

CAPITAL UNIVERSITY OF SCIENCE AND  
TECHNOLOGY, ISLAMABAD



**Impact of Financial Development  
on Economic Growth and Energy  
Consumption: Moderating Role  
of Information and  
Communication Technology**

by

**Raies**

A thesis submitted in partial fulfillment for the  
degree of Master of Science

in the

**Faculty of Management & Social Sciences**

**Department of Management Sciences**

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*I want to dedicate this achievement my parents, teachers and friends who always  
encourage and support me in every crucial time*



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## *Abstract*

This study aims to analyse the impact of financial development on energy consumption, through the channel variable economic growth and moderating effect of information communication technology and also includes foreign direct investment, energy price, urbanization, trade openness, human capital, and investment into a structural model of 138 countries using the panel least square model from the period 1980 to 2020. The result reveals that economic growth and information and communication technology have a positive impact on energy consumption. financial development has a positive effect on energy consumption and economic growth. Financial development also has positive and significant effects on energy consumption through economic growth. The result of the study is significant for policy makers for effective energy demand arranging and conservation approaches that would guarantee reasonable economic improvement as well as fill the inspiration to search alternate energy sources that meet the demand of the energy for all the world countries. The policymakers in these various countries should balance the connection between the supply and demand of energy to accomplish the sustained development of the economies.

**Keywords: Energy Consumption, Economic Growth, Financial Development, Information and Communication Technology, Panel Least Square.**



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# Abbreviations

<b>CPI</b>	Energy Prices
<b>EC</b>	Energy Consumption
<b>EG</b>	Economic Growth
<b>EIA</b>	Energy Information Administration
<b>FD</b>	Financial Development
<b>FDI</b>	Foreign Direct Investment
<b>HC</b>	Human Capital
<b>ICT</b>	Information and Communication Technology
<b>INVST</b>	Investment
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>TO</b>	Trade Openness
<b>URBN</b>	Urbanization
<b>WDI</b>	World development Indicators
<b>WEF</b>	World Economic Forum's

# Chapter 1

## Introduction

In the current era, the role of financial development on energy consumption is broadly explained in recent literature, the discussion on energy strategy and its guideline is viewed as a basic area of exploration by researchers and specialists. The empirical results of this literature are providing diverse results. However, in previous studies the relationship of financial development, economic growth, and information and communication technology on energy consumption is limited. The main focus of the study is to see the relationship between financial development and energy consumption by using economic growth as a channel variable, and the impact of information and communication technology as a moderation.

Previous studies define the different ways to explain the relationship between financial development and energy consumption and how financial development influenced energy consumption. Economic growth is linked with the relationship between financial development and energy consumption and how it affects the relationship of these two variables. Advancement in the financial sector stimulates the growth of the economies, hence, economic growth creates productive outcomes for energy usage. The theoretical framework explained by Sadorsky (2010) where he clarifies that is related to energy consumption is positively affected by financial development, where his results stressed i.e., the connection between these two variables is not clear. Furthermore, he claims that only empirical evidence can explain the actual connection of these variables. It is broadly recognized that development in a financial sector speeds up economic growth. (Fung, & Michael,

2009; Levine & Zervos, 1996) well- developed financial system plays a significant part to contribute in the growth of the economy. advancement in financials influences saving rates, investment decisions, technological advancement, and, hence, long-run growth rates. (Levine & Ross, 2004; Beck, 2006) literature currently provides four different perspectives on financial development and economic growth. i) the demand following approach, which asserts that financial progress is a result of economic expansion; (Robinson, 1952) ii) the supply leading approach, which assumes that financial development leads to increased economic growth (Patrick, 1966), iii) the existence of a bidirectional connection between financial development and growth, and iv) Lucas (1988) proposes a lack of causality impacts.

However, multiple approaches and time periods have been used to explain the link between energy use and economic growth in numerous countries. The literature's empirical evidence generates a variety of results under the area of causality. Neutrality, conservation, growth, and feedback which are four different hypothesis that are explored for causality issues. (Ozturk, 2010; Nicholas & Payne, 2009). The first hypothesis explain that economic growth and energy consumption have no causal relation, and it's also show that policies that have negative impact on energy consumption has not increase economic growth. The next is conversation hypothesis which explain that there is a unidirectional relation between economic growth and the energy usage, means that with the increase of growth of the economy the usage of the energy also increases. Third hypothesis is growth which explain that there is a one-way correlation exist between EG and EC. The last hypothesis is feedback hypothesis which explain bidirectional relation between energy use and economic growth.

Economic activity increases as time passes. Almost all countries, both emerging and developed, will need more energy as a result of this expansion. As a result, the role of energy in the creation of products and services is critical for a country's economic success (Gomez & Rodriguez, 2019; Lu, 2018). Excessive pressure on energy development, on the other hand, has resulted in environmental risks. Because energy is necessary for the creation of products and services, emerging countries will demand more energy as time goes on to meet their needs (Sadorsky, 2010).

Demand of the energy increases in the financial sector due financial development. Advancement in financial sector improves the banking sector and increases the foreign direct investment flows, also reducing the risks that are related to finance. It also increases the transparency between Borrower and lender that they can easily connect with each other due to the increase of information technology in the all over the world nation. When the financial sector grows people invest more that increase the purchasing power of the individual, they can buy more products like cars, Mobil, house, and refrigerators, these are some parts of the example where energy is used. It increases the energy demand of the country. So financial development can increase energy usage. It also allows business to borrow more money to expand their business because in today's era banking and other institution are giving loans on a very easy term. Funds are easily availed for the business so they can add new machinery. All of these factors are increasing the demand for energy (Sadorsky, 2010).

Currently, the COVID-19 pandemic also affects the demand for energy, though there have been drastic changes in the level of fuel costs, electro lively frameworks that use an enormous portion of environmentally friendly power sources are working effectively. In this covid decrease in a production of goods temporarily led to decrease in demand of energy but this is not enough to meet the needs of controlling the energy demand. In this pandemic the ICT usage increases, people are using more internet that consumes electricity so this can cause of energy usage.

From the future perspective, alternative use of energy consumption that the nations use the renewable energy consumption such as electricity made through water and wind instead of fossil fuels. Wind energy is more useful as compared to the other perspectives in terms of cost.

Energy consumption increasing day by day since the 1950s. The causes of increasing energy consumption are economic development, technological advancement, and the rising population. So, for that reason, people are using more energy. Technological development has both positive and negative impacts on energy usage. Governments are trying to reduce energy consumption by adopting information technology. According to a recent empirical study, the use of information technology is one viable technique for generating economic growth with greater

efficiency and lower energy consumption. Several studies have shown, however, that ICT can contribute to raising power or energy demand. As a mediator, this study investigates the impact of ICT on financial development, economic growth, and energy use. According to the 2015 report that is published by (WEF) in 2016 by United Nations which show that the ICT is leading growth in Asia and Pacific for many years. All around the world ICT is very important factor for the economy, developing countries experience fastest growth by adopting ICT with the developed nation. (Saidi, Toumi & Zaidi, 2015). Such as, from 2000 to 2010, mobile cellular subscriptions increased by 107 percent in industrialized countries worldwide, 187 percent globally, and 255 percent in emerging nations. Between 2000 and 2010, the number of Internet clients per 100 residents increased by 102 percent in affluent countries, 153 percent globally, and 235 percent in emerging markets. Between 2002 and 2010, the number of people with Internet connections increased by 62 percent in wealthy countries, 75 percent globally, and 123 percent in emerging economies.

Energy will expand by 28% globally from 2015 to 2040, as according to Energy Information Administration (EIA), and in Asia mostly China and India which is not parts of (OECD) countries they more than 60% increasing in the energy consumption the world during the period from 2015 over 2040 also IEO-2019 in the reference case (EIA) projects that world energy consumption will grow almost (50%) among 2018 and 2050. The maximum growth related to this concern comes from those countries that there are not parts of (OECD). According to the (EIA), worldwide energy consumption would increase by 56 percent between 2010 and 2040. Simultaneously, too much-increased utilization of energy could deliberate economic development. Like in countries like Pakistan and Bangladesh, people face an energy crisis that will slow the pace of economic development (Islam et al., 2013; Sadorsky, 2011). For making it sure that everything goes smoothly with nature, will have to make a balance between the interest and supply of energy. According to the EIA, worldwide energy consumption is predicted to grow at a pace of 1.8 percent per year from 2005 to 2030. United States, Canada, Russia, Germany, China, India, Japan, South Korea, Brazil, and France are top countries where usage of the energy is very high. Meanwhile, energy usage is expected to



growth from, the case of India and China by 3 percent resulting in the global growth of 40%. (Sadorsky, 2011).

The rates of economic growth in different parts of the world vary greatly, with strong growth rates in the developed world and moderate growth rates in the developing world. This disparity is the result of multiple interconnected economic and political environment elements, and it is not a result of chance. The ability of countries to generate valuable products and services efficiently determines their economic status. The rate of increase in productivity growth is, in theory, directly proportional to the rate of increase in GDP per capita. This productivity growth rate is rapidly increasing due to technological improvement and innovation, which results in more productive labor, knowledge and human capital accumulation, research and development (R&D) activities, learning-by-doing procedures, and other spill-over effects. The vast range of capabilities of Information and Communication Technologies has revolutionized growth potential by reducing the operational effort required to set the framework for long-term growth and considerably facilitating eventual productivity gains.

The adoption of modern financial applications has increased competitiveness in the communication sector, and electronic finance financial reporting are the main concern of the financial sectors advancement in ICT that enables financial sectors to maintain their internal records. All countries must evaluate the causes of the ICT sector's rapid global growth, notably in terms of financial applications, due to its rapid global growth. GCC countries want to grow their income and wealth by the advancement in the industrial sector. The advancement in the industry sector led them to higher rank of the growth of the economy. Countries in the Gulf Cooperation Council (GCC) are seeking to grow their wealth through developing their industrial sectors to improve their worldwide economic classification. Many studies have found a positive relationship between the use of electronic applications and financial growth. A positive relationship has also been observed between a country's financial turn of events and cell phone usage. Providing E-data accounts for a decrease in value changes while also supporting financial areas. Several studies have examined the impact of financial considerations on small and medium-sized businesses, whereas others have not. other studies have focused on iPhone

portable applications and have a greater impact on social perspectives.

Financial activities such as Foreign direct investment, increased banking activity, stock market activity, and domestic loans to the private sector are all financial activities that have an impact on economic efficiency, economic activity, and energy demand. Financial development decreases financial risk and loan costs, encourages higher flows of financial resources and investment, and makes more energy-efficient products more available, all of which can alter energy demand through raising consumption and business investments. Financial development has an impact on energy demand in the following ways: (a) it makes it easier and less expensive for consumers to obtain loans to buy durable goods like cars, houses, refrigerators, washing machines, and other large energy consumers that can affect a country's overall energy demand; (b) it makes it easier and less expensive for businesses to obtain financial capital to start new businesses or expand existing ones. such as purchasing or constructing additional plants, employing additional people, and purchasing machinery and materials.

Many changes occur within a country as a result of financial development. For example, in countries with a strong and advanced structure, the cost of acquiring is relatively cheap, which allows for easier access to financial capital and greater transparency between borrowers and creditors. All these factors result in the flow of investment between countries which helps in getting access to better technology. So, these doings increase the demand for energy through business fixed Investment and utilization of energy. The result of financial development also boosts investor confidence, allowing both domestic and foreign companies to invest more, such as expanding their plants, hiring more workers, purchasing more machinery and equipment, as well as developing new technologies. It promotes industrial expansion, the construction of new infrastructure, and the use of additional energy (Zhang, 2011).

Financial sector development promotes asset allocation diversification, resulting in a wealth effect that boosts company and consumer confidence. As a result, we can argue that financial development is a crucial role in gaining access to a country's development. Even in countries with limited financial resources, effective

management leads to increased output with fewer resources. Financial development stimulates industrial expansion while also assisting in the construction of new infrastructure facilities. influence on energy consumption in a good way, as a result, a well-developed and regulated financial sector can help to balance energy demand and supply (Farhani & Solarin, 2017). To maintain a reasonable balance between energy supply and consumption, a well-managed financial sector was formed, which permits adequate financial resources to be allocated to the energy sector.

However, through economic expansion, financial development has an indirect effect on energy use. Depending on whether or not financial development is efficient, this effect might be either favorable or negative. Economic progress is supported by financial development. Masoud et al. (2012) explain that financial development positively affects economic growth. So, the GDP of the economies is increasing that leading to the higher consumption of energy. we need finance when developing new technologies and renewable infrastructure. According to (Wu & Broadstock, 2015) financial development and institutional quality had positive influences on REC in emerging economies. The relationship between power usage and economic growth was investigated by Hossain and Saeki. And their results show that only high-income, upper-middle-income, and worldwide panels showed cointegration when using the panel cointegration approach. Financial efficiency increases because of financial development. Advancement in the financial sector will boost economic growth by having a beneficial impact on stock markets. When stock markets rise, it's a good sign for the economy, which will lead to higher energy demand. Growth in the financial sector increases the availability of funds for investment projects, resulting in industrial growth, which leads to increased production and the need for new infrastructure and energy. Furthermore, the European Union (EU) Commission funds a variety of research projects aimed at reducing fossil fuel usage, increasing energy efficiency, and developing new technological advances, particularly in the field of renewable energy. To examine the relationship between financial development and energy consumption, as well as the relationship between financial development and economic growth, using information and communication technologies. ICT investment is expected to increase productivity, improve

economic growth, and lower energy intensity. However, several research has discovered that ICT places a significant strain on electrical demand or energy use. Furthermore, ICT use has the potential to raise both energy consumption and economic growth at the same time (Lee and Brahmairene 2014; Sadorsky 2011). As a result, information and communication technology may have a positive or negative impact on the relationship between energy consumption, financial development, and economic growth.

