Ijaz, Syeda Tayyaba; Chughtai, Sumayya

Article

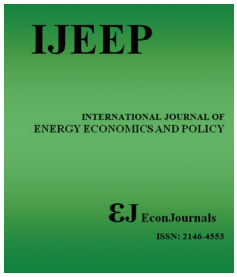
The impact of financial, economic and environmental factors on energy efficiency, intensity, and dependence : the moderating role of governance and institutional quality

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Ijaz, Syeda Tayyaba/Chughtai, Sumayya (2022). The impact of financial, economic and environmental factors on energy efficiency, intensity, and dependence : the moderating role of governance and institutional quality. In: International Journal of Energy Economics and Policy 12 (4), S. 15 - 31. https://econjournals.com/index.php/ijeep/article/download/13157/6805/30649. doi:10.32479/ijeep.13157.

This Version is available at:
http://hdl.handle.net/11159/12258



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2022, 12(4), 15-31.

The Impact of Financial, Economic and Environmental Factors on Energy Efficiency, Intensity, and Dependence: The Moderating Role of Governance and Institutional Quality

Syeda Tayyaba Ijaz*, Sumayya Chughtai

Department of Business Administration, Faculty of Management Science, International Islamic University Islamabad, Pakistan.
*Email: tayyaba.phdfin79@iiu.edu.pk

Received: 04 March 2022 **Accepted:** 06 June 2022 **DOI:** https://doi.org/10.32479/ijeep.13157

ABSTRACT

Economies are under serious pressure to sustain themselves due to globalization, focusing simply on economic growth and operational efficiency will not yield the desired sustainable financial and economic position for economies. Management of energy efficiency and reducing the energy dependence and intensity is the core objective for the economy and achievement of the above objective financial, economic, and environmental factors need to be studied. Economic wellbeing critically depends on the efficient use of energy and which type of governance mechanism is in place will also define the ways toward energy efficiency. A better understanding of the relationship will help the economies to fulfill their energy needs efficiently, realize developmental goals, and overcome environmental issues. This study examines the relationship between financial, economic, and environmental factors with energy efficiency, intensity, and dependency with moderating role of governance including institutional quality and governance index for belt and road initiative countries. The core objective of the study is to analyze which financial, economic, and environmental factors serve well in the management of energy efficiency, intensity, and dependence issues and how various dynamics of governance policies including market structure moderate the above-mentioned relationship. For this secondary data is used from world development indicators, market insiders, and Chicago Board Options Exchange (CBOE) data. This research will help the researchers and practitioners to achieve long-term economic, financial, and environmental sustainability. The proposed model predicts that 0.44% change in Total Factor Energy Productivity measure of Energy Efficiency, 0.03% changes in Energy use/Purchasing Power Parity ratio measure of Energy Intensity, and 9.63% changes in Energy Reserves/Energy Production ratio measure of Energy Dependence. Results also reveal that environmental factors including Rural population, Urbanization, Co2 emission, energy use, and energy production will contribute most to achieving sustainable economic growth.

Keywords: Energy Efficiency, Intensity, Economic and Environmental Factors, Institutional Quality
JEL Classifications: G18, C23, E06, F03, F05

1. INTRODUCTION

Energy is an essential input in production and its availability and use are indispensable for socio-economic uplift. Now economies focus to attain energy efficiency and lessen the energy intensity and dependence for improving financial stability. Because efficient use of energy at a national level can reduce energy imports, thereby reducing pressure on foreign reserves. At a micro level, energy efficiency is indispensable for reducing operating costs and enhancing profitability. Thus, society can benefit from increased energy efficiency and reduced energy intensity and dependence. Enhanced economic activity can adversely affect the environment and better technological advancement can help to mitigate the environmental risk with the help of economic cooperation to generate solutions of enormous energy use through the discovery of energy-efficient techniques. Financial development stimulates

the financial activities in a country such as banking activity, stock market activity, and foreign capital and investment flows, which increase economic efficiency and expand the level of output (Sadorsky, 2010). No doubt, energy is an indispensable factor in the expansion of financial development, but governance structure and institutional quality pave the way for more stable financial output by balancing the Government effectiveness, Political stability, and Rule of law.

Fulfillment of the required supply of resources is mandatory for the smooth running of the functions of any economy, apparently that all economies will not possess these resources. Resource-based theory state that economies will rely on other economies for the supply of such resources (Garnter, 1989). Depending on the resource-based needs they will indulge in making other countries their allies, here comes the role of the International Trade theory which will pave the way for how international trade relations can deliver outcomes (Markusen et al., 1995) then Gravity Trade Theory which will help the economies to make bilateral trading relations with the countries who can have a positive impact on the economy (Benedictis, and Taglioni, 2011).

In the current era of globalization, international trade is growing rapidly, and this is interrelated to Financial and economic growth. More trade means more production, more energy consumption, more transport activities, and possibly more environmental deterioration. Given these facts, Financial, Economic, and Environmental factors and governance and market structure are important variables to be considered in the analysis of the relations between energy and finance (Mahi et al., 2020). Likewise, Belt and Road Initiative can also be an important variable in the analysis of this relationship as international trade ties are an important factor in determining the future economic prospects of any economy (Oliveira et al., 2020). Volatility index and global crude oil price are also important to be discussed in the model of financial growth and energy (Dutta et al., 2020).

Striding for sustainable financial, economic, and environmental factors relies on the Finance-growth-energy nexus. The energy sector serves as the mainstay of the manufacturing and service sector of any economy, henceforth the growth process is energy-sensitive (Ferguson et al., 2000). Energy usage is universally recognized as a requisite factor of production (Apergis and Tang, 2013). Discussion on the nexus initiated by the seminal work of Kraft and Kraft (1978) they had explored the causal relationship between growth and energy for the very 1st time. Later, the author recognized that the directions of a causal effect between growth and energy will be substantial for making valid policies.

The literature on causality cast around two schools of thought one with the view that energy usage leads to an increase or decrease in the economic growth known as Energy led growth hypothesis, others are in the view that massive advancements in economic growth will lead to massive energy consumption known as Growth-led energy (Hubrich et al., 2001). The causality between growth and energy is also known as Granger Causality in literature, a term associated with the seminal paper of Granger, 1969. Growth of the Literature led to four cases of Granger Causality (a) Unidirectional Energy-to-growth effect (Growth Hypothesis), (b) Unidirectional Growth-to-energy (Conservation Hypothesis), (c) Bidirectional (Feedback Hypothesis), (d) No Causality between growth and energy (Neutrality Hypothesis). Researchers have preferred the Granger causality test over other available theories, the reason is inherently profound empirical testability (Asafu-Adjaye, 2000). Despite the availability of extensive literature on Granger Causality, available results are indecisive.

Focusing on the most recent research on the Nexus between financial and economic development and energy, a significant relationship is found. So, it could be perfectly anticipated that a significant relationship prevails between financial development and energy consumption (Mahi et al., 2020). Although many studies have documented the aspects of the Finance-Growth-Energy Nexus, implementation of nexus with sustainable development indicators is an important research area. Resource-based theory or resource based view (RBV) has been initiated by the work of Barney's 1991 article "Firm Resources and Sustained Competitive Advantage," many researchers have contributed their efforts in refining the theory in the context of sustainable competitive advantage based on available resources (Famiola and Wulansari,2019). Talking about the relationship between resources and Resource-Based Theory, the most important resources in terms of production activity and resource abundance are energy resources. If any country has an abundance or reduction in resources, they will indulge in trade activity to maintain the sustainable level of these resources. Resource-based theory can influence the policy perspective for sustainable development. Resource-based theory has been studied in the context of resource-based cities in China recently.

The main objective of current research is to explore the dynamic interaction among energy efficiency, intensity, dependency, financial factors, economic factors, and environmental factors. The proposed study is relevant given that the findings of current literature investigating the association between energy usage and macroeconomic variables are in general mixed and do not reach any definite conclusion (Knack et al., 2020). Economies are indulging in regional agreements for prosperity, side by side they are facing acute and lingering energy issues that are affecting the overall financial, economic, and environmental factors of those countries. Reasons for setbacks are mainly credited to ad-hoc energy policies and governance policies. Research shows that many countries still rely on the traditional sources of energy, putting upward pressure on energy prices, putting more funds into this effort, and deteriorating the climate.

This research contributes to the existing literature as follows. Firstly, this is the first study of its kind that conducts a comparative study of the BRI country's Financial, Economic and Environmental Factors and the impact of governance and market structure is also assessed as moderator which no study has conducted in the context of energy efficiency, intensity, and dependence. Secondly, the Pricing of energy is also addressed, by oil benchmarks and volatility context. The gravity model of trade will be addressed in the context of China's Belt and Road Initiative. An appropriate methodology has been adopted including second-generation statistical testing. This study carries special

importance because policymakers might be able to use its results to explore new avenues to formulate and execute comprehensive financial, economic, environmental, and energy policies. This will ensure long-term sustainable development with improved environmental quality in BRI Countries. Furthermore, our findings may have implications for other countries as well. Based on our research findings, policy initiatives will be recommended to help policymakers. The proposed study will help the member countries of the belt and road initiative (BRI) to make their economic, environmental, and energy policies contingent on those countries that can have a positive impact on them. The current study will enable the Belt and Road Initiative (BRI) member countries to indulge in trade ties that can have a positive impact and avoid over-dependence on other fellow countries.

2. LITERATURE REVIEW

2.1. Financial Factors and Energy Efficiency, Intensity, and Dependence

Financial and economic activities are central for sustainable development and energy efficiency, intensity, and dependence measures will define how much energy sustainability is prevalent in the country (Gartner, 1988). Private sector performance aids in financial growth as well as the long-term sustainability and development of a country. Beyond doubts international development forums including G20 Summit, Busan Partnership, SARAC, European agenda for change have accepted the notion of financial sustainability can only sustain if the private sector in the economy is performing well. Belt and Road countries are not the exceptions to private participation. The motivation behind insisting so much on the importance of the private sector role lies behind the reason that the private sector can help in making a valuable contribution to the economy; likewise, poverty eradiation by doing the good to society private business also earns profits.

The business sector consists of wide-ranging subtypes involved in economic activity, from small businesses to multinational corporations (MNCs). Most of the research in the business arena is focused on large business management, it is as important to study the informal business too for financial activity understanding. Thus, talking about achieving the development benchmark set by the World Development Bank (WDI) it gets foremost important to consider the private sector economy. Changes in telecommunication investment, energy investment, transportation investment, water and sanitation investment, domestic credit to the private sector, and business registered all depend on the private sector contributions and all long forward for sustainable financial development (Havila and Wilkinson, 2002).

