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REVIEW ARTICLE

Does foreign private investment affect the clean industrial environment? Nexus among foreign private investment, CO2 emissions, energy consumption, trade openness, and sustainable economic growth

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Abstract
This study examines to what extent foreign private investment (FPI) affects the clean industrial environment and sustainable economic growth through developed countries investment in China. Moreover, this study investigates an association among FPI, CO2 emission, energy consumption, trade openness, and sustainable economic growth. This study uses random effects and generalized least squares (GLS) and panel VAR estimators for data analysis. The results show that China's economy has a great positive impact on the location and choice of investment in domestic markets in emerging countries and developed countries. In addition, investment in emerging and developed economies has increased the contribution of domestic enterprises and environmental sustainability to the national economy. The further results show that foreign private investment and gross domestic investment have positive impact on sustainable economic growth.

Keywords Clean industrial environment · Energy consumption · CO2 emissions · FPI

Introduction

The fundamental objective of the economies (with high GDP per capita) is to accomplish practical financial development and government assistance of the economy with mechanical advancement (clean ecological-based advances), improvement of natural strategies to moderate the level CO2 discharge (Yu et al 2020). According to Panayotou (1993), economies (after reached at highest level of income per capita) want to move from worse environmental condition to clean environment to get sustainable economic growth. The three stages of environmental Kuznets curve (EKC) premise shows that when economy moving from traditional agricultural sector to industrial sector then the ratio of

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environmental degradation is high at stage first. Finally, the EKC scheme shows that when the economy moves toward administrations area they requests for clean climate suggested that the scale, specialized, and synthesis impacts are the primary parts of the premises of the altered U-molded EKC. The scale impact is identified with the pre-industrialization stage where expands the degree of pay prompts increment the degree of ecological contamination, in this stage modern area is wasteful and fundamentally dirtying the climate.

Besides the positive side of foreign investment, it was often seen as the most controversial regarding their effect on the recipient's growth level. Literature on FPI effectiveness has three basic points, and the first point was the positive impact of FPI on growth and development (Dalgaard and Hansen 2001. Now the world is the global village and many factors effecting economic growth economics, so it is very hard to peruse the answers of the questions usually like "what factor could determine the growth in long run." Many factors influence the economic growth and determination of these factors is so difficult.

Determinants like capital which is in the form of human and physical capital and savings act as the main ingredients for economic growth (Romer, 1988). But some other factors which influences economic growth are FDI, net exports, and collection of remittances from foreign countries (Almfraji and Almsafir, 2014). It is observed that for the improvement in the living standards of the people economic growth encompasses the main role and main tool because it increases the education level, skills, and health of the people.

There was an adverse correlation between foreign assistance and growth rate of GDP, whereas foreign assistance posed negative effect in both long and short term on growth level. Economic growth is the most important instrument in decreasing the poverty and inequality and increasing the living life styles of the people mainly of the developing world. The main growth theories are classical theories (1776), innovative growth theory of, Keynesian theories (1930), neo-Keynesian theories (1950), neo-classical theories and exogenous theory of Robert Solow (1950–1960s), and endogenous growth theories (1980–1990s).

Additionally, there is a significant relationship and impact of CO2 emissions on healthcare expenditure and economic growth. Several other researchers Anser et al 2021a, b, c, Saleem et al 2019; Chaabouni et al. 2016) have investigated and found significant association between environmental degradation effects on health expenditure. A robust and healthy environment will make it easier to produce goods and services and form a productive and healthy working society in every area of life.

Moreover, this notion was also endorsed that the strength of economic development in a nation and community is dependent on the stabilization of the healthcare systems. Also, the results confirm a positive correlation between health spending vs. economic development in terms of Pakistan by demonstrating that ecological conditions are not treated to an adequate degree during her planning process, which contributes to adverse health effects. The researches conducted on Pakistan to date are bivariate in terms of CO2, healthcare spending, and economic growth, while several studies have found links between health and development, as well as pollution and growth.

During the last two decades, the energy and environment sectors have gained intensive attention due to economic, social, and environmental reasons; these sectors grow tremendously, which is the primary concern of the energy sector policymakers, economists, and researchers. In relation to energy and environment sectors expenditures, a number of studies exhibit that the increased government spending on environment improve human life expectancy (Qureshi 2009; Prasetyo and Zuhdi 2013; Anser et al, 2021a, b, c, Arif et al., 2021, Fadilah et al. 2018), and others are, Wang (2011), Oni (2014), and Kurt (2015) and two key hypotheses on energy expenditure have been established. According to the approach of the first hypothesis, spending on energy is like another spending on other luxury items. Another side of the hypothesis suggested that the government spending on energy is just like a basic necessity of life, and market forces determine the energy and environment sectors spending rate.