Our focus of the study is to analyze the relationship across energy consumption, economic growth, financial development, and information and communication technology of all over the world countries, where we see the impact of economic growth as a mediating variable, also information and communication technology as a moderator between financial development and energy consumption as well as between financial development and economic growth. ICT has transformed into a critical variable in the future improvement of the financial services industry and particularly the financial business. The growth in the ICT industry increases the growth of the financial sector of the industry, especially in the bank sector (Suholu, Pludn, & Kudomhylf, 2008). ICT has kept on assuming a significant part in the growth of the business in the 21st century (Lee & Robert, 2009). ICT enables companies to communicate faster and better so they reduce production and improve productivity. It's also increased the sustainable development of entrepreneurship and small and micro business. It provides knowledge abilities and resources. Understanding the energy economy is also an essential part, particularly for organizations, financial sectors, and investors hoping to acquire a preferable growth technique. However, sustainability is mainly connected to energy/carbon productivity, prompting proficient recourse allocation and usage, which thus improves the organizations, and upgrades the performance of the corporate sector in the long run.

## 1.1 Theoretical Background

Financial development increases the GDP of the economies so it might increase the energy consumption of countries and it also may effect by the information

and communication technology because in today's era the usage of information communication increases rapidly this will cause energy consumption because individuals' phone or other accessories are connected to energy. Theoretically, scholars Ozturk & Acaravci, (2013), Sadorsk, (2010) theorized that the financial systems that are well developed give funds in a very low rate to the business. He also explains that the FD has a positive impact on energy usage. allowing them to expand their production scale and thus increase energy consumption.

Sadorsky (2010) used the GMM technique to figure out the relationship between FD and energy usage. in twenty-two developing nations over a 26-year period from 1990 to 2006. FD has a substantial favourable link with energy consumption, according to the findings, which were based on three separate stock market characteristics. Sadorsky (2011) used panel data from nine nations to evaluate the effect of banking and stock markets on energy use. Using three different banking variables, he concludes that there is a positive and significant relation exist between FD and energy use, while on the basis of different M. A. Destek (2018) stock-market variables just one variable like stock market-turnover positive direction also significant connection with the utilization of energy. Almulali and Lee (2013) study in GCC countries based on co-integration technique and covering the from 1980 to 2009. The findings show that financial development is a vital factor together with a shorter- and longer-term period that increases consumption-related energy. Second, it has been discovered that financial development reduces energy usage. Farhani and Solarin (2017) examined the finance-energy relationship in the United States from 1973 to 2014 using quarterly data and the unit root LM test. The finding indicates that in the longer-term utilization of energy decreases but in the shorter-term financial development increase consumption of energy. M. A. Destek (2018) studied over the period of 1991-2015 based on annual data using (CCE) estimation approach and they conclude that development of banking and bound market negative direction with statistically significant with the consumption of energy.

Al-mulali & Lee (2013) studied GCC countries to figure out the finance-energy linkage. These outcomes tell us about in GCC nations the financial development decline the energy-consumption. Now Kahouli (2017), concludes FD is supportive

to decline EC. Gomez & Rodriguez (2019), studied (NAFTA) nations to the influence finance-energy association by using panel data during the period of 1971 to 2015, and his finding indicates that finance-energy negative connection among each other.

Some of the researcher found that there is no relation or link between FD and energy usage. The finance-energy nexus in EU27 is based on GMM estimation approaches and taking data panel over the period 1990-2011. The finding indicates that when the sample dividing into an old member of EU27 FD had a favorable influence on energy consumption (EC) but no significant relationship among EC and FD in the EU27 (Coban & Topcu, 2013). Keskingoz & Inancli (2016), a study in Turkey, from the period of 1960 to 2011 based on VAR Granger causality and Johansen co-integration test and his finding indicates that in the short term, positively association with EC but in the long term, no obvious correlation occurs among FD and EC. Topcu & Payne (2017), a study in 32 high-income countries from the period of 1990 to 2014 scrutinized the finance-energy relationship with two heterogeneous estimation methods. They made a different comprehensive index to measure the financial development like overall index, then stock, bond, and banking sectors and his findings show that the overall-index no significant with consumption of energy and also increase the stock market index decline utilization of energy. However, a non-linear relationship between FD d energy use was discovered in another group of investigations.

Baloch and Meng (2019) study in OECD countries data collect out of 9-year form 2006-2015 based on the pane data to figure out the association among financial development on energy consumption and the finding tells us about the upturned U-shape connection occurs among the utilization of energy and financial development. Yue et al., (2019) studied twenty-one transitional countries covering the period of 2006-2015 based on panel data to investigate the impact of FD on EC by using the PSTR models. These findings conclude that no strong linear connection occurs among FD and EC, where the nonlinear parameters are significant. Sare (2019), studied in forty-five African nations during the period of 1973-2017 to observe the finance-energy links using a threshold and sample splitting estimation

approach based on the panel data. The empirical data suggest that energy use has a substantial effect on financial developments.

As a result, there are two opposing effects related to financial development and energy use. According to the theoretical study, financial development has two opposing effects on energy consumption, and it may be difficult to identify the combined influence of financial development and energy consumption. However, empirical studies, such as empirical studies with different methods, samples periods, and countries selection, powerfully support the point of view of theoretical studies, demonstrating that the result varies across countries in relation to the effect of financial development and also energy consumption. Therefore, this research focuses on how financial development affects energy consumption via channel variables also moderators the effect of information and communication technology from all over the world perspective.

The growth rate can be accomplished through labor and capital. Theory indicates that the different amounts of labor and capital changed economic growth. Theory grounded capital accumulation of capital in the economy and the relationship between capital and labor to determine the outputs. A better financial system and skilled human capital improve the productivity of labor. An increase in any one factor impacts the GDP.

Economies around the world extremely differ regarding their rates of economic growth having high growth rates in the developed world and slow growth rates for developing countries. This disparity is not a coincidence, but the consequences of several interacting economic and political environment factors. The economic situation of a specific country depends on the capabilities of that country to produce valuable products and services efficiently. Theoretically, increases in GDP per capita or the pace of economic growth are inextricably linked to increases in productivity growth. The rapid increase in this productivity growth rate is primarily due to technological advancement and innovation, which result in more productive labor, knowledge and human capital accumulation, R&D activities, learning-by-doing processes, and other spillover effects. The broad range of capabilities of information and communication technologies has transformed growth opportunities, reducing the operational effort required to lay the groundwork for

long-term growth and significantly facilitating subsequently increased productivity improvements.

The relationship between ICT and energy use has been studied since 1950 (Thirring, 1958), but the topic didn't really take off until the early 1980s (Walker 1985, 1986). When the two shocks to oil prices hit in 1970, researchers were interested in reducing the energy consumption of economies through the use of information and communication technology. The potential that energy demand in industrialised countries may decline while economic development rises stem from a Schumpeterian belief that new information technology will result in large energy savings (Walker, 1985). The impact of rising information and communication technology use on power was usually neglected or dismissed because many of these publications were produced before the widespread use of the Internet and cell phones. While overall energy demand would decline as countries advanced toward better information and communication technologies in the 1980s, some foresighted scholars predicted that more data innovation would boost energy usage.

## 1.2 Gap Analysis

Numerous studies have been conducted in recent years on the relationship between energy use, economic growth, and financial development. Previous studies have looked at the impact of financial development on economic growth and energy use (Sadorsky, 2010; Mahalik et al., 2016; Shahbaz et al. 2016; Ahmed et al., 2021). Sadorsky (2010) investigates the impact of financial development on energy consumption. The effect of financial development on energy use is looked into (Ahmed, Rehman, Zuhaira, & Nisar, 2021). However, other studies have found that financial development is a factor in reducing energy usage (Kahouli, 2017). According to another study, FD reduces the US's energy requirement (Farhani & Solarin, 2017). According to Gomez & Rodriguez's (2019) findings in (NAFTA) countries, these variables have a negative relationship. According to Ahmed et al. (2021), financial development has a detrimental impact on energy. According to Solarin, Shahbaz, Khan, and Razali (2019), ICT has increased energy usage. It indicates that as more people use ICT, the need for energy would rise. In



the 1990s, the use of information and communication technology (ICT) grew. According to Mills (1999), internet-connected equipment was responsible for only a small portion of the rise in US power consumption during the previous ten years. It is noticeable from the studies described above that there is a questionable link between energy use and financial development. The relationship between these variables generates a lot of questions. Many important factors can affect the relationship between these two variables in both direct and indirect ways. According to the literature, there is a gap in how financial development influences energy consumption via economic growth. In addition, the role of economic growth as a mediator between financial development and energy consumption, as well as the role of information and communication technology as a moderator in determining the impact on financial development, energy consumption, and economic growth, should be investigated. To bridge this gap the study's main goal is to look into the relationship between financial development and energy consumption, as well as how economic growth affects that relationship. Also consider the impact of information and communication technologies on financial development, energy consumption, and the relationship between financial development and economic growth.

### 1.3 Problem Statement

Numerous studies have been undertaken in the literature on the relation of FD, EG, information and communication technology, and energy usage. The majority of empirical studies focused on specific nations or regions with varying income levels; however, some researchers focused on this study from a global perspective, while others focused on developed and developing countries with diverse methodologies and sample sizes. While the relevant literature does not reach a unique conclusion, it has provided us with a comprehensive picture of the impact of financial development and information and communication technology on energy use in various nations, which could help with energy policymaking. In contrast, while a study from a global viewpoint ignores the features of different countries, it may help us gain a better understanding of the topic, which may aid in the

development of applicable energy and environmental policies. As a result, this research adds to the body of knowledge on financial development, economic growth, energy consumption, and information and communication technology from 138 countries throughout the world. The literature has filled in the gaps by addressing the questions listed below.

## 1.4 Research Questions

Following are the research questions of this study:

1. How does financial development have an impact on energy consumption?
2. How does financial development have an impact on economic growth?
3. How does economic growth have an impact on energy consumption?
4. Does economic growth mediate between financial development and energy consumption?
5. Does information and communication technology moderate financial development and energy consumption?
6. Does information and communication technology moderate financial development and economic growth?

## 1.5 Research Objectives

Following are the research objective of this study:

1. To explore the impact of financial development on energy consumption.
2. To explore the impact of financial development on economic growth.
3. To explore the impact of economic growth on energy consumption.
4. To check the mediating role of economic growth between financial development and energy consumption.

5. To check the moderating role of information and communication technology between financial development and energy consumption.
6. To check the moderating role of information and communication technology between financial development and economic growth.

## 1.6 Significance of the Study

This research will contribute to the development of a more robust environmental strategy for long-term economic development and will significantly improve long-run environmental performance. This concentrate also helps the government and policymaker in all the world countries to support foreign investment, efficient projects, and trade to create clean energy. This study will help the policymakers and financial authorizers while settling on the choices about strategies guidelines and effective advancements. This research is also useful for Asian governments that need to limit the import of obsolete technology and apply dumping tariffs on high-consumption equipment that is transferred globally. This research also aids policymakers in making effective use of information and communication technology to reduce energy demand.

## 1.7 Scheme of the Study

The paper of the study is organized as fallow the second chapter of the study is a literature review where the past empirical evidence is shown, the third chapter of the study is data and methodology from where the data is collected. The fourth chapter of the study shows the results where the interpretations of the models are shown. And in chapter 5 conclusion and Implication of the study are explained.

# Chapter 2

## Literature Review

Because energy consumption has increased in both developing and developed economies over the last few decades, researchers have focused their attention on this area of study. Some previous studies have found a long-run and a short-run relationship between financial development and energy consumption.

In addition, some of the studies look at the effect of economic growth and energy consumption on CO<sub>2</sub> emissions. The study's primary goal is to investigate the impact of financial development, as well as the mediating and moderating roles of economic growth and information and communication technology, on global energy.

### 2.1 Financial Development and Energy Consumption

Komal & Abbas (2015) use a panel GMM framework to observe the oblique effect of economic improvement on energy consumption via the economic growth channel from 1972 to 2012. The effects exhibit that economic growth has an effective impact on electricity consumption, and financial development has a considerable and effective effect on strength consumption via the channel variable financial growth.

Sadorsky (2011) using statistics from 1996 to 2006 for the 9 Central and Eastern European frontier economies, examines the connection between financial development (FD) and strength consumption (EC). His findings exhibit that financial development has an effective and statistically vast effect on energy consumption.

