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Relationship between Power Energy Consumption, FDI and Economic Growth: A Case Study of Pakistan

Saddam Hussain* and Chunjiao Yu

Department of International Economics and Trade, Hubei University, Wuhan, China

Abstract

This study investigates the causal relationship between power energy consumption, FDI and Economic growth in Pakistan using time series data from 1965 to 2019. Johansen co-integration test is employed for finding out relationship and Granger causality test is used to find the direction of causality amongst the variables used. The results Granger test of causality finds unidirectional causality from FDI to GDP growth, a unidirectional causality relationship running from GDP growth toward power energy consumption and from foreign direct investment toward economic growth. Foreign Direct Investment has positive impact on the economic growth and economic growth stimulate energy consumption, so indirectly energy consumption is enhanced with the expansion of FDI, hence the government should pay full attentions to the security of foreign investors and enhance the energy production in order to enhance the economic growth of Pakistan.

Keywords: Power energy • FDI • Economic growth • Co-integration • Energy consumption

Introduction

Economic development is nowadays considered as one of the leading priorities and an enviable objective of any economy and has captured the supreme attentions of every policy maker for any country worldwide. To accomplish this target, countries are making every single possible attempt and take every possible measure. Many businesses are participating in the global investments and financial distributions, and many countries stimulate foreign investment to enhance their economic growth. Researcher have analyzed through various techniques and models for different regions and have proved that the more effective way to enhance economic growth is to boost up the foreign investment (FDI) which is considered as the cheap and efficient way technology transfer in-between economies, putting their own interests on the top [1-3]. Most of the trade and business associations, policymakers and economists deem Foreign Direct Investment as a significant mean of the expansion of an economy and a profound solution of economic problems especially during scarcity of national savings [4]. To attract foreign investment, countries are making efforts to provide a favorable and business friendly platform for the investors i.e., security, energy, infrastructure and financial policies for the investors etc. but the most important factor that foreign investors often prior when they are investing, is the energy availability in the reign where they are investing. This is so because, in the current climate, energy plays a vital role in almost every aspect of our daily lives i.e., production, manufacturing, businesses, trade, health, education, agriculture and even services sectors [5]. Everyone has come up with that the wheel of life is now revolving around it. It is not surprising that energy has become the bedrock of a country's progress and economic development, as it has a huge impact on economic and social upgrading. Numerous emergent nations, comprising Pakistan, continue to experience and undergo the adverse effects of the energy dilemma. Its crises bedevil manufacturing and production industries, reduce agricultural output, reduces exports, causes foreign investment to flow back, leads to more job losses, closing businesses and services industries, and causing prices to rise [6]. Pakistan has been facing energy crisis since 2006.The main reasons are low efficiency in increasing production capacity, limited research resources, low efficiency against the consumption of energy i.e., hydropower and coal etc. and lesser renewable energy resources. These shortcomings lead to a huge gap between demand and supply, causing a heavy load-shedding of electricity and gas. On average, the power supply gap remained about 5,000 megawatts (MW), which increased to 7,000 MW in July 2014. The mega shortfall of energy has adversely affected Pakistan's economy, resulting in the shifting of majority of the textile industries abroad and much more were closed down, GDP growth rate was decelerated, inflation rate rose up which caused unemployment and resulted in poverty increase [7]. In fact, energy crisis in Pakistan afflicted all the economic sectors which ultimately deteriorated the national development in a dire manner, an estimated 2–2.5% off Pakistan's annual gross domestic product. Especially during the past couple of decades, energy crises reached to its boom and government failed to deal with the heavy shortfall, precipitously and promptly growing demand, power thievery, losses of electricity due to outdated transmission lines and seasonal squeezing of hydropower due to shortfall of water which had adversely blemished the economic situation of the country. But governments did not stop their efforts to overcome this serious problem and finally found clues in the form of the China-Pakistan Economic Corridor (CPEC), which offers a promising path for resolving these crises. Pakistan and China signed a mega project on the soil of Pakistan with the financial assistance from China with the intentions to promote trade by upgrading the infrastructure and Gwadar sea port of Pakistan in 2013. Initially the project was cost $46 billion which presently cost $ 62 billion as of 2020, due to the addition and expansion of some projects. As the name suggests that it's a mega project restricted to the development of roads but the fact is that it's a versatile project which will cover infrastructure, industrial, security and energy sectors as well. Around 70% of the investment is to be made in the energy sector due to which sometimes the project is termed as Pakistan-China Energy and Economic Corridor (PCEEC). Pakistan's hallucination and expectations are to make Pakistan the next market leader by 2025. In this stratum, the China Pakistan Economic Corridor (CPEC) ideology of road, rail and port projects throughout its portfolio is well-aligned with Pakistan, and is it the right solution to relieve Pakistan of its economic and development calamities. More than $33 billion worth of energy infrastructure was to be built by private federations to help ease Pakistan's chronic energy shortages – approximately 4500 MW caused an estimated loss of 2-2.5% of annual GDP. It was deemed that Pakistan would be able to generate 10,400 MW of energy capacity between 2018 and 2020, as a part of the "Early Harvest" scheme of the CPEC project.

