta_i \Delta \ln G_{t-i}$$
$$+ \sum_{j=0}^{q} \vartheta_j \Delta \ln E_{t-j} + \sum_{k=0}^{r} \vartheta_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \vartheta_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \vartheta_m \Delta \ln L_{t-m} + \mu_t \quad (3)$$

$$\Delta \ln E_t = \alpha_1 + \alpha_T T + \alpha_G \ln G_{t-1} + \alpha_E \ln E_{t-1} + \alpha_F \ln F_{t-1} + \alpha_K \ln K_{t-1} + \alpha_L \ln L_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \ln E_{t-i}$$
$$+ \sum_{j=0}^{q} \alpha_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta \ln F_{t-k} + \sum_{l=0}^{s} \alpha_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \alpha_m \Delta \ln L_{t-m} + \mu_t \quad (4)$$

$$\Delta \ln F_t = \beta_1 + \beta_T T + \beta_G \ln G_{t-1} + \beta_E \ln G_{t-1} + \beta_F \ln F_{t-1} + \beta_K \ln K_{t-1} + \beta_L \ln L_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \ln F_{t-i}$$
$$+ \sum_{j=0}^{q} \beta_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \beta_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \beta_l \Delta \ln K_{t-l} + \sum_{m=0}^{t} \beta_m \Delta \ln L_{t-m} + \mu_t \quad (5)$$

$$\Delta \ln K_t = \rho_1 + \rho_T T + \rho_G \ln G_{t-1} + \rho_E \ln F_{t-1} + \rho_F \ln F_{t-1} + \rho_K \ln K_{t-1} + \rho_L \ln L_{t-1} + \sum_{i=1}^{p} \rho_i \Delta \ln K_{t-i}$$
$$+ \sum_{j=0}^{q} \rho_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \rho_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \rho_m \Delta \ln L_{t-m} + \mu_t \quad (6)$$

$$\Delta \ln L_t = \sigma_1 + \sigma_T T + \sigma_G \ln G_{t-1} + \sigma_E \ln E_{t-1} + \sigma_F \ln F_{t-1} + \sigma_K \ln K_{t-1} + \sigma_L \ln L_{t-1} + \sum_{i=1}^{p} \sigma_i \Delta \ln L_{t-i}$$
$$+ \sum_{j=0}^{q} \sigma_j \Delta \ln G_{t-j} + \sum_{k=0}^{r} \sigma_k \Delta \ln E_{t-k} + \sum_{l=0}^{s} \sigma_l \Delta \ln F_{t-l} + \sum_{m=0}^{t} \sigma_m \Delta \ln K_{t-m} + \mu_t \quad (7)$$

The 1st difference operator is shown by Δ and μ_t is for residual terms. The appropriate lag length of the first differenced regression is chosen on the basis of minimum value of akaike information criteria (AIC). The F-statistic is much sensitive with lag order selection. The inappropriate lag length selection may provide misleading results. Pesaran et al. (2001) developed an F-test to determine the joint significance of the coefficients of lagged level of the variables. For example, the hypothesis of no cointegration between the variables in equation (3) is $H_0: \vartheta_G = \vartheta_E = \vartheta_D = \vartheta_K = \vartheta_L = 0$ while hypothesis of cointegration is $H_0: \vartheta_G \neq \vartheta_E \neq \vartheta_D \neq \vartheta_K \neq \vartheta_L \neq 0$. Pesaran et al. (2001) generated two asymptotic critical values i.e. upper critical bound (UCB) and lower critical bound (LCB), are used to take decisions whether cointegration exists or not between the series. The lower critical bound is used to test cointegration if all the series are integrated at I(0) otherwise we use upper critical bound (UCB). Our computed F-statistics are $F_G(G/E,F,K,L)$, $F_E(E/G,F,K,L)$, $F_F(F/Y,E,K,L)$, $F_K(K/Y,E,F,L)$ and $F_L(L/G,E,F,K)$ for equations (3) to (7) respectively. The long run relationship between the variables exists if our calculated F-statistic is greater than upper critical bound (UCB). There is no cointegration between the series, if our calculated F-statistic does not exceed lower critical bound (LCB). Our decision regarding cointegration is inconclusive if calculated F-statistic falls between LCB and UCB. In such an environment, error correction method is an easy and suitable way to investigate cointegration between the variables. We have used critical bounds generated by Narayan (2005) to test cointegration rather than Pesaran et al. (2001) and Turner (2006).

Once cointegration is confirmed between the series, the next turn is to test the direction of causal relationship between electricity consumption, financial development, economic growth, capital and labor using augmented production function. It is suggested by Granger (1969) that we should apply vector error correction method (VECM) to detect causal relation between the variables if the series are found to be stationary at unique order of integration. Comparatively, the VECM is restricted form of unrestricted VAR (vector autoregressive) and restriction is levied on the presence of long run relationship between the series. All the series are endogenously used in the system of error correction model (ECM). This shows that in such an environment, response variable is explained both by its own lags and lags of independent variables as well as the error correction term and by residual term. The VECM in five variables case can be written as follows:

$$\Delta \ln G = \alpha_{\circ 1} + \sum_{i=1}^{l} \alpha_{11} \Delta \ln G_{t-i} + \sum_{j=1}^{m} \alpha_{22} \Delta \ln E_{t-j} + \sum_{k=1}^{n} \alpha_{33} \Delta \ln F_{t-k} + \sum_{r=1}^{o} \alpha_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{p} \alpha_{55} \Delta \ln L_{t-s} + \eta_1 ECT_{t-1} + \mu_{1i} \quad (8)$$

$$\Delta \ln E = \beta_{\circ 1} + \sum_{i=1}^{l} \beta_{11} \Delta \ln E_{t-i} + \sum_{j=1}^{m} \beta_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \beta_{33} \Delta \ln F_{t-k} + \sum_{r=1}^{o} \beta_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{p} \beta_{55} \Delta \ln K_{t-s} + \eta_2 ECT_{t-1} + \mu_{2i} \quad (9)$$