Sadorsky (2010) used a GMM estimate model to verify the impact of FD on EC in 22 rising international locations from 1990 to 2006, and lookup addressing the following that economic boom has a high-quality impact on energy consumption. Mahalik et al. (2016) employ Bayer-combined Hanck's cointegration and Pesaran's ARDL bounds testing models for Saudi Arabia from 1971 to 2011 to see if there are short-run and long-run causality between financial development and energy consumption. Both tests revealed that these factors are cointegrated, and the ARDL technique also suggests that long-term financial progress leads to improved power use. Economic enlargement has a poor effect on energy, in accordance with empirical evidence, and power demand is often driven by using urbanization and capital. The consequences exhibit a U-shaped and nonlinear connection between financial improvement and strength used in Saudi Arabia. Ma and Fu (2020) observe how financial development influences energy use using panel information from one hundred twenty countries. The findings reveal that FD has a tremendous and favorable have an effect on EC and that the result, which is based on public reverence, clarifies that in developing.

Shahbaz et al. (2016) from 1985Q1 to 2014Q4, examine the connection between financial improvement and environmental quality in Pakistan. They found that wasteful power use has a detrimental impact on environmental quality, and they suggest that favorable technological know-how use will enhance environmental excellent and amplify production while saving energy. They conclude that FD, EC, EG, and CO2 emissions have a huge association between the variable. Shahbaz et al. (2017) from 1960 to 2015 in the case of India, used a ARDL testing method to take a look at the uneven cointegration between energy usage and FD via incorporating economic growth, capital, and labour into production. Financial improvement and energy use have a bad effect on economic growth, according to their findings.

Zhe et al. (2021) use VAR analysis to evaluate the favourable affiliation between renewable strength consumption and financial improvement and economic increase from 1990 to 2015. Their findings reveal that renewable strength use has no impact on financial growth, but that financial improvement has a useful have an effect on renewable energy usage. Mukhtarov et al. (2020) in the case of Kazakhstan, use the autoregressive dispensed lagged (ARDL) technique to locate that EG have an impact on power consumption, electricity consumption rise by the development of the financial sector, whilst strength costs have a bad connection with strength consumption. Coban & Topcu (2013) find out about carried out in the European Union, determined that financial improvement and strength consumption have a statistically insignificant association in (EU27), meaning that these variables have no hyperlink in EU27. There was once statistical value with the direction of these variables favourably in ancient member countries, regardless of whether or not it is measured using the stock market or the banking area after the sample was once divided into two categories, ancient member and new member.

TABLE 2.1: Summary of Similar Empirical Studies in the Literature

Author(s)	Time riod	Pe-	Country	Method	Result
Nicholas et al. (2008)	1980-2004		Central America	1. panel cointegration 2. error correction model	Presence of short-run and long-run causality between EC and EG.
Sadorsky (2011)	1996–2006	9	CEE frontier economies	GMM	FD strongly positive impact on EC
Jalil, & Feridun (2010)			China	ARDL	FD has led to a decrease in environmental pollution.
Sadorsky (2010)	1990-2006	22	emerging countries	GMM	Positive and statistically significant relationship
Shahbaz, Khan & Tahir (2013)	1971-2011		China	1.ARDL	1. Positively influenced economic growth.

Continued Table 2.1 Summary of similar empirical studies in the literature

Author(s)	Time Period	Country	Method	Result
			2.GCT	2. Unidirectional causality between EC and.
Shahbaz,Hye, &Tiwari (2013)	1975-2011	Indonesia	1.ARD	1.EC and EG has a positive impact on CO2 emissions.
Komal & Abbas (2015)	1972-2012	Pakistan	2.VECM, GCT GMM	2. variables are cointegrated FD has a Positive significant impact on EC
Saidi, Toumil & Zaidi (2015)	1990-2012	67 countries	Dynamic data model	ICT and EG has a positive significant impact on EC
Mahalik et al. (2016)	1971-2011	Saudi Arabia	1.ARD	EG negatively impacts EC
Shahbaz et al., (2016)	1985Q1-2014Q4	Pakistan	2.Bayer-Hanck's 1. ADF and FADF	Strong and positive impacts among FD, EC, EG and CO2 emissions. FD positive impact EG
Solarin et al. (2019)	1990Q-2015Q	Malaysia	2.Assimetric ARDL Toda-Yamamoto Granger causality approach	ICT, FD and EG has a positive effect on electricity consumption
Ahmed et al, (2021)	1990-2019	136 countries	GMM	Negative impact of FD and positive impact of EG on energy consumption.
Zhe et al (2021)	1990-2015	Turkey	VAR	REC positively effect FD

consumption. Table 1 shows some of the previous empirical studies on energy consumption.

GMM = generalized method of moment, ARDL = autoregressive distributed lags bound testing; GCA is a Granger causality analysis, VECM is a vector error correction model, VAR is a vector autoregression approach. FD is financial development, ICT is information and communication technology, EC is energy consumption, EG is economic growth.

The causality linkage that runs from financial development to energy consumption has two important channels: negative and positive. Financial development, according to the first channel, rises strength consumption while also raising GDP (Aslan, Apergis, & Topcu, 2014; Rashid & Yousaf, 2015; Sadorsky, 2010; Sadorsky, 2011; Zhang, 2011). Three essential influences characterize nice causation: business, wealth, and direct effects. First, businesses have many opportunities, which leads to expanded strength demand; second, affluence leads to multiplied economic confidence, which leads to raised energy demand; and third, the direct effect, which leads to men and women purchasing more energy-consuming items. Furthermore, in the poor case of these issues, ideas referring to greater modern and much less energy-consuming tools, progress (R&D) technology, and consequences lead to a minimize in electricity consumption. Examples of technological effects related to these channels encompass (Jalil & Feridun, 2011; Mahalik & Mallick, 2014; Tamazian, Chousa, & Vadlamannati, 2009).

Wu & Broadstock (2015) look at the association between economic growth and energy consumption in 22 emerging nations, finding that financial development had a favourable influence on electricity consumption from 1990 to 2010. Lin et al. 18 looks at this connection in the case of China, and their findings show that the greater the financial development, the greater the energy consumption.

Tresselet et al. (2008) used financial integration to appear at the influence of economic modifications on improvement in ninety-one nations. They use the OLS ordinary least squares and GMM approaches to look into the link. The safety market index, capital account openness index, and overseas exchange index all exhibit a superb and sturdy hyperlink with financial development, demonstrating



that countries with a developed economic machine have an excessive stage of economic integration. They came to the conclusion that nations with a higher level of financial integration noticed extra development and reform in the banking area when tariffs are diminished and capital account openness is raised. Development has a widespread fantastic hyperlink with per capita GDP and a negative relationship with inflation, according to the data. According to the study, if the basis is firm, financial reforms affect the development of the economy's economic sector. Financial reforms, in accordance with academics, have an impact on economies with a robust political structure.

Mahalik & Mallick (2014) for the period of 1997 to 2009 for the case of India test the connection of FD, EG, and EC. His finding show that the india decrease the energy consumption by the financail development.

Wang et al. (2020) from 1990 to 2017, evaluate the impact of carbon emission, FD, EC, and technological innovation for N-11 countries. The carbon emission is favorable impact by FD it means that the financial development rises the carbon emission in these 11 countries also identify that the other variables growth of the economic development, as well as the EC, positively effect carbon emission.

Cetin & Bakirtas (2019) employ a heterogeneous dynamic panel data technique to analyse 15 rising markets. Their findings demonstrate that energy use (fossil fuel) has a detrimental impact on these economies' environmental quality. They conclude that those countries must employ environmentally friendly technologies that do not contribute to carbon emissions.

Eren, Taspinar, & Gokmenoglu (2019) examine the relation by ordinary least squares (DOLS) method for the period 1971-2015. They find that the energy consumption positive effect by the rise of financial development and economic growth. They also apply the other method that is Granger causality test, which reveals the bidirectional relation of economic growth and the financial development. Coban and Topcu (2013), explain that the increases energy usage also rises financial development. According to Kakar et al. (2011), with the progress of the economy the energy consumption rises in Pakistan. Different studies use different variables in a structural model to investigate these impacts.

## 2.2 Financial Development and Economic Growth

A prior study discovered that financial improvement has a really useful effect on economic growth. Financial development is facilitated through the enlargement of the banking area and inventory markets, which has resulted in an extended domestic and overseas direct investment, all of which contribute to the countries' financial progress. According to (Levin, 2002), development in the banking enterprise will rise financial growth. The previous lookup has discovered that financial development has a favorable or terrible have an effect on economic growth. Using annual statistics for 64 nations, Omri and Kahouli (2014) from 1990 to 2011 examine that there is a unidirectional correlation exist between the variables of financial development and economic growth.

It is simple for households to borrow money for home-related items, and they can do it at a low cost. Because of the rising financial sectors, it is easier for entrepreneurs to get low-cost capital to expand their business or establish a new one in the industrial sector. Rises in the stock market will result in raised economic growth, which will boost risk diversification for individuals and businesses. It has also boosted the amount of money available for investment projects, allowing more individuals to invest, hence increasing energy consumption. Shahbaz & lean (2014) analyze that growth in a financial sector rises the demand for energy in two different ways first is the cross-sectional way and second is the demand for consumable goods is creating the by the growth of the economy and increase in income.

Shahbaz et al. (2016) use quarterly data in the case of Pakistan to see the impact of FD on the quality of the environment where they identify energy usage has a negative effect on environmental quality when it uses negatively. They suggest that the energy should use in an efficient manner for this latest technology would be a better option to use energy in an efficient way. Results also reveal that the banking related sector also prevents environmental quality. Mukhtarov et al. (2019) use annual data for 1993-2014 to have an impact on FD and CPI on EG.

They come to the conclusion that financial improvement and economic growth have a really useful effect on strength usage. They utilize the client rate index as a proxy for electricity prices, and the estimated hyperlink between the two variables is negative.

Ahmed et al, (2021) for the period 1990-2019, employ GMM and panel statistics regression to look at the influence of economic improvement on electricity usage in 136 countries. The findings exhibit that energy usage is negatively affected by financial development.

Shahbaz, Khan, & Tahir (2013) purposeful connection between economic growth and energy usage by using financial development over the period 1971 to 2011 for China and the ARDL testing method is used. The key feature of the production function is capital and international commerce. Their findings show that energy usage, international commerce, and capital have all had a favourable impact on economic growth.

Jalil, et al., (2011) purposeful connection between economic development and growth for the period 1975-2008 in Pakistan. For the assessment, the ARDL econometric strategy was used. PCA is used to measure financial development variables. In addition to national bank resources, PCA uses three financial indicators: fluid liabilities, private division credit, and business bank resources. According to the study's conclusions, there is a considerable and favourable link between Pakistan's financial development and economic growth. Concentrate also clarifies expansion assistance based on the financial area's arrangement. The growth of the Pakistani economy, as well as the economies of other developing countries, can be boosted by advancement in growth. Cesar, et al., (2003) using the annual data of 1960 to 1994 explore the relation of FD and EG for the developing and as well as developed countries. To construct the connectivity between growth and financial development, Geweke's decomposition test was used. Their research examines the 5 factors of the study and concludes that financial development has an effect on financial growth. They additionally observe whether there is a bidirectional causal association between economic growth and financial development. They additionally look at the link between the financial rise and financial development in emerging and developed countries. They additionally declare that analyzing huge

quantities of data has an influence on economic growth. Finally, they appear at how financial improvement influences economic rise via capital accumulation. All of the factors have a really helpful influence on economic growth, according to the findings.

Dimitris, et al. (2004) examined the quarterly data for valuation of EG with the stock market development<sup>6</sup> effect for seven countries of the world for two-year data. Results of the study reveal that economic growth is positively affected by the development of the stock market. They also looked into the bidirectional connection but discovered that there is none between financial development via the stock market and economic growth. Their result also reveals that there is a link between the variable by the ordinary least square method. The findings also show that EG has a long-term effect related to the development of the stock market.

Khan, et al., (2006) used the ARDL approach to estimate how financial development affects economic growth. They demonstrate that economic growth rise with the effect of financial development. Economic growth accelerates as financial development accelerates. They also show that the rate of interest is related to economic growth in a beneficial way. Investment has a favourable influence on income as well, but it was shown to be minor in their study. Their result suggests that the development and rate of interest work well in the short run and long run in the economy. The findings of the study suggest some policies measure. Results indicate that the growth rises through long-term policies for the improvement of the financial market, banking segment, and the improvement of the market. Stock market improvement changes the cost of firms that helps to promote the investment that promotes growth. If the cost of investment is low then the growth is promoted for long period.

The Asian Development Bank (ADB) examines the accession between EG and the growth of Asian developing nations. The findings show that the banking sector's economic expansion, as well as financial market development, are inextricably linked to the financial boom in Asia's developing economies. Every control variable also has a projected sign that was proposed in writing and is consistent with the hypothesis. Fluid liabilities have a greater impact in Asian agricultural countries

than in other places. The findings show that economic development has a higher risk of contributing to the development of the United States' financial zone. In a wide manner, the study coordinates that development work on the economic growth and development can be worked on through progress of financial system and securities exchange. Greater speculation leads to more development in the states, which promotes the country's progress.

Guglielmo et al. (2004), investigated the relation of FD, EG, and the banking sector. The analysis for the seven nations from 1997Q1 to 1998Q4. VAR econometric techniques were used to test causation. Only two countries rely on domestic lending to expand their economies, while three others rely on bank deposits. The results were skewed because the essential variables were neglected. The stock market's performance and economic growth have evolved as a result of the dynamic association between financial changes. Financial and stock market expansion drives EG for five nations. The overall conclusion of growth is the unrelated effect on the development of the stock. Domestic credit is a result of economic growth. Chile, Korea, Malaysia, and the Philippines are among the countries represented.