The electric power generation sector facing the regime shifting from traditional resources to renewable energy resources and renewable energy resources are more energy efficient. Richter (2013) elaborated that such regime shifting poses a challenge for business model, specifically for German setup energy generation utilities succeed on large scale only, provided that it's crucial to adapt business model innovation to tackle the energy regime transition. The time required to deal with the government regulations, tax regulations, to obtain an operating license, and bribery incidence can affect the private investment and resultantly energy efficiency, intensity, and dependence. Firm's competition against unregistered firms, female top management, working capital financing by banks, value lost due to load shedding, international quality standards ownership, export clearance time, and firms which offer formal training for saving electricity all according to world development indicators can affect the energy intensity (Havila and Wilkinson, 2002).

Some prerequisite criteria determine the overall response of the business environment. The number of procedures to start a business, time requirement, cost, procedures to register property, warehouse building procedures, time is taken to get electricity connection, contract enforcement time, business disclosure index and time requirement for resolving insolvency-related issues all can determine the business environment essential for operating and all these have the effect on the business venture as well as for the demand of energy. Gabriel and Kirkwood (2016) developed a business model canvas to analyze entrepreneurs' ventures in renewable energy, they identified three models Consultants, Distributors, and Integrators, Energy entrepreneurship policy should be devised based on the appropriate model. Frei et.al. (2018) studied business portfolios of the world's largest electricity suppliers, they suggested that changes in policy mandate are required to increase the business flow of healthy activities.

Stock market activity helps to demonstrate the financial stability of any economy, market capitalization changes can help in defining the energy efficiency, intensity, and dependence, dropping stock market prices indicate the low business activity thus low demand for energy is anticipated. Vale of traded shares, the turnover ratio can be used to indicate the economic status. More registered companies also exhibit the volume increase in business activity as well as tax calculations that can be used to develop energy-efficient products. Not only local stock markets but global equity indices like S&P also affect the anticipation about energy efficiency. Paramati et al. (2016) added to the discussion by studying the impact foreign direct investment has on clean energy usage, they found out that economic output, stock market activity, and foreign direct investment have a positive impact on clean energy consumption.

To understand the impact of tax policies on energy efficiency, intensity, and dependence, Tax revenue collected by the federal government has a direct impact on the investment decision of the government in energy-efficient projects or any subsidy government is ready to offer (Hoeller and Wallin, 1991). Other parameters of tax policies include the number of tax payments by business and time required by the business to prepare file and pay taxes and business profit tax that has an impact on energy efficiency, intensity, and dependence. Landon and Smith (2010) explained the revenue vitality of the Alberta government and its impact on energy efficiency.

Changes in macroeconomic factors, fiscal policy, debt policy, trade, and economic management provide the starting point for the development of a renewable energy finance strategy. Brown and Chandler (2008) elaborated that fiscal policy and regulation describe the impact on government adaptability of green technologies for making energy-efficient products.

Financial sector stability, business regulatory environment, structural policy, gender equality, equity of public resources, human resource development, social protection, and labor laws, policies and institutions governing environmental laws, property rights and rule-based governance, budgetary and financial management, revenue mobilization, public administration, transparency, accountability and corruption in the public sector all of these variables helps in understanding the impact of public regulations and policies on the energy efficiency, intensity, and dependence (Bridge et al, 2013).

H_1: Changes in financial factors (Bank Capital to Asset Ratio, CPIA Quality of budgetary and financial management, time spent dealing with the requirement of government regulations, IDA Resource Allocation Index, Interest Rate Spread, Domestic Credit to the private sector, stocks trade total value, Tax revenue, Risk Premium on lending New Business registered, the Business extent of disclosure index) cause the changes in energy efficiency, intensity, and dependence for BRI countries.

2.2. Economic Factors and Energy Efficiency, Intensity, and Dependence

Discussion on economic factors was led by Kraft and Kraft (1978) they studied that the United States (US) has shown a tremendous increase in energy demand followed by an increase in economic activity. Following their work, several researchers have examined the relationship between economic development and energy demand through two-way Granger causality, which led to four testable hypotheses (a) growth hypothesis, (b) conservation hypothesis, (c) feedback hypothesis, and (d) neutrality hypothesis (Apergis and Tang, 2013, Jamil and Ahmad, 2010; and Kahsai et al., 2012). The causality relationship differs for countries due to several factors including model specification issues, study period, sample selection, development level of an economy, and modeling technique (Fatai et al., 2004). More research work revealed that causality between two variables might be mutually determined as both higher economic growth and energy efficiency, intensity and dependence need each other; therefore, causality direction may not be judged earlier (Hajko, 2017).

The relationship between economic activity and energy consumption can be determined by different subcategories working under economic activity in the country. To completely grasp the gist of the said relationship it is important to deeply study all possible aspects in this regard. Economic activity is defined by the output[1] level in the economy. World Development Indicators have pointed to variables under the economic factors.

The relation between GDP and energy is known as the energy intensity (Leamer and Stern, 2017 & Montgomery, 2017)—it measures energy inefficiency by calculating units of energy per unit of GDP. Figure 1 represents the energy intensity for Pakistan. A higher value indicates the higher cost of converting energy into GDP and a lower value indicates a lower cost of conversion.

Determination of national income depends on the GDP, GNI, Fixed capital, Natural resource depletion, and adjusted national income, all these measures are used to standardize the economic growth of the economy. Ajmi et al. (2015) studied the relationship between GDP, CO2 emissions, and energy efficiency for G7 countries, results show bidirectional Granger causality between GDP and energy consumption for Japan, for Italy there is unidirectional Granger causality from GDP to energy consumption, for Canada unidirectional granger causality has been documented from energy consumption to GDP, for USA bidirectional time-varying Granger causality has been documented from energy to CO_2 emission same for results have been shown for France.

Central government finance revolves around revenues and expenses of the government, net investments, net lending, net borrowings, net acquisitions of financial assets, net incurrence of liabilities, and debt and interest payments. All these together dictate the government's preferences for picking up projects for sustainable economic development, government's tendency to invest in energy generation projects also comes from the revenue string. But the direction of the relationship can be defined by the type of investment, if an investment is being made into the construction project surely that will increase the energy intensity, and if so, the investment is meant for a renewable energy plant it will help in managing the energy efficiency. If the government is interested in achieving sustainable development, it will make a plan to preserve its resources and reduce energy dependence, likewise, China's ESER program helped in the development of energy policy and investment plans for China's economy (Wang and Chen, 2012).

Exchange rate and energy efficiency, intensity, and dependence are interlinked through a channel of imports and exports, for Non-OECD countries imports of fuel have an impact on the exchange rate of the economy. Jensen and Tarr (2003) studied the trade, exchange rate, and energy pricing reforms' effect on Iran, they analyzed that combined reforms could generate large consumer gains, whereas commodity subsist can have a perverse effect. Sadorsky (2000) examined that there exists a long-run relationship between crude oil, heating oil, and unleaded gasoline futures prices and exchange rates, prices of energy futures determine the exchange rate expectations. The exchange rate can also have a pass-through impact on the import prices, especially for OECD countries, currencies with higher rates of exchange rate volatility have higher pass-through elasticities (Campa and Goldberg, 2006).

Balance of payment helps in defining the economic status of the country. Thus, following the Signaling theory usually used for the dividend and capital structure of a firm, its applicability can be expanded in determining the country's economic development through signals formed from the balance of payment account. The relationship between the balance of payment and factors of production can show causality. Another study has taken the dynamics of mineral resources and their linkage with environmental sustainability, Ponomarenko et al. (2020) stated that sustainable development is aimed at ensuring the protection of the rights of the public in the present and future.

H_2: Changes in economic factors(GDP, GNI, FDI, External Debt, Revenue excluding grant, Household Final Consumption Expenditure, General Governmental Final Consumption

1 Quantity of goods or services produced in each time period, by a firm, industry, or country.

Expendturie) cause changes in energy efficiency, intensity, and dependence for BRI countries.

2.3. Environmental Factors and Energy Efficiency, Intensity, and Dependence

Whenever energy is employed to create any source of comfort for humans, pressure on the environment is excreted. Environment and energy have a strong relationship, one can have a causal impact on another variable. Energy intensity and dependence can pollute the environment, these adverse effects can range from household to the global level. That is why it is important to study how the environment reacts in connection with energy efficiency, intensity, and dependence.

Rural environment and land use have a direct impact on the relationship between environment and energy efficiency, intensity, and dependence The rural population can be inductive in determining the source of power and requisites required to maintain their energy needs, some ancient societies used human labor for energy production but later on advances in the energy field led to more efficient choices. Many rural residents live below the poverty line because they use too little energy and use it inefficiently. Revelle (1976) conducted a study on rural India and explained that the transformation of rural Indian society could be brought about by increasing the quantity and improving the technology for energy-efficient use. Kang et al, (2019) studied that due to urbanization demand and supply structure of energy is also changing.

Regardless of reforms in environmental factors, still, energy efficiency has not been received from an environmental perspective (Owusu and Asumadu-Sarkodie, 2016). The study of energy dependency is important to determine the sustainability of energy resources. Carbon dioxide emissions are also studied in connection with energy efficiency. Net energy imports, GDP, and carbon intensity are selected as proxy variables to study the relationship. Energy efficiency and economic growth relationship and carbon dioxide emission have been tested for China findings revealed that there is a positive long-run cointegrated relationship between real GDP per capita and energy usage(Li, Dong, Li, Liang & Yang, 2011).

Economic sustainability cannot be achieved unless environmental sustainability is maintained, for the purpose analysis of hazardous greenhouse gasses is required to study the environmental toxin level of the country. That will determine the use of energy sources and the limits of their use. Earlier examinations have discovered that substituting biofuels for gas will decrease ozone-harming substances because biofuels sequester carbon through the development of the feedstock. These investigations have neglected to tally the carbon emanations that happen as ranchers overall react to more expensive rates and convert backwoods and fields to new cropland to supplant the grain (or cropland) redirected to biofuels (Searchinger et al., 2009). For studying the impact of greenhouse gas emissions, methane emissions, and nitrous oxide emissions will be used as prime sources. . Society cannot afford to miss out on global greenhouse-gas emission reductions and local environmental and socioeconomic advantages when biofuels are done correctly in a world seeking solutions to its energy, environmental, and food concerns. However, society cannot accept the negative consequences of biofuels used incorrectly (Tilman et al, 2009).

For environmental protection carbon dioxide emissions are foremost important, five sectors' emissions have been taken electricity and heat production, manufacturing and construction industry, residential building, commercial and public services, and transport. It is a profound fact that carbon dioxide emissions harm the environment. If energy efficiency is more there will be less harm to the environment. (Asumadu-Sarkodie and Owusu, 2016). There was evidence of a short-run parity relationship running from essentialness use to carbon dioxide releases and GDP to carbon dioxide radiations. As a course of action proposal, the extension of the maintainable power source and clean essentialness headways into Ghana's imperativeness mix can support moderate ecological change and its impact later (Asumadu-Sarkodie and Owusu, 2017). Air poloution is also causing health hazards, Particulate air pollution causes more deaths from cardiorespiratory disorders than it does from other causes. People over the age of 60 have a higher chance of dying from particle air pollution than those under the age of 60 (Yin et al, 2017).