In this twisted world of substantially industrial economies, the role of power energy (electricity) is as crucial as other factors of production land,

***Address for Correspondence:** Dr. Saddam Hussain, Department of International Economics and Trade, Hubei University, Wuhan, China, E-mail: saddamakaash@gmail.com*

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labor and capital are, and its weigh of consumption is considered as a scale of measuring the socio-economic development of economies [8,9]. Hence, the substantial significance of the share of power energy consumption enlarges with quite a pace. Developed economies necessitate power energy to operate their industrial sectors, while emerging economies require it to "catch up" with established and technologically advanced economies.

In the economic history of Pakistan, electricity consumption has been increasing with the growth in economic expansion and FDI growth [10,11]. As we know that FDI brings an expansion in the technology and production which ultimately leads to energy consumption [12]. However, since the second last decade until the mid of last decade this relation confronted with massive fluctuations in Pakistan. For example, the growth rate in the fiscal year 2004-2005 and 2008-2009 was recorded 9% and 2.4% respectively, while the power energy consumption rate was recorded with a persistent rate of 6% per year during the period 1998-2008. Additional factors like political instability, terrorism and governmental inability to enhance the capacity of the already installed power generation sectors and further expansion of the power stations to meet the demand lead the country toward serious energy crisis which ultimately resulted a lower economic growth rate in the country. From 1999-2007 an increase in the power generation was recorded at the rate of 12% only, which was recorded 53% during the period 1994-1999. In 2009, the installed capacity of power generation was 19420 MW but unfortunately the output was 15903 MW, while the demand was between 17000-19000 MW (varied due to seasonal variations). That shortage (difference between demand and supply) of approximately 3000-4000 MW caused a loss of Rs.2.2 billion along with a huge loss of around 400,000 jobs and a decline in the exports around Rs.75 billion per year. Thus hypothetically, we can assume that economic growth and electricity consumption in Pakistan move on cheek by jowl. But this needs to be empirically proven, and the direction of causality requires to be concluded so that to analyze which is the driving variable and which variable is to be driven i.e., whether power energy consumption in Pakistan effecting the economic growth or economic growth constraining power energy and similarly to investigate the case of FDI and power energy consumption.

There is a substantial literature available that has defined the causal relationship between power energy consumption and economic growth, foreign direct investment (FDI) and economic growth, energy consumption and foreign direct investment (FDI) using various econometric models over the past couple of decades. Those findings are mostly with limited results. The limitations involve concentrating on single countries with too-short data samples or sometimes the non-inclusion of other significant economic variables. To lessen these hitches in econometric estimation, this study further incorporating the impact of population growth and long-term time series data set for the period of 1965-2019. The dynamic association of the GDP-FDI- power energy consumption nexus is evaluated by applying co-integration techniques and for the short-run and long-run causality linkage amongst these variables, granger causality techniques is used. The remainder part of this paper is shaped in the following mode. Section 2 offers a brief review of the energy consumption, FDI and economic growth nexus. Section 3 summarizes the model description and estimation methodology; the estimated empirical results are discussed in section 4 and policy interpretations and conclusions are presented in the final section.

