

Linkage of financial development with electricity-growth, nexus of India and Pakistan

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Abstract. This paper tries to identify the indirect linkage between intermediary development with energy-growth nexus for India and Pakistan. In this succession the study employ system based GMM approach along with principal component analysis for development of intermediary index. Findings of the study demonstrate the positive and significant impact of economic growth on electricity consumption of both nations. However a miscellaneous trend for urbanization and negative trend for prices with electricity consumption has also been found in this study. On the other hand, the linkage between financial development through growth on electricity consumption is positive and significant for both nations. These findings have important implications for the policy makers. They can use these Findings to ensure long term structural development to control future power constraints, which leads them towards higher level of sustainable development.

Keywords: electricity consumption, economic growth, financial development, GMM, India, Pakistan

1 Introduction

The contribution of electricity consumption due to its intensive participation in growth process has been widely accepted in the world. By the time, electricity sector play its contribution in the development of nations, hence became one of the main determinant of the growth process. The prevalence of such hypothesis has been observed in India and Pakistan in last few decades, where the drastic rise in population through electricity consumption raises the level of development. However, apart from this development a constant increase in the demand been observed in the power demand of both resources. As per the projections of IEA, Indian economy due to their impressive strategies attains higher level of development in upcoming decades, which increase its lion's share in the power consumption after china through 2035¹. On the other hand, the intentional decline in the production of electricity in Pakistan has outage the gap between demand and supply of power resources in the economy. The engineering of power resources raise their demand at the stake of its economic development. This massive rise in the demand of resources stresses the need of study to re-investigate the linkage between the electricity-growth nexus of these nations.

Existing literature is equipped with a vast number of studies that delineates the contributing role of electricity consumption in growth process of the economies. Most of these studies through their application of multiple econometric tools, time spans and country levels extend the contributing work of Kraft and Kraft (Payne, 2010). Such extensiveness of literature gives birth to the four different hypothesis including growth hypothesis, conservation hypothesis, feedback hypothesis and neutrality

¹ <http://www.eia.gov/forecasts/ieo/>

hypothesis. Each of these hypotheses is observed in almost every country of the world and concluded with heterogenous policy implications (Abbas & Choudhury, 2013). However a few number of studies also found on the trilateral relationship between financial development and electricity-growth nexus. Although research's findings are fail to raise consensus about the single direction of causality or the nature of relationship between the stated variables.

Most of these studies employ a direct or single equation modeling to identify the linkage between electricity and finance-growth nexus (Komal & Abbas , 2015). However the influence of intermediary development is indirect in nature, because intermediary sector through affecting the economic situations affect the electricity demand in the economy. For example; different levels of financial sector development directly change the flow of funds in the economy, which directly hurts the trading activities of nations and change the demand of the energy by affecting the income of the people (Rashid, 2015). Theories state that Financial sector (intermediary development) through changing the technological development in the nation stimulate the economic activity (Sadorsky, 2010). However, the heterogeneity among the adoption of technological advancements alters the country's demand of power resources. In this succession this study explores the linkage of intermediary development through electricity-growth nexus in India and Pakistan. This study further tries to explore the influence (positive or negative) of intermediary development on electricity-growth nexus between both nations.

This study utilizes the data from 1980 to 2011, and applies system GMM approach to capture the impact of financial sector development on the electricity-growth nexus of both nations. However, channel effect is included in this study to capture the changing effect of financial development on economic growth and from such economic growth through electricity consumption. This approach helps in the determination of direction of relationship. As far as I Know, we are the first to conduct a study that defines the indirect contribution of financial development for electricity-growth nexus in cross country pattern.

The organization of this study contains the chapter 1 includes the brief introduction of the study. Portion 2 contains the detailed scrutiny of existing literature. However the 3rd portion defines the methodology, while findings are presented in 4th portion of the study. In contrast, the final section defines the conclusion of the study.

Brief history of India electricity sector

India became a 3rd largest producer of electricity resources in 2013 with the 4.8 % of the total production after Russia and Japan. In the fiscal year of 2013-14, total of 1102.9 TW of electricity is produced in the economy comprises of 967 TW² from thermal and hydro power resources³. This production level is high as compared to the previous ones, because the economic progression leads to the increased demand of electricity resources in the nation. In order to get a considerable portion in the world economy government of India devised an ambitious rural plan, but this plan does not play its considerable role in eradicating power shortage problem. The electrification rate in the economy is 65.5% with a 35% of the total population comprises of 300 million people have no access to electricity⁴. This shortage of power goes on with the passage of time as the power and distribution losses increases. In order to eradicate this problem of electricity shortage, the government took some considerable steps like special courts, appellate tribunal and audit information flow programs to raise the electrification levels in the country.