Urbanization influences energy utilization. Industrialization and urbanization go with one another amid financial advancement, yet urbanization applies various autonomous effects on energy efficiency, intensity, and dependence (Sheather and Jones, 1991). Liu et al. (2018) conducted a 30-year review of China's urbanization and energy efficiency, intensity, and dependence resulting from points that Urbanization and energy are significantly related to each other, urban sprawl and intense transportation systems are adding in energy usage, over time interest has been shifted to consume clean energy, compact building structures and green building policies helped in reducing energy usage. Moreover, the focus should be on changing lifestyles for consuming lesser energy. Wang et al. (2016) studied the relationship between urbanization, energy, and carbon dioxide emission with provinces changes in China, they also confirmed that urbanization increases energy dependence, and supported the urban environmental transition theory. The impact of urbanization on residential energy consumption can also be used to discuss how residential building constructions and management have increased energy use over time with urbanization (Jia et al., 2017). Short-run and long-run causalities from urbanization to carbon dioxide have been deducted by researchers and urbanization together with energy use increased the carbon dioxide emission (Wang et al., 2016). Xu et al (2012) studied that due to urbanization smart building mechanism deisgn should be followed, in order to increase the energy effeciecny of building structure.

It has been discussed by the researcher that sustainable energy can be achieved by enhancing financing in energy-efficient entrepreneurship projects, supporting the innovation system for technological changes and economic development, socio-technical regimes should be changed, the emergence of the market for solar panels, and Sharpe focus on the policy regime interaction (Ockwell and Byrne, 2016). Occupancy of natural resources makes any country rich, utilization of these natural resources in the most

effective manner helps in getting sustainable development goals. Natural resources directly help in the generation of energy, oil rent, natural gas rent, coal rent, mineral rent, and forest rent can be used to study the cost of these resources and how these costs are impacting the energy efficiency, intensity, and dependence.

H_3: Environmental factors (Rural Population, Urban Population, Energy use, Co^2 emission, Energy Production)causes the changes in energy efficiency, intensity, and dependence for BRI Countries.

2.4. Institutional Quality and Governance Index as a Moderators

Institutional quality and financial and economic factors reinforce each other over the longer term. Sun et al. (2019) conducted a study on institutional quality and energy efficiency, they found a significant positive influence of both green innovation and institutional quality on energy efficiency, regarding energy efficiency levels of the individual countries- USA, Japan, Germany, and Australia lead the chart while Belize, Panama, Singapore, Malta, Sierra Leone, Iceland, Jamaica, Bahrain, and Ghana are the least energy-efficient countries. Increased institutional quality will reduce the energy intensity and dependence. Institutional quality and economic development reinforce each other over the long term and affect the energy development of the country. Khan et al. (2020) empirically examined the nexuses between the natural resource rent and financial development in the context of the emerging economy of Pakistan, by subsuming the moderating role of institutional quality, natural resource rent negatively influences financial development, whereas institutional quality boosts financial development and positively moderates the relationship in the context of Pakistan. The governance index assesses the status of governance and the impact of various interventions taken up by the State Government. Bazilian et al. (2014) have studied the impact of the governance index on energy availability, and their results endorse that governance and energy efficiency are interrelated.

H_4: Changes in the Institutional Quality and Governance effect moderates the relationship between financial, economic, and environmental factor with energy efficiency, intensity, and dependence of BRI countries.

2.5. Volatility Index VIX

To study how uncertainty will have an impact on energy efficiency, intensity, and dependence current study intends to incorporate a volatility index. VIX predicts the market volatility by aggregating the weighted prices of S&P 500 puts and calls over a wide range of strike prices. More specifically, the VIX is calculated by looking at the midpoints of the real-time S&P 500 option bid and ask prices. Cochran et al. (2015) studied equity market implied volatility and energy prices, they found that natural gas can withstand considerably more variation in the VIX index as compared to other energy products. For energy portfolio investment, the impact of uncertainties on energy prices is studied by VIX Index, results suggest that negative dependence exists between uncertainty changes and energy returns (Ji, et al., 2018). Dutta et al. (2018) has also used VIX as the control variable oil and energy sector stock market in the short and long term, results reveal the short run "Lead-Lag" association between the implied volatilities. volatility indices are a better suitable barometer of the fragility of the markets and the economy. Therefore, this work aims to investigate the relationship between the volatility index with energy efficiency, intensity, and dependence. Accordingly, investigation of the relationship between volatility index and energy efficiency, intensity, and dependence can give necessary insight into how oil market volatility will get affected.

H_5: Changes in the Volatility Index cause the changes in energy efficiency, intensity, and dependence of BRI countries.

2.6. Proxies used in Literature for Energy Efficiency, Intensity, and Dependence

As the most traded form of energy is oil so it's important to discuss how they affect the energy efficiency, intensity, and dependence of countries. Bluszcz (2017) studied the energy dependence of European economies, result of the analysis seven clusters were selected groups of homogenous countries in terms of the import dependence due to the major energy resources (oil, natural gas, and coal), results reveal that countries with more oil imports are more energy-dependent. Fei et al (2011) suggested that Gross Dometic Product depicting economic growth and energy consumption, result reveal that increase in Gross Domestic Product will lead to increase in energy consumption. Pickl (2019) demonstrated that with the use of renewable energy technologies and the response of the oil sector, Five of the oil majors pursue strategies to transition from oil to energy companies, Oil reserves seem to be a major determinant of the chosen renewable strategy. Table 1 provides the overview of variables used as a proxy for energy efficiency, intensity, and dependence and their use in literature.

3. DATA, VARIABLES, AND METHODOLOGY

The data period will cover 2000 to 2020 for all Belt and Road initiative economies that allowed us to study the impact of said variables in various structural breaks. Our population consists of the 83 economies benefiting from the six growth corridors of China, to draw conclusive findings regarding the Financial, Economic, and Environmental factors in BRI countries all countries will be studied by the proposed model. Following are the names of countries selected for the proposed model, Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Armenia, Azerbaijan, Austria, Bangladesh, Bahrain, Barbados, Belarus, Benin, Bolivia, Bosnia, and Herzegovina, Bulgaria, Brunei Darussalam, Burundi, Cabo Verde, Cameroon, Chad, Chile, China, Comoros, Congo, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, Djibouti, Dominica, El Salvador, Ecuador, Egypt, Estonia, Ethiopia, Fiji, Gabon, Gambia, Georgia, Ghana, Greece, Guyana, Hungary, Indonesia, Iran, Iraq, Jamaica, Kazakhstan, Kiribati, Kenya, Latvia, Lebanon, Lao PDR, Libya, Liberia, Lithuania, Luxembourg, Madagascar, Macao SAR, Malta, Maldives, Mali, Pakistan, Oman, Portugal, Romania, Saudi Arabia, Russian Federation, Rwanda, Samoa, South Africa, Sri Lanka, Sudan, Tajikistan, Thailand, Turkey, UAE, Uruguay, Uzbekistan, Yemen, Zimbabwe, Zambia. Using the roots of Information Theory, the dimensionality reduction method of PCA will be used to transform the data set into indexes using Eigenvalues. Hence;

Table 1: Proxies of dependent variables

Dependent variables	Proxies	Measurement	Use in literature
Energy efficiency	Total factor energy productivity	Ratio of aggregate inputs to aggregate outputs	Pickl (2019), Bluszcz (2017)
Energy intensity	Energy use/ppp	Ratio of energy consumption to purchasing power parity	Ma et al. (2004)
Energy dependence	Energy reserves/ energy production	Total value of energy reserves in a country to production	Feygin and Satkin (2004); Ewing and Thompson (2016)

$$Final\ Data\ Set=Feature\ Vector^{T}*Standarized\ Orginal\ Data\ Set^{T} \quad (1)$$

$$EnE=f(EcoF_t+EnvF_t+FinF_t+INSTQ+GOVI+VIX \quad (2)$$

$$ENERGY\ EFFICIENCY_t=\beta_0+\beta_1FINF_{i,t}+\beta_2ECOF_{i,t}+\beta_3ENVF_{i,t}+\beta_4GOVINDEX_{i,t}+\beta_5INSTQ_{i,t}+\beta_6VIX_{i,t}+\beta_7WTI_{i,t}+\beta_8FINF.GOVINDEX_{i,t}+\beta_9FINF.INSTQ_{i,t}+\beta_{10}ECOF.GOVINDEX_{i,t}+\beta_{11}ECOF.INSTQ_{i,t}+\beta_{12}ENVF.GOVINDEX_{i,t}+\beta_{13}ENVF.INSTQ_{i,t}+\beta_{14}GOVINDEX.INSTQ_{i,t}+\beta_{15}FINF.GOVINDEX.INSTQ_{i,t}+\beta^{16}ECOF.GOVINDEX.INSTQ_{i,t}+\beta_{17}ENVF.GOVINDEX.INSTQ_{i,t}+\varepsilon t \quad (3)$$

$$ENERGY\ INTENSITY_t=\beta_0+\beta_1FINF_{i,t}+\beta_2ECOF_{i,t}+\beta_3ENVF_{i,t}+\beta_4GOVINDEX_{i,t}+\beta_5INSTQ_{i,t}+\beta_6VIX_{i,t}+\beta_7WTI_{i,t}+\beta_8FINF.GOVINDEX_{i,t}+\beta_9FINF.INSTQ_{i,t}+\beta_{10}ECOF.GOVINDEX_{i,t}+\beta_{11}ECOF.INSTQ_{i,t}+\beta_{12}ENVF.GOVINDEX_{i,t}+\beta_{13}ENVF.INSTQ_{i,t}+\beta_{14}GOVINDEX.INSTQ_{i,t}+\beta_{15}FINF.GOVINDEX.INSTQ_{i,t}+\beta_{16}ECOF.GOVINDEX.INSTQ_{i,t}+\beta_{17}ENVF.GOVINDEX.INSTQ_{i,t}+\varepsilon t \quad (4)$$

$$ENERGY\ DEPENDENCY_t=\beta_0+\beta_1FINF_{i,t}+\beta_2ECOF_{i,t}+\beta_3ENVF_{i,t}+\beta_4GOVINDEX_{i,t}+\beta_5INSTQ_{i,t}+\beta_6VIX_{i,t}+\beta_7WTI_{i,t}+\beta_8\ FINF.GOVINDEX_{i,t}+\beta_9FINF.INSTQ_{i,t}+\beta_{10}ECOF.GOVINDEX_{i,t}+\beta_{11}ECOF.INSTQ_{i,t}+\beta_{12}ENVF.GOVINDEX_{i,t}+\beta_{13}\ ENVF.INSTQ_{i,t}+\beta_{14}GOVINDEX.INSTQ_{i,t}+\beta_{15}FINF.GOVINDEX.INSTQ_{i,t}+\beta_{16}ECOF.GOVINDEX.INSTQ_{i,t}+\beta_{17}ENVF.GOVINDEX.INSTQ_{i,t}+\varepsilon_t\ t \quad (5)$$

Note: *FINF* for Financial Factors, *ECOF* for Economic Factors, *ENVF* for Environmental Factors, *GOVINDEX* for Governance Index, *INSTQ* for Institutional Quality, *VIX* for Volatility Index and ε_t as error term.