Benhabib et al., (2000) Economic growth, development, and investment were studied. Data in panel form were used for the sample economies of Argentina, Chile, Indonesia, and Korea from 1965 to 1985. The fixed-effect model and the Generalized method of moments (GMM) estimation strategies were employed in this study. The neoclassical mannequin equation has all fantastic and sizable variables, however not the economic development indicators. In the endogenous boom model, all variables are widespread and have an effective sign. According to the financial depth coefficient, financial depth enhances financial rise via 0.5 percent, whilst private credit boosts boom by means of 0.7 percent. The findings show that economic improvement is more based on the country's financial device than on growth. In general, the authors conclude that development boosts financial rise and that improvement can be boosted via enhancing the economic machine and inventory market. Greater spending results in an extra improvement in states, which promotes national growth.

Jordan (2001) investigates the relation for OECD nations between the FD and EG. (The United States, New Zealand, Denmark, and Japan, as well as Italy, France,

the United Kingdom, and Australia) and China from 1976 to 1998. They investigated using the VAR Granger causality test. Economic growth has no directional causality; hence the results indicate progress. The study's findings suggest that economic growth is affected by over-only banking system development.

Gregorio et al. (1995) looked at the association of growth of the economy and the financial in 100 nations for 1950 - 1995, as well as a regression that was run independently with 19 Latin American governments. The result is calculated with the ordinary least square method. Middle-income and low-income countries are the main focus of the study. For Latin American countries, the researchers used a random effect model with controlling factors such as investment rate, literacy rate, and inflation. The findings show how the spread of financial division helps all countries, especially those in Latin America, advance economically.

Liang et al. (2006) from 1952 to 2002, investigate the relation of FD and EG. To discuss the nexus VAR approach that was employed. Financial and other growth elements, according to the study, have a favorable effect on the growth of the economy. Different development indicators were utilized individually for estimation to address robustness. Foreign trade, liquid deposit liabilities, and interest rates all influence China's growth.

Khan & colleagues (2000) looked into the link between GDP and the financial development and economic growth. They use the data of 32 years for 109 countries, including developed and developing. The OLS and 2SLS estimation approaches were utilized. GDP and financial development have a favorable relation between the variable, according to the research. A different model was used to determine robustness, which included financial development proxies. The size of the influence varies depending on the indicator. Other growth factors have a substantial impact on economic development.

Najeb et al. (2018) stressed the connection of financial deepness and GDP growth in 42 emerging economies over the period 1995-2006. They used an endogenous growth model in their research. Controlled factors included investment, education, trade openness, inflation, and population growth, as well as a range of banking organization measures and the establishment of financial market indicators.

Economic growth is boosted by financial and stock market development indices, according to the data. There is a bidirectional link in the emerging economy between the stock market and the growth. The study claims that development aids economic growth by enhancing the financial system and delivering better banking services. The stock market's performance is linked to a country's long-term economic performance.

Ram (1999) analysed the relation of growth the development of the financial sector in 95 economies, 1966 - 1982. All 95 countries established a poor connection between FD and growth. For the same financial development indicators, there is a substantial link between countries in cross-country estimates. In a cross-country viewpoint, most of the literature review. Favourable signals of financial development across the country suggest a link between growth and financial development, however, this was not discovered in his research.

Rana et al. (2015) investigated the hyperlink between economic gadget improvement and financial growth in 5 creating countries: Sri Lanka, Nepal, Pakistan, India, and Bangladesh. For the years 1974 through 2012. The connection has estimated the use of a constant and random impact model. Independent variable alerts are consistent with literature assumptions, however, solely two variables, gross home saving, and total debt service are enormous at the 5

Ahmed, et al. (1998) from 1973 to 1991, demonstrated the link of FD and the GDP, and the rise of Sri Lanka, Pakistan, and India in South Asia. Three methods were used to look at the association: correlation analysis, Granger causality test, and pooled regression. According to the findings of correlation research, development and growth are strongly linked. Economic growth is induced by development, according to Granger causality testing. According to their pooled regression, there is a favorable relation between the FD and the growth of the economy in these counties.

Bader, et al., (2008) employed vector autoregressive models to estimate the relation of Egypt's FD and growth of the economy from 1960 to 2001. The findings showed that in Egypt, financial development and economic growth are linked. Economic growth is boosted by factors such as development, investment, and efficiency. The

study's policies measure reveals that Egypt's economic growth is boosted by taking steps to improve the country's financial system.

Khalifa (2002) evaluated the relation of FD and the growth of the economy in 95 economies between 1966 and 1982. They conclude that the FD and the EG both are negatively linked with each other. in 95 distinct country states. In estimation, there is a significant association across the nation for the financial development variables. This depicts the majority of the literature review in a multi-national context. Positive indicators of financial development across the country imply a link between growth and financial development, but this was not discovered during his research. The findings of the study explain other aspects such as the demand and supply sides, as well as some that do not explain any connection between the variables. The measurement indicators are used to determine the magnitude of the financial development effect. Because of the structure of their financial systems, each country's influence on economic growth differs.

Bucci & Marsiglio (2018) investigated the association between financial improvement and financial boom from several angles. Many additional research was only concerned with the impact of easy economic development on growth. They investigated the role of intermediaries in financial rise as nicely as the improvement of human capital. Financial improvement rises financial growth, in accordance with the research.

Asteriou et al. (2019) from 1966 to 1982, examined the association between financial development and economic growth in ninety-five economies. In 95 exclusive country states, they established a negative connection between improvement and growth. For the identical financial development indicators, there is a massive hyperlink between international locations in cross-country estimates. As a result, the majority of the literature review is carried out in a cross-national context. Favorable alerts of financial improvement throughout the United States of America advise a hyperlink between growth and economic development, however, his investigation did no longer find this. Other elements of the study's conclusions consist of demand and supply, as nicely as the lack of an association between the variables in some circumstances. The size metrics are used to determine the quantity of the



economic improvement effect. The influence of development on economic growth differs. due to the shape of wonderful financial systems.

Wang et al. (2015) studied the connection between China's economic development and rise from 1978 to 2013. The reason of this study was once to inspect the have an effect on of China's financial sector growth on the growth of the major and secondary sectors. To estimate the statistical method, the OSL mannequin is used. Macroeconomic variables such as labor force, inflation, capital growth, and export boom are used to assess the have an impact on of development on China's economic growth. According to the data, development has a terrible effect on China's tertiary sectors. Furthermore, there was no discernible impact in China's essential and secondary industries. Modernizing China's financial system, according to the findings, will help the country's financial development.

The association between African states' integration, development, and rise was studied by means of (Ahmed, 2016). Their findings published that the financial sector's development had a great and fine influence on the countries' economic growth. They say that countries with a robust economic quarter resource in the financial growth of their economies.

### **2.3 Economic Growth as Mediation between Financial Development and Energy Consumption**

Shahbaz et al. (2017) use quarterly data to check the relation of FD, EG, and the energy usage of the country for 1960-2015 through using the ARDL approach. The findings suggest that negative shocks have an influence on economic development when they affect energy use. Asymmetric cointegration exists between the variables as well. Dagher & Yacoubian (2012), studied in Lebanon and they observed that together the present moment and long term a two-way association between GDP and energy usage. Additionally, the finding shows that it accepts the feedback hypothesis and in Lebanon energy is a limited part of GDP.

Apergis & Payne (2008) use the panel cointegration and error correlation model to examine the relations of energy consumption (EC) and economic growth (EG) for 24 years 1980 to 2004. Their findings imply that energy usage and economic growth are linked in both the short and long run.

Jalil & Feridun (2010) investigate the association between FD, EC, and EG on environmental pollution in China using the ARDL bound testing approach. They come to the conclusion that financial development has resulted in less pollution in the environment. energy usage and economic expansion, according to their findings, have a favorable impact on pollution levels.

Shahbaz et al. (2013) evaluated the association between economic growth and energy consumption by adding financial development, international trade, and capital as major features of the production function, utilizing data from 1971 to 2011 for China and the ARDL testing method. Their findings reveal that energy usage, international trade, and capital have all contributed to economic expansion. An additional Granger causality test demonstrates the existence of unidirectional causality between energy use and economic growth.

Ahmed et al. (2021) use GMM and panel data regression to analyse the impact of financial development on energy consumption in 136 countries over the period 1990-2019. Economic growth has a detrimental impact on energy use, according to the data.

Batuo et al. (2018) GMM has historically focused on the financial crisis of 2008 and its economic consequences. According to the report, while integration encouraged economic growth and progress, it also generated instability if the financial system was not improved. To evaluate the influence of financial development, they used a range of replacements to prolong the development. Private credit was the key gauge, but assets held by commercial banks and central banks were also employed as economic development proxies. The findings demonstrated a robust and favorable association between growth and development. Another finding is that economic expansion destabilizes a country's stability. Beck et al. (2000), according to their study a developed financial system, boosts savings in the economy, promotes the production, and creates changes in the production of items in the

economy. To evaluate the influence of financial development, they used a range of replacements to prolong the development. The major indicator was private credit, but assets held by commercial banks and central banks were also employed as proxies for economic development. Development has a good and strong association with growth, according to the data.

Mahalik & Mallick (2014) for the period of 1997 to 2009 for the case of India test the association of financial development, GDP, and the energy usage where they identify that the energy usage of India is decreased by the economic growth of the country. They also suggest that the energy consumption rises with the proportion of the urban population, with the rise of the population the demand for energy increase, because the use of household product rises. They also use the cointegration approach where energy usage rises by economic growth.

Mody & Murshid, (2005) explained the indirect association between economic growth and international financial integration through FDI and portfolio inflows for 60 developing countries from 1979-1999. They used first serial correlation for annual data and then Generalized method of moments GMM for three-year averaged data. The study also discussed that financial integration encourages the investors for the investment and results showed that rises in the investment due to these diversifications. Their findings indicated FDI and economic growth of countries are positively related.

According to Soytas & Sari (2003), growth to energy causality runs in Korea and Italy, but unidirectional energy to growth causality runs in Turkey, France, Japan, and Germany, (Chien-Chiang Lee, 2006) for Switzerland, Canada, Sweden, Germany, and the United Kingdom; (Bowden & Payne, 2009) for the United States; and (Narayan & Smyth, 2008) for the G-7 countries reveal reverse causality. Due to the use of varied approaches, tools, and procedures, sample selection, and countries, as well as different climate and phase of energy-growth trends, there is a lack of consensus in this research.

Akarca & Long (1980) Using the data from 1947 to 1972, discovered no link between growth to energy nexus. They hypothesized that data from 1973 to 1974

infected the series as a result of the impact of oil limitations. Erol & Yu (1987) from 1952 through 1982, conducted a study in six countries: Germany, Canada, Japan, Italy, England, and France (GCJIEF). His findings show that the causality connection for China is two-way energy growth, for Italy and Germany it is growth-energy, for Japan it is bidirectional causality, and for England and France, it is none. Masih and Masih (1996) conducted a study in six nations utilizing integration and error correction modeling approaches. Their findings show that energy to growth causation exists in India, but not in Pakistan or Indonesia and that no causality exists in the Philippines, Singapore, or Malaysia.

Ozturk (2010) investigates the relation of financial development and the energy nexus using annual data empirical results. He hypothesized that the financial development and growth of the economy has positively linked with the energy. There is no consensus on the existence or direction of causality between energy use (electricity consumption) and economic growth, according to the findings of this research.

The authors employ the autoregressive distributed lags bound test, two-regime threshold co-integration models, panel data technique, and multivariate models integrating new variables to prevent contradicting and unreliable results (such as real gross fixed capital formation, labor force, carbon dioxide emissions, population, exchange rates, interest rates, and so on).

From 1975 through 2011, Shahbaz, Hye, and Tiwari (2013) studied the connection between Indonesian economic growth, energy usage, financial development, trade openness, and CO<sub>2</sub> emissions. According to the result of the study CO<sub>2</sub> emission is favorably affected by energy usage and economic growth.

Eren et al. (2019) employed the Dynamic Ordinary Least Squares (DOLS) model in the case of India to see the relation of financial development, economic growth, and energy usage for 45 years from 1971-2015, Their data reveal that energy consumption rises in tandem with financial and economic growth. They also analyse the association between these variables using the Granger model; empirical evidence reveals that economic growth and energy use are bidirectional.

## 2.4 Information and Communication Technology as a Moderation

Information and communication technology (ICT) has the potential to harm the environment in different ways, which are incredibly damaging and detrimental to the environment. Pollution of the environment is also a result of the disposal of trash from electrical and electronic IT equipment. Over the previous two decades, increased usage of ICT has resulted in tremendous growth in electricity demand. ICT-related electricity usage has risen dramatically in both the workplace and at home. ICT equipment's are almost using the 7% electricity of the countries includes communication networks, personal computers, and data centers use roughly. The usage of ICT increased by 3.9 percent in 2007 and this number is increased to 4.6 percent in 2012 on global electricity usage.

Saidi, Toumi & Zaidi (2015) use the dynamic panel model to examine the effect of information and communication technology and economic growth on electricity consumption from 1990 to 2012. Their findings show that electricity usage favorable effect by information and communication technology and EG, which show that with the increase of ICT electricity demand also increases.