² 1 Tera Watt = 1000 Giga Watt

³ BP Statistical Review of World Energy June 2014, accessed 29-05-2015.

⁴ The Electricity Access Database. iea.org

Electricity sector of Pakistan:

The power sector of Pakistan is reconstructed in 1988 with the development of Pakistan electric Power Company, but later on two public vertically integrated organizations WAPDA and KESC included in the system and served the nation (ICCI, 2012). The electricity generation process is somewhat similar to India, as it relies mostly on fossil fuels and hydroelectric resources (Alam, 2013). This reliance on the fossil fuels reduces the capacity of the system up to 50% in last few years. Power sector of this nation due to inefficiency, inappropriate strategic planning and political instability faced sewer power crises of 6000 MW in 2007. Furthermore the economy suffered with the power and distribution loss of 20% in the fiscal year 2009-2010. The excessive power shortage with inefficient structure and inappropriate system reduce the nation's speed of development as compared to others (GOP, 2010). This is not enough, the power shortage evil give annual gift to the economy in the form of loss of \$ 2.60 Billion and 400,000 jobs (Atif & Siddique, 2012; GOP, 2009). In contrast the rise in the use of appliances in the economy further raise the demand of electricity from 23% in fiscal year 1980-81 to 43% in 2012-13 (Komal & Abbas , 2015).

The rapid growth in the demand of electricity products along with economic progression stress the need of the system which not only meet their ever increasing demand, but also control the problems of transmission losses. In this regard, there is a need of financial and technological assistance from the developed nations which helps both of these nations to control the evil of power shortage.

2 Literature review

The associationship between financial development and electricity growth nexus has been widely debated in the literature. However the heterogeneity among the nations and regions leads towards different findings of the seminal work of Kraft & Kraft (1978). Kraft & Kraft while defining causality between electricity-growth nexus shows a univariate analysis running from economic growth towards electricity consumption in USA. Studies later on in this succession raise the strength of this topic by further subdividing it into four different hypotheses (Odhiambo, 2009). Proponents of the first view suggest the essential role of electricity consumption in raising economic position of the economy. Second view in contrast to the findings of first comprehends the findings of Kraft & Kraft (1978) by stating the causality from economic growth towards electricity consumption. Third schools of thought in this regard state that dependence of both of these elements upon each other and state a bidirectional relationship between electricity consumption and economic growth. Finally the forth view oppose the findings of all three areas mentioned above by stating a neutrality between the stated variables (Rashid, 2015).

Each of these areas is well equipped with the number of studies to validate its findings. In this race of determination of causality, another variable named as financial development is also found to moderate the existing relationship between electricity growth nexus. For instance Love and Zicchino (2006) in their study defines the impact of financial development on electricity consumption through real variables. i.e. real interest rate and less borrowing cost. Similarly Sadorsky (2010) suggest that the financial development raise the electricity consumption through raising the demand of big tickets in the economy. Shahbaz and Lean (2012) defines the role of financial development in raising the electricity demand through two different dimensions. One of these dimensions is the cross sectional growth in the economy, while the other state the rise in demand of electricity due to the income improvement in the economy. The sound financial sector raises the production activity in the economy; also raise the profitability through enhancement of supplier-customer relationship in the economy. This whole picture leads towards the improvement in business atmosphere and thereby

raises the level of development in the economy.

In contrast, studies also define the role of financial sector development in reducing the consumption of electricity in the economy. Such reduction in electricity demand is achieved through application of technological innovation in along with efficient financial sector of the economy. For instance studies like Shahbaz et al., (2013) states that the entrepreneurs in the free market system play a significant role in raising the level of advancements. This means level of advancement in electricity sector is dependent upon the complete system, in which financial development along with capital; labor and government affect the electricity consumption in the economy. However the impact is different due to the heterogeneous economic position.