4. RESULTS AND DISCUSSION

4.1. Principal Component Analysis

In the predictive model's Principal component analysis is used for dimensionality reduction by projecting every data point only on the first principal components to get lower-dimensional data with the least data variations. Olawale and Olanrewaju (2016) conducted the study to pinpoint the hurdles faced by SMEs using different clusters of Financial, Economical, Management, Environment, and Infrastructure using the principal component analysis they reveal that financial factors create the most obstacles for SMEs. Ince and Trafalis (2006) also used Principal component analysis for stock market predictions using Multilayer Perceptron (MLP) and Support Vector Regression (SVR), analysis confirms that there is no difference between results obtained by component analysis and individual analysis.

4.1.1. Financial factors

Financial factors are very essential for the enhancement of commercial activity in any country and for strengthening the economy (Apergis and Tang, 2013), hence the following factors are selected for inclusion in the research model. Business disclosure index, stock market capitalization, bank capital to asset ratio, interest rate spread, the risk premium on lending, tax revenue, international development association resource allocation index, quality of budgetary and financial management, domestic credit to the private sector, total business registered, time dealing with government regulations to determine whether the factor analysis will be of any use of not, two things are used by data analysts, screen plot of eigenvalues and KMO and Bartlett's test of sphericity. Here are the results of both. KMO and Bartlett's tests validate the null hypothesis that the correlation matrix of the variable under consideration is an identity matrix, which means that variables are unrelated to each other and not suitable for structure detection. To obtain the useful component matrix value of KMO measure of sampling adequacy should not be <0.5. Table 2 presents the result of KMO and Bartlett's test performed on financial factors. The value of KMO measure of sampling adequacy is not <0.5. Communalities represent the percentage of variance being accounted for by the principal component analysis. Hence Table 2 represents the commonalities in financial factors. IDA Resource allocation index has the highest value of variance explained by component analysis test 0.912 and time spent dealing with the requirement of government regulation has the lowest value 0.141.

4.1.2. Economic factors

For economic factors following variables are selected, gross domestic product, gross national income, foreign direct investment, total external debt, central government revenue, household final consumption, central government final consumption, exchange rate, consumer.

Price index, balance of payment current account, net trade volume (Sadorsky, 2011; Asafu-Adjaye, 2010, Payne, 2010). Table 3 represents KMO and Bartlett's test of sphericity. Here are the results of both. KMO and Bartlett's tests validate the null hypothesis that the correlation matrix of the variable under consideration is an identity matrix, which means that variables are unrelated to each other and not suitable for structure detection. To obtain the useful component matrix value of KMO measure of sampling adequacy should be less than 0.5. The Table 3 presents the result of KMO and Bartlett's test performed on financial factors. The value of KMO measure of sampling adequacy is not less than 0.5. Looking at the extraction IDA Rural Population has the highest value of variance explained by component analysis test 0.904 and Energy Production has the lowest value 0.415.

Table 2: Commonalities in financial factor

Variables	Extraction
Bank capital to assets ratio	0.472
CPIA quality of budgetary and financial management	0.896
Time spent dealing with the requirements of government regulations	0.141
IDA resource allocation index	0.912
Interest rate spread	0.848
Domestic credit to private sector of GDP	0.585
Stocks traded total value	0.579
Tax revenue	0.398
Risk premium on lending	0.831
New businesses registered number	0.387
Business extent of disclosure index	0.618
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.667
Bartlett's Test of Sphericity	
Approx. Chi-square	1829.756
df	55
Sig.	0.000

Table 3: Communalities in economic factors

Variables	Extraction
GDP	0.981
GNI	0.977
Foreign direct investment net inflows	0.857
External debt stocks total	0.908
Revenue excluding grants	0.604
Household final consumption expenditure	0.965
General government final consumption expenditure	0.966
Exchange rate	0.455
Consumer price index	0.561
Current account balance	0.575
Net trade volume	0.451
Kaiser-Meyer-Olkin measure of sampling adequacy	0.868
Bartlett's test of sphericity	
Approx. Chi-square	32914.247
df	55
Sig.	0

Table 4: Communalities in environmental factors

Variables	Extraction
Rural population	0.904
Urban population	0.902
Energy use	0.815
CO_2 emissions	0.813
Energy production	0.415
Kaiser-Meyer-Olkin measure of sampling adequacy	0.567
Bartlett's test of sphericity	
Approx. Chi-square	11179.139
df	10
Sig.	0.000

4.1.3. Environmental factors

Environmental factors are relevant to the preservation of climate in the energy production and consumption process including Rural population, Urbanisation, Energy Production, Energy Use, Carbon Dioxide Emission (Morgenstern and Pizer, 2007; Tol, 2002; Popkin et al., 2005). Table 4 represents the results of KMO and Bartlett's Test of sphericity for environmental factors. To obtain the useful component matrix value of KMO measure of sampling adequacy should not be <0.5. The value of KMO measure of sampling adequacy is not <0.5. Hence Table 4 represents the communalities in Economic factors. Looking at the extraction IDA Rural Population has the highest value of variance explained by component analysis test 0.904 and Energy Production has the lowest value 0.415.

4.2. Descriptive Statistics and Correlation Matrix

The Table 5 provides the descriptive statistics of the variables involved in the research model. The Table 6 represents the results of correlation analysis between financial factors, economic factors, environmental factors, energy efficiency, energy intensity, energy dependence, Volatility index, institutional quality, and governance index. Research reveals that any correlation matrix after principal component analysis is an unbiased robust estimator of the model (Croux and Haesbroeck, 2000). Figure 1 provides an overview of the trend in each series, on the x-axis kernel density probability distribution is also presented.

4.3. Levinsohn-Petrin Productivity Estimator

Levinsohn Petrin Productivity estimator function is used in STATA to obtain the estimates for the input-output ratio of energy productivity table provides the overview of the result and Figure 2 represents the estimates of Total Factor Energy Productivity. Table 7 provides the result of the level function in STATA taking GDP as output and Energy use, Labor, and capital as inputs. Figure 2 provides the graphical representation of estimates of Total Factor Productivity.

The macro reality of economies being differentiated from each other is their level of productivity, economies try to achieve a higher level of productivity. The main issue in the estimation of production function comes with the correlation between unobservable shocks in productivity and the level of inputs. Petrin et al. (2004) explained that micro-level firms respond to positive productivity shocks, they expand the level of output. Meanwhile, negative shocks lead to decreasing inputs. As ordinary least square estimates of production function produced biased estimates, there is a need for an unbiased estimator of the production function. OLS and Fixed effect estimators also possess the issue of inconsistent estimates for production function, they ignore the endogeneity.

Following the work of Zhang et al. (2011) they studied total factor energy efficiency in 23 developing countries, and they revealed that China has the highest trend in Total Factor Energy Efficiency, Zhang et al. (2015) calculated ecological total factors energy efficiency in different regions of China, they suggested that most of the regions of China are not performing well in terms of environmental energy efficiency taking carbon dioxide CO_2 and sulfur dioxide so 2as output variable. Xiaoli et al. (2014) studied total factor energy efficiency for the provincial industrial sector in China, they reported that Industrial sectors in eastern provinces have higher Total Factor Energy Efficiency. Hu and Wang (2006) also studied the same for regional energy efficiency in China and reported that the central region of China is performing worse in terms of total factor energy efficiency.

Honma and Hu (2014) studies the total factor energy efficiency in 14 developed countries, they suggested that Japan should adopt an energy conservation strategy. Literature on total factor energy efficiency is more inclined toward China and Japan.

Following the work of Olley and Pakes (1996) and Levisohn and Petrin (2003), the Estimator of Total Factor Energy Productivity

Table 5: Descriptive statistics

	ECOF	ENVF	FINF	EFY	ETY	EDE	VIX	INSQ	GOVI
Mean	0.00	0.05	−0.01	61.74	26.15	−29.20	20.03	54.05	53.24
Median	−0.08	−0.42	−0.11	54.62	24.06	0.00	17.50	57.44	56.63
Maximum	5.90	8.46	2.82	244.89	84.80	100.00	32.71	100.00	100.00
Minimum	−8.94	−0.68	−4.04	0.00	0.00	−1938.66	11.05	−2.31	−2.31
Std. Dev.	0.60	1.28	0.53	31.06	14.48	160.99	6.40	27.12	27.59
Skewness	2.43	3.77	1.16	1.35	0.90	−4.83	0.54	−0.34	−0.33
Kurtosis	60.14	19.84	8.67	5.77	3.93	35.34	2.07	2.16	2.11
Observations	1723.0	1723.0	1723.0	1723.0	1723.0	1723.0	1723.0	1723.0	1723.0

Table 6: Correlation matrix

	ECOF	ENVF	FINF	EFY	ETY	EDE	VIX	INSQ	GOVI
ECOF	1.00	0.02	−0.03	0.02	0.05	0.05	−0.13	−0.08	−0.08
ENVF	0.02	1.00	−0.04	−0.02	0.12	−0.02	0.03	0.10	0.11
FINF	−0.03	−0.04	1.00	0.08	0.01	−0.04	−0.06	−0.02	−0.02
EFY	0.02	−0.02	0.08	1.00	0.30	−0.14	−0.04	0.00	0.02
ETY	0.05	0.12	0.01	0.30	1.00	−0.60	−0.02	−0.19	−0.17
EDE	−0.13	0.03	−0.06	−0.04	−0.02	−0.04	1.00	0.06	0.05
VIX	−0.08	0.10	−0.02	0.00	−0.19	0.19	0.06	1.00	0.95
INSQ	−0.08	0.11	−0.02	0.02	−0.17	0.18	0.05	0.95	1.00
GOVI	0.05	−0.02	−0.04	−0.14	−0.60	1.00	-0.04	0.19	0.18

Table 7: Result of LEVPET function in STATA

	Coefficient	P-value
Energy use	−0.156033	0.000***
Labor	0.402117	0.253
Capital	−0.389521	0.827
Number of obervation	1763	1763
No of groups	84	84

***P>0.05 significance level 95%

is computed for 84 countries involved in Belt and Road Initiative using the STATA command levpet st0060. Later on, estimates of Total Factor Energy Efficiency Productivity are taken as the dependent variable in our analysis. The table 7 represents the output of levpet estimation. It can be seen that energy use is significantly affecting the gross domestic product with a coefficient value of 0.1560, for labor and capital coefficient value is 0.0402 and -0.1389 respectively. It may please be noted that capital added here is as a value-added function, any shock in capital level will reflect in the GDP.