Torkayesh (2021) evaluates the impact of information and communication technology in a modern world for the G7 countries, result of their study shows that information and communication technology has favorably increased the growth and social growth of the countries. Governments are also want to enhance the infrastructure of information and communication technology that people are getting information faster as well as easily. In today's era, all the information is available on the internet. The results show that to improve the performance of the ICT the countries that are Italy and Canada have to improve their policies. On the other hand, Japan and the United States of America have managed the ICT.

Within the context of neoclassical economics, Robert Solow and Trevor Swan independently devised a new exogenous growth model (which succeeded the Keynesian Harrod Domar model) to estimate the persistent growth rate of the economy in the 1960s. Solow (1956) and Swan (1956) made significant contributions to EG

and EC in developing a production function based on constant returns on scales for the long term, decreasing returns on capital, and an exogenous technological explanation. For a long time, existing theories have argued that capital, labor, and technology advancement are the primary drivers of long-term economic growth. In the sense that it offers productivity gains in production through new knowledge and inventions, the technology component is considered to complement capital and labor (Solow, 1956; Romer, 1990; Gottfries, 2013).

Solarin et al. (2019) estimate the connection for Malaysia of how energy usage is effected by information and communication technology, financial development, and economic growth using the Toda-Yamamoto Granger causality test for the period 1990Q-2015Q. Their empirical findings reveal that as information and communication technology improves, so does financial development and economic expansion, resulting in increased energy consumption.

Salahuddin & Alam (2016) assess the effects of how electricity usage affected by ICT and economic growth using the OECD panel data model for estimation of the results for the period of 1985-2012. The results show that in the short run and long run there is a positive association exists between information and communication technology and economic growth to energy usage (electricity use). There result also reveals that the use of mobile and the internet increase electricity use and economic growth as well. Result also reveals that information and communication technology has not achieved efficiency of the energy in OECD countries.

Nguyen, Pham, & Tram (2020) results show that economic growth will raise CO2 emissions. To begin with, just five determinants, such as energy pricing, foreign direct investment, technology, research spending, and trade openness, decrease carbon emissions, whereas the remaining determinants, such as financial development, increase pollution. Second, information and communication technology, as well as financial development, are significant economic drivers. The lack of an Environmental Kuznets Curve (EKC) in their sample is refuted by their findings.

Caglar, Mert, & Boluk (2021) sees the connection of ICT, EC as well as on renewable energy consumption on the environment, by using ten countries' data China, Germany, Brazil, India, Japan, Mexico, United States, Russian Federation, United

Kingdom, and Indonesia. The findings from the ARDL approach suggest that information and communication technologies, as well as renewable energy use, can help to slow the degradation of environmental quality.

Sahoo et al. (2021) examine the long-term relation of development of financial, growth of the economy, CO<sub>2</sub> emissions, energy usage, and information and communication technology from 1990 to 2018. The result indicates that India's energy usage is reducing environmental sustainability. They also discover CO<sub>2</sub> emissions is adversely related to energy usage. They use the proxy of internet use per individual and mobile phones for information communication, both of which have a negative impact on environmental sustainability. According to the findings, CO<sub>2</sub> emissions also have a negative relation with financial development.

Arshad et al. (2016) used the GMM estimation technique to assess the connection of the relations for the study of Pakistan between energy prices and economic growth for the period 1991-2011. Their findings demonstrate economic growth adversely related to the energy prices. As per their discoveries, high energy costs seem to bring down loan fees, investment, and stock costs. It additionally decreases the real worth of the local currency. For energy costs set a strain on government spending plans and increment the country's joblessness rate. As indicated by the discoveries, energy costs emphatically affect development by means of the exchange rate fee and government utilization, however is an adverse consequence on creative development through speculation, stock costs, the genuine conversion scale, and joblessness. The information uncovers that most of the impact of energy costs on financial improvement is represented by stock costs, trade rates, government utilization, and unemployment.

## 2.5 Hypotheses

**H<sub>1</sub>**: There is a positive impact of financial development on energy consumption.

**H<sub>2</sub>**: There is a positive impact of financial development on economic growth.

**H<sub>3</sub>**: There is a positive impact of economic growth on energy consumption.

**H<sub>4</sub>**: Economic growth mediates the relationship between financial development

and energy consumption.

**H<sub>5</sub>**:Information and communication technology moderates the relationship between financial development and energy consumption.

**H<sub>6</sub>**:Information and communication technology moderates the relationship between financial development and economic growth.



# Chapter 3

## Data and Methodology

### 3.1 Data Description

Data description and methodology provide the information about from where the data is collected. The information is gathered from world development indicators (WDI). secondary data is used for the study that is available on WDI. On WDI website uses the filter for extracting the data that is for countries selected all over the world and the time is selected from the year 1980 to 2020 and uses the study proxies one by one to download the data. This study to see the effect of independent variables (financial development, information and communication technology, energy prices, foreign direct investment, urbanization, trade openness, human capital, and investment) and also mediating variable (economic growth) and moderating variable (information and communication technology) on the dependent variable (energy consumption).

#### 3.1.1 Population

Selection of the population is all of the world countries.

#### 3.1.2 Sample

A balanced panel of 138 countries from 195 countries was used in this study. Data have been collected annually from 1980 to 2020 because reasonable data is available

for this time period, and also because this time period of data has reasonable observations for model estimation techniques. Sample selection is based on the countries that have data. The sample selection and countries are based on 41 years of the data, because the data is available from the 1980s onward. Before this period random data is available for the countries that can give biased results. The list of countries selected as a sample for the study is given below in table 3.

TABLE 3.1: Countries list

Albania	France	North Macedonia
Algeria	Gabon	Norway
Angola	Georgia	Oman
Argentina	Germany	Pakistan
Armenia	Ghana	Panama
Australia	Greece	Paraguay
Austria	Guatemala	Peru
Azerbaijan	Haiti	Philippines
Bahrain	Honduras	Poland
Bangladesh	Hong Kong SAR, China	Portugal
Belarus	Hungary	Qatar
Belgium	Iceland	Romania
Belize	India	Russian Federation
Benin	Indonesia	Saudi Arabia
Bhutan	Iran, Islamic Rep.	Senegal
Bolivia	Ireland	Serbia
Botswana	Israel	Singapore
Brazil	Italy	Slovak Republic
Brunei Darussalam	Jamaica	Slovenia
Bulgaria	Japan	South Africa
Cambodia	Jordan	Spain
Cameroon	Kazakhstan	Sri Lanka
Canada	Kenya	Sudan
Central African Republic	Kuwait	Suriname

Continued Table: 3.1 Countries list

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Chile	Kyrgyz Republic	Sweden
China	Latvia	Switzerland
Colombia	Lebanon	Syrian Arab Republic
Comoros	Libya	Tajikistan
Congo, Dem. Rep.	Lithuania	Tanzania
Congo, Rep.	Luxembourg	Thailand
Costa Rica	Malaysia	Togo
Cote d'Ivoire	Maldives	Trinidad and Tobago
Croatia	Malta	Tunisia
Cyprus	Mauritius	Turkey
Czech Republic	Mexico	Turkmenistan
Denmark	Moldova	Ukraine
Dominica	Mongolia	United Arab Emirates
Dominican Republic	Morocco	United Kingdom
Ecuador	Mozambique	United States
Egypt, Arab Rep.	Myanmar	Uruguay
El Salvador	Namibia	Uzbekistan
Equatorial Guinea	Nepal	Venezuela, RB
Eritrea	Netherlands	Vietnam
Estonia	New Zealand	Yemen, Rep.
Ethiopia	Nicaragua	Zambia
Finland	Nigeria	Zimbabwe

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### 3.1.3 Data Sources

This study depends on secondary data from the World Development Indicators, posted by the world bank. This study uses Energy consumption as the proxy of GDP per kg of oil equivalent (Aslan et al, 2021) uses this proxy. economic growth uses GDP per capita constant 2015 US\$ also used by (Aslan et al, 2021) as well, financial development uses (GDP percentage rate of Domestic credit to the private sector by banks), information and communication technology uses a percentage

of the population of Individuals using the Internet, foreign direct investment uses (GDP percentage of net inflow), energy price uses (Consumer price index 2010 = 100), most countries don't have a data of energy prices that's why researcher use the CPI for calculation of energy. In some earlier studies researchers uses the CPI as a proxy (Sadorsky, 2010; Mahadevan, 2007; Komal et al. 2015; & Chang 2015). urbanization uses the proxy of (Urban population of the total percentage of population), trade openness uses GDP percentage of trade, human capital uses (School enrolment, secondary percentage gross) and uses the investment proxy is (Gross fixed capital formation % of GDP), all the proxies are deriving from WDI. Converted all the variables into a natural logarithmic for empirical results.

## **3.2 Description of Variables**

The dependent variable of the study that use in this study is energy consumption. On the other hand independent variable are financial development, urbanization, foreign direct investment, energy prices, human capital, trade openness, and investment while the channel variable if the study is economic growth and the moderating variable is information and communication and technology. The further explanation of the variable is given below.

### **3.2.1 Energy Consumption (EC)**

The amount of energy or power consumed is referred to as EC. One example of energy consumption is the electricity use that is derived from various things like fossil fuels. It is equivalent to domestic manufacturing plus imports and inventory adjustments, minus exports and fuels provided to ships and planes engaged in international transportation. (Saud et al., 2018).

### **3.2.2 Financial Development (FD)**

Financial development affects a country's economy to fluctuate in many ways. In countries with a robust and advanced developed structure, borrowing costs, for

example, are generally low. It also raises transparency among borrowers and creditors and improves access to financial capital. All these factors result in the flow of investment between countries which helps in getting access to better technology. Additionally, financial sectors increase investing streams among borders and offer more prominent admittance to advanced energy-effective items and cutting-edge innovation. These exercises animate energy interest through energy utilization and business fixed venture. The FD offers loans in a very low demand to the businessman so that they can buy innovative technology and tools and increase consumption for the energy Shahbaz et al. (2013). Boutabba (2014) concludes that finance-energy linkage longer-term positively and two-way connection among each other. Also, Furuoka (2015) originates that finance granger causal with the demand of energy. Furthermore, most of the previous studies (Gould, Melecky, & Panterov, 2016; King & Levine, 1993; Law & Singh, 2014; Saud et al., 2018; Yang et al., 2020b) among others, only rely on financial depth's indicators such as the money supply percentage of GDP, DCPS percentage of GDP, market-capitalization percent by GDP and percentage of liquid liability by the GDP as alternative indicators of financial development.

### **3.2.3 Economic Growth (EG)**

Good and services are increasing in the economy with the one time period to another period are called the growth of the economy. There are two main aspects that increase economic growth one is growing in the workplace and the other is growth in productivity. Productivity is measured by how much increase the unit of output by per unit of input. Energy consumption is the one aspect that cause by Economic growth. Increased energy demand is a result of rising economic growth (income effect). This suggests that energy demand grows in accordance with GDP, at a slower pace. (GDP constant, 2010 US \$) per capita employed to calculate it.

### **3.2.4 Urbanization (URBN)**

Urbanization is where large number of the people are migrating from urban to the rural area. The goal of this condition is for people to relocate from rural to

urban areas in order to enjoy a better and more settled way of life, better job opportunities, and easy access to other daily life supplies. In the early stages of urbanization, people consume more electronic items, which increases energy demand (Saud et al., 2018).

### **3.2.5 Foreign Direct Investment (FDI)**

This means that person or investor or the business purchases the share of other businesses that are outside of the country is called foreign direct investment. Generally, investors or businessmen use this strategy to move or for expanding their business. With the increase of employment the buying power of the people is also increasing. As a result, FDI is defined as net inflows of investment for the purpose of obtaining a long-term management interest. As indicated by FDI, the worth of non-inhabitant financial inward' internal direct interest in the economy. It is the total of equity capital and earnings reinvestment. Regarding the foreign investors, this sequence shows that newly investment inflow with minus dis-investment and it's divided by GDP in the economy.

### **3.2.6 Energy Prices (CPI)**

Energy prices are the prices that are linked with the energy that are electricity, fuel oil, gasoline, heating oil, natural gas, or another source that are connected to the operations are another sector. It is calculated using the consumer price index (2010 = 100). Because most countries lack access to energy pricing data. Prior research that used the CPI as a proxy include (Sadorsky, 2010; Mahadevan, 2007; Komal et al. 2015). The CPI tracks changes in the cost of acquiring goods and services for the consumer, which can change or remain constant over time.

### **3.2.7 Trade Openness (T)**

The ratio of exports and imports over GDP is used to measure trade openness. Trade openness is defined as the total number of imports and outputs adjusted

by GDP. Reciprocal value speculation is integrally tied to basic examples of exchange, according to Mishra (2007), Lane & Milesi-Ferretti (2008). As a result, investors are better prepared to access accounting and administrative information on unknown business sectors through exchange and, as a result, invest in unknown resources. Tighter exchange integration also reduces the chance of default. Finally, cross-line financial streams such as exchange credits, send-out protection, and installment aid can be simply generated through trade exchanges. The data on trade openness came from the World Bank's World Development Indicators.

### **3.2.8 Human Capital (H)**

The term human capital refers to the financial value of a worker's knowledge and abilities. Human capital includes resources such as education, training, knowledge, abilities, health, and other qualities that employers value such as dedication and dependability. Human capital proxy percentage of gross school enrollment in secondary (Komal & Abbas, 2015).