$$\Delta \ln F = \phi_{\circ 1} + \sum_{i=1}^{l} \phi_{11} \Delta \ln F_{t-i} + \sum_{j=1}^{m} \phi_{22} \Delta \ln E_{t-j} + \sum_{k=1}^{n} \phi_{33} \Delta \ln G_{t-k} + \sum_{r=1}^{o} \phi_{44} \Delta \ln K_{t-r} + \sum_{s=1}^{P} \phi_{55} \Delta \ln L_{t-s} + \eta_3 ECT_{t-1} + \mu_{3i} \quad (10)$$

$$\Delta \ln K = \varphi_{\circ 1} + \sum_{i=1}^{l} \varphi_{11} \Delta \ln K_{t-i} + \sum_{j=1}^{m} \varphi_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \varphi_{33} \Delta \ln E_{t-k} + \sum_{r=1}^{o} \varphi_{44} \Delta \ln F_{t-r} + \sum_{s=1}^{p} \varphi_{55} \Delta \ln L_{t-s} + \eta_4 ECT_{t-1} + \mu_{4i} \quad (11)$$

$$\Delta \ln L = \delta_{\circ 1} + \sum_{i=1}^{l} \delta_{11} \Delta \ln L_{t-i} + \sum_{j=1}^{m} \delta_{22} \Delta \ln G_{t-j} + \sum_{k=1}^{n} \delta_{33} \Delta \ln E_{t-k} + \sum_{r=1}^{o} \delta_{44} \Delta \ln F_{t-r} + \sum_{s=1}^{p} \delta_{55} \Delta \ln K_{t-s} + \eta_4 ECT_{t-1} + \mu_{4i} \quad (12)$$

Where u_{it} are residual terms and assumed to be identically, independently and normally distributed. The statistical significance of lagged error term i.e. ECT_{t-1} further validates the established long run relationship between the variables. The estimates of ECT_{t-1} also shows the speed of convergence from short run towards long run equilibrium path in all models. The VECM is superior to test the causal relation once series are cointegrated and causality must be found at least from one direction. Further, VECM helps to distinguish between short-and-long runs causal relationships. The VECM is also used to detect causality in long run, short run and joint i.e. short-and-long runs respectively in the following three possible ways:

The statistical significance of estimate of lagged error term i.e. ECT_{t-1} with negative sign confirms the existence of long run causal relation using the t-statistic. Short run causality is indicated by the joint χ^2 statistical significance of the estimates of first difference lagged independent variables. For example, the significance of $\alpha_{22,i} \neq 0 \forall_i$ implies that electricity consumption Granger-causes economic growth and causality runs from economic growth to electricity consumption can be indicated by the significance of $\beta_{22,i} \neq 0 \forall_i$. The same inference can be drawn for rest of causality hypotheses. Finally, we use Wald or F-test to test the joint significance of estimates of lagged terms of independent variables and error correction term. This further confirms the existence of short-and-long run causality relations (Shahbaz et al. 2011) and known as measure of strong Granger-causality (Oh and Lee, 2004).

The VECM granger approaches are failed to capture the relevant strength of causal effect of the variables beyond sample period (Wolde-Rufael 2009). This approach also does able to drag out the degree of the feedback from one variable to the other. To overcome this limitation of VECM Granger causality test, Shan, (2005) proposed new term, innovative accounting approach (IAA) which is combination of variance decomposition and impulse response function to check the direction of causality between the variables. Variance decomposition method (VDM) helps to determine the response of the dependent variable to shocks stemming from independent variables. The variance decomposition method is considered an alternative to impulse response function (IRF).

V. Results and their Discussions

The Table-1 shows descriptive statistics and correlation matrices. The statistics of Jarque-Bera normality test indicate that there is no normality problem in the series. The correlation matrices indicate that there is positive correlation between electricity consumption and economic growth. Financial development, capital and labor are also positively correlated with economic growth. The correlation from financial development and capital to electricity consumption is positive while negative from labor to electricity consumption. Financial development is positively correlated with capital and labor and positive correlation is also found between capital and labor.

Table-1: Descriptive Statistics and Correlation Matrix

Variables	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
Mean	10.0154	5.4493	8.6234	8.3477	3.4435
Median	10.0890	5.6225	8.7036	8.3891	3.4388
Maximum	10.4336	6.1730	9.2101	8.7272	4.0006
Minimum	9.54917	4.4601	7.9453	7.9465	2.9052
Std. Dev.	0.2808	0.5690	0.3299	0.1983	0.2999
Skewness	-0.3047	-0.4254	-0.2133	-0.3739	-0.0070
Kurtosis	1.7844	1.6668	2.3611	2.3567	2.0753
Jarque-Bera	3.0046	4.0646	0.9591	1.5812	1.3897
Probability	0.2226	0.1310	0.6190	0.4535	0.4991
$\ln G_t$	1.0000				
$\ln E_t$	0.5015	1.0000			
$\ln F_t$	0.2460	0.1303	1.0000		
$\ln K_t$	0.3890	0.1442	0.3102	1.0000	
$\ln L_t$	0.0467	-0.1805	0.1007	0.1335	1.0000

The long run relationship between the variables has been investigated by applying ARDL cointegration approach to cointegration. The main merit of ARDL bounds testing is that it can be used if the variables are integrated either at I(0) or I(1) or I(0)/I(1). So, to ensure this that no variables is stationary at I(2) or beyond this level, we have applied ADF unit root test by Dickey and Fuller (1979), DF-GLS unit root test by Elliot et al. (1996) and Ng-Perron unit root test by Ng and Perron (2001)[16]**.** These unit root tests indicated that all the variables have unit root problem at their level form but found to be integrated at I(1). But, Baum (2004) pointed out that unit root analysis by ADF, DF-GLS and Ng-Perron unit root tests may provide biased results when structural break occurs in the series.