Literature review

The association between FDI growth, energy consumption and economic growth is a contentious theme throughout the economic world due to its diverse empirical results. Taking into account factors such as GDP growth rate, total foreign direct investment, energy consumption, etc., a large number of research articles and different research results have been produced. In the former presented research studies, economists are greatly concerned about the significance or the association of each from these three dynamics with each other. Hence, the present study is intended to be roughly categorized in the following three sections. The first section is to explain the status quo of energy in Pakistan. Second section is concentrating on literature reviews about FDI, energy consumption and economic growth. The third section explores the impact of other additional factors on the overall GDP growth.

FDI and energy consumption: The FDI-energy nexus has grabbed a massive attention since the last couple of decades. Various developing economies are expanding with quite a pace by attracting and motivating the foreign investment which ultimately escalates the demand for energy. As energy is used almost in every production and services sector so with the increase of FDI, economic activities increase that leads toward the greater demand for energy [13]. There have been a lot of studies related to the literature of FDI-energy nexus and there have been contradictory results of these studies. Some studies show negative impact, some shows positive while some have resulted in the “mixed” impact of FDI on energy efficiency. The so called “mixed” indicates that some models result in multiple conclusions (both positive and negative) impact about FDI and energy efficiency. Following are some examples from the pre-existing literature on FDI and energy relation.

- **Negative impact:** The study of 20 developing countries, using correlation analysis concluded that FDI has a negative influence on energy intensity, which is due to the introduction of modern technologies in the economies [14]. Elliott determined a substantial and negative association between the FDI and energy, but it was discovered that the effect was fluctuated with changes in the geographical location, absorption capacity and environmental drives of the regions [15]. The case of developing countries 1975-2004 using panel estimation techniques and tests resulted negative impact of FDI on energy consumption [16]. Another example is the study of 17 cities of China 1996-2010 using super-efficiency DEA resulted with negative impact [17]. The results of the study of 13 cities of China for the period 2005-2007 using the PCSE estimator indicated a negative impact [18]. Similarly, the finding of the study about China 2005-2014 using the spatial Durbin panel model also resulted the negative impact [19]. Likewise, the study conducted taking time series data of Pakistan for the period 1990-2017, employed Johansen co-integration and Granger causality tests and indicated a positive short-run and long-run association [20]. So, it is concluded that apart from FDI’s direct impact there are some additional factors as well which affects energy-FDI relation.
- **Positive impact:** The study about China, using a penalized panel quantile regression model for the period 2000-2016 for the relation of FDI and energy find a positive impact of FDI on the energy consumption [21]. Lu n 2018 used static-dynamic mode for China for the period 1990-2015 and found the positive impact of FDI with energy efficiency [22]. Wang studies for FDI and energy efficiency in China for the period 2001-2013 using the sequential data envelopment analysis also fined the positive impact on each other. In 2012 found positive impact using Shephard energy distance function for the period 2001-2010 [23]. Robert and Elliot in 2031, while using Linear and quadratic log estimation, for the period 200-2008 in the case of China also fined the positive impact [15]. They were using panel co-integration methodologies for the emerging market economies for the period of 199-2012 found a positive impact of both these factors on each other [24]. The relationship analysis of FDI and energy in China in the year 2017 for the period 1982-2012 using the bounds testing approach also resulted in the positive impact [25].
- **Mixed impact:** Some studies’ results derived from the models have shown a mixed impact of FD on energy consumption, depending upon the economic, social and geographical condition the countries under considerations. For example, the study of FDI influence on renewable energy consumption for 74 countries for the period 1985–2012 using the Blundell–Bond dynamic panel estimator found that the effects of FDI changes in magnitude as well as in significance [26]. Similarly, the study of FDI in France using time series data for the period 1955–2016 also resulted in

mixed impact of FDI on energy innovation and consumption [27]. The evidence from the studies in case of GHANA to examines the relationship of foreign direct investment and energy consumption for the period 1981-2014 using Fully Modified Ordinary Least Squares (FMOLS) and the Canonical Co-integration Regression (CCR) showed a positive correlation of energy consumption with that FDI and industry value-added and negative impact with financial development and energy prices [28]. The outcomes of the study using Panel Corrected Standard Errors for China over the period of 1999-2007 also resulted in mixed impacts. Also, the study taking data of 100 countries over the period of 1980-2015 using fixed effects methodology gave mixed results.

