
A NEXUS BETWEEN FINANCIAL DEVELOPMENT AND RENEWABLE ENERGY CONSUMPTION

Fareeha Zaidi

The University of Lahore (Lahore School of Accountancy & Finance), Lahore

Dr. Salman Riaz

The University of Lahore (Lahore School of Accountancy & Finance), Lahore

Zubair Saleem

SKANS School of Accountancy, Lahore

Abstract

The purpose of the present study is to explore the impact of financial development on renewable energy consumption. The period of study is from 1980 to 2018. Economic growth plays a mediating role in the nexus between energy consumption and financial development. The transmission and distribution losses are the moderator between economic growth and renewable energy consumption in the structural model. For developing economies like Pakistan, estimation for energy demand without considering financial development would provide an inaccurate picture. Zivot-Andrews unit root test has been applied under the structural break method to check the stationary property of variables. The study is employing Simple time-series regression analysis to find out the relationship between the variables. The results of the empirical research indicate that financial development and economic growth have a significant impact on renewable energy consumption, and the findings of the economic growth equation suggest that there is a significant impact of financial development and investment on economic growth in Pakistan. The study results urge the attention of policymakers in Pakistan to design a comprehensive energy conservation policy to minimize the consequences of massive energy consumption and energy export-driven revenue by adding financial development and investment as explanatory determinants in the energy demand function..

Key words: Renewable energy, Financial development, Economic growth, Transmission and distribution losses.

Introduction:

Energy is an essential source for reshaping modern society. The everlasting demand for energy has been accelerated in the past decades and continues to increase today. Today the industrial progress plays a vital role in the development of any country. But the industrial progress, which leads to economic growth, relies on a reliable supply of electricity. Population growth, production improvements, and economic competitiveness are some of the reasons for the high energy demand. According to Pang, J., & Wu, H. (2009), renewable energy stands as a potential tool to achieve energy diversification. Theoretically, growth in the financial sector improves funds availability for investment projects that result in industrial development, leading to an expansion in production activities in any economy. Sadorsky (2010) pointed out that financial

development can be described as a handy tool in obtaining energy efficiency and reducing energy consumption. One of the most direct ways that financial development can affect the energy demand is by making it easier and cheaper for consumers to borrow money to purchase durable consumer items like automobiles, refrigerators, air conditioners, and other household machines. These items typically consume a lot of energy, affecting a country's overall demand for energy.

Many studies measure financial development with energy consumption, real GDP, energy price, urbanization, investment, trade, etc. (e.g., Islam et al., Komal and Abbas, 2015). The present study intends to explore the nexus between finance, economic growth, and energy using transmission and distribution losses in Pakistan. It, therefore, prepares solid theoretical grounds for empirical analysis. Examining the possible linkages between economic growth, financial development, and energy consumption in Pakistan is justified and needed for few reasons. First, energy is the crucial ingredient for the development of any country, and Pakistan has no exception. The current study will assist the policymakers in the country in assessing their priorities for resource allocations for the country's development. Secondly, the study adds light to policymakers with the role of financial development, industrialization, population growth as another essential factor to consider the outages of electricity and shortages of some fuels in the country.

1.1. OverView of Pakistan

Pakistan is a country blessed with numerous natural resources including one of the world's highest mountain range, the flow of fresh water, and rich reserves of natural gas, coal and with remarkable energy resources found across the country, these energy resources are distributed evenly from northern areas where there are a lot of geothermal energy resources and mountains covered with snow which are the cause of large rivers that flow down towards the Arabian Sea, in the south. Unfortunately, limited work has been done in the past to explore and utilize naturally existing renewable energy sources. effective utilization of locally developed renewable energy technologies can play a vital role in meeting the current energy shortage in Pakistan. Rafique and Rehman(2017) examined that Pakistan is currently facing severe energy deficiency, and most of the northern area is still not connected with the grid. So it is necessary to diversify the energy resources to overcome the energy shortfall in the country like solar, biogas, and wind energy.