[16] Results of these tests are available upon request from authors.

To resolve the issue, we used two structural break unit root tests such as Zivot-Andrews (1996) unit root test which has information about one structural break while Clemente-Montanes-Reyes (1998) de-trended structural break unit root test contains information about two structural break points in the series. Clemente-Montanes-Reyes unit root test provides information about two possible structural break points in the series through (1) an additive outliers (AO) model that point out a sudden change in the mean of a series and (2) an innovational outliers (IO) model that indicates gradual shifts in the mean of the series. As a result, the additive outlier model is more appropriate for series having sudden structural changes as compared to gradual shifts.

Table-2: Zivot-Andrews Structural Break Trended Unit Root Test

Variable	**At Level**		**At 1st Difference**	
	T-statistic	Time Break	T-statistic	Time Break
$\ln G_t$	-3.692 (2)	1997	-6.440 (0)*	1993
$\ln E_t$	-2.958 (0)	1991	-6.306 (2)*	1978
$\ln F_t$	-4.716 (1)	1989	-5.102 (1)**	1985
$\ln K_t$	-4.094 (1)	1997	-5.894 (0)*	2006
$\ln L_t$	-3.105 (0)	2001	-7.176 (0)*	2003
Note: * and *** represent significant at 1%, and 10% level of significance. Lag order is shown in parenthesis.				

Table-3: Clemente-Montanes-Reyes Detrended Structural Break Unit Root Test

Variable	Innovative Outliers				Additive Outlier			
	t-statistic	TB1	TB2	Decision	t-statistic	TB1	TB2	Decision
$\ln G_t$	-4.921 (2)	1978	2002	I(0)	-6.769 (3)*	1991	2003	I(1)
$\ln E_t$	-3.173 (6)	1976	2002	I(0)	-6.140 (3)*	1976	1991	I(1)
$\ln F_t$	-3.669 (1)	1980	2002	I(0)	-5.917 (2)*	1973	2008	I(1)
$\ln K_t$	-3.827 (2)	1980	2003	I(0)	-8.533 (3)*	1995	2003	I(1)
$\ln L_t$	-2.536 (6)	1994	2001	I(0)	-8.011 (3)*	1978	2001	I(1)
Note: * indicates significant at 1% level of significance.								

Our decision to test stationarity properties of the variable is based on Clemente-Montanes-Reyes (1998) unit root test. The results reported in Table-2 show that all the series may have unit root problem at their level but are found stationary at their 1st differenced form. The same inference can be drawn for the variables using Clemente-Montanes-Reyes (1998) unit root test as results are detailed in Table-3. This shows that variables are integrated at I(1). It leads us to apply ARDL bounds testing approach to cointegration to examine long run relationship between the variables i.e. electricity consumption, financial development, capital, labor and economic growth in case of Pakistan over the period of 1971-2009.

As it is confirmed that all the series are found to be integrated at I(1) then next step is to find cointegration relationship between the series applying bounds testing approach. Before proceeding to ARDL bounds testing, appropriate lag length of the variables should be selected by using AIC and SBC criterions. It is pointed out by Lütkepohl, (2006) that AIC lag length criteria provide efficient and consistent results to capture dynamic relation between the variables. So, using AIC criteria, optimal lag length of the variables is reported in 2 column of Table-4 with the results of the cointegration test.

Table-4: The Results of ARDL Cointegration Test

Bounds Testing to Cointegration			Diagnostic tests			
Estimated Models	Optimal lag length	F-statistics	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
$F_G(G/E,F,K,L)$	3, 1, 2, 1, 0	8.480*	4.9468	[2]: 0.0755	[1]: 0.3661	[1]: 3.6200; [3]: 2.1902
$F_E(E/G,F,K,L)$	3, 2, 2,1, 2	5.874**	1.0161	[1]: 0.7085	[1]: 0.0439	[1]: 1.4380; [2]: 0.7342
$F_F(F/G,E,K,L)$	3, 2, 2, 2, 1	13.379*	0.2246	[2]: 2.2181	[1]: 1.7402	[1]: 0.1757; [2]: 3.7296
$F_K(K/G,E,F,L)$	2, 2, 2, 2, 2	6.510*	1.0518	[1]: 0.0002	[1]: 0.0382	[1]: 0.7386; [2]: 1.0894
$F_L(L/G,E,F,K)$	3, 2, 2, 1, 1	3.417	0.7295	[1]: 0.0381	[7]: 4.3960	[2]: 2.0707; [3]: 3.2867
Significant level	Critical values (T= 40)#					
	Lower bounds $I(0)$	Upper bounds $I(1)$				
1 per cent level	6.053	7.458				
5 per cent level	4.450	5.560				
10 per cent level	3.740	4.780				

Note: The asterisks * and ** denote the significant at 1, 5 and 10 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. # Critical values are collected from Narayan (2005).

To take decision whether cointegration between the variables exists or not, we have to compare our calculated F-statistic following null hypothesis i.e. no cointegration with critical bounds such as LCB and UCB. The results reveal that there are four cointegrating vectors. This represents cointegration relationship at 1 and 5 per cent significance levels when economic growth, electricity consumption, financial development and capital are treated as response variables. The results reported in Table-4 show that long run relationship between economic growth, electricity consumption, financial development, capital and labour exists over the study period in case of Pakistan.

Table-5: Gregory-Hansen Structural Break Cointegration Test

Model	$T_G(G/E,F,K,L)$	$T_E(E/G,F,K,L)$	$T_F(F/G,E,K,L)$	$T_K(K/G,E,F,L)$	$T_L(L/G,E,F,K)$
ADF-Test	-4.1391	-3.0372	-4.9593	-3.6176	-2.6414
Prob. values	0.0000	0.0033	0.0000**	0.0006	0.0097
Note: * shows significance at the 1% level. The ADF statistics show the Gregory-Hansen tests of cointegration with an endogenous break in the intercept. Critical values for the ADF test at 1%, 5% and 10% are -5.13, -4.61 and -4.34 respectively.					