So, from the mentioned evidences from the pre-existing literature, we can conclude that the relationship of energy and FDI is not a fixed and uniform throughout the world for every economy, it varies depending on the economic conditions, capability of absorption of new technological change of an economy and its geographic location etc.

FDI and economic growth: Foreign Direct Investment (FDI) has cropped up as the most essential measure of resource inflow since years and has turned into a very substantial mean of capital development for the developing economies. It is considered an important vehicle for the transfer of technology and help boost economy more rapidly than the investment made domestically. This part of the existent literature emphases on the relationship of FDI in the economic growth. For example, the study conducted using panel data of several Asian countries over the period 1990-2013 found a significant positive relationship between FDI and economic growth [29]. The study of 69 developing countries over the period 1970-1989 suggested that role of FDI in economic expansion is comparatively more significant and beneficial for the economic progression of an economy as compared to the domestic investment [30]. The study that used the panel data of 72 countries based on a cross-section of countries over the period 1960-95, using simple ordinary least squares (OLS) regressions and a dynamic panel procedure concluded the positive linkage between FDI and growth and further showed that FDI encourage technology pass on which ultimately accelerate the overall economic growth of the beneficiary countries [31]. The study to examine foreign direct investment (FDI) effects on economic growth using a panel data of 84 countries for the period 1970–1999 employing both single equation and simultaneous equation system techniques showed a significant endogenous relationship [4]. The study conducted to analyze the role of FDI in the income growth and market-oriented transition of China, Utilizing the growth model on the cross-section and panel data over the period 1984-98 showed that FDI ameliorate China's income growth of Sampling technique (Figure 1) [32].

Similarly analyses conducted for the case of Pakistan also showed a significant impact of FDI on the overall economic growth. For example, a study conducted in 1992, to analyze the FDI and economic growth, taking the data for the period for 1959-60 to 1987-88 concluded that foreign direct investment and growth of real GNP had a significant relation and the earlier had a positive impact on the later one [33]. Another study which analyzed

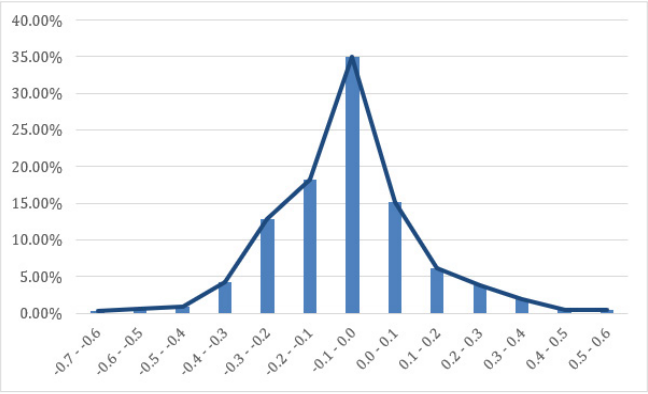

Figure 1. Cost estimating errors.

the causal association of FDI, exports and output for the period 1972 to 2001 using Granger non-causality procedure, noticed significant effect of FDI on domestic production [34]. Likewise, many more studies conducted for Pakistan which had concluded that there is always a significant relationship of FDI and economic growth in Pakistan [35-40]. It is concluded from findings of the mentioned studies that FDI will bring a substantial reform in the economic progression and technological advancement in Pakistan. The interaction term between FDI and financial development indicator is positive, while the coefficient of FDI is negative in the case of Pakistan. This suggests that FDI will have a positive impact on growth performance only if the domestic financial sector is well developed and functioning efficiently, otherwise the effect of FDI on economic growth will be negative. The studies also provide the evidences that there is always a causal relationship between FDI and economic growth, where FDI stimulates growth the development of financial sector.