1.1.1. Renewable energy consumption

In the mid of 1980's Pakistan's power sector first began to restructure due to electricity shortage in-country (Khattak, et al. 2006). To overcome the energy crisis the government of Pakistan introduced its first private energy policy to explore renewable energy options in 1985. According to Khattak, et al. (2006) during the period of 1983 to 1988 government invested about 14 million rupees in renewable energy production but all in vain. Although various renewable energy policies were implemented between 1985 and 2002 these policies failed to attract private investors towards renewable energy development. In 2002 Pakistan council of renewable energy technology was established to promote the RET through research and development. In 2003

AEEDB (the alternative energy development board) was established to develop renewable energy policies related to new projects of wind and solar energy (Khattak, et al. 2006).

1.1.2. Economic Growth & Financial Development:

In Pakistan, the macroeconomic crises were characterized by slow-down growth along with a high inflation rate, unemployment, and an energy crisis in the era of the 2000s. The macroeconomic imbalances have been building up from 2004 to 2005. The fiscal surplus of 3.7 percent of GDP in 2003 turned into a deficit of 2.3 of GDP in 2004 joined the above negative trend (Shabbir and T, 2009). Pakistan faced an economic crisis in 2008 which was the prime effect of the global financial and economic crisis of 2007-2009. Pakistan was certainly in a helpless situation when in late 2008 and early 2009, the full recessionary impact of the global crisis affected many developing countries including Pakistan. During the period 2006 to 2008 Pakistan has significant dependence on imported oil i.e 80 percent of crude oil was imported for the energy sector. From 2004-05 to 2007-08 the oil import bill was almost tripled i.e. \$4.7 billion to \$ 11.4 billion. The immediate effects of the financial crisis resulted in the reversal of capital inflows in the country. The inflows in form of equities and bank lending were dropped between 2007 and 2009. However, Pakistan experienced an adverse effect both in the stock as well as the debt markets. Due to dependence on energy imports, the inflation rate for Pakistan high in 2008 i.e. 12%, and in 2009 20.8%, and it is difficult to achieve accelerated economic growth soon (Shabbir and T, 2009).

2. Literature Review

Despite the importance of the topic, until very recently, there has been a lack of empirical studies that examine the relationship between renewable energy consumption, financial development, and economic growth in the presence of transmission and distribution losses in Pakistan. In this modern age, energy is the basic need, and Pakistan is considered an energy deficiency country. The findings of the study show that financial development hurts renewable energy consumption in China. Among these financial factors, stock market development is the most important one. Eren et al. (2019) examined the impact of financial development and economic growth on renewable energy consumption in the case of India. The data used in the study are annual figures that cover the period of 1971–2015. The finding showed that there is a statistically significant and positive impact of financial development on renewable energy consumption. Charfeddine and Kahia, (2019) expressed the relationship between renewable energy, financial development, and economic growth for 24 countries of the Middle East and North Africa (MENA) region. However, the results showed a negative significant impact of financial development on economic growth and renewable energy consumption. which indicates that the financial sector does not play its expected role in the improvement of the renewable energy sector in the MENA region. Bekun et al.,(2019) explore the economic growth and energy consumption nexus in South Africa from 1960 to 2016. The empirical evidence finds support for a long-run equilibrium relationship between energy use and economic growth. The results of the study expressed that there is an inverted U-shaped pattern between energy consumption and economic growth in the long run. Ali et al.,(2018) explore the dynamics between financial development and renewable energy in

19 Asia cooperation dialogue member countries by using panel data from 1995 to 2015. The study explored the long-run relationship between total reserve with financial development and renewable energy consumption in nineteen countries from Asia cooperation Dialogue. Ouyang and Li, (2018) examine the relationship between financial development, energy consumption, and economic growth in China by using panel data of 30 Chinese provinces divided into three regions throughout 1996Q1-2015Q4. The study expresses that financial development plays a negative role in both economic growth and energy consumption in China, while economic growth can boost by energy consumption.