It may be noted that presence of structural break in the time series makes long run relations prejudiced, less powerful and unreliable. To overcome this deficiency of ARDL bounds testing approach to cointegration, we have applied Gregory-Hansen (1996) structural break cointegration test to examine the robustness of long run relationship between electricity consumption, financial development, capital, labour and economic growth. The Gregory-Hansen cointegration test is powerful over residual based cointegration tests and allows the presence of one structural break in the series. The results are reported in Table-5. The results show that cointegration relationship exists between electricity consumption, financial development, capital, labour and economic growth after allowing structural break in 1990 was investigated by applying FMOLS (fully modified ordinary least square) approach. This approach indicated the statistical significance of dummy variable for structural break in the financial development series[17]. The break point in financial development series is due to implementation of financial reforms in financial sector of Pakistan. The empirical evidence indicated that there is cointegration relationship between the variables as electricity consumption, economic growth, capital and labor are used as forcing variables including dummy variable. This implies that long run relationship exists between the variable and long run results are robust.

[17] The results are available from authors upon request.

After finding cointegration relationship between the variables, we move toward long run marginal effects of electricity consumption, financial development, capital and labor on economic growth. The Table-6 details long-and-short run results. The results show that electricity consumption contributes to economic growth significantly. It is concluded on the basis of our findings that a 1 per cent increase in electricity consumption raises economic growth by 0.26 per cent, all else being same. These results are consistent with Shahbaz and Feridun (2012) in case of Pakistan. The effect of financial development on economic growth is positive and statistically significant at 1 per cent. A 0.08 per cent economic growth is stimulated with a 1 per cent increase in financial development keeping other economic agents constant. This finding is matched with the findings of Shahbaz (2009a) in case of Pakistan. The impact of capital and labor has positive and significant at 1 per cent level of significance. An increase in capital and labor contribute economic growth by 0.12 and 0.28 per cent respectively. The impact of labor on economic growth is dominant in long run

In short run, effect of electricity consumption is positively and strongly associated with economic growth. The contribution of financial development to economic growth is positive and statistically significant. Similarly, capital and labor are also important determinants of economic growth. The significance of lagged error term i.e. ECM_{t-1} with negative sign further validates the existence of established long run relationship between the variables. The results reported in Table-6 show that estimate of lagged error term is -0.9300 and it is statistically significant at 1 per cent level of significance. This suggests that deviations in economic growth are corrected by 93 per cent every year in long span of time. The statistically significance of lagged error term i.e.

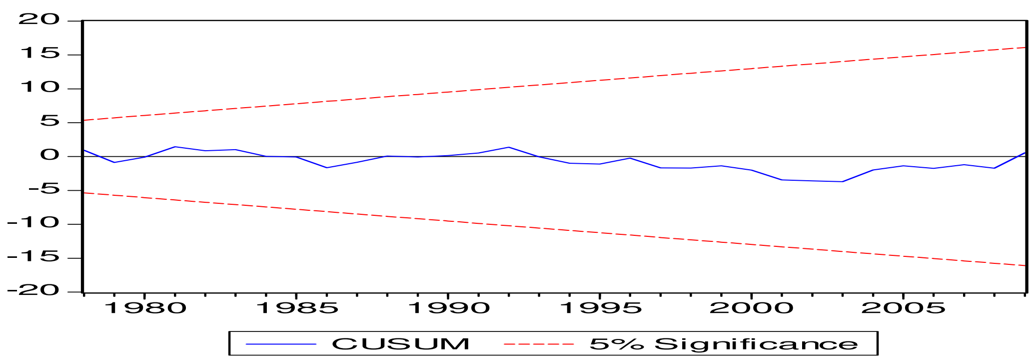
ECM_{t-1} is a further proof of the existence of stable long run relationship between the series (Bannerjee et al. 1998).

Table-6: Long and Short Runs Results

Dependent variable = $\ln G_t$				
Long Run Analysis				
Variables	Coefficient	Std. Error	T-Statistic	Prob. Values
Constant	5.8457*	0.2263	25.8221	0.0000
$\ln E_t$	0.2604*	0.0211	12.3049	0.0000
$\ln F_t$	0.0867*	0.0274	3.15702	0.0033
$\ln K_t$	0.1224*	0.0354	3.4508	0.0015
$\ln L_t$	0.2846*	0.0368	7.7314	0.0000
Short Run Analysis				
Variables	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.0002	0.0033	0.0771	0.9392
$\ln E_t$	0.3270*	0.0323	10.1224	0.0000
$\ln F_t$	0.0478**	0.0176	2.7151	0.0123
$\ln K_t$	0.1412*	0.0230	6.1271	0.0000
$\ln L_t$	0.1850**	0.0759	2.4346	0.0231
ECM_{t-1}	-0.9300*	0.1133	-8.2076	0.0000
R^2	0.8500			
F-statistic	26.0760*			
D. W	1.7280			
Short Run Diagnostic Tests				
Test	F-statistic	Prob. value		
χ^2 *NORMAL*	0.9117	0.6338		
χ^2 *SERIAL*	0.4088	0.6695		
χ^2 *ARCH*	0.3613	0.5529		
χ^2 *WHITE*	0.4226	0.8865		
χ^2 *REMSAY*	0.9233	0.4475		
Note: * and ** show significant at 1 and 5 per cent level of significance respectively.				