We extended that model by inclusion of energy use, capital, labor as inputs, and GDP as output, Figure 2 shows the plot of total factor energy efficiency for 84 Belt and Road Initiative countries in our analysis. Bangladesh, Portugal, and Belarus have shown decreased TFEP, Maldives, Oman have shown an increasing trend in TFEP, and the following countries have shown their progress is taking place, and they have maintained the slightly increased level of TFEP including, Azerbaijan, Barbados, Cameroon, Chad, Chile, China, Comoros, Costa Rica, Cyprus, Egypt, Hungary, Liberia. Mali, Pakistan, United Arab Emirates, Uruguay, Uzbekistan, Yemen, Zimbabwe, Zambia.

4.4. Levin, Lin, and Chu Test for Panel Data Stationarity

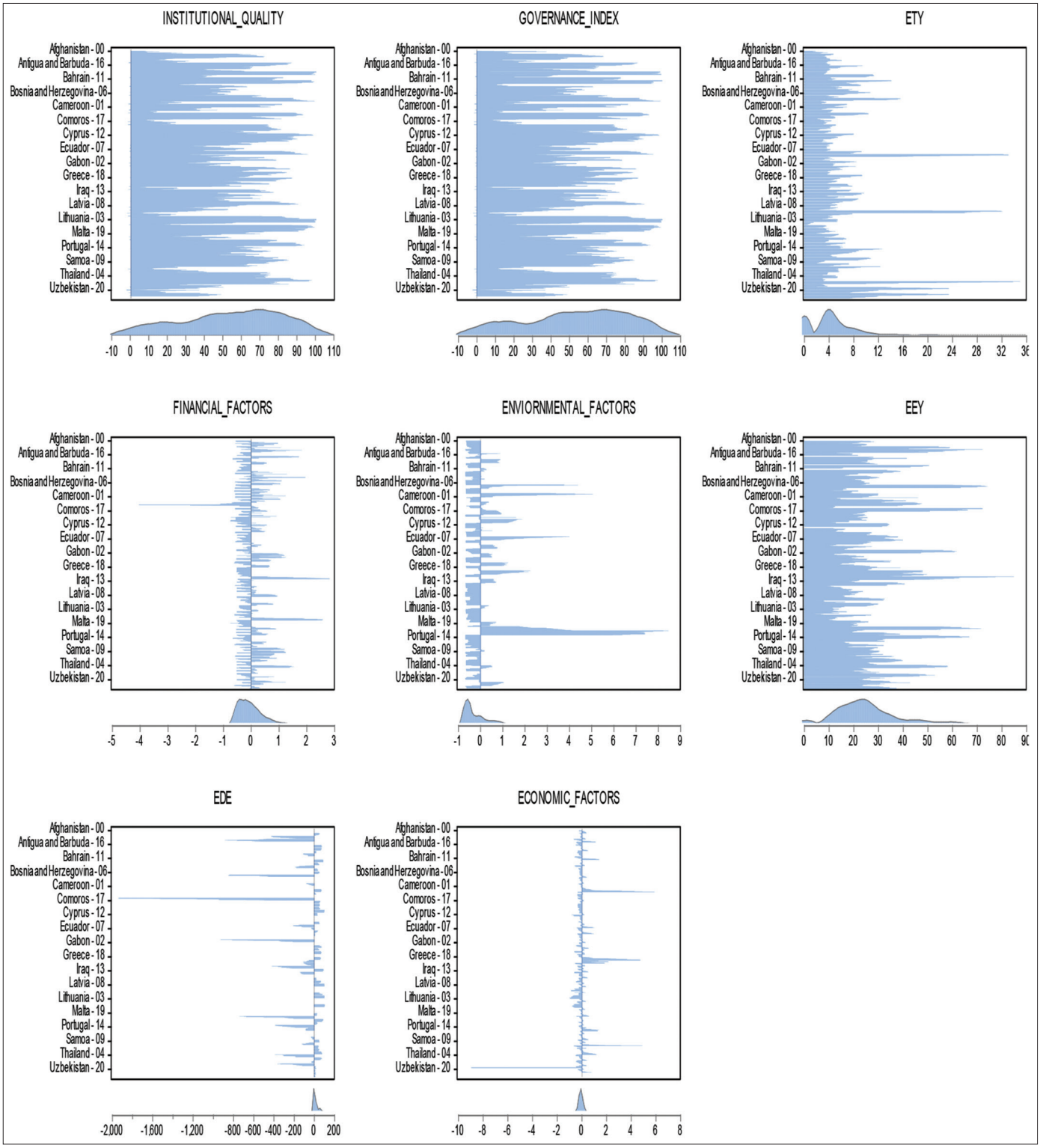
Before starting statistical analysis its important to test whether data is stationary or not, for this purpose we used levinlin test developed by Levin et al. (2002), which assumes that each unit in the panel share the same AR(1), allowing individual effect, time effect and time trend. Table 8 reports the results of levinlin test for each variable included in the data set. Table 9 report the test of fixed and random effect.

4.5. Three-Way Moderation Analysis

Table 10 reports estimates for the link between financial factors, economic factors, environmental factors, volatility index with the measures of energy efficiency taking Total Factor Energy Productivity, energy intensity taking energy use to purchase power parity ratio, and energy dependence taking energy reserves to production ratio, It has also been analyzing how institutional quality and governance effectiveness changes the dynamic of the relationship between above-mentioned variables for the countries involved in China belt and road initiative. Standardized coefficients are being reported because they will help to compare the results of different energy parameters. Additionally, as Hausman and Brause Pegan LM test suggested that total factor productivity estimator possesses the fixed effect and energy use to purchasing power parity and energy reserves to energy production ratio to possess the random effect, fixed effect regression is used for Total Factor Energy Productivity and Random effect regression is used for a random effect. All analysis is performed with the help of the statistical tool package of STATA.

Column 1 reports the results of fixed-effect regression estimates, it is observant that financial factors are not significantly related to total factor energy productivity, and any change in financial factor brings a negative change in TFEP. It may be noted that for obtaining TFEP GDP is taken as output and energy use, labor, and capital are taken as input. When bank capital to asset ratio increases it has an impact on the availability of capital in the economy, availability of excess capital hits the use of energy-efficient products and labor reduces, eventually nominator of the ratio between input

Figure 1: Kernel density probability graph



out reduces and leads to lower output. Okorie 2021conducted a study on the relationship between capital inputs and energy use. the results confirm our results. Another factor was the quality of budgetary and financial management, when it increases economies grow, and GDP increases in the economy. When the denominator of TFEP increases value of TFEP will reduce and an inverse relationship will result. Magazzino (2017) reported the same for Italy. Time dealing with the equipment of government regulation decreases GDP increases and TFEP has a negative relationship. Another factor is IDA Resource allocation index, which is based on annual country policy and institutional assessments, when it increases meaning that country is showing stable and sustainable policy and institutional arrangement, energy use will reduce but at the same time, capital and labor become questionable in our analysis it also documents that BRI countries policy is focusing not focusing on reduced energy use and encourage the enrolment

Figure 2: Graph of total factor productivity

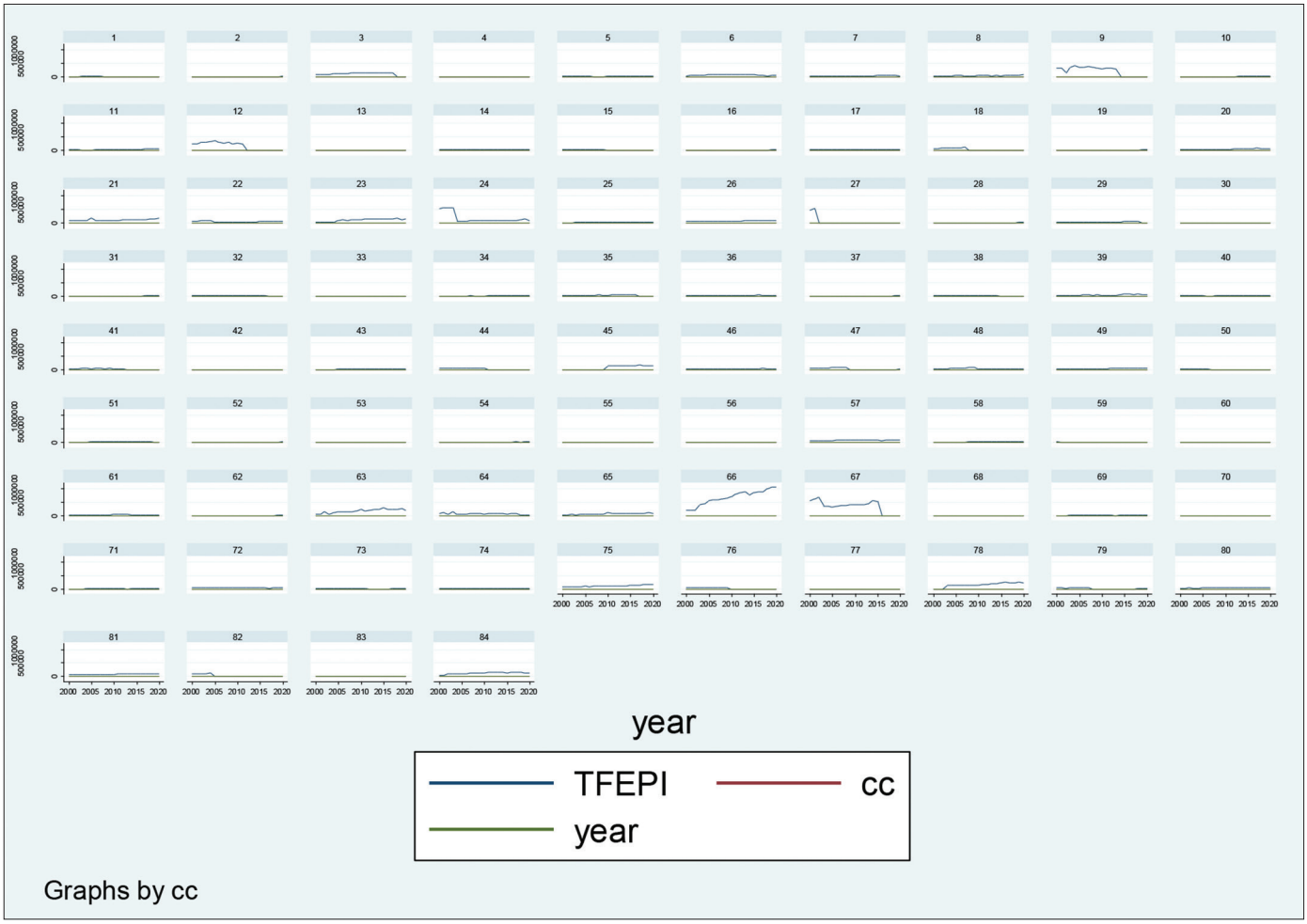


Table 8: Levin, Lin and Chu test of panel data stationarity

Sr.No	Variable	Statistics	Probability	Integration Level	Ho Reject?
1	Financial factors	−26.4840	0.0000***	I (I)	Yes
2	Economic factors	−21.9270	0.0004***	I (I)	Yes
3	Environmental factors	−14.3979	0.0000***	I (0)	Yes
4	Institutional quality	−30.6382	0.0000***	I (I)	Yes
5	Governance effectiveness	−15.0778	0.0000***	I (0)	Yes
6	Volatility index	−23.8056	0.0000***	I (0)	Yes
7	Total factor energy productivity	−2.4+05	0.0000***	I (0)	Yes
13	Energy use/Purchasing power Parity	−12.3421	0.0000***	I (0)	Yes
14	Composite Index of Energy Intensity	−48.8719	0.0000***	I (2)	Yes
16	Energy Reserves/Energy Production	−26.5054	0.0000***	I (I)	Yes