Energy consumption and economic growth: It has been pivotal for a long time that economic development and energy demand are quite associated with each other. As economies expand, energy demand upsurges; if energy is limited, GDP growth backtracks consecutively. This has been the case probably since the emergence of the Industrial Reform in the economic world, if not long before. In the modern energy economics literature, the relationship of energy consumption and economic growth has grasped mounting considerations from the analysts and researchers. For the very first time in 1978, the interest in the subject matter was showed when the data for USA was used and found the causality relationship between energy consumption and economic growth [41]. The study showed that there is a causality relation that runs toward energy consumption from economic growth. A study in 1988 conducted for both the developed and developing countries which resulted more significance in the case of developing countries as compared to the developed countries [42-45]. The case which studied causality between energy and GNP in Taiwan in 1997, using data for the period 1955-1993, applying Hsiao's version of the Granger causality found the causality running from GDP growth to energy consumption [46]. Recently, attentions have been diverged to the study of causality direction and assessing the magnitude between energy consumption and GDP in the emerging economies using different econometric methodologies. The study conducted for three sub-Saharan African countries Using the ARDL-bounds testing technique found a unidirectional relationship i.e., from energy consumption to economic growth in South Africa and Kenya while the case of Congo showed the causality run from economic growth to energy consumption [47]. Similarly, a study for the emerging countries of south Asia, Pakistan India and Bangladesh over the period 1973–1991 using Granger causality test explored that financial development leads to technological expansion which ultimately leads to the energy consumption growth [35]. Likewise, many more studies have explored the relationship of these variables employing various models and techniques [48-51]. These are some of the references that explain the relation and direction of causality.

However, several studies have examined the causal association between energy consumption and economic growth in Pakistan using different econometric models. A study in 2001 for Pakistan using techniques of co-integration and Hsiao's version of Granger causality, to find out the causality and relationship between energy and economic growth which has resulted that economic growth cause energy consumption [52]. The analysis of the relation of financial growth and energy consumption for Pakistan in 2015 for the period of 1972–2012 employing the GMM estimation technique concluded the positive and significant impact of economic growth on energy consumption [11]. The study conducted for the period of 1980–2009 using Johnson Co-integration test, VECM Granger causality test for Pakistan showed the existence of a significant long run relationship and Unidirectional causality from economic development to energy consumption [53]. A study using annual data over the period 1971–2004 employing ARDL and ECM found a positive and significant impact of economic expansion on the energy consumption in long run [54]. Likewise, the empirical results of a latest study, investigating the sector-level energy consumption showed long-run relationship between the two variables in the case of Pakistan

while using the annual data for the period of 1980–2016B [55].

Thus, our investigation based on the review of pre-existing literature, provides evidence that energy consumption is emerging due to economic and financial expansion. The results of previous studies of both these economic factors show that there is almost always a positive and a significant effect on each other. The bottom line of this literature review is that economic expansion directly led to greater energy demand and a sufficient energy supply contributes quite to an extent in the industrial, technological and production expansion which ultimately led to economic growth.

Materials and Methods

The study employs annual time-series data over the period 1965-2019 for energy consumption, economic growth and foreign direct investment. The data was collected from various sources mentioned in table. Various studies have been carried out to investigate the relationship of energy–GDP growth. FDI-Energy consumption and FDI-GDP growth in Pakistan and have estimated assorted results. As far to our knowhow, none has explained both FDI and economic growth along with the power energy consumption. This paper attempts to explain the relationship and the direction of causality among FDI, economic growth and power energy consumption in Pakistan using co-integration econometric models (Table 1).

Model specification

To analyze the relationship among energy consumption, FDI and economic growth by adding total population per year variable to construct a multivariate regression framework. To confront with the heteroskedasticity issue, all the logarithm form of all variables is taken into consideration while running the model for estimating relationship. The form is used hence, to analyze the relationship between energy consumption, FDI and economic growth; the log linear quadratic equation can be drawn in the form of following model;

$$LECt = \alpha_1 + \alpha_{LFDI} LFDI_t + \alpha_{LGDP} LFDI_t + \alpha_{LPOP} LPOP_t + \varepsilon t \quad (1)$$

Where,

α ⇒ Constant term used in the model

LEC ⇒ the natural log of energy consumption

LFDI ⇒ the natural log of Foreign Direct Investment

LGDP ⇒ the natural log of Grass Domestic Product (economic growth)

LPOP ⇒ the natural log of total population of Pakistan

ε ⇒ The error term

Data

Unit root test: To determine the stationarity of annual time series data of energy consumption, economic growth and foreign direct investment the unit root tests are employed. To ensure the stationarity of data and to determine the order of integration amongst variables, we will employ "Dickey–Fuller (DF) and augmented (ADF) unit root test ".