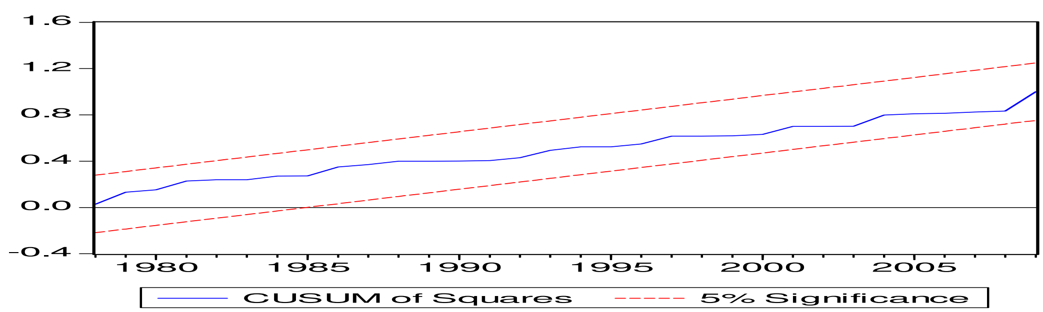
The stability of ARDL parameters is tested by applying cumulative sum of recursive residuals (CUSUM) and the CUSUM of square ($CUSUM_{SQ}$) suggested by Brown et al. (1975). Hansen argued that misspecification of model may provide biased results that influence the explaining power of the results. The CUSUM and CUSUMsq tests are employed to test the parameters constancy[18]. Further, Brown et al. (1975) pointed out that these test provide help in testing the gradual changes in parameters. The expected value of recursive residual is zero leads to accept that null hypothesis of parameter constancy is correct, otherwise not.

Figure-1 Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Figure-2 Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

[18] The first of these involves a plot of the cumulative sum (CUSUM) of recursive residuals against the order variable and checking for deviations from the expected value of zero. Symmetric confidence lines above and below the zero value allow definition of a confidence band beyond which the CUSUM plot should not pass for a selected significance level. A related test involves plotting the cumulative sum of squared (CUSUMSQ) recursive residuals against the ordering variable. The CUSUMSQs have expected values ranging in a linear fashion from zero at the first-ordered observation to one at the end of the sampling interval if the null hypothesis is correct. Again, symmetric confidence lines above and below the expected value line define a confidence band beyond which the CUSUMSQ plot should not pass for a selected significance level, if the null hypothesis of parameter constancy is true. In both the CUSUM and CUSUMSQ tests, the points at which the plots cross the confidence lines give some in diction of value(s) of the ordering variable associated with parameter change.

The plots of both CUSUM and CUSUMsq are shown by Figure-1 and 2 at 5 per cent level of significance. Results indicate that plots of both tests are within critical bounds at 5 per cent level of significance. The Table-6 showed results of diagnostic tests. The results indicated that short run model successful pass all tests of normality, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and functioning form of the model. It is found that normality of residual term is confirmed by Jarque-Bera estimates, and variables are not serially correlated in short span of time. There is no evidence of autoregressive conditional heteroskedasticity, and same inference can be drawn for white heteroskedasticity. The functional form of short run model is well specified as confirmed by estimates of Ramsey Reset test. The stability and sensitivity analysis shows that ARDL and short run results are stable and reliable for policy purpose regarding economic growth in Pakistan.

The existence of long run relationship between electricity consumption, financial development, economic growth, capital and labor tends us to apply Granger causality test to provide consistent findings that help policy makers in formulating a comprehensive electricity production policy to situating economic growth for long span of time. It is noted that once the variables are integrated at I(1) and cointegration exists between the variables then VECM Granger causality framework is an appropriate approach to detect the long-and-short runs causal relationship between electricity consumption, financial development, economic growth, capital and labor. The Table-7 reports results of Granger causality test.

Table-7: The VECM Granger Causality Analysis

Dependent Variable	Direction of Causality										
	Short Run					Long Run	Joint Long-and-Short Run Causality				
	$\Delta \ln G_{t-1}$	$\Delta \ln E_{t-1}$	$\Delta \ln F_{t-1}$	$\Delta \ln K_{t-1}$	$\Delta \ln L_{t-1}$	ECT_{t-1}	$\Delta \ln G_{t-1}, ECT_{t-1}$	$\Delta \ln E_{t-1}, ECT_{t-1}$	$\Delta \ln F_{t-1}, ECT_{t-1}$	$\Delta \ln K_{t-1}, ECT_{t-1}$	$\Delta \ln L_{t-1}, ECT_{t-1}$
$\Delta \ln G_t$	....	6.0515* [0.0070]	0.0291 [0.9713]	3.0515*** [0.0645]	0.3633 [0.6988]	-0.7740* [-3.1818]	....	6.4977* [0.0020]	4.9652* [0.0074]	4.0147** [0.0179]	3.4471** [0.0283]
$\Delta \ln E_t$	11.4951* [0.0003]	....	1.1310 [0.3381]	3.8765** [0.0336]	0.2261 [0.7759]	-0.5938* [-3.5080]	12.3208* [0.0000]	....	4.1223** [0.0162]	5.0640* [0.0068]	9.8772* [0.0002]
$\Delta \ln F_t$	2.9724*** [0.0688]	0.0417 [0.9592]	....	0.6889 [0.5110]	0.3729 [0.6923]	-0.8114* [-4.3607]	6.8194* [0.0015]	6.4969* [0.0020]	....	7.8796* [0.0007]	6.3414* [0.0023]
$\Delta \ln K_t$	4.8144** [0.0166]	3.3032*** [0.0527]	1.3236 [0.2835]	....	1.3037 [0.2887]	-0.4328* [-4.5132]	15.2221* [0.0000]	6.8543* [0.0015]	9.5668* [0.0002]	....	19.6129* [0.0000]
$\Delta \ln L_t$	0.1912 [0.2871]	3.6867** [0.0384]	0.8741 [0.4287]	3.0268*** [0.0652]	....	....	....	....	....	....	....
Note: *, ** and *** show significance at 1, 5 and 10 per cent levels respectively.											

The results indicate that there is bidirectional causal relationship exists between electricity consumption and economic growth, financial development and electricity consumption, financial development and economic growth, capital and electricity consumption and, economic growth and capital. The bidirectional relationship between electricity consumption and economic growth reveals that electricity conservation policies retard economic growth[19] and decline in economic growth further lowers demand of electricity. This implies that government of Pakistan must discourage energy conservation policy and encourage the policy making authorities to explore alternate sources of energy to meet the rising demand of energy to sustain economic growth.