Lotz (2016) examines the impact of renewable energy consumption on economic growth. The annual data from 1990 to 2010 of thirty-four countries members of OECD. The findings of the study show that the influence of renewable energy consumption or its share to the total energy mix on economic growth is positive and statistically significant. Komal and Abbas (2015) examined the finance and energy nexus for Pakistan by taking a sample of the 1972-2012 period. Variables used for estimation purposes are Energy consumption, Gross Domestic Product, Financial Development. The study finds that in the short run, there is a positive and highly significant impact of financial development on energy consumption through economic growth channels. Alam et al., (2015) examine the relationship between economic growth, energy consumption, and financial indicators in the panel of selected South Asian Association for Regional Cooperation (SAARC) countries throughout 1975–2011. The findings of the study showed that financial development indicators have a larger impact on increasing energy demand in the SAARC region; this implies that variables are influenced by country effects only. Chang (2015) examines the nonlinear effects of financial development on energy consumption by using a sample of 53 countries throughout 1999-2008. The study investigates that in emerging market and developing economies the energy consumption increases with income, while in advanced economies when they achieved a threshold level of income the energy consumption increases. In a non-high income regime, energy consumption increases with financial development by using private and domestic credit as financial development indicators. Furuoka (2015) examines the relationship between financial development and energy consumption in Asia from 1980 to 2012. The findings of the study showed that there is a long-run equilibrium relationship between financial development and energy consumption as well as unidirectional causality from energy consumption to financial development in this region. Shahbaz et al. (2015) examine the relationship between renewable energy consumption and economic growth. The data span of the study is 1972Q1–2011Q4. The findings of the analysis expressed that all the variables in the study are cointegrated, which shows the long-run relationship between the variables. The results reveal that renewable energy consumption has a positive impact on economic growth. Abosedra et al., (2014) investigate the relationship between energy consumption, financial development, and economic growth in Lebanon from 2000 to 2010. The data of financial development obtained from the Central Bank of Lebanon while energy consumption data is obtained from the Central Administration of Statistics Lebanon and economic growth is measured by the index of coincident indicator as a measure for real economic activity in Lebanon. The results indicate that financial development and energy consumption contribute to economic growth in Lebanon. There is a positive and significant impact of energy consumption on economic growth. The findings of the study indicate that financial development plays a vital role in enhancing economic

growth. Shahbaz et al.,(2013) examine the dynamic relationship between economic growth, energy consumption, and financial development throughout 1975Q1-2011Q4 in the case of Indonesia. The results of the study confirm that in long run the variables are cointegrated with each other in the presence of structural breaks. Financial development granger causes energy consumption which reveals that adoption of energy conservation policy would not adversely affect economic growth.

2.1. The hypothesis of study:

H₁: Financial development has an impact on renewable energy consumptions

H₂: Economic growth and financial development has an impact on renewable energy consumption

H₃: The Transmission and distribution losses moderate the link between economic growth and energy consumption

3. Theoretical Framework and Model

The causal link between financial development and economic growth assumes greater significance in macroeconomics. In this context, it is essential to have an analytical definition of financial development and its importance in explaining the behavior of energy demand through different channels. In a broad sense, financial development refers to a growth-enhancing platform of developing economies by promoting the banking activities and the role of other financial intermediaries in the country. Mishkin, (2009) theoretically argued that the role of financial development is very important because financial sector development can improve the economic efficiency of the financial system of a country. As a result of financial sector development in developing counties, it is expected that financial development can mobilize the savings and investments and ultimately leading to economic growth. It is commonly believed that increasing economic growth indicates the larger needs of people in society in the form of energy consumption in their day-to-day life. So the rising energy demand is linked with increasing economic activities in developing economies.

Alan Warde (2005) introduced practice theory into cultural consumer studies, in response to arguments that excessive attention had been devoted to conspicuous consumption at the expense of efforts to understand more routine and ordinary consumption, such as energy consumption (Gram, 2010). Shahbaz et al.,(2013) has asserted that the impact of financial development on energy consumption depends on the efficiency of the overall system that includes capital or investment, technology, and institutions. In an economy, less energy will be consumed when industrialist or business can upgrade their technology through easy credit availability. To improve the growth in an economy the role of the financial sector bringing efficiency in energy utilization.