### **3.2.9 Investment (INVST)**

The commitment of a resource in order to attain an increase in esteem over an indefinite time period is referred to as an investment. Venture necessitates the sacrifice of a current resource, such as time, money, or effort. In finance, the motivation for donating is to generate a profit from the resource that has been contributed. In this study using of investment proxy is the Gross fixed capital percentage of GDP formation.

Descriptive statistics is a type of statistic that captures data's statistical behavior. The mean, median, and standard deviation numbers in descriptive statistics represent the average value of the data, while the median is the midpoint value when the data set is arranged from smallest to biggest value. The standard deviation calculates the data's dispersion and gives us statistics on how far the data deviates from its mean value. If the mean and standard deviation are used independently, they will be meaningless.

TABLE 3.2: Variable's Names, Definitions and Sources

<b>Variables</b>	<b>Measurement</b>	<b>Source</b>
Energy consumption (EC)	Per unit of GDP energy use (per kg of oil equivalent)	World Development Indicators (WDI)
Economic growth (EG)	GDP per capita (constant 2015 US\$)	WDI
Financial development (FD)	Domestic credit to the private sector by banks to percentage of GDP	WDI
Information and communication technology (ICT)	Individuals using the Internet (% of the population)	WDI
Foreign direct investment (FDI)	GDP percentage of net inflow	WDI
Energy prices (CPI)	Consumer price index (2010 = 100)	WDI
Urbanization (URBN)	Urban population (% of total population)	WDI
Trade openness (T)	Trade (% of GDP)	WDI
Human capital (H)	School enrolment, secondary (% gross)	WDI
Investment (INVST)	Gross fixed capital formation (% of GDP)	WDI



### 3.3 Descriptive Statistics

Skewness captures the positive and negative spread of data, but kurtosis infers the flatness of data spread. In table 3.3 all the variables are shown that are used for the study. Mean value of the energy consumption is 0.04 and the maximum value of the descriptive statistics is 0.53. The minimum value is -0.36 and the standard deviation value is 0.06.

The skewness value in the descriptive statistic table of the energy consumption is negative which means that the data of the energy consumption is negatively skewed, negative skewness of the data means that the tail of the variable is a move to the left side. The kurtosis value of the energy consumption is higher than 3 which is 10.26 indicating that the variable's curve is leptokurtic.

Financial development (FD) is the next variable. The mean value of the financial development is 3.62 and the maximum value is 5.7. the minimum value of the variable is 0.15 and the standard deviation value is 0.93. value of the skewness of FD on the descriptive statistic table is negative which shows that the data of the variable is negatively skewed and the curve impacts the left side, and the kurtosis value is less than three  $2.83 < 3$ , shows the platykurtic curve of the variable.

The mean value of the EG is 8.84 and positive. the maximum value of the variable is 11.53 and the minimum value is the economic growth is 5.49. EG stands for economic growth. It has a standard deviation of 1.36 and a skewness value of negative, implying that the information in this variable is skewness and the curve flows to the left. The variable is platykurtic because the kurtosis is less than three  $2.18 < 3$ .

The next variable in the descriptive statistics is information and communication technology (ICT), which has a mean value of 1.87 and maximum and minimum values of 4.57 and -10.95, respectively. It has a 2.61 standard deviation. The skewness value in ICT is negative, indicating that the data has negative skewness. As a result, the curve moves to the left, and the kurtosis value in ICT is greater than three  $5.03 > 3$ , indicating that the variable's curve is leptokurtic.

The mean value of the financial development indicators is 0.97 and positive. and 6.11 and -12.96 are the highest and lowest values of the FDI, respectively. The skewness value on the bent left side is negative, and the standard deviation is 1.36. Kurtosis has a higher FDI value than three, at  $19.16 > 3$ , indicating that it is leptokurtic.

The Consumer Price Index is the following variable (CPI). CPI has a mean value of 4.31, with the highest and lowest values being 5.83 and - 3.14, respectively. The value of the skewness is negative which means that the data is negatively skewed and the curve is moving to the left side. The kurtosis value of the variable is more than 3 which is 40.18, indicating that the variable's curve is leptokurtic. The urbanization mean value is 4.08 and the maximum value is 4.60. The minimum value of urbanization is 2.42. The standard deviation value on the descriptive state is 0.36. The skewness value of the urbanization is negative that data is negatively skewed and the curve is a move to the left side. The value of the kurtosis is higher than 3 which is 4.73, indicating that the variable's curve is leptokurtic.

Human capital (H) has a mean value of 4.36, the maximum value of the variable is 5.08 a with a minimum value of 1.66. It has a 0.41 standard deviation. The value of the skewness is negative which means data is negatively skewed and the curve moves left side and the kurtosis of the variable is higher than 3 which is 7.81 which shows leptokurtic of the variable.

The mean value of the T that is human capital is 4.31. The maximum value of this variable is 6.09 and the minimum value is -1.74. The standard deviation value of the human capital is 0.52. The skewness of the variable is negative which means that the data is negatively skewed as well as the curve of the variable is also moved to the left. The kurtosis value is more than 3 which is 16.6 indicated that the leptokurtic of the variable.

Investment has a mean value of 3.09. The maximum value of the investment is 3.98 and the minimum value is 1.49. The standard deviation value is 0.25 of the investment. The skewness value is negative which shows that the data is left-skewed. The kurtosis value of the investment is more than 3 which is 5.17 indicates that the variable's curve is leptokurtic.

TABLE 3.3: Descriptive Statistics N=138 Countries

	<b>LEC</b>	<b>LFD</b>	<b>LEG</b>	<b>LICT</b>	<b>LFDI</b>	<b>LCPI</b>	<b>URBN</b>	<b>LH</b>	<b>LT</b>	<b>LINVST</b>
Mean	0.0376	3.6225	8.8448	1.8681	0.9745	4.3111	62.8839	4.3574	4.3129	3.0891
Median	0.0391	3.7304	8.7598	2.6877	1.0753	4.4508	64.741	4.483	4.3003	3.0873
Maximum	0.5377	5.7189	11.5353	4.5728	6.1072	5.8317	100	5.0815	6.0927	3.9796
Minimum	-0.3611	0.1536	5.4955	-10.9533	-12.9609	-3.1389	11.35	1.6646	-1.7448	1.4934
Std. Dev.	0.0625	0.9328	1.3638	2.614	1.3692	0.6349	18.825	0.4112	0.523	0.2504
Skewness	-0.1021	-0.4439	-0.1124	-1.4681	-1.8742	-5.0181	-0.3795	-1.8466	-0.7011	-0.3022
Kurtosis	10.2875	2.8315	2.181	5.0324	19.1641	40.1871	2.5731	7.8121	14.6367	5.1743
Jarque-Bera	3443.615	52.904	46.736	826.205	17839.11	96125.45	49.139	2384.09	8900.943	329.974
Probability	0	0	0	0	0	0	0	0	0	0
Observations	1555	1555	1555	1555	1555	1555	1555	1555	1555	1555

TABLE 3.4: Correlation Matrix

	LEC	LFD	LEG	LICT	LFDI	LCPI	LURBN	LT	LH	LINVST
LEC	1									
LFD	0.2967	1								
LEG	0.3272	0.6653	1							
LICT	0.4252	0.5344	0.5577	1						
LFDI	0.0024	0.1999	0.1914	0.2981	1					
LCPI	0.3046	0.2666	0.1706	0.5571	0.1863	1				
LURBN	0.1314	0.281	0.5741	0.3325	0.2353	0.1033	1			
LT	-0.0158	0.2464	0.2278	0.2492	0.443	0.0995	0.2128	1		
LH	0.1156	0.4296	0.5786	0.4456	0.1817	0.1856	0.6723	0.2384	1	
LINVST	0.0469	0.1292	0.0538	0.0094	0.1004	0.0552	-0.0305	0.0956	0.0546	1

### 3.4 Correlation Analysis

The degree of strength among variables is captured through correlation analysis. This tool additionally considers the direction of a variable's association. The correlation analysis of variables reveals both positive and negative relationships between them. The correlation of several variables employed in the empirical analysis is shown in the correlation matrix table explanatory. Checking for collinearity between variables is crucial. The coefficient of the correlation is relying on -1 to +1.

The value that is close to the -1 means that the connection between the variable is perfectly negative, and the values that are close to the +1 mean that the connection between the variable is perfectly positive. the value that is 0 or close to 0 are showing that the connection between the variable is weak or no connection between them. Multicollinearity is uncommon if there is a low correlation between two variables, but it is likely if there is a significant connection between two variables.

FD and the EC has a positive correlation, and the value is 0.29 which mean that the correlation between the variable is weak. The correlation between Economic growth and energy consumption is positive and the value is 0.03 and the correlation between the ICT and energy consumption is also positive and the value is 0.42 which mean that correlation between the variable is weak. The correlation of FDI and energy consumption is positive but the value is 0.002 which means that there is no correlation between these variables. The CPI value is also positive and the value is 0.3 which means that the correlation between CPI and EC is weak. The urbanization value is positive and the value is 0.13 which shows the weak correlation of the variable.

The correlation between the energy consumption and trade openness (T) is negative and the value is -0.01 which means that the correlation is n negative weak. EG has a positive correlation with FD and the value isa 0.66 which means that there is a moderate correlation between the variables. ICT value is positive and the value is 0.53 which means that the correlation between ICT and FD is moderating. The FDI, CPI, FDI, URBN, T, and H also has a positive correlation with

the EG and all the variable are close to 0.4 which means that all the variable has a weak correlation with the FD. The ICT and the EG value in the correlation matrix is positive, value is 0.55 means that the moderating correlation exists between the variable. The FDI and CPI also have a positive value correlated to the EG which but the value is relying on 0.2 means that the correlation of the variable with EG is weak. FDI, CPI, URBN, T, H, INVST shows a positive relationship with information and communication technology. CPI, URBN, T, H, INVST also show a positive correlation with FDI. URBN, T, H, INVST have a positive correlation with Energy prices. T, H, INVST also positively correlated with urbanization. All the other variables are positively correlated.

## 3.5 Econometric Model

### 3.5.1 Panel Data Analysis

The panel data set includes both cross-sectional and time-varying data. A balancing panel is one in which each cross-section of a variable has the same series of time observations. Unbalanced panels are created when a time observation fluctuates between cross-sections for each series (Gujarati & Porter, 2003). The explanation for the panel estimation approach is figured out in this part. The panel data method was used to analyse the data in this study.

**Model 01:**

$$\begin{aligned} LnEC_{it} = \beta_o + \beta_1 LnFD_{it} + \beta_2 LnICT_{it} + \beta_3 LnFDI_{it} + \beta_4 LnCPI_{it} + \\ \beta_5 LnURBN_{it} + \beta_6 LnH_{it} + \beta_7 LnT_{it} + \beta_8 LnINVST_{it} + \epsilon_{it} \end{aligned} \quad (3.1)$$

1 This model explains the impact of financial development on energy consumption. Where EC is energy consumption, FD is financial development, ICT is information and communication technology, FDI is foreign direct investment, CPI is energy price, URBN is urbanization, H, is human capital, T is trade openness, INVST, is an investment in this equation, and psilon is error term represents the all countries form 1980-2020.

**Model 02:**

$$\begin{aligned} LnEG_{it} = \beta_o + \beta_1 LnFD_{it} + \beta_2 LnICT_{it} + \beta_3 LnFDI_{it} + \beta_4 LnCPI_{it} + \\ \beta_5 LnURBN_{it} + \beta_6 LnH_{it} + \beta_7 LnT_{it} + \beta_8 LnINVST_{it} + \epsilon_{it} \end{aligned} \quad (3.2)$$

1 This model explains the effect of FD on EG by using ICT, foreign direct investment, Energy prices, urbanization, human capital, trade openness, and investment into a structural model.

**Model 03:**

$$\begin{aligned} LnEC_{it} = \beta_o + \beta_1 LnFD_{it} + \beta_2 LnEG_{it} + \beta_3 LnICT_{it} + \beta_4 LnFDI_{it} + \beta_5 LnCPI_{it} \\ + \beta_6 LnURBN_{it} + \beta_7 LnH_{it} + \beta_8 LnT_{it} + \beta_9 LnINVST_{it} + \epsilon_{it} \end{aligned} \quad (3.3)$$

1 This model explains the effect of economic growth on energy consumption, and the mediating effect of economic growth between financial development and energy consumption by using the ICT, foreign direct investment, Energy prices, urbanization, human capital, trade openness, and investment into a structural model.

**Model 04:**

$$\begin{aligned} LnEC_{it} = \beta_o + \beta_1 LnFD_{it} + \beta_2 LnEG_{it} * LnICT_{it} + \beta_3 LnFDI_{it} + \beta_4 LnCPI_{it} \\ + \beta_5 LnURBN_{it} + \beta_6 LnH_{it} + \beta_7 LnT_{it} + \beta_8 LnINVST_{it} + \epsilon_{it} \end{aligned} \quad (3.4)$$

1 Model 4 explains the moderating effect of ICT between FD and EC by using other dependent variables into a model.

**Model 05:**

$$\begin{aligned} LnEG_{it} = \beta_o + \beta_1 LnFD_{it} + \beta_2 LnEG_{it} * LnICT_{it} + \beta_3 LnFDI_{it} + \beta_4 LnCPI_{it} \\ + \beta_5 LnURBN_{it} + \beta_6 LnH_{it} + \beta_7 LnT_{it} + \beta_8 LnINVST_{it} + \epsilon_{it} \end{aligned} \quad (3.5)$$

This model explains the moderating effect of ICT between financial development and economic growth by using foreign direct investment, Energy prices, urbanization, human capital, trade openness, and investment into a structural model.