[19] The trend of energy intensity is declining with passage of time in Pakistan

In this regard, government of Pakistan should utilize existing resources of coal properly using environment friendly technology and need to explore new sources of coal that must be safe, clean and cheaper. Therefore, government must develop cleaner and more efficient technology to condense energy emissions to reap sustainable economic growth and hence economic development. In doing so, government must adopt green mining system to use the coal efficiently and save the environment from degradation. Pakistan has fourth largest coal reserve of the world and adoption of advanced technology is helpful to convert coal into green gas to use it as an alternate source of energy which is considered a best strategy to limit carbon dioxide emissions. Although, government started to produce electricity by solar sources in cities (in some areas) and government must expand bio-energy network to village areas to generate electricity by training the people through environment awareness programs. As well as, government should also launch micro-financing schemes regarding bio-energy in indigenous areas.

The bidirectional causality between financial development and electricity consumption reveals that state bank of Pakistan should launch loose monetary policy. The loose monetary policy by state bank enables banking sector to offer loans at cheaper rates which enhances capitalization in the country that in resulting boosts economic growth. Further, the availability of loans at cheaper cost helps in expanding existing business and generates new business activities that means, buying or building more plants, employ more workers, purchasing advanced machinery and plants will also increase the demand for energy (electricity). In this regard, stock market is also considered as leading indicator of economic activity, prosperity and hence economic growth that raises the confidence of both consumer and business classes (Mankiw and Scarth, 2008). The increased confidence and economic activity both will boost the energy demand. This whole will increase the demand of financial services that raises profitability of financial sector and hence financial development (Sadorsky, 2010, 2011 and latter on Shahbaz and Lean (2012).

The feedback relationship between financial development and economic growth reveals that financial development promotes economic growth through supply-side effect and in turn, economic growth increases financial development through demand-side effect. This implies that adoption of tight monetary policy will adversely effect economic growth and in turn, decline in economic growth will negatively affect financial development. In short run, bidirectional causal relation exists between electricity consumption and economic growth and same inference can be drawn for capital and economic growth and electricity consumption and capital. The unidirectional causality is found running from electricity consumption and capital to labor. Finally, economic growth Granger causes financial development.

It is argued in economics literature that the Granger causality approaches such VECM Granger causality test has some limitations. The causality test cannot capture the relative strength of causal relation between the variable beyond the selected time period. This weakens the reliability of causality results by VECM Granger approach. To overcome this problem, we applied innovative accounting approach (IAA). The IAA is combination of variance decomposition method (VDM) and impulse response function (IRF). The variance decomposition approach (VDM) determines the response of the dependent actor to shocks stemming from independent actors. The IRF is an alternate of VDM. The Table-8 shows the results of VDM while the IRF graph is shown in Figure-3. The variance decomposition approach indicates the magnitude of the predicted error variance for a series accounted for by innovations from each of the independent variable over different time-horizons beyond the selected time period.

Table-8 reports the empirical evidence regarding variance decomposition method (VDM) and results reveal that innovative shocks of electricity consumption, financial development, capital and labor contribute to economic growth by 42.29%, 12.42%, 1.71% and 1.92% and rest is explained by innovative shock of economic growth itself. Electricity consumption is explained 68.31% by its own shocks. The response of electricity consumption due to shocks in economic growth is 22.39%. The contribution of financial development, capital and labour to explain electricity consumption is 0.91%, 2.90% and 5.47% respectively.

Table-8: Variance Decomposition Method (VDM)

Variance Decomposition of $\ln G_t$:						
Period	S.E.	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	0.0191	100.0000	0.0000	0.0000	0.0000	0.0000
2	0.0271	84.5918	3.9004	10.4856	0.1386	0.8833
3	0.0334	73.3015	8.5019	16.4329	0.1238	1.6396
4	0.0386	66.1780	12.8699	18.7106	0.0945	2.1467
5	0.0429	61.3060	16.9037	19.2060	0.1184	2.4656
6	0.0467	57.6562	20.5957	18.8963	0.2038	2.6479
7	0.0501	54.7342	23.9576	18.2410	0.3373	2.7297
8	0.0533	52.2928	27.0124	17.4556	0.5019	2.7370
9	0.0563	50.1967	29.7900	16.6406	0.6830	2.6894
10	0.0591	48.3637	32.3225	15.8418	0.8698	2.6019
11	0.0619	46.7385	34.6410	15.0784	1.0551	2.4868
12	0.0645	45.2809	36.7742	14.3564	1.2344	2.3539
13	0.0672	43.9595	38.7474	13.6758	1.4052	2.2117
14	0.0697	42.7497	40.5825	13.0337	1.5663	2.0676
15	0.0723	41.6308	42.2978	12.4259	1.7171	1.9282
Variance Decomposition of $\ln E_t$:						
Period	S.E.	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	0.0512	34.5118	65.4881	0.0000	0.0000	0.0000
2	0.0736	33.9534	65.4775	0.2244	0.2692	0.0754
3	0.0920	32.9489	65.6153	0.5880	0.6408	0.2067