Co-integration test: To find out the relationship amongst variables co-integration test is employed. In this study for the long run relationship among energy consumption, economic growth and foreign direct investment is assessed using the Johansen co-integration technique which involves the evaluation of a Vector Error Correction Model (VECM) for determination of the likelihood-ratios [56]. If there are n numbers of variables have unit roots the number of co-integrating vectors that this model gives at most will be n-1. For the current study the general form of VECM model, based on the variables used, is constructed as follows:

$$\Delta Y = \theta_0 + \sum_{i=1}^{K-1} \theta_i \Delta Y_{t-1} + \propto \beta Y_{t-k} + \varepsilon_t \quad (2)$$

Where,

Δ ⇒ the difference operator in the model

Y_t⇒ (LEC, LFDI, LGDP, LPOP)

θ⇒ The intercept

ε ⇒ The vector of white noise process

This technique consists of two likelihood ratio tests i.e., the maximum eigenvalue and the trace test. On the basis of number of significant non-zero Eigen values, the number of co-integrating vectors is further determined. Once it is confirmed that there is co-integration relation that means that there is causality association among variables. To find out the direction of causality we employ granger causality test.

Granger-causality: The presence of co-integration among the variables implies the causal relationship but not the tendency of that causality. To estimate the direction of causality between EC, FDI, GDP and POP, we employed the empirical equations of the VECM Granger-causality as follows one by one for each variable.

For energy consumption (EC)

$$\Delta LEC_t = \alpha_0 + \sum_{i=1}^{q} \alpha_1 \Delta LEC_{t-i} + \sum_{i=1}^{r} \alpha_1 \Delta LFDI_{t-i} + \sum_{i=1}^{s} \alpha_1 \Delta LGDP_{t-i} + \sum_{i=1}^{t} \alpha_1 \Delta LPOP_{t-i} + \Psi_1 ECT_{t-1} + \varepsilon_{1t} \quad (3)$$

For foreign direct investment (FDI)

$$\Delta FDI_t = \alpha_0 + \sum_{i=1}^{q} \alpha_2 \Delta FDI_{t-i} + \sum_{i=1}^{r} \alpha_2 \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_2 \Delta LGDP_{t-i} + \sum_{i=1}^{t} \alpha_2 \Delta LPOP_{t-i} + \Psi_2 ECT_{t-1} + \varepsilon_{2t} \quad (4)$$

For economic growth (GDP)

$$\Delta GDP_t = \alpha_0 + \sum_{i=1}^{q} \alpha_3 \Delta GDP_{t-i} + \sum_{i=1}^{r} \alpha_3 \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_3 \Delta LFDI_{t-i} + \sum_{i=1}^{t} \alpha_3 \Delta LPOP_{t-i} + \Psi_3 ECT_{t-1} + \varepsilon_{3t} \quad (5)$$

For population growth (POP)

$$\Delta POP_t = \alpha_0 + \sum_{i=1}^{q} \alpha_4 \Delta POP_{t-i} + \sum_{i=1}^{r} \alpha_4 \Delta LEC_{t-i} + \sum_{i=1}^{s} \alpha_4 \Delta LGDP_{t-i} + \sum_{i=1}^{t} \alpha_4 \Delta LFDI_{t-i} + \Psi_4 ECT_{t-1} + \varepsilon_{4t} \quad (6)$$

Where

α ⇒ Constant term used in the model

ε_it ⇒ serially uncorrelated random error terms. (1, 2, 3, 4, 5....)