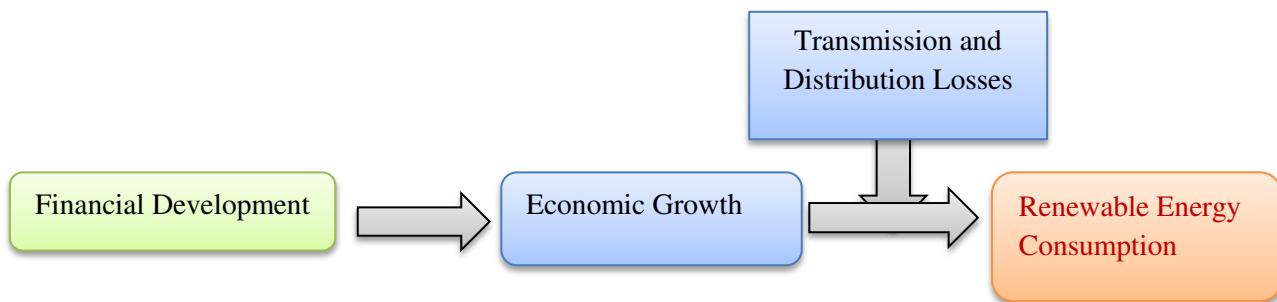
3.1. Economic growth and Energy:

As per the economic growth theory, the growth of every economy is heavily dependent upon energy as it is the basic ingredient for the production of goods and services. According to Stern, D. I. (2004) the energy plays an important role in economic production, and business and financial economists pay significant attention to the impact of oil and other energy prices on economic activities, but a conventional theory of economic growth pays little or no attention to other natural resources in promoting or enabling economic growth.

3.2. Conceptual Frame Work:

Conceptually, in an economy, energy consumption is directly affected by economic growth and population growth, while it is indirectly affected by financial development through the economic growth channel. Based on the literature reviewed a multivariate framework has been employed to empirical study the role of economic growth towards the relationship between financial development and renewable energy consumptions in the presence of transmission and distribution losses. In this study renewable sources of energy consumption are taken as dependent variables, financial development is an independent variable whereas economic growth and transmission and distribution losses are considered as mediating variables and moderating variables respectively.

3.3. Structural Model:



4. Data and Methodology

4.1. Data

The current empirical study is based on secondary data. The annual time series data of Pakistan for 38 years covering the period of 1980 to 2018 to examine the interactions among the studied variables. It includes a reasonable time length of observations to employ model estimation techniques. The indicators of energy consumption consist of Renewable energy consumption

(percentage of total final energy consumption), Domestic credit to the private sector (percentage of GDP) is the proxy for financial development. Gross Domestic Product growth (annual percentage) measures the economic growth. Gross fixed capital formation (percentage of GDP) is a proxy for Investment, Energy transmission, and a distribution Loss percentage of output. The selection of the variables is based on the sustainable development goals of the country.

4.2. Data Source:

The data for the study is extracted from the World Development Indicators (WDI). (www.databank.worldbank.org).

4.3. Operationalization of variables

Table 1:

Variables (Measurement)	Definitions (signs)	Sources
Financial development (Domestic credit to the private sector as % of GDP)	It indicates the financial capital granted to the private sector through trade credits, loans, purchases of non-equity securities, and other accounts receivable that set up a claim for reimbursement. (FD)	WDI
Economic growth (GDP growth %)	which refers to collective gross value added by all local manufacturers in the country including product taxes and excluding subsidies, not including the value of products. (EG)	WDI
Renewable energy consumption (% of total output)	It includes the energy consumption from renewable sources i.e. solar, wind and biomass. (RE)	WDI
Transmission and Distribution Losses	The energy losses occur in the process of supplying electricity to consumers and these can be categorized as technical and commercial losses.	WDI
Investment (gross fixed capital formation as % of GDP)	It refers to machinery, land developments, plant and equipment procurement, and construction of roads, railways, schools, hospitals, offices, private residential dwellings, and commercial and industrial buildings. (Inv.)	WDI

5. Methodology:

The unit root is used to find out the stationary of data. Zivot- Andrews unit root test has been applied under the structural break method to find out stationarity of data at the same level.

5.1. Structural Break:

The models in time series estimate the relationship between the variables throughout a period. Across the entire period mostly models assume that the relationship between these variables remains constant. However, the relationship between the variables in the model causes changes due to some changes in the factors outside the model. The structural break models incorporating sudden or permanent changes captured in the parameters of models. Bai and Perron, 1998 provide the standard framework for the structural break model, where some parameters of the model can break into m breakpoints. Under the structural break method sample data of the study is divided into two groups i.e.1980 to 2002andfrom2003to2018.