4	0.1084	31.8168	65.8643	0.9262	1.0108	0.3817
5	0.1236	30.6936	66.1865	1.1733	1.3466	0.5997
6	0.1382	29.6282	66.5437	1.3241	1.6406	0.8632
7	0.1523	28.6321	66.9040	1.3955	1.8938	1.1744
8	0.1661	27.7019	67.2445	1.4082	2.1097	1.5355
9	0.1799	26.8296	67.5495	1.3803	2.2928	1.9476
10	0.1936	26.0067	67.8092	1.3254	2.4470	2.4114
11	0.2076	25.2251	68.0183	1.2536	2.5761	2.9266
12	0.2217	24.4782	68.1738	1.1720	2.6833	3.4925
13	0.2363	23.7603	68.2749	1.0855	2.7715	4.1076
14	0.2512	23.0673	68.3221	0.9976	2.8431	4.7697
15	0.2667	22.3959	68.3167	0.9108	2.9001	5.4762
Variance Decomposition of $\ln F_t$:						
Period	S.E.	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	0.0939	12.5190	0.2107	87.2702	0.0000	0.0000
2	0.1149	13.3370	0.1901	86.4202	0.0132	0.0393
3	0.1243	14.2175	0.4486	85.2163	0.0189	0.0985
4	0.1293	15.0351	0.9338	83.8498	0.0182	0.1629
5	0.1324	15.7461	1.6024	82.4083	0.0185	0.2244
6	0.1347	16.3475	2.4144	80.9331	0.0261	0.2787
7	0.1366	16.8524	3.3352	79.4449	0.0440	0.3234
8	0.1384	17.2778	4.3367	77.9548	0.0729	0.3575
9	0.1400	17.6395	5.3974	76.4694	0.1122	0.3813
10	0.1416	17.9505	6.5016	74.9920	0.1604	0.3954
11	0.1432	18.2208	7.6382	73.5240	0.2157	0.4011
12	0.1448	18.4580	8.7998	72.0649	0.2768	0.4001
13	0.1464	18.6679	9.9818	70.6133	0.3423	0.3944
14	0.1480	18.8544	11.1816	69.1666	0.4110	0.3862
15	0.1497	19.0205	12.3979	67.7213	0.4822	0.3779
Variance Decomposition of $\ln K_t$:						
Period	S.E.	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	0.0623	22.5948	3.7810	2.8101	70.8138	0.0000
2	0.0774	27.4062	3.6067	2.6309	66.1978	0.1581
3	0.0853	31.1227	3.1090	3.0879	62.3282	0.3520
4	0.0902	33.8897	2.8190	3.8359	58.9126	0.5427
5	0.0938	35.8548	3.0212	4.6065	55.7870	0.7302
6	0.0968	37.1570	3.8134	5.2352	52.8711	0.9230
7	0.0996	37.9153	5.1780	5.6612	50.1152	1.1300
8	0.1023	38.2290	7.0370	5.8889	47.4851	1.3597
9	0.1052	38.1826	9.2885	5.9511	44.9581	1.6194
10	0.1082	37.8483	11.8278	5.8872	42.5205	1.9160
11	0.1114	37.2877	14.5594	5.7328	40.1648	2.2551
12	0.1148	36.5522	17.4018	5.5165	37.8876	2.6416
13	0.1185	35.6842	20.2885	5.2602	35.6876	3.0793

14	0.1224	34.7181	23.1668	4.9796	33.5644	3.5709
15	0.1267	33.6814	25.9958	4.6861	31.5184	4.1180
Variance Decomposition of $\ln L_t$:						
Period	S.E.	$\ln G_t$	$\ln E_t$	$\ln F_t$	$\ln K_t$	$\ln L_t$
1	0.0175	0.0855	6.6305	2.2451	0.5751	90.4636
2	0.0254	0.0721	8.7971	2.7623	0.4448	87.9233
3	0.0321	0.0481	10.7904	3.3741	0.3894	85.3976
4	0.0382	0.0376	12.6891	3.9100	0.3733	82.9898
5	0.0442	0.0543	14.5444	4.3061	0.3818	80.7132
6	0.0501	0.1047	16.3821	4.5580	0.4073	78.5476
7	0.0561	0.1908	18.2111	4.6859	0.4453	76.4667
8	0.0623	0.3118	20.0307	4.7155	0.4927	74.4492
9	0.0686	0.4654	21.8351	4.6709	0.5471	72.4813
10	0.0752	0.6482	23.6164	4.5724	0.6069	70.5559
11	0.0822	0.8564	25.3660	4.4359	0.6705	68.6710
12	0.0894	1.0860	27.0755	4.2738	0.7367	66.8278
13	0.0971	1.3330	28.7375	4.0956	0.8045	65.0292
14	0.1053	1.5935	30.3456	3.9083	0.8730	63.2794
15	0.1139	1.8638	31.8946	3.7173	0.9415	61.5825

Innovative shocks of economic growth, electricity consumption, capital and labor explain financial development by 19.02%, 12.39%, 0.48% and 0.37% respectively. A 67.72% contribution in financial development is explained by its own innovative shocks. A 33.68% and 25.99%, capital is explained by shocks of economic growth and electricity consumption. The contribution of financial development and labor to capital is minimal i.e. 4.68% and 4.11%. Finally, response of labor by its own innovative shock is 61.58% and rest contribution to labor is by shocks of economic growth, electricity consumption, financial development and capital which are 1.86%, 31.89%, 3.71% and 0.94% respectively.

Overall results indicate that bidirectional causality exists between economic growth and electricity consumption but strong causality is running from economic growth to electricity consumption. The feedback hypothesis is also valid between financial development and economic growth. Electricity consumption Granger causes financial development. The unidirectional causal relationship is found running from economic growth and electricity consumption to capital. Labor is Granger caused by electricity consumption. Overall results of electricity consumption and economic growth relationship are consistent and robustness.