To date a number of studies have been found in literature that can study the impact of financial development on electricity-growth nexus in direct manner. Conceptually, this is not possible, because of the effect of financial development on economic position of the economy and later such economic position on the electricity consumption in the economy.

3 Research model

This study by keeping in consideration the existing literature employs a multivariate model to demonstrate a linkage between financial development and electricity-growth nexus. In this regard, system equation modeling is used along with GMM approach to capture the indirect impact of financial sector development on economic growth and through such growth on electricity consumption. In this regard, we have employed the following research model:

$$EC_t = \beta_1 + \beta_2 Y_t + \beta_3 EP_t + \beta_4 Urb_t + \mu_t \quad (1)$$

$$Y_t = \alpha_1 + \alpha_2 FD_t + \alpha_3 T_t + \alpha_4 L_t + \alpha_5 GS_t + v_t \quad (2)$$

Where the term EP in represents relative electricity price⁵, EC represents electricity consumption measured in MWH, URB represents urbanization, Y represents economic growth, FD became financial development, L became labor, GS is government size, and T & I as trade and investment. On the other hand, μ_t and v_t represents the error term with the t as time intercept.

In this model the equation 1 defines the direct associationship between electricity consumption and economic growth. While the equation 2 represents the linkage between financial development and economic growth in presence of certain control variables. These control variables are added in the system, because of their indirect involvement in energy-growth nexus.

4 Data and methodology

This study is based upon the annual time series data ranges from 1980 to 2011 for India and Pakistan. Data has been extracted from online database of World Bank and IFS of international financial statistics. All the variables used in this study contain annual observations, so any presence of trend distorts their efficiency. In this consideration natural log transformation is used to normalize the data.

The literature is well equipped with the cointegration and causality approaches in determination of relationship among energy, finance growth nexus. Mostly single equation modelling has been observed about determination in both long and short run. This study contributes to the existing

⁵ Relative energy price= crude oil petroleum future contract / GDP deflator

literature through its multivariate model, where the indirect impact of financial development is identified through the application of GMM regression approach. Furthermore the system equation approach is also used, which treats economic growth as endogenous and financial development as exogenous.

A large number of studies have been found that focus on single equation modeling to capture the impact of financial development on energy-growth nexus. In this succession, they employ ordinary regression or cointegration etc., to account for such relationship. Among these models, the main limitation observed is about the correlation between dependent or independent variables, which departs the assumptions of ordinary CLR models (Wooldridge, 2001). In this succession, application of estimation approaches considers instrumental variables by eliminating the correlation between disturbance and independent variables raises the efficiency of the results. Among these different approaches, GMM approach for time series data was introduced by Hansen (1982), because of the involvement of serial correlation in the time series data. Such correlation departs the assumptions of CLRM and makes ordinary estimators as inefficient. In this situation, GMM approach is allowed to use its weighting for controlling the problem of heteroskedasticity along with serial correlation (Hansen, 1982; White, 1984; Newey & West, 1987).

Among these instrumental approaches, GMM is most widely used in energy-finance- growth nexus. Such wide application is due to its several benefits as compared to other estimation approaches. Firstly GMM through the use of instruments validates the independence of disturbance term, which enables this approach to control for endogeneity bias in the data. Secondly, GMM estimation provides without any consideration of error terms provides accurate results. Thirdly, GMM application without any dependence on weighted average matrix yields towards asymptotic and accurate results. Fourthly, GMM is a simplest approach as compared to others in writing maximum likelihood estimators. Finally, GMM has an advantage of its limited number of restrictions for estimation as compared to maximum likelihood approach (Wooldridge, 2001). The main limitation for the application of GMM is its reliability on the number of instruments; any change in the instruments directly affects the validity of the model. In order to avoid such problem, different lags of variables are used separately for each of the system equation. Furthermore the problem of serial correlation along with heteroskedasticity is resolved by selecting HAC weighting matrix option during estimation. Such selection enables the estimation process to account for heteroskedasticity along with serial correlation.

Apart from use of GMM model, this study further employs the use of Principal component analysis to for determination of financial development index (FDI). Principal component analysis became one of the most widely used techniques in energy-growth nexus about the calculation of FDI. In which the amount of variance defines the maximum suitable variable for the better explanation of the concept. PCA is basically a modern tool of multivariate analysis and is mostly applied as a measure of variable reduction for identification of relationship between the variables. The information available in series of variables is determined through the number of principal components. Each of which is the weighted average of the underlying variables. If more than one component are found then the maximum variance (Max Eigen values) is defined by the first variable, and gradually decreases as the number of components increases. The weights of the variables along with their Eigen values for development of index in both nations India and Pakistan are given in the table mentioned below.