5.2. SOBEL Test for Mediation (For Both Samples):

The Sobel test is used for the mediation analysis of the dependent variable REC and an independent variable FD. The main focus of the analysis is on the interrelationship between renewable energy consumption (REC), financial development (FD), and a third variable economic growth (EG). The sample size calculations are based on the work of Sobel in 1982. For mediation testing, a popular method was applied by Baron and Kenny (1986) and a model for mediation discussion can be found in Hayes (2018). The proposed methodology has advantages such as high flexibility, high efficiency, and ease of use.

Regression Analysis:

$$EG_t = \alpha + \beta_1 FD_t + \beta_2 Inv_t + \varepsilon_t \text{ ----- (1)}$$

$$REC_t = \alpha + \beta_1 FD_t + \beta_2 Inv_t + \varepsilon_t \text{ ----- (2)}$$

$$REC_t = \alpha + \beta_1 FD_t + \beta_2 EG_t + \beta_3 Inv_t + \varepsilon_t \text{ ----- (3)}$$

$$REC_t = \alpha + \beta_1 EG_t + \beta_2 TDL_t + \beta_3 TDL_t \times EG_t + \varepsilon_t \text{ ----- (4)}$$

Results:

Mediating effect of economic growth on financial development and renewable energy consumption

Table 2:

	(1.1)	(1.2)	(2.1)	(2.2)	(3.1)	(3.2)
Variables	EG	EG	REC	REC	REC	REC
FD	0.27 (0.21)	-.45 (0.09)	-.74 (0.10)	0.01 (0.14)	-.75 (0.06)	-.12 (0.09)
EG					-.02 (0.04)	-.53 (0.21)
Inv.	-.10 (0.45)	-.34 (0.3)	-.33 (0.13)	0.73 (0.30)	-.33 (0.09)	0.52 (0.19)
Constant	.19 (0.47)	.24 (0.3)	-.74 (0.13)	-0.07 (0.42)	-.75 (0.12)	-.10 (0.35)
Observations	26	12	12	13	12	13

Sobel-test F-stat/(sig)	(0.36)	(0.0001)	(0.03)	(0.09)	(0.00)	(0.01)
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Model 1.1 represents the sample during the period 1980-2002

Model 1.2 represents the sample from 2003 to 2018

Models 2.1 and 3.1 represent the sample from 1980 to 2002

Models 2.2 and 3.2 represent the sample from 2003 to 2018.

Standard errors in parentheses.

Table 3: Moderating effect of transmission and distribution losses on economic growth and renewable energy consumption:

	(4.1)	(4.2)
Variables	REC	REC
EG	.01	-.68
	(0.07)	(0.14)
TDL	.12	.24
	(0.06)	(0.16)
TDLEG	-.09	-.13
	(0.04)	(0.05)
Constant	-.53	-.15
Sobel-test F-stat/(sig)	(0.008)	(0.007)

Model 4.1 represents the sample during the period 1980-2002

Model 4.2 represents the sample 2003 to 2018.

Standard errors in parentheses
p < 0.01 , ** p < 0.05 , * p < 0.1

Result Summary & Discussion:

simple regression analysis has been employed in the present study to

jointly estimate the parameters of the structural model. Results of the regression equations are reported in tables. The results related to energy consumption and financial development are consistent with existing findings in the literature i.e. Ji and Zhang, (2019), Ouyang and Li, (2018), Shebaz et al., (2017), Kakar (2016), Komal and Abbas, (2015). Whereas the results related to the impact of financial development through economic growth on energy consumption is following past studies (for instance Eren et al., (2019), Charfeddine and Kahia, (2019), Ali et al., (2018), Hassine and Harrathi (2017), Kim and Park, (2016). Furthermore, the results of empirical analysis related to the role of Transmission and distribution losses in the relationship between economic growth and energy consumption are consistent with the findings of Bhatti et al., (2015), Belaid, and Abderrahmani (2013), Nagayama (2010). For Pakistan, the relationship between energy consumption and financial development postulated because the energy-saving mechanism is not up to the mark. Based on empirical analysis, H1 has been accepted and null hypothesis Ho was rejected. Estimates show that financial development is positively and significantly linked with economic growth. Table 2 expresses the results of mediating effect of economic growth on financial development and renewable energy consumption while table 3 explains the moderating effect of transmission and distribution losses on economic growth and renewable energy consumption.