Figure-3: Impulse Response Function

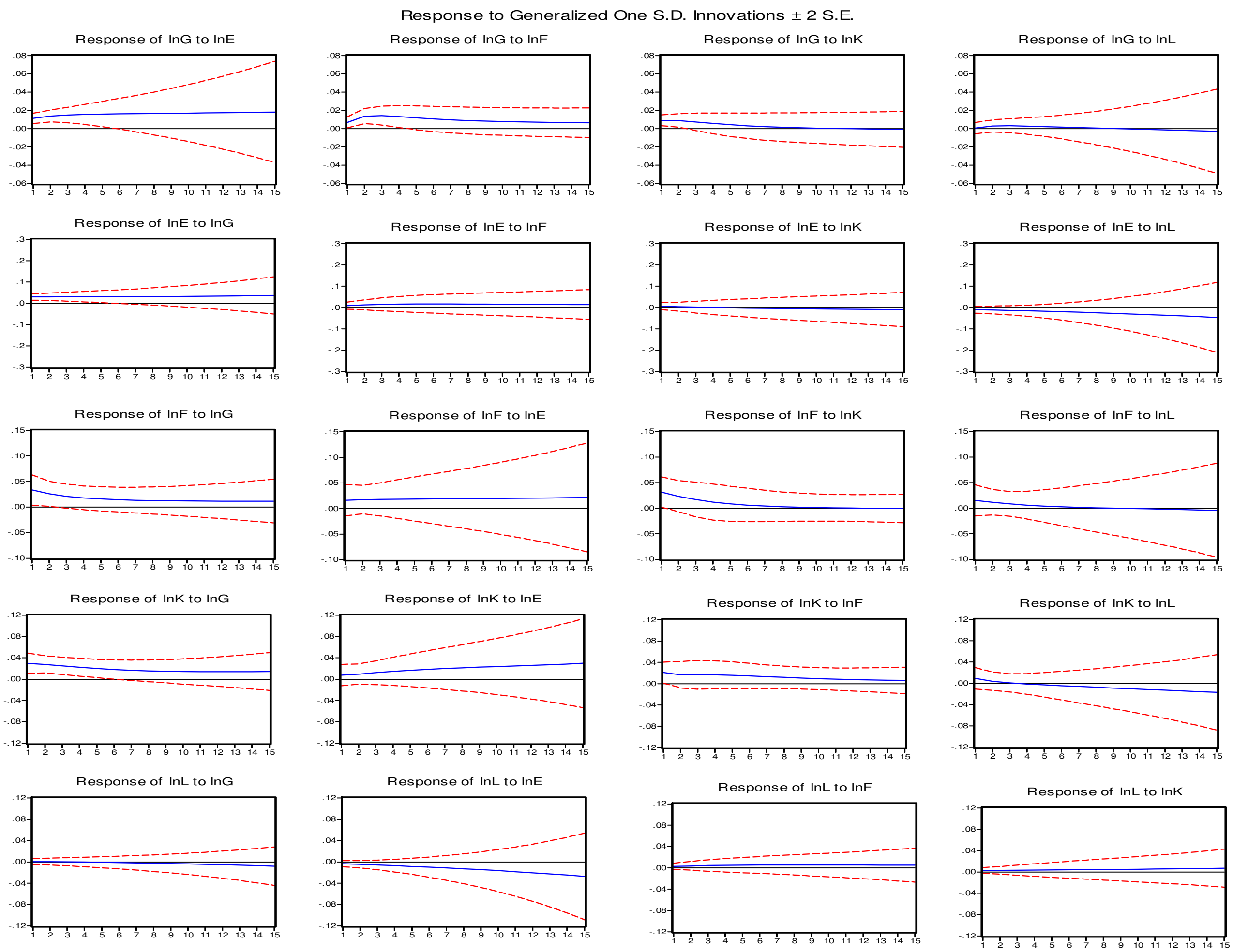


Figure-3 shows the results of impulse response function. The diagram indicates that positive response is found in economic growth following innovative shocks stemming in electricity consumption and financial development. The innovative shocks in capital and labor affect economic growth but response in economic growth is minimal but positive till 7^{th} time horizon. The response in electricity consumption is positive due to innovative shocks in economic growth and financial development but financial development has little effect to explain electricity consumption. This implies the existence of feedback hypothesis between economic growth and electricity consumption. The response from economic growth and electricity consumption to financial development is positive. The response in financial development due to shocks in capital and labour is positive till 7^{th} time horizon, after that effect of capital and labour on financial development dies out. Bidirectional causal relation also exists between economic growth and financial development and, electricity consumption Granger causes financial development but affect is negligible. Furthermore, the positive response is found in capital due to shocks stemming in economic growth, electricity consumption and financial development. Innovative shocks in economic growth, electricity consumption, financial development and capital could not contribute to labour successfully.

VI. Conclusions and Future Research

The study examines the relationship between electricity consumption, financial development and economic growth incorporating capital and labor as important factors of production by employing augmented neo-classical production function. The study used time series data over the period of 1971-2009. The ARDL bounds testing approach to cointegration was applied to investigate the long run relationship between the variables. The direction of causality was tested by applying VECM Granger causality test and innovative accounting approach (IAA) was applied to confirm the robustness of causality results.

Our empirical evidence indicated that variables are cointegrated for long run relationship. The impact of electricity consumption on economic growth is positive which implies the significance of electricity as a main stimulant of economic growth in economic activity. Financial development also plays its vital role by enhancing capitalization to enhance economic growth. A rise in capital stock promotes economic growth and increases the demand for skilled and unskilled labor which supports to increase the domestic production and in turn, economic growth is stimulated. The empirical evidence indicates that labor has dominant effect on economic growth in long span of time.

The causality analysis indicates that the bidirectional causal relationship exists between electricity consumption and economic growth. This implies that energy (electricity) conservation policies will not be appreciated in case of Pakistan. Furthermore, government of Pakistan should encourage making investments on research and development to articulate new energy savings technology to sustain economic growth for long span of time. In this manner, financial sector should launch new policy to encounter the rising demand for electricity and enhance the process of capitalization to raise economic growth by offering and distributing financial resources to efficient and profit oriented ventures. The bidirectional causality between capital and economic growth and, financial development and capital also suggest offering the financial services at cheaper cost to promote economic activity and hence economic growth in case of Pakistan.

The growth pattern of four provinces of Pakistan is different as well as development of financial sector at province level. For future, study can be focused on the provincial level to detect the directional of causal relationship between electricity consumption, financial development and economic growth which will provide help to policy makers in formulating comprehensive energy policy to sustain economic growth at provincial level. Sectoral analysis should be conducted between electricity consumption, financial development and economic growth to sustain economic growth for strong contributing key sectors such as agriculture, industrial and services to gross domestic product in the country.

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