LEC ⇒ the natural log of energy consumption

LFDI ⇒ the natural log of Foreign Direct Investment

LGDP ⇒ the natural log of Grass Domestic Product (economic growth)

LPOP ⇒ the natural log of total population of Pakistan

Ψ⇒ the adjustment coefficient, which shows the amount of disequilibrium corrected

ECT_ (t-1) ⇒ Error correction term which shows the number of co-integrating vectors

Variable name	Description	Source
GDP	Gross domestic product in billion (US $)	World bank's world development indicators, macro trend data
PE	Power energy consumption in (KWH)	Our world in data
FDI	Foreign direct investment in billion (US $)	Macro trend data
POP	Population growth in Pakistan (real value)	Macro trend data

Table 1. Data descriptions and sources.

To find out the flow of long-term causality between variables i.e., dependent and independent variables, the adjustment coefficient ECT (Ψ) has to be significant. When it is significant then we can test the causality from energy consumption (EC) to GDP, FDI AND POP using equation 3. Similarly for the causality from FDI, GDP and POP we use equation 4, 5 and 6 respectively. The Wald test on differenced and lagged differenced terms of the dependent variables is employed to estimate the short run causality.

Results

The results of our estimations are presented step by step as following:

Test for unit roots

The major objective of this study is to analyze the relationship energy consumption with foreign direct investment and economic growth in Pakistan. To resolve the issue of non-stationarity of time series data and order of integration amongst variables, we applied "DF and ADF unit root tests" both the level and at first difference as a unit root test. The results in Table 1 at first difference have indicated stationarity at the 5% level of significance, which implies that the variables i.e., energy consumption, FDI, economic growth and population growth are integrated of order one (Table 2).

Co-integration

Since testified by DF and ADF unit root tests, there exists a similar order of integration which endorses the application of the Johansen co-integration test. But before estimating the co-integration between variables, the optimal lag must be determined. Following the Schwarz information criterion and Akaike information criterion we selected the optimum "lag 2" to be the best option (Table 3) [57].

Co-integration test

Johansen co-integration test is employed to estimate the Co-integration among the variables (Table 4).

The results of demonstrates that for R=0, the λ max statistics value is 45.0775, which is larger than the 95% critical value of 27.07. Also, the maximal Trace statistics value 63.2044 is larger than the 95% critical value of 47.21. This infers the rejection of null hypothesis R=0 at 5% level of significance. So, we reject the null hypothesis at R=0. However, the results of hypothesis R ≤ 1, R ≤ 2 and R ≤ 3 show the λmax statistics values less than the 95% critical values which favors the acceptance of null hypotheses and cannot be rejected. The existence of a single co-integrating vector is realized from the estimated results of trace test and the maximum Eigen test. Hence, the existence of a long run relationship is concluded between energy consumption, FDI, economic growth and population growth in Pakistan.

Hsiao's version of granger causality test

Granger causality test is exercised to signify the direction of casual relationship amongst the variables. Shown in below table the directions of causality between power energy consumption, economic growth, FDI and Population (Table 5).

Discussion

From the results of Hsiao's version of granger causality test it is concluded that there is a causal relation between energy consumption and economic growth, P.E consumption and FDI and P.E and POP growth which runs from economic growth toward power energy consumption, from FDI to P.E and POP growth to P.E consumption. Similarly, we can see

Variables	Level		First difference		Results
	DF ADF		DF ADF		
P. E	-1.321	-1.34	-7.651***	-4.467***	I (1)
GDP	2.081	.0.907	-4.096***	-3.0039***	I (1)
FDI	-1.699	-2.512	-5.121***	-4.758***	I (1)
POP	19.122	-0.018	-0.018	-3.479***	I (1)

Note: ***p<0.01, **p<0.05, *p<0.1 indicates stationarity of data at 5% Significance level

Table 2. ADF unit root test.

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-1607.82	NA	3.10E+21	60.8235	60.8807	60.9722
1	-1176.05	863.55	4.70E+14	45.134	45.134	45.8775
2	-1075.83	200.43*	2.0e+13*	41.956*	42.4707*	43.2943*

*Indicates lag order selected by the criterion. (Each test at 5%)

Table 3. Selection of order criterion.