The possible justification for this effect of financial development over economic growth is that only one indicator of financial development has been employed in the present study rather than

the range of indicators. Underlying perception regarding this effect is that when financial sector development happens, investor's confidence in the financial system grows which incentivize their investment in productive and economically viable projects through financial institutions, due to which real output of the economy increase and economic growth occurs. Consequently, an increase in income level causes the aggregate demand to rise to lead to higher energy demand.

6. CONCLUSION

Pakistan is a developing country in Asia and due to increase in the population and industrialization, there is a drastic increase in energy demand. The country's power infrastructure needs to be modified and reorganized with the help of the financial sector. The financial sector of Pakistan has seen notable and unprecedented growth occur particularly concerning the banking sector after the 1990s. Islam et al.,(2013), expressed that emerging economies that are developing their financial sectors should anticipate growth in energy demand. For developing economies, estimation for energy demand without considering financial development would provide an inaccurate picture. In the case of developed countries, various forms of renewable energy sources are being utilized to reduce their dependence on fossil fuels. The objective of the present study is to investigate the relationship between financial development and renewable energy consumption in Pakistan by using the annual time series data for 1980 to 2018. Here, economic growth plays a mediating role between financial development and renewable energy consumption while the transmission and distribution losses play moderating role between economic growth and energy consumption. The simple time series, regression analysis was applied to find out the relationship between the variables. The parameter estimate of the individual equation of the model confirmed the existence of the hypotheses constructed for the present study. So in the light of the above analysis, the null hypothesis i.e. (Ho1, Ho2, Ho3) has been rejected, while the alternative hypothesis of the study has been accepted. Which indicated that the EG plays a mediating role in the nexus between the FD and REC in Pakistan. And TDL is the moderator between EG and REC in Pakistan. The underline intuition regarding this effect is that when there is financial development in the country the investor's confidence in the financial system grows which incentivizes their investments in productive projects through financial institutions, due to which the real income level will increase and economic growth occurs. The underestimation of energy consumption is alarming for sustainable economic growth. However, to overcome the energy crisis, the financial sector can play a vital role in terms of intermediary development. While granting loans, the banks should ensure that these funds are channeled to those businesses and research and development sectors that come up with innovative ideas with advanced and energy-saving technologies. There is also a need to control the electricity transmission and distribution losses to overcome the energy crisis and get maximum productive use of renewable energy sources in Pakistan.

6.1. Implications

The obtained empirical outcome leads to some important implications that should be considered by the Pakistani policymakers. To achieve the higher usage of renewable energy resources, new projects and investments in renewable systems should be supported by providing incentives. To

expand the utilization of renewable energy systems, tax credits should be granted to investors in the stage of purchasing and installation of technologies. Instead of following, an aggressive strategy to cut down fossil fuel usage, and an efficient way of producing renewable energy can be achieved by encouraging new researches in renewable technologies for long-run benefits. The authorities should spread awareness of the role of the financial sector in their policy designs. The financial intermediaries may not always be willing to provide credits for such projects having a longer payback period. Unlike fossil fuel projects, renewable energy investments require high initial costs and have a long payback period. The government of Pakistan makes sure that funds will flow into feasible projects and bank risk-taking incentives will be granted to investors. In addition, financial market development can attract private investors who would normally avoid investing in renewable energy projects.

6.2. Limitation and Recommendations for future research:

No doubt, the research is a continuous process and there are some limitations in present work as well due to space and time. These limitations motivate researchers to extend the work in the future. The empirical analysis of the study was conducted at an aggregated level, but the intensity level of renewable energy and other sources of energy would be different across different industries. Another possible direction for future investigation could be to test the relationship between energy consumption with different sources and financial development with other control variables and in other regions of the world. Additionally, the relationship between investment and tax incentives in the renewable energy and tourism industry may be investigated to examine the efficacy of tax incentives in promoting renewable energy consumption and tourism development

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