***P>0.05 significance level 95%

Table 9: Test of fixed or random effect

	Hausman test	Breusch and Pagan Lagrangian multiplier test	Fixed effect, random effect or pooled OLS
Model 1	106.49 (0.000)***	5636.87 (0.000)***	Fixed effect
Model 2	8.36 (0.9376)	5290.72 (0.0000)***	Random effect
Model 3	15.34 (0.4997)	6080.56 (0.0000)***	Random effect

***P>0.05 significance level 95%

of labor, that's why negative relation depicted. We hypothesize taking interest rate spread in the financial factor that will depict the potential of investment loss in case of an interest rate increase, it shows that for BRI Countries Interest rate is affecting the value of capital investment and GDP but the inclusion of interest rate spread in GDP outpaced the effect on capital investment and resulted in a negative relationship.McMillan et al. (2017) stated that the term structure of interest rate contains predictive power for GDP for the USA, Canada, and Australia.

Table 10: Test results for Model 1, Model 2 and Model 3

Dependent variable	Model	(1)	(2)	(3) It
		Total Factor Energy Productivity	Energy Use/Purchasing Power Parity	Energy Reserves/ Energy Production
Independent variables				
Financial factors	H1	−4227.433 (0.802)	668.6526 (0.123)	7025701 (0.571)
Economic Factors	H2	−327.07 (0.994)	−472.7694 (0.330)	2.92e+07 (0.035)**
Environmental Factors	H3	−1960.013 (0.047)**	−165.8028 (0.505)	−1.65e+07 (0.023)**
Control				
Volatility index	H5	−108.4148 (0.602)	55.54553 (0.016)**	165056.6 (0.800)
Moderators				
Institutional quality		291710.7 (0.078)*	−28272.29 (0.121)	1.99e+09 (0.000)***
Governance effectiveness		−700077.8 (0.550)	22259.28 (0.090)*	−5.68e+08 (0.130)
Interaction terms				
Institutional Quality*Governance Effectiveness	H4	−14.64997 (0.538)	−2015.399 (0.882)	1.40e+09 (0.000) ***
Financial Factors*Institutional Quality	H4	−26489.4 (0.200)	110.8995 (0.961)	−1.10e+08 (0.089)*
Financial Factors*Governance Effectiveness	H4	87075 (0.000)***	−1877.027 (0.436)	9.12e+07 (0.185)
Financial Factors*Institutional Quality*Governance Effectiveness	H4	−4412.043 (0.787)	−2623.409 (0.144)	−3.41e+07 (0.505)
Economic Factors*Institutional Quality	H4	−128229.4 (0.090)*	13286.78 (0.109)	−8.41e+08 (0.000)***
Economic Factors*Governance Effectiveness	H4	−22332.12 (0.664)	−8003.431 (0.167)	2.01e+08 (0.224)
Economic Factors*Institutional Quality*Governance Effectiveness	H4	−81699.54 (0.149)	3154.979 (0.612)	−6.14e+08 (0.001)***
Environmental Factors*Institutional Quality	H4	−8006.337 (0.000)***	549.6032 (0.000)***	1.51e+07 (0.000)***
Environmental Factors*Governance Effectiveness	H4	8819.642 (0.000)***	423.3911 (0.007)***	−1.36e+07 (0.003)***
Environmental Factors*Institutional Quality*Governance Effectiveness	H4	−4560.309 (0.000)***	249.4356 (0.031)**	7410533 (0.025)**
Fit indexes				
Constant		56766.61	906.7061	1.60e+08
R-square		0.44%	0.03%	9.63%
Wald Chi^2		-	90.46***	46.27***
F-statistics		7.02***	-	-

There is a straightforward justification for the indirect relationship between Domestic credit to the private sector of GDP and TFEP because domestic credit to the private sector has an impact on the GDP denominator of TFEP. An increase in stock traded value increases the GDP and reduces TFEP. Tax revenue and the risk premium on lending reduced the level of capital in the economy. and TFEP reduces. Registration of new business increases energy use, use of labor and capital and GDP also increases and TFEP reduces. The business extent of disclosure increases investor confidence and GDP and reduces TFEP.

Although fixed effect regression of economic factors with TFEP shows insignificant impact but is important to discuss the direction of the relationship. Gross domestic product, gross national income foreign direct investment, and revenue these factors of economic analysis affect the level of capital in the economy, level of labor deployment energy use, and GDP as a denominator so when they increase and GDP as denominator increases and the ratio of TFEP decreases that's why the negative relationship is prevalent in our analysis. Other than that external debt stock affects the capital two-fold, it increases it but also burdens the economy with principal and interest payments, so it hurts the efficiency of total factors in energy productivity. Coming towards the household and central government expenditure it increases the energy use, reduces capital, and reduces the TFEP. The exchange rate increase will decrease the capital level of an economy, same goes for consumer price index, current account balance and net trade volume all of them have an impact on the capital level of the economy and poss indirect impact on TFEP. Efficiency. Hayat et al. (2018) proposed that economic factors do not have a significant impact on energy efficiency, analysis of economic factors takes more measures of economic factors, and our results confirm them for financial factors.

Fixed effect regression of TFEP with environmental factor shows negatively significant impact at 95% level of confidence, while interpreting the result we infer that dynamics of the rural and urban population affect the consumption pattern energy use and supply of labor, increase in urbanization increase energy use and decrease capital in the economy and put the downward effect of TFEP, energy use cross-checked in the ratio and decrease the TFEP, level of Co2 emission increase the energy use and reduces TFEP, increase in energy production leads toward a higher level of energy use and GDP and reduces TFEP.

It is essential to add the control variable in our model, that has the impact on energy dynamics, literature suggests that the Volatility Index is a widely used and accepted control variable in the analysis of financials and energy dynamics. In model 1 volatility index shows an insignificant but negative relationship with TFEP, the reason negatively that the increased level of volatility decreases the GDP decreases capital and reduces the TFEP. I UNIT change in environmental factors will result in the negative -1960.013 unit change in TFEP.

Research suggests that inclusion of country dynamics through the inclusion of moderators as Instutoonal Quality and governance effectiveness helps in analyzing the relationship for any economy more robustly, to test the hypothesis interaction terms are added

using the three-way moderation approach. Itself moderators institutional quality significant impact on the TFEP, 1 unit increase in institutional quality will result in the 291710.7 unit change in TFEP. Governance effectiveness results in an insignificant and negative relationship with TFEP.

While interacting both moderators with financial factors separate interactions show that institutional quality and financial factors have an insignificant impact on TFEP while Financial factors and governance effectiveness together have a significant impact on the TFEP with a P = 0.000 at 99% level of confidence, 1 unit increase in interaction term with bringing the 87075 unit change in TFEP. while both moderators have interacted with financial factor results is again insignificant.

The interaction term of an economic factor with institutional quality shows a statistically significant impact with a P = 0.090 at 90% level of confidence, 1 unit change in interaction term will reduce the TFEP by 128229.4 units. Torgler and Schneider (2009) endorsed that economy and institutional quality run in coordination. the interaction term of economic factors with governance effectiveness and the interaction term of economic factors with institutional quality and governance effectiveness provides a statistically insignificant impact.

The interaction term of environmental factors with institutional quality shows a highly significant impact with a P = 0.000 at 99% level of confidence, 1 unit increase in interaction term will reduce the TFEP by 8006.337 units. The interaction term of environmental factors with governance effectiveness also shows a highly significant impact with a P = 0.000 at a 99% level of confidence, 1 unit increase in interaction term will increase the TFEP by 8819.642 units. The interaction term of environmental factors with institutional quality and governance effectiveness also show a significant impact with a P = 0.000 at 99% level of confidence, 1 unit increase in interaction term will decrease the TFEP by 4560.309.

It is observed that environmental factors pose a high impact on TFEP, while economies are making policies to increase energy efficiency, according to fixed-effect modeling they should focus more on the environmental factors.

R-square value is 0.44%, together all variables will bring 0.44% change in TFEP. The value of F-statistics is 7.02 which shows the significant impact of all variables in the model.

Model 2 Hausman and Breusch and Pagan Lagrangian multiplier test states that random effect prevails for model 2 taking energy use to purchasing power parity as a measure of energy intensity, Random effect regression shows that financial factor and energy use/PPP are not statistically significantly related, but the direction of the relationship is positive, it's important to shed some light on the direction of the relationship.

Bank capital to asset ratio increases the energy use and reduces the purchasing power parity, overall increasing the ratio. When talking about CPIA quality of budgetary and financial management, an increase in that will reduce the PPP and increase the EU/PPP. If the time spent dealing with government regulation increases energy use increases so EU/PPP increases.

Another factor is IDA resource allocation index, which is based on annual country policy and institutional assessments when it increases meaning that the country is showing stable and sustainable policy and institutional arrangement, energy use will reduce but at the same time, PPP will also reduce, increase TFEP. An increase in interest rate spread will increase the PPP, domestic credit to the private sector will increase the EU, the stock traded value, tax revenue, risk premium, a new business registered, and business extent of disclosure index all these variables, increase the investor confidence in the economy to invest so energy use increase with the level of investment and PPP decrease so the ratio will increase. Pan et al. (2017) and Pan et al. (2019) suggested that financial factors and energy intensity are positively related confirming our results.

Random effect regression also documents that economic factors and EU/PPP are not statistically significantly related, but the direction of the relationship is negative. Coming towards the economic factors GDP, GNI, FDI, Revenue excluding grants reduces the PPP, but increases the EU, household final consumption and government final consumption also increase eu and increase eu and reduce ppp. Exchange rate and CPI reflects in PPP, Current account balance and net trade volume also stengthne the economic activity and increase the EU and reduce EU/PPP. Economic factors and energy effeciency are negatively related (Khan et al., 2019).

Impact of environmental factors on EU/PPP is also insigifant and negative. When ruralization decrease energy use increase, energy production excelrates the energy use. Co^2 emission increase with energy use. Volatility index and EU/PPP have statistically significant relationship with P = 0.016 at 95% level of confidence. Instutional quality is not statictically significant with EU/PPP, but governance effectiveness and EU/PPP are statisctially significant with P = 0.09 with 90% condidence intervanl, 1 unit change in governance effevtiveness will bring the 22259.28 unit change in EU/PPP.