Table 1 Principal Component Analysis

Banking Sector Variables	India	Pakistan
M2GDP	0.450061	0.502478
M3GDP	0.451299	0.544139

Banking Sector Variables	India	Pakistan
Financial system deposit	0.451769	0.555496
Domestic credit to banking sector	0.439303	-0.106744
Credit to private sector	0.443499	0.362571

Note: All results are not reported, but they are available on demand

The findings of the table mentioned below represents the weights obtained from principal component analysis for the development of financial development index. These weights comprise to form the index, which defines the concept of financial development better than any single indicator.

5 Results and discussion

In this study, instrumental variables approach has been adopted to identify the indirect linkage of financial development through economic growth model. However, the separate number of instruments (lagged value of the variables) are used for each regression equation. However the empirical finds of tables are mentioned in the table presented below.

Table 2 Empirical results

	Pakistan		India	
	electricity consumption	economic growth	electricity consumption	economic growth
Economic growth	0.694650***		0.3301***	
Urbanization	-2.93425*		0.7946***	
Electricity prices	-0.058984*		0.00284	
Financial development index		0.138855***		0.056225**
Government size		-2.325886		3.110944***
Trade Openness		6.44		2.751904***
Investment		-6.679853		-0.95537*
Inflation		-0.538536		-0.09554**
J-Statistics	0.248871		0.285041	

Findings of primary equation of electricity equation are mentioned in the table given below. Findings of the study about the positive relationship between electricity consumption and economic growth are in line with the finds of Masih and Masih, (1997); Kashai et al, (2012); Tang and Tan, (2014); and Komal and Abbas, (2015). This means that one percent increase in the economic growth raise the electricity consumption by 69% in Pakistan and 13% in India. Furthermore, a negative and significant relationship has been visualized between electricity consumption and relative prices for both of the nations. This shows that the one percent increase in price of electricity prices reduces the demand by 5% in case of Pakistan. However, no relationship has been visualized between relative prices and electricity consumption of India. The easy availability of power resources along with increasing power generation became the main justification for such absence of relationship in Indian economy. In contrast, the small coefficient is due to the ever increasing demand of electricity as compared to the

limited supply of resources and hence the increase in the prices of electricity goods has small impact on the demand of the electricity demand.

Empirics of the study also demonstrate the positive and significant relationship between urbanization and electricity consumption in India, while a negative relationship in case of Pakistan. Such negative relationship adhere the current energy situation of the country. In current scenario, the gap between demand and supply of electricity products will further increase, if the demand of big tickets due to urbanization increases. On the other hand, a significant, but positive relationship has been visualized in case of India. Such positive relationship is in line with the existing work of Parikh and Shukla, (1995); Zhang and lin, (2012); Sadorsky, (2013). The main justification for such relationship is the rise in per capita income of people, which raise their demand of energy sensitive goods in the economy.

Results about the second equation demonstrating the impact of financial development shows a positive and significant relationship in both nations. Results of intermediary development on economic growth are mentioned in the second column of the table. However the coefficient shows that the 1% ascent in economic growth raise the intermediary development by 13.8% in Pakistan, and 6% in India. The conceivable legitimization for such limited impact of financial development is the adoption of only one decision along with few indicators. Financial development is a broad concept and cannot be measured through any single impact, consideration of one decision only define a specific portion of financial development. However the ascent in financial development raises the confidence of investors along with reducing the risk in the financial operations in the market. The easy availability of capital where raise the production sector of the economy, also enables the entrepreneurs to raise the level of innovation. Consequently, such innovation through excessive employment opportunities raises the income level in the economy. Such rise of income at later stages raises the electricity consumption of the economy.

Different other macroeconomic variables are also considered while examining the impact of financial development upon economic growth. Among these variables a miscellaneous trend has been found in case of government size and economic growth. For instance positive in case of India and negative in case of Pakistan. These findings are also in line with the Barro, (1989), who states that the expenses made by government have a negative relationship with economic uplift, when they are made on non-productive activities like; defense activities. Moreover, a positive relationship had been found, when government starts expenses on productive areas like; development of infrastructure for production, provision of incentives for business etc.