**Model 06:**

$$\begin{aligned} LnEC_{it} = & \beta_o + \beta_1 LnFD_{it} + \beta_2 LnEG_{it} + \beta_3 LnFD * LnICT_{it} + \beta_4 LnFDI_{it} + \\ & \beta_5 LnCPI_{it} + \beta_6 LnURBN_{it} + \beta_7 LnH_{it} + \beta_8 LnT_{it} + \beta_9 LnINVST\epsilon_{it} \end{aligned} \quad (3.6)$$

Model 6 explains the overall effect of ICT as a moderator and economic growth as mediation on financial development and energy consumption.

### 3.5.2 Fixed Effect Model

It is a statistical model which shows that the level of the independent variables that are value are assumed to be constant or remain the same, and only the dependent variable varies in response to the independent variable levels. A fixed-effect model is one in which the model's parameters have a fixed or random quality.

### 3.5.3 Random Effect Model

Random-effects models are statistical models in which some of the model's systematic components' parameters (effects) vary at random. Variation in observed variables is always explained in statistical models in terms of systematic and un-systematic components. The random-effect model, also known as the variance effect model, has a random variable in the model values.

From the fixed effect model and the random effect model, the valuation of the study is based on the fixed-effect model because the Hausman test is significantly less than 0.05.

## 3.6 Panel Unit Root Test

The panel unit root test is used to determine if data of EC, FD, EG, ICT, FDI, CPI, URBN, T, H, and investment variables are stationary or not. If the unit root exists the data is providing biased results it may exist because of the large number of observations in a data set. That's why avoiding the biased results converted all



the variables into a natural logarithmic for empirical results the unit root test is performed to see if there are any information series limitations due to the biased data. In this study, we used a variety of indicators to identify the unit root in the data set. As a result, the LLC (Levin, Lin, & Chu, 2002) and PP - Fisher Chi-square (Phillips and Perron, 1988) are employed in this study to investigate strong cross-sectional and heterogeneity. Table 3.5 shows the unit root test of the variables. Table 3.5 shows the stationery series ate level, that unit root does not exist in the variables.

TABLE 3.5: Unit Root Test

variable	Levin, Lin & Chu t*		Chi-square PP - Fisher	
	Statistic	Prob.	Statistic	Prob.
LnEC	-1.81499	0.0348	321.373	0.0258
LnFD	-4.27541	0.0000	293.700	0.1975
LnEG	-3.24975	0.0006	290.669	0.1851
LnICT	-80.0182	0.0000	3131.01	0.0000
LnFDI	-19.479	0.0000	909.295	0.0000
LnCPI	-50.9813	0.0000	1689.94	0.0000
LnURBN	-46.2009	0.0000	1295.10	0.0000
LnINVST	-4.39445	0.0000	419.012	0.0000
LnH	-5.91544	0.0000	423.159	0.0000
LnT	-12.8839	0.0000	385.136	0.0000

# Chapter 4

## Results and Discussion

### 4.1 Impact of Financial Development on Energy Consumption

The findings of studies on the influence of financial development on energy consumption through the economic growth channel, as well as the moderating effect of information and communication technology, are presented in this chapter for 138 countries.

The financial development coefficient has a positive and significant effect on energy usage. As a result of the 1% increase in financial development, energy consumption has grown by 0.19 percent. As a result of the increase in FD, the financial sector will expand, resulting in an increase in energy demand. The findings of this study are backed up by actual evidence (Komal and Abbas 2015; Sadorsky 2010).

The impact of information and communication technology on energy usage is favorable and statistically significant. This means that a 1% increase in ICT will result in a 0.05% increase in ICT energy consumption. However, the correlation is too modest, implying that the rise in ICT leads to a very small increase in energy usage. These findings are consistent with those of a previous study (Torkayesh, 2021; Salahuddin & Alam, 2016). They discover that information and communication technology raise the need for electricity. Foreign direct investment (FDI)

has a negative influence on energy consumption; a 1% increase in FDI resulted in a 0.02 percent reduction in energy usage.

EC is positively influenced by energy prices and trade openness, which is statistically significant. This suggests that a 1% increase in energy prices and a 1% increase in trade openness resulted in 0.08 and 0.11 percent increases in energy consumption, respectively. The energy price coefficient is too weak, implying that energy consumption has grown very little in response to rising energy prices. This is understandable in the current energy situation, where energy consumption is increasing, causing energy prices to rise. Because energy is such a crucial part of our daily lives in today's world, an increase in energy prices has relatively little impact on energy usage. The impact of investment on energy usage is negligible. The effects of urbanization and human capital on energy consumption are negative and minor. The conclusions of (Poumanyong & Kaneko, 2010) that urbanization is negatively related to energy usage in high-income countries are supported by this empirical research. Adjusted R Square is the extent of the influence or ability of independent variables to simultaneously explain the dependent variable, as measured by the standard error. When the adjusted R square value is high, it means that the independent variables financial development, information and communication technology, foreign direct investment, urbanization, human capital, trade openness, and investment all play a significant role in explaining the dependent variable energy consumption (EC). The adjusted R square value in this model is 0.89, indicating that the IVs strongly explain the DV. The F test's p-value, or significance level, is used to establish whether or not the impact of independent factors on the dependent variable is statistically significant. The p-value in the model is less than 0.05, indicating that the impact of independent factors on the dependent variable is statistically significant.

In **Table 4.2**, the influence of information and communication technology (ICT) as a mediator between financial development (FD) and energy consumption (EC) is estimated, in table 4.1 estimate that the ICT has a direct and significant relationship between these two variables. But using as a moderator, we exclude the ICT from the model and use the interaction term of FD and ICT to avoid multicollinearity.

TABLE 4.1: Impact of Financial Development on Energy Consumption

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.191074	0.013589	14.06105	0
LICT	0.053472	0.003641	14.68526	0
LFDI	-0.017243	0.004673	-3.689752	0.0002
LCPI	0.077132	0.010601	7.276187	0
LURBN	-0.083635	0.127822	-0.654307	0.513
LH	-0.03687	0.042559	-0.866328	0.3865
LT	0.106558	0.025815	4.127717	0
LINVST	0.005736	0.025416	0.225668	0.8215
C	0.884143	0.478198	1.848906	0.0647
R-squared	0.900934		Mean dependent var	1.965595
Adjusted R-squared	0.892283		S.D. dependent var	0.522394
S.E. of regression	0.171451		Akaike info criterion	-0.611611
Sum squared resid	42.41745		Schwarz criterion	-0.178126
Log likelihood	607.1144		Hannan-Quinn criter.	-0.45049
F-statistic	104.1509		Durbin-Watson stat	0.229725
Prob(F-statistic)	0			

## 4.2 Moderating Effect of Information and Communication Technology between Financial Development and Energy Consumption

In table 4.2 same results are reported that already had in the previous model. The interaction term shows the positive coefficient which means that it increases the energy consumption when the FD is increased. It also has a significant value it means that ICT plays a significant role and strengthens the relationship of FD and EC. 1% rise in interaction term will result in a 0.016 percent increase in energy consumption, implying that ICT has a considerable positive impact on financial development and energy consumption. Energy prices have a positive significant impact on energy consumption. energy consumption is negatively related to the FDI. T and H also have a positive impact on energy usage. The adjusted R Square value is 0.89 same as a previous model which means that our IVs are strongly explaining the DV. And Information and Communication Technology as a moderator strengthen the relationship of Financial Development and Energy Consumption. The magnitude of the influence or ability of independent variables to simultaneously explain the dependent variable is measured by adjusted R Square. If the modified R square value is high, it means the independent variables financial development, foreign direct investment, urbanization, human capital, trade openness, and investment, as well as ICT as a moderator, strongly explain the dependent variable energy consumption (EC). The probability value of F statistics is similarly significant in this model, indicating that the influence of independent factors on the dependent variable is statistically significant. ICT also has a moderating effect. **Table 4.3** shows that FD and ICT have a favorable and considerable impact on EG, implying that when the financial sector expands, we may not be able to prevent FD from expanding the economy. Economic growth is a mediator variable to see the mediation effect of economic growth first we use this variable as a dependent variable to analyze the impact of financial development on economic growth.

TABLE 4.2: Moderating effect of ICT between FD and EC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.185204	0.013184	14.04732	0
LFD*LICT	0.016345	0.000917	17.82813	0
LFDI	-0.014209	0.004508	-3.152193	0.0017
LCPI	0.083039	0.009865	8.417486	0
LURBN	-0.280054	0.125734	-2.227354	0.0261
LH	-0.006153	0.040911	-0.15041	0.8805
LT	0.08727	0.025093	3.47785	0.0005
LINVST	0.0253	0.0247	1.024303	0.3059
C	1.536694	0.463753	3.313603	0.0009
R <sup>2</sup>	0.906683		Mean dependent var	1.965595
Adjusted R-squared	0.898535		S.D. dependent var	0.522394
S.E. of regression	0.166401		Akaike info criterion	-0.671395
Sum squared resid	39.95587		Schwarz criterion	-0.23791
Log likelihood	654.0449		Hannan-Quinn criter.	-0.510274
F-statistic	111.2729		Durbin-Watson stat	0.230311
Prob(F-statistic)	0			

### 4.3 Impact of Financial Development on Economic Growth

The results show that the financial development coefficient value is positive as well as the value is significant which means that the financial development increases the energy consumption. Advancement in the financial sector will bring growth in growth of the economy.

People have easier access to funds when the financial sector grows, which leads to country growth. A 1% rise in FD resulted in a 0.13 percent boost in economic growth. The study's findings seem to be the same (Komal et al, 2015; Shahbaz, et al, 2016). Information and communication are also beneficial to EG. ICT has a considerable impact on EG, with a 0.04 percent boost in economic growth resulting from a one percent rise in ICT. These findings are similar to those of a previous study (Nguyen, Pham, & Tram, 2020).

Human capital and foreign direct investment have a negative and substantial impact on economic growth. It reveals that an increase of one percent in FDI can reduce economic growth by 0.006%. The coefficient's value is relatively modest, implying that it has a negligible impact on economic growth. The findings are consistent with those of (Saini, Baharumshah, & Law, 2010), which suggest that foreign direct investment has no direct effect on output growth. Trade openness has a minor beneficial impact on economic growth, however, energy costs have a big positive impact on economic growth, implying that as energy prices rise, so does economic growth.

Economic growth grew by 0.05 percent as a result of a one percent increase in energy prices. Energy prices have a minor impact on economic growth. Urbanization has a beneficial impact on economic growth; a 1% rise in economic growth leads to a 0.70 percent gain in economic growth. Finally, investment has a big positive impact on economic growth. When investment increased by one percent, economic growth increased by 0.05. Adjusted R Square is the extent of the influence or ability of independent variables to simultaneously explain the dependent variable, as measured by the standard error.

TABLE 4.3: Impact of Financial Development on Economic Growth

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.125993	0.008451	14.90788	0
LICT	0.041084	0.002278	18.03852	0
LFDI	-0.006206	0.002982	-2.081252	0.0376
LCPI	0.053187	0.006522	8.155418	0
LURBN	0.703828	0.069946	10.06242	0
LH	-0.082411	0.025307	-3.256407	0.0011
LT	0.015011	0.014257	1.052935	0.2925
LINVST	0.05083	0.015503	3.27872	0.0011
C	5.362175	0.258798	20.71951	0
R-squared	0.992907		Mean dependent var	8.883313
Adjusted R-squared	0.992404		S.D. dependent var	1.345697
S.E. of regression	0.117287		Akaike info criterion	-1.383983
Sum squared resid	24.62362		Schwarz criterion	-1.012994
Log likelihood	1455.24		Hannan-Quinn criter.	-1.247475
F-statistic	1972.98		Durbin-Watson stat	0.145852
Prob(F-statistic)	0			



If the adjusted R square value is high, it means that the independent variables financial development, foreign direct investment, urbanization, human capital, trade openness, and investment, as well as information and communication technology, all play a significant role in explaining the dependent variable economic growth. The adjusted R square value in this model is 0.99, indicating that our IVs strongly explain the DV.

The F test's p-value, or significance level, is used to establish whether or not the impact of independent factors on the dependent variable is statistically significant. The F statistics' probability value is similarly significant, indicating that the model is statistically significant.

#### 4.4 Moderating Effect of Information and Communication Technology between Financial Development and Economic Growth

**Table 4.4** examines the impact of information and communication technology (ICT) as a moderator between financial development (FD) and economic growth (EG). To avoid multicollinearity, leave the ICT out of the equation and employ the FD/ICT interaction term instead. This model has similar results that we had in table 4.3 where use ICT and FD as the independent variable and both the variables have a positive and significant effect but, in this model, we use ICT as a moderator to see how its effect on financial development and economic growth for this purpose we exclude the ICT from the model and use the interaction term of ICT and FD to avoid multicollinearity. The interaction term shows the positive coefficient which means that it increases the economic growth when the FD is increased. It also has a significant value it means that ICT plays a significant role and strengthens the relationship of FD and EG. EG is positively effected by the energy price, urbanization, trade openness, and investment. Foreign investment and human capital have a negative impact on economic growth.