Interaction term of instutional quality and governance effevtiveness is not statically signfucant, Regarding interaction term of moderators with financial factors, financial factor with instutional quality, financial factor with governance effevtiveness and financial factor with instutional quality and governance effevtiveness none of the interaction term came statisctially significant.Interaction term of economic factor with instutuional quality is not statically significant, interaction term of economic factor with governance effevtiveness is also not statictially significant, The interaction term of economic factors and governance effectiveness doesn't statistically significantly impact the relationship between economic factors and energy efficiency. The current analysis supports the results of Granger, Huangb, and Yang (2000) and Kraipornsak (2018). statisctially term of economic factor with instutuional quality and governance effevtiveness is also not significant.

Internaction term of environmental factor with instutional quality is statistically significant with P = 0.000 at 99% level of confidence

1 Unit change in interaction term will bring the 549.6032 unit change in EU/PPP, internaction term of envriomnetal factor with governance effectiveness is also significant with P = 0.000 at 99% level of confidence, 1 unit change in interaction term will bring the 423.3911 unit change in EU/PPP. Interaction term of environmental factors with instutional quality and governance effectiveness is also sgnficant with P = 0.031 at 95% level of confidence. Paramati et al. (2022) analyzed the role of the environment on energy demand and energy efficiency for OECD countries and their results confirm our analysis. R-square value is 0.03% for the model, value of wald chi square statistics is also significant 90.46.

Model 3 represent the measure of energy dependence, energy use of energy production. Bank capital to asset ratio, quality of budgetary and financial management, time spent dealing with the requirement of government regulation, Increases the energy use whereby reducing the energy reserves, stock trade value resource allocation index, domestic credit to private sector helps in energy production, tax revenue an risk premium increase the energy related investment whereby increase energy production and reserves. Overall financial factors have positive but insigficant impact on ER/EP.

Economic factors are not statiscaly signficaly related to ER/EP but direction of relationship is positive, GDP, GNI, FDI, External debt, revune, house hold and government expendiue, echange rate, current account balance and net trade volume increase the demand of energy, increasing ER/EP. Environmental factors including rural polulation, urban population, energy use reduces the energy reserves, co2 emission reduces energy production and energy production are statisctally signficantky and negatively related to ER/EP, with P = 0.023 at 95% level of confidence, 1 unit change in environmental factors will decrease the ER/EP with 1.65e+07 unit change in ER/EP.

Volatility index is not statisctally sigfnicatly related to ER/EP, Moderator instutional quality is statiscally signficatnly related to ER/EP with P = 0.000 at 99% level of confidence, 1 unit change in institutional quality will bring 1.99e+09 unit change in ER/EP. Governance effectiveness is not statstcially signficanlt related to ER/EP.

Interaction term of institutional quality and governance effectiveness is significantly related to ER/EP with P = 0.000 wt 99% level of confidence, 1 unit change in interaction term will bring the 1.20e+09 unit change in ER/EP, Our analysis confirms the results of Moon and Min (2020) and Qarnain et al. (2021). interaction term of financial factors with institutional quality is also significantly related to ER/EP with P = 0.089 at 90% level of confidence, I unit change in interaction term will reduce the ER/EP with 1.10e+08 units. Interaction term of financial factor with institutional quality is statistically insgificant, interaction term of financial factors it instutuonal quality and governance effectiveness is also statistically insfifiacly.Interaction term of economic factors with institutional quality is statistically significant with P = 0.000 at 99% level of confidence, 1 unit change in interaction term will reduce the ER/EP will 8.41e+08 units. Torgler and Schneider (2009) endorsed that economy and institutional quality runs in coordination. Interaction term of economic factors with governance effectiveness is statistically insigdficant, The interaction term of economic factors and governance effectiveness doesn't statistically significantly impact the relationship between economic factors and energy efficiency. The current analysis supports the results of Granger et al. (2000) and Kraipornsak (2018). interaction term of economic factors with institutional quality and governance effectiveness is statistically significant with P = 0.001 at 99% level of confidence, 1 unit change in interaction term will reduce the ER/EP with 6.14e+08.

Interaction term of environmental factors with institutional quality is statiscaly significant with P = 0.000 at 99% level of confidence, 1 unit change in interaction term will reduce the ER/EP with 1.51e+07. Interaction term of environmental factors with governance effectiveness is statiscally significant with P = 0.003 at 99% level of confidence, 1 unit change in interaction term will reduce the ER/EP with 1.36e+07. Interaction term of environmental factors with insitional quality and governance effectiveness is statically significant with P = 0.025 at 95%, 1 unit change in interaction term will increase the ER/EP with 7410533. Value of R-square is 9.63%, value of wald chi square statistics is also significant 46.27.

5. CONCLUSION

Belt and road initiative is hope for changing the economic and financial sustainability for 83 countries involved in it. The purpose of the research has been accomplished by reviewing the existing literature regarding the finance-energy-growth nexus and the involvement of a vast range of variables in financial factors, economic factors, and environmental factors. A detailed analysis of impact of financial, economic, and environmental factors on 83 countries involved in belt and road initiative is conducted. Three-way moderation analysis of relationship of financial, economic and environmental factors with energy efficiency, energy intensity and energy dependence moderated by institutional quality and governance index reveals that in panel least square financial factors and economic factor's impact on energy efficiency and energy intensity is significantly moderated by institutional quality, the result is insignificant for energy dependence. For environmental factors impact is significant for energy efficiency and energy dependence and the result of energy intensity is insignificantly moderated by institutional quality and governance index. The study has succeeded in explaining its purpose regarding the Finance-Growth-Energy scenario in Belt and Road initiative countries. The study also endorsed that by use of traditional OLS regression and regressing variables with forced regresses, glittery results as reported by many studies may be produced.

Development of energy system with energy efficiency, energy intensity, and energy dependence framework is the novelty and contribution of the study, future research can test the model for other countries. Future research can expand the model by inclusion of oil benchmarks in the model. Policymakers can also draw a valuable conclusion from the analysis as analysis revealed that the proposed model predicts 0.44% changed in energy efficiency, 0.03% changes in energy intensity, and 9.63% changes in energy dependence. With the analysis conducted in current research, policymakers will have the exact relationship between financial, economic, and environmental factors and energy efficiency, intensity, and

dependence with the moderated role of institutional quality and governance index. The study of finance-economic-environmental nexus with energy has so many dimensions, in a short span, all cannot be covered it is suggested that future research may study the impact of oil benchmark pricing with these variables.

REFERENCES

Ajmi, A.N., Hammoudeh, S., Nguyen, D.K., Sato, J.R. (2015), On the relationships between CO_2 emissions, energy consumption and income: The importance of time variation. Energy Economics, 49, 629-638.

Apergis, N., Tang, C.F. (2013), Is the energy-led growth hypothesis valid? New evidence from a sample of 85 countries. Energy Economics, 38, 24-31.

Asafu-Adjaye, J. (2000), The relationship between energy consumption, energy prices and economic growth: Time series evidence from Asian developing countries. Energy Economics, 22(6), 615-625.

Asumadu-Sarkodie, S., Owusu, P.A. (2017), Recent evidence of the relationship between carbon dioxide emissions, energy use, GDP, and population in Ghana: A linear regression approach. Energy Sources, Part B: Economics, Planning, and Policy, 12(6), 495-503.

Barney, J. (1991), Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99-120.

Bazilian, M., Nakhooda, S., Van de Graaf, T. (2014), Energy governance and poverty. Energy Research and Social Science, 1, 217-225.

Benedictis, L.D., Taglioni, D. (2011), The gravity model in international trade. In: The Trade Impact of European Union Preferential Policies. Berlin, Heidelberg: Springer. p55-89.

Bluszcz, A. (2017), European economies in terms of energy dependence. Quality and Quantity, 51(4), 1531-1548.

Bridge, G., Bouzarovski, S., Bradshaw, M., Eyre, N. (2013), Geographies of energy transition: Space, place and the low-carbon economy. Energy Policy, 53, 331-340.

Brown, M.A., Chandler, S. (2008), Governing Confusion: How Statutes, Fiscal Policy, and Regulations Impede Clean Energy Technologies. Vol. 19. California: Stan. L. and Pol'y Rev. p472.

Campa, J.M., Goldberg, L.S. (2006), Distribution Margins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates. NBER Working Paper, (W12121).

Cochran, S.J., Mansur, I., Odusami, B. (2015), Equity market implied volatility and energy prices: A double threshold GARCH approach. Energy Economics, 50, 264-272.

Croux, C., Haesbroeck, G. (2000), Principal component analysis based on robust estimators of the covariance or correlation matrix: Influence functions and efficiencies. Biometrika, 87(3), 603-618.

Dutta, A., Bouri, E., Das, D., Roubaud, D. (2020), Assessment and optimization of clean energy equity risks and commodity price volatility indexes: Implications for sustainability. Journal of Cleaner Production, 243, 118669.

Dutta, S., Lanvin, B., Wunsch-Vincent, S. (2018), Global Innovation Index 2018: Energizing the World with Innovation. Geneva, Switzerland: World Intellectual Property Organization.

Ewing, B.T., Thompson, M.A. (2016), The role of reserves and production in the market capitalization of oil and gas companies. Energy Policy, 98, 576-581.

Famiola, M., Wulansari, A. (2019), SMEs' social and environmental initiatives in Indonesia: An institutional and resource-based analysis. Social Responsibility Journal, 16, 15-27.

Fatai, K., Oxley, L., Scrimgeour, F.G. (2004), Modelling the causal relationship between energy consumption and GDP in New Zealand, Australia, India, Indonesia, The Philippines and Thailand. Mathematics and Computers in Simulation, 64(3-4), 431-445.

Fei, L., Dong, S., Xue, L., Liang, Q., Yang, W. (2011), Energy consumption-economic growth relationship and carbon dioxide emissions in China. Energy Policy, 39(2), 568-574.

Ferguson, R., Wilkinson, W., Hill, R. (2000), Electricity use and economic development. Energy Policy, 28(13), 923-934.

Feygin, M., Satkin, R. (2004), The oil reserves-to-production ratio and its proper interpretation. Natural Resources Research, 13(1), 57-60.

Frei, F., Sinsel, S.R., Hanafy, A., Hoppmann, J. (2018), Leaders or laggards? The evolution of electric utilities' business portfolios during the energy transition. Energy Policy, 120, 655-665.

Gabriel, C.A., Kirkwood, J. (2016), Business models for model businesses: Lessons from renewable energy entrepreneurs in developing countries. Energy Policy, 95, 336-349.

Gartner, W.B. (1989), Some suggestions for research on entrepreneurial traits and characteristics. Entrepreneurship Theory and Practice, 14(1), 27-38.

Granger, C.W. (1969), Investigating causal relations by econometric models and cross-spectral methods. Econometrica: Journal of the Econometric Society, 1969, 424-438.