However, a negative relationship and significant relationship has been visualized between inflation and economic growth. Literature is equipped with a number of studies that demonstrate a linkage between inflation and economic growth. Among them, a consensus has been found on the negative relationship between inflation and economic growth. It has been found that the higher level of inflation raises the negative externalities on the economy and raises the cost of production, which by reducing the investor confidence decreases the economic growth (Gokal & Hanif, 2004). Similarly a significant relationship has been found for trade and investment with economic growth. The notion for such negative relationship between the investment and economic growth is the huge investment in non-productive activities. Investment inflow is a positive signal for an economy, but wastage of such investment by freezing it into non-productive projects ruin the economic progress. Furthermore, notion for the positive relationship between trade and economic growth is the ability of both of these nations for acceptance of foreign investment. Both of these nations have a potential to participate in the world trade by raising their foreign investment. If, governments change their preferences from borrowing of funds towards attraction of investment towards them, such change will enhance their economic positions.

Table 3 Empirical results

	GDP on ELEC	FD on GDP	FD on ELEC
Pakistan			
GDP	0.69465	0.138855	0.096455626
Wald Test (p-Value)			55.489 (0.0000)
India			
GDP	0.33011	0.056225	0.01855425
Wald Test (p-Value)			116.4942 (0.0000)

In this study, the indirect linkage is determined with the help of system equation modeling. This approach due to its consideration of short run dynamics makes this study form the previous literature. Wald test approach is used in this study for determination of joint significance among the variables, which use the chi-square distribution to reject the null of no relationship. Wald test explores the relationship from electricity consumption towards economic growth and from such growth towards financial development. Results show that 1% rise in intermediary development led 13% electricity consumption in Pakistan and 6% in India. Both of these nations show significant results in short run. This short run relationship further validates the hypothesis about the indirect involvement of financial development in energy growth nexus.

This positive associationship between intermediary development and electricity consumption validates the findings of Karanfil, (2009); Sadorsky, (2010, 2011); Tang and Tan, (2014); Islam et al., (2012); Shahbaz and lean, (2012). However, these results negative the negative relationship between financial development and electricity consumption defined for Pakistan by Kakar et al. (2011). These findings show the dependence of electricity consumption of both of these nations upon their financial sectors, which means that their economic progress is satisfactory in short run. These results shows that financial sector play a moderating role in the energy-growth relationship due to its excessive activities as a results of rise in level of development.

6 Conclusion

The dramatic changes in demographics where make a change in economic situations, also cast an affluent changes in the financial sector of India and Pakistan from 1980's. It has been found the development in financial sector is followed by the development in power sector of emerging economies. (Islam et al., 2012). This means that the rise in financial activity of the nation raise the demand of big tickets in the market, which further raise the demand of electricity in the economy (Sadorsky, 2011).

The aim of the current study is to examine the indirect impact of financial development on energy growth nexus. In order to fulfil such objective system equation modelling approach has been employed in this study. Findings of the study validate the existence of positive and significant relationship between financial sector development and energy-growth nexus. Moreover, the strength of such relationship is different due to heterogeneous economic situations of India and Pakistan.

Foregoing findings of the study stress the need of consideration of financial development, while making strategic development about power shortage. However it is noted that the development in financial sector is impossible without financial reforms. These reforms play a pivotal role in development of infrastructure for the economy. The financial system of both of these nations are well equipped with the efficient reforms that kept them save in times, when the whole world economy was suffered from financial crises in 2008 (Alam, 2013).

In this situation, governments should change their preferences about development of new strategies for mitigation of the problem. Strategies present a very efficient look in their development stage, but this efficiency is lost in application. A lot of strategies has been found that are quite efficient, but their application was not possible in that manner. So, it is a time to redefine the plans and change the consideration from development towards adaptation. Governments should seek the ways that enables them to efficiently achieve their target results. They have to place their enough emphasis on identification of the problem, rather alternative developments. Every strategy which is quite efficient, if deployed without identification of problem fails to achieve its results.

The current study only uses a limited number of variables along with principal component analysis for development of financial development index. However, a future avenue is present regarding development of financial development by increasing the number of variables along with residual approach of index development.

7 References

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