H1: Alternative hypothesis	H0: Null hypothesis	λMax test	λMax test (0.95)	Trace test	Trace test (0.95)
R=1	R=0	45.0775	27.07	63.2044	47.21
R=2	R≤1	13.4260*	20.97	18.1268*	29.68
R=3	R≤2	4.2011	14.07	4.7009	15.41
R=4	R≤3	0.4998	3.76	0.4998	3.76

*Denotes acceptance of the hypothesis at the 0.95 level

Table 4. Johansen co integration.

Hypothesis on the basis p-value of 5%	No. observations	F. statistics	Probability
P.E consumption does not Granger Cause GDP	54	1.88	0.1764
GDP growth does Granger cause P.E*	54	0.49	0.0487
P.E consumption does not Granger Cause FDI	54	3.96	0.052
FDI does not Granger Cause P.E consumption	54	1.58	0.2149
P.E consumption does not Granger cause POP	54	0.78	0.8138
POP growth does Granger Cause P.E consumption*	54	93.3	0
FDI growth does Granger cause GDP *	54	2.95	0.0217
GDP growth does not Granger cause FDI	54	1.71	0.1968
FDI growth does not Granger cause POP	54	2.37	0.1301
POP growth does Granger Cause FDI	54	3.56	0.065
POP does Granger Cause GDP*	54	39	0
GDP growth does Granger cause POP*	54	5.56	0.0216

*Denotes rejection of the hypothesis at the 0.05 level and accept the alternative hypothesis that is "it has the casual impact on each other."

Table 5. Results of Hsiaos version of the causality tests.

the impact of FDI on economic growth which is positive and the causality run from FDI to GDP growth and there is a causal relation between POP growth and GDP that run from POP growth to GDP. Although power energy consumption does not cause GDP growth directly but indirectly it can boost up the economic growth i.e., as we know that Pakistan's industrial sector is greatly dependent on power energy, so greater the production causes the greater consumption, so greater availability and consumption of power energy enhance the production which ultimately push the GDP upward. Another perspective of energy consumption which leads to GDP growth is that of population growth which cause energy consumption, and that growth help increase production that helps expansion in economic development. So, we can conclude that energy consumption cause GDP growth indirectly, if not directly, because sometime the energy is used for purposes other than commercial or industrial production, like cooking, lighting, cooling and heating in domestic use, that is why we cannot see a direct impact of energy consumption on GDP growth [58,59]. Hence, we can conclude that the overall impact of these variables is causal on each other either in one direction or in both directions. Same is the case of FDI, if Pakistan can supply the needed amount of power energy for technological operations, consumption will increase which will further attract the FDI and hence will help country to boost the FDI inward to Pakistan which will ultimately lead Pakistan to a technologically and industrially prosperous country (Figure 1).

Although sometime they do not impact each other directly but indirectly they do, as discussed above. From the directional causality of power energy to economic growth, it is concluded that power energy is a major engine to economic prosperity and overall development and its supply, to a great extent, can turn out to be the confining component in economic growth of Pakistan.

As we concluded from the findings that FDI plays a vital role in economic growth, further, FDI can attracted heavily through enough supply of energy, security and developed infrastructure, so Pakistan should consider these factor and prior importance is to be given for enhancing these factors. Pakistan should further transform its technological infrastructure to make an efficient use of power energy on both domestic and industrial level, hence to boost production and lower down energy consumption. The third factor that can play a substantial role in the development of its economy is the population, but it will in the case if Pakistan educate its people, both technically and socially so that to help constructing country's economy and give up all those activities terrorism, violence, extremism, corruption etc. which are not in favor of Pakistan's prosperous future.

Conclusion

In this study, we evaluated the causal relationship and the direction of the causal relationship for power energy consumption and FDI and economic growth (using population growth as control variable to form a multivariate framework) in Pakistan in the following fashion:

First, we estimated the relationship between power energy consumption, FDI and economic growth then examined the causal relationship and at last explored the direction of causality amongst the variables used. The main objective is the analyses of the impact of power energy consumption, FDI, economic growth. The estimated results imply that energy consumption FDI and economic growth affect each other quite to an extent.

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