TABLE 4.4: Moderating Effect of ICT between FD and EG

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.124879	0.008346	14.96249	0
LFD_LICT	0.011442	0.000592	19.33179	0
LFDI	-0.003719	0.002934	-1.267712	0.2051
LCPI	0.062105	0.006172	10.06243	0
LURBN	0.625504	0.070081	8.925511	0
LH	-0.060523	0.024831	-2.437456	0.0149
LT	0.008003	0.014139	0.565995	0.5715
LINVST	0.06122	0.015353	3.987379	0.0001
C	5.531817	0.256598	21.5583	0
R-squared	0.993065		Mean dependent var	8.883313
Adjusted R-squared	0.992573		S.D. dependent var	1.345697
S.E. of regression	0.11597		Akaike info criterion	-1.406573
Sum squared resid	24.07361		Schwarz criterion	-1.035584
Log likelihood	1476.903		Hannan-Quinn criter.	-1.270065
F-statistic	2018.378		Durbin-Watson stat	0.138969
Prob(F-statistic)	0			

Adjusted R Square is the extent of the influence or ability of independent variables to simultaneously explain the dependent variable, as measured by the standard error. If the adjusted R square value is high, it means that the independent variables financial development, foreign direct investment, urbanization, human capital, trade openness, all play a significant role in explaining the dependent variable economic growth. The adjusted R Square value is 0.99 which means that our model is explained very well, and results are also the same as model 03 which shows that information and communication technology as a moderator does not have a negative impact on the model. And Information and Communication Technology moderate the relationship between Financial Development and Energy Consumption. The probability value of F statistics is also significant which means that model is statistically significant.

## 4.5 Mediating Effect of Economic Growth between Financial Development and Energy Consumption

The mediation effect of EG between FD development and EC is explained by Model 4.5. When economic growth is factored into the equation, the link between financial development and energy use becomes stronger. However, because EG has a positive coefficient, it plays a full mediation role between financial development and energy consumption, as shown in **Table 4.1**.

Financial development has a positive and significant effect on energy consumption, with a coefficient value of 0.19, implying that a 1% increase in financial development leads to a 0.19 percent increase in energy consumption, but when economic growth is included in the model, the coefficient value drops to 0.09 percent. Financial development stimulates industrial growth, and as economies expand, new infrastructure facilities are built, resulting in increased energy consumption. Our empirical research confirms the findings of earlier studies (Coban and Topcu, 2013; Islam et al., 2013; Sadorsky, 2010; Sadorsky, 2011).

In table 4.5, EG is used as a mediation variable to see if there is a mediation between financial development and energy consumption. The results demonstrate that there is a mediation between these two variables, and the steps for mediation analysis (Baron & Kenny's, 1986) remain the same.

The coefficient value for energy prices is positive and significant, indicating that energy prices have a positive and significant impact on energy use. As seen in the model, a 1% increase in energy consumption resulted in a 0.04 percent increase in energy consumption. This number is relatively small due to the usage of the mediation effect, which does not have many variations with the variable outcomes.

The value of the FDI is negative, which indicates that a one percent increase in foreign direct investment will result in a 0.01 percent reduction in global energy consumption. The value of the human capital coefficient is positive but negligible, implying that it has no effect on energy consumption. The trade openness coefficient value is positive and significant, which suggests that increased trade openness increases energy consumption by 0.07 percent for every one percent rise in trade openness.

Both investment and urbanization exhibit negative but significant values, indicating that both variables have reduced energy consumption; a 1% increase in investment and 0.7 percent rise in urbanization reduce energy consumption by 0.09 and 0.7 percent, respectively.

Independent variables strongly explain the dependent variable, as evidenced by the adjusted R Square value of 0.92. It shows that the dependent variable energy consumption is well explained by the independent variable's financial development, foreign direct investment, urbanization, human capital, trade openness, and investment, as well as the mediating influence of economic growth.

The F test p-value, which is the F value's significance level, is used to determine whether the impact of independent variables on the dependent variable is statistically significant. In addition, the F statistic's P-value is substantial, indicating that the model is statistically significant.

TABLE 4.5: Mediating Effect of EG between FD and EC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.089765	0.012397	7.241037	0
LEG	0.876372	0.037727	23.22913	0
LICT	0.021439	0.003402	6.302789	0
LFDI	-0.015964	0.004009	-3.982138	0.0001
LCPI	0.049316	0.009135	5.398698	0
LURBN	-0.734399	0.112684	-6.517334	0
LH	0.047934	0.036534	1.312045	0.1897
LT	0.076312	0.022082	3.455814	0.0006
LINVST	-0.091668	0.022118	-4.144565	0
C	-3.609149	0.451793	-7.988492	0
R-squared	0.927971		Mean dependent var	1.965715
Adjusted R-squared	0.921715		S.D. dependent var	0.523205
S.E. of regression	0.14639		Akaike info criterion	-0.927995
Sum squared resid	30.83798		Schwarz criterion	-0.496806
Log likelihood	852.1559		Hannan-Quinn criter.	-0.767702
F-statistic	148.3133		Durbin-Watson stat	0.226849
Prob(F-statistic)	0.000			

## 4.6 Mediating Effect of Economic Growth and Moderating Effect of Information and Communication Technology between Financial Development and Energy Consumption

The effect of ICT as a moderator with the mediation effect of EG between FD and EC was examined in final table 4.6. Economic expansion and financial development have a positive and considerable impact on energy consumption, as empirical evidence reveals in the previous equation. The empirical evidence shows that ICT has a positive significant effect when used as a moderator with the mediation effect. When the FD coefficient is positive, it suggests that the financial development has a positive impact on EC. Where the financial development coefficient is 0.09, implying that for every 1% growth in financial development, energy consumption rises by 0.09 percent.

Also, look into the role of economic growth in mediating the relationship between energy use and financial development. The positive value of economic growth is also shown in model 03 results, indicating that FD has a positive impact on EGS, implying that as financial development increases, so does economic growth, which can have a favorable impact on energy consumption. Our findings are consistent with those of the prior study (Komal, 2015). Their findings also reveal that financial development influences energy consumption via an economic growth channel variable. Progress in the financial sector's gross domestic product (GDP) is boosting economies and increasing investment in energy projects. This model also reveals the moderating effect of information and communication technology between financial development and energy consumption, thanks to the mediation effect. We utilize financial development and information and communication technology as interaction terms for this. The positive interaction term indicates that there is a moderating effect between financial development and energy consumption as a result of economic expansion.

TABLE 4.6: Mediating Effect of EG and Moderating Effect of ICT between FD and EC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LFD	0.092087	0.012275	7.502154	0
LEG	0.826021	0.038419	21.50055	0
LFD_LICT	0.007489	0.000899	8.334689	0
LFDI	-0.014855	0.003944	-3.766257	0.0002
LCPI	0.052019	0.008718	5.966819	0
LURBN	-0.801158	0.112176	-7.141989	0
LH	0.054669	0.035758	1.528878	0.1265
LT	0.067081	0.021879	3.066019	0.0022
LINVST	-0.077051	0.022049	-3.494513	0.0005
C	-2.966863	0.455008	-6.520463	0
R-squared	0.929392		Mean dependent var	1.965715
Adjusted R-squared	0.923258		S.D. dependent var	0.523205
S.E. of regression	0.14494		Akaike info criterion	-0.947908
Sum squared resid	30.22995		Schwarz criterion	-0.516719
Log likelihood	867.7383		Hannan-Quinn criter.	-0.787616
F-statistic	151.5279		Durbin-Watson stat	0.227816
Prob(F-statistic)	0			

The negative sign on the foreign direct investment coefficient value indicates that foreign direct investment has a negative significant impact on energy consumption. A one percent increase in FDI will result in a 0.01 percent reduction in energy use. Because this value is so little, it means that it has a very minor negative influence on energy consumption. The urbanization coefficient value in model 06 is also negative and significant, indicating that urbanization has a negative impact on energy consumption.

The value of energy costs is positive and considerable, implying that it has a favourable impact on energy use. With a 1% increase in energy prices, the energy consumption value will increase by 0.05 percent, resulting in a negligible impact. Because the trade openness coefficient is negative and the investment value is positive, the investment has a positive impact on energy consumption.

The adjusted R Square value is 0.92, indicating that the independent variables of financial development, economic growth, the interaction term between ICT and FD, and all other independent variables substantially explain the dependent variable (energy consumption). The F statistic's probability value is also significant, indicating that the model is statistically significant.



# Chapter 5

## Conclusions and Policy

### Implication

Energy demand increases with the passage of time. Continuously, increasing the in population and the industrial sector the energy demand increase but the supply of energy is not incising in an efficient manner because of lack of sources that produce energy so, it will not meet the demand of growing economy for that purpose-focused of the study to examine the relationship between financial development and energy consumption by using mediation variable economic growth and also evaluate the moderation effect of information and communication technology between financial development and energy consumption as well as between financial development and economic growth for the period of 1980-2020 by using balances panel least square approach for 138 countries.

In this study energy prices, foreign direct investment, urbanization, trade openness, human capital, and investment are also included in the structural models. Financial development has a favorable and substantial impact on energy usage, according to the findings of the study. This means that when a country's economy grows, so does its energy consumption. Through economic expansion, we can also observe an indirect relationship between financial development and energy use.

Through economic expansion, financial development has a positive major impact on energy usage. Because of the positive and significant impact of financial sector

development on energy consumption, this increase in energy consumption as a result of increased financial development must be taken into account when planning energy consumption for economies; failure to do so would result in an underestimation of energy consumption, which would be concerning for long-term economic growth. The impact of information and communication technology on energy use is significant. ICT also has a favorable impact on the relationship between financial development and energy consumption, as well as the relationship between financial development and economic growth, implying that the usage of ICT has enhanced the relationship. The findings are congruent with those of Kirmani et al. (2015), who asserted that by changing how transactions are handled in any financial system, ICT increases the efficiency, dependability, effectiveness, performance, and other features of modern-day commercial operations. Energy costs and trade openness have a positive substantial impact on energy consumption, indicating that this variable has led to increased energy consumption. Foreign direct investment and urbanization have a negative but significant impact on energy consumption.

Based on empirical analysis, the following policy implications of this study are offered. The rise of the financial sector is widely regarded as beneficial to many sectors of the economy; nonetheless, financial development has a positive impact on energy consumption through economic growth. These findings are critical for policymakers in terms of energy demand planning and conservation policies that assure reasonable economic development while also stimulating the search for alternative energy sources to meet the energy demands of all countries. Policymakers in these countries must find the right balance between energy supply and demand in order to ensure long-term economic growth. This study also helps the government of the all the world countries to support foreign investment, efficient projects, and trade to create clean energy and reduces the demand of the energy. This study will help the policymakers and financial authorizers while settling on the choices. This research is also useful for governments that need to limit the import of obsolete technology and apply dumping tariffs on high-consumption equipment that is transferred globally. This research also aids policymakers in making effective use of information and communication technology to reduce energy demand. For

long term economic growth policymaker has to take a step to enhance credit to a private sector for the advancement of the financial institution. The results overall show that the policymaker should consider the financial development while making the decision about energy policies. Financial development is important for the business investment because when financial institution grows it will create funds availability and equity financing, which mean that when the policymaker formulating the strategy for energy utilization, they should remove the barrier so that the goal of reducing energy consumption can be met.

## **5.1 Limitations of the Study**

Firstly, this study has a limited time period from 1980 to 2020 because the data is unavailable for most of the countries from the previous of this period.

This study examines macro-level perceptions from a global viewpoint, and numerous micro-level aspects are undoubtedly overlooked for a variety of reasons. Many political or economic events occurred throughout the sample period, for example, those factors could have altered the relationship between energy use and financial development, but they weren't included. As a result, this study focuses our research target on a global scale, because it's tough to discuss too many problems in one study,

Many economic or political events occurred during the sample period that may have influenced the finance-energy nexus, and Covid 19 is also influencing global energy demand. And also, one limitation of the study is that it also could have been done region-wise, which were not considered, and it is genuinely difficult to explain too many problems in a single study.

## **5.2 Future Direction**

Because of the limitations mentioned above, region-specific data can be used to develop the model for the results in the future. for example, A comparative analysis between regions can be performed to better understand this relationship based

on region type. Furthermore, researchers can use a range of methodologies to capture the results. When it comes to Pedroni panel cointegration and the Dumitrescu Hurlin panel, causality analysis can be extremely valuable. Furthermore, the ARDL approach can be used to determine causality even if the variables are integrated into a different sequence. Future research can also take into account a variety of aspects. Future studies could utilize a variety of proxies as well.

This study is limited to panel least square analysis. Thus, its extension through country-level analyses based on time series data will give complementary findings of the connection among these variables.

According to the report, countries should develop green information technology, which has the ability to greatly improve environmental efficiency and design processes. Finally, efficient coordination of ICT, energy, and growth policies is critical for tackling climate change in the region and contributing to the advancement of information technology, which has a positive impact on financial development.

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