Granger, C.W., Huangb, B.N., Yang, C.W. (2000), A bivariate causality between stock prices and exchange rates: Evidence from recent Asianflu. The Quarterly Review of Economics and Finance, 40(3), 337-354.

Hajko, V. (2017), The failure of Energy-Economy Nexus: A meta-analysis of 104 studies. Energy, 125, 771-787.

Havila, V., Wilkinson, I.F. (2002), The principle of the conservation of business relationship energy: Or many kinds of new beginnings. Industrial Marketing Management, 31(3), 191-203.

Hayat, F., Pirzada, M.D.S., Khan, A.A. (2018), The validation of Granger causality through formulation and use of finance-growth-energy indexes. Renewable and Sustainable Energy Reviews, 81, 1859-1867.

Hoeller, P., Wallin, M. (1991), Energy prices, taxes and carbon dioxide emissions. OECD Economic Studies No. 17, Autumn. Paris, France: OECD. p91-105.

Honma, S., Hu, J.L. (2014), Industry-level total-factor energy efficiency in developed countries: A Japan-centered analysis. Applied Energy, 119, 67-78.

Hu, J.L., Wang, S.C. (2006), Total-factor energy efficiency of regions in China. Energy Policy, 34(17), 3206-3217.

Hubrich, K., Lütkepohl, H., Saikkonen, P. (2001), A review of systems cointegration tests. Econometric Reviews, 20(3), 247-318.

Ince, H., Trafalis, T.B. (2006), A hybrid model for exchange rate prediction. Decision Support Systems, 42(2), 1054-1062.

Jamil, F., Ahmad, E. (2010), The relationship between electricity consumption, electricity prices and GDP in Pakistan. Energy Policy, 38(10), 6016-6025.

Jensen, J., Tarr, D. (2003), Trade, exchange rate, and energy pricing reform in Iran: Potentially large efficiency effects and gains to the poor. Review of Development Economics, 7(4), 543-562.

Ji, Q., Liu, B.Y., Nehler, H., Uddin, G.S. (2018), Uncertainties and extreme risk spillover in the energy markets: A time-varying copula-based CoVaR approach. Energy Economics, 76, 115-126.

Kahsai, M.S., Nondo, C., Schaeffer, P.V., Gebremedhin, T.G. (2012), Income level and the energy consumption-GDP nexus: Evidence from Sub-Saharan Africa. Energy Economics, 34(3), 739-746.

Kang, Y., Cheng, C., Liu, X., Zhang, F., Li, Z., Lu, S. (2019), An ecosystem services value assessment of land-use change in Chengdu: Based on a modification of scarcity factor. Physics and Chemistry of the Earth, Parts A/B/C, 110, 157-167.

Khan, M.A., Khan, M.A., Ali, K., Popp, J., Oláh, J. (2020), Natural resource rent and finance: The moderation role of institutions. Sustainability, 12(9), 3897.

Khan, M.K., Teng, J.Z., Khan, M.I., Khan, M.O. (2019), Impact of

globalization, economic factors and energy consumption on CO_2 emissions in Pakistan. Science of the Total Environment, 688, 424-436.
Knack, S., Parks, B.C., Harutyunyan, A., Di Lorenzo, M. (2020), How Does the World Bank Influence the Development Policy Priorities of Low-income and Lower-middle Income Countries? World Bank Policy Research Working Paper, 9225.
Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. The Journal of Energy and Development, 3, 401-403.
Kraipornsak, P. (2018), Good governance and economic growth: An investigation of Thailand and selected Asian countries. Eurasian Journal of Economics and Finance, 6(1), 93-106.
Landon, S., Smith, C.E. (2010), Energy Prices and Alberta Government Revenue Volatility. Toronto, Canada: CD Howe Institute Commentary. p13.
Leamer, E.E., Stern, R.M. (2017), Quantitative International Economics. United Kingdom: Routledge.
Levin, A., Lin, C.F., Chu, C.S.J. (2002), Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108(1), 1-24.
Levinsohn, J., Petrin, A. (2003), Estimating production functions using inputs to control for unobservables. The Review of Economic Studies, 70(2), 317-341.
Liu, L., Zong, H., Zhao, E., Chen, C., Wang, J. (2014), Can China realize its carbon emission reduction goal in 2020: From the perspective of thermal power development. Applied Energy, 124, 199-212.
Liu, R., Wang, D., Zhang, L., Zhang, L. (2019), Can green financial development promote regional ecological efficiency? A case study of China. Natural Hazards, 95(1), 325-341.
Ma, D., Fukao, K., Yuan, T. (2004), Price Level and GDP in Pre-war East Asia: A 1934-36 Benchmark Consumption Purchasing Power Parity Analysis for China, Japan, Korea and Taiwan. Utrecht: Paper for Conference "Towards a Global History of Prices and Wages".
Magazzino, C. (2017), The relationship among economic growth, CO2 emissions, and energy use in the APEC countries: A panel VAR approach. Environment Systems and Decisions, 37(3), 353-366.
Mahi, M., Ismail, I., Phoong, S.W., Isa, C.R. (2021), Mapping trends and knowledge structure of energy efficiency research: What we know and where we are going. Environmental Science and Pollution Research, 28(27), 35327-35345.
Markusen, J.R., Melvin, J.R., Kaempfer, W.H., Maskus, K.E. (1995), International Trade: Theory and Evidence. New York: McGraw-Hill. p281-285.
McMillan, M., Rodrik, D., Sepulveda, C. (2017), Structural Change, Fundamentals and Growth: A Framework and Case Studies (No. w23378). National Bureau of Economic Research.
Moon, H., Min, D. (2020), A DEA approach for evaluating the relationship between energy efficiency and financial performance for energy-intensive firms in Korea. Journal of Cleaner Production, 255, 120283.
Morgenstern, R.D., Pizer, W.A., editors. (2007), Reality check: The nature and performance of voluntary environmental programs in the United States, Europe, and Japan. Resources for the Future. United Kingdom: Routledge.
Ockwell, D., Byrne, R. (2016), Sustainable Energy for All: Innovation, Technology and Pro-poor Green Transformations. United Kingdom: Routledge.
Olawale, R., Olanrewaju, I. (2016), Investigating the influence of financial reward on Lagos State University staff turnover intention. European Scientific Journal, 12(10), 161-170.
Oliveira, G., Murton, G., Rippa, A., Harlan, T., Yang, Y. (2020), China's belt and road initiative: Views from the ground. Political Geography, 82, 102225.
Owusu, P.A., Asumadu-Sarkodie, S. (2016), A review of renewable energy sources, sustainability issues and climate change mitigation. Cogent Engineering, 3(1), 1167990.
Pan, X., Uddin, M.K., Han, C., Pan, X. (2019), Dynamics of financial development, trade openness, technological innovation and energy intensity: Evidence from Bangladesh. Energy, 171, 456-464.
Paramati, S.R., Shahzad, U., Doğan, B. (2022), The role of environmental technology for energy demand and energy efficiency: Evidence from OECD countries. Renewable and Sustainable Energy Reviews, 153, 111735.
Paramati, S.R., Ummalla, M., Apergis, N. (2016), The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. Energy Economics, 56, 29-41.
Petrin, A., Poi, B.P., Levinsohn, J. (2004), Production function estimation in Stata using inputs to control for unobservables. The Stata Journal, 4(2), 113-123.
Pickl, M.J. (2019), The renewable energy strategies of oil majors-from oil to energy? Energy Strategy Reviews, 26, 100370.
Ponomarenko, T., Nevskaya, M., Marinina, O. (2020), An assessment of the applicability of sustainability measurement tools to resource-based economies of the commonwealth of independent states. Sustainability, 12(14), 5582.
Popkin, B.M., Duffey, K., Gordon-Larsen, P. (2005), Environmental influences on food choice, physical activity and energy balance. Physiology and Behavior, 86(5), 603-613.
Qarnain, S.S., Muthuvel, S., Bathrinath, S. (2021), Review on government action plans to reduce energy consumption in buildings amid COVID-19 pandemic outbreak. Materials Today: Proceedings, 45, 1264-1268.
Revelle, R. (1976), Energy Use in Rural India: It is surprisingly high, but an increase in energy supplies and more efficient utilization are needed. Science, 192(4243), 969-975.
Richter, M. (2013), Business model innovation for sustainable energy: German utilities and renewable energy. Energy Policy, 62, 1226-1237.
Sadorsky, P. (2000), The empirical relationship between energy futures prices and exchange rates. Energy Economics, 22(2), 253-266.
Sadorsky, P. (2010), The impact of financial development on energy consumption in emerging economies. Energy Policy, 38(5), 2528-2535.
Sheather, S.J., Jones, M.C. (1991), A reliable data-based bandwidth selection method for kernel density estimation. Journal of the Royal Statistical Society: Series B (Methodological), 53(3), 683-690.
Shi, K., Chen, Y., Yu, B., Xu, T., Chen, Z., Liu, R., Wu, J. (2016), Modeling spatiotemporal CO_2 (carbon dioxide) emission dynamics in China from DMSP-OLS nighttime stable light data using panel data analysis. Applied Energy, 168, 523-533.
Stern, D. I. (2017). How accurate are energy intensity projections?. Climatic Change, 143(3), 537-545.
Sun, H., Edziah, B.K., Sun, C., Kporsu, A.K. (2019), Institutional quality, green innovation and energy efficiency. Energy Policy, 135, 111002.
Tilman, D., Socolow, R., Foley, J.A., Hill, J., Larson, E., Lynd, L., Williams, R. (2009), Beneficial biofuels-the food, energy, and environment trilemma. Science, 325(5938), 270-271.
Tol, R.S. (2002), Estimates of the damage costs of climate change. Part 1: Benchmark estimates. Environmental and resource Economics, 21(1), 47-73.
Torgler, B., Schneider, F. (2009), The impact of tax morale and institutional quality on the shadow economy. Journal of Economic Psychology, 30(2), 228-245.
Wang, Y., Chen, L., Kubota, J. (2016), The relationship between urbanization, energy use and carbon emissions: Evidence from a panel of Association of Southeast Asian Nations (ASEAN) countries. Journal of Cleaner Production, 112, 1368-1374.
Xiaoli, Z., Rui, Y., Qian, M. (2014), China's total factor energy efficiency of provincial industrial sectors. Energy, 65, 52-61.

Xu, Z., Guan, X., Jia, Q.S., Wu, J., Wang, D., Chen, S. (2012), Performance analysis and comparison on energy storage devices for smart building energy management. IEEE Transactions on Smart Grid, 3(4), 2136-2147.

Yin, P., He, G., Fan, M., Chiu, K.Y., Fan, M., Liu, C., Zhou, M. (2017), Particulate air pollution and mortality in 38 of China's largest cities: Time series analysis. BMJ, 356, 667.

Zhang, X.P., Cheng, X.M., Yuan, J.H., Gao, X.J. (2011), Total-factor energy efficiency in developing countries. Energy Policy, 39(2), 644-650.