Review of literature

According to existing literature, the "energy consumption and economic growth are induced CO2 emission nexus can be subdivided in three categories for instance; the association between energy and growth, the association between growth and CO2 emission, the association between energy and economic growth and CO2 emission." The nexus between growth and energy has been employed by the various researchers and they followed the semi work of in their empirical work. The energy-growth nexus postulates three hypotheses, i.e., growth, conservation, feedback, and neutrality hypothesis. Energy utilization is consolidated in the financial development actuated outflows in the current writing. The construction of energy utilization can be partitioned into inexhaustible and non-sustainable power use. The significant supporter of ecological debasement is nonrenewable energy as far as petroleum products. The utilization of nonrenewable sources through energizes ignition is discouraging the natural quality with builds the degree of CO2 emanation (Shabbir 2016). Energy is the principle fixing during the time spent creation; it is the foundation of the modern area. The objectives of monetary development cannot be accomplished without the utilization of fuel sources and an ascent in financial development. It further builds the degree

of energy use and both move equal together (Shabbir 2018; Muhammad et al 2020; Liu et al 2020).

Moreover, environment quality and energy led economic growth have causal relationship and interrelated to each other. The growth of the economy highly depends on the energy sources; analyzed that more noteworthy the utilization of fuel sources may expand the degree of financial development. The creation interaction of the merchandize required energy as mandatory information and without energy different financial exercises cannot develop. Moreover, current monetary development needs energy for modern development, efficiency, and exchange also.

Asghar (2008) assessed the circumstances and logical results of financial development and utilization of fuel sources, where monetary development essentially intensifies the degree of energy use and consequently energy altogether upsurge the degree of GDP development. The energy-development nexus has been examined in different experimental examinations; however, results are as yet uncertain.

The future of fossil energy depends upon the decisions of the top leading organizations because their choices may affect the market situation and the expectations of the decision-makers. Further, it was also observed that technological advancement worked as a key indicator that identified the dominancy of the global trend of fossil energy resources by 2040. On the other hand, the second school of thought determined that the expenditure on the renewable energy sector and economic growth have a bidirectional association (Atilgan et al., 2017). More spending on the energy sector increases the economic growth; on the other side nation with higher GDP can be able to spend more on the energy sector and vice versa. In the recent era, CO2 emission and expenditure on the energy sector have to grab the attention of policymakers, healthcare and environmental specialist, and researchers showed that there was a strong positive significant correlation between CO2 emissions and economic growth. In 30 provinces of China, Lu et al. (2017) studied the relation between the CO2 emission levels and their environmental effects on public health. The findings indicate that both variables are correlated negatively and significantly while facilities and the state of the health sector have a direct influence on public health and economic development.

Similarly, more spending on the healthcare sector enhances the condition of the workers, which enhances their level of efficiency; hence, their productivity increases that ultimately enhances economic growth. On the other hand, the second school of thought determined that the expenditure on the health care sector and economic growth have a bidirectional association (Atilgan et al., 2017). More spending on the health care sector increases the economic growth; on the other side nation with higher GDP can be able to spend more on the healthcare sector and vice versa. In the recent era, CO2 emission and expenditure on the healthcare sector have to grab the attention of policymakers, healthcare and environmental specialist, and researchers showed that there is a strong positive significant correlation between CO2 emissions and expenditure on healthcare. In 30 provinces of China, Lu et al. (2017) studied the relation between the CO2 emission levels and their environmental effects on public health. The findings indicate that both variables are correlated negatively and significantly while facilities and the state of the health sector have a direct influence on public health and economic development.

Examined the link between CO2 and SO emission and health care expenditure in a case study of Iran from 1967 to 2010. The study employed ARDL and co-integration technique, the result suggested that the emission has a positive and significant link with healthcare expenditures studied the economy of Ghana for the period of 1970 to 2008 by taking the three variables, i.e., health care expenditures, GDP, and CO2 emission, and found the association between them. The FMOLS technique was used to determine the association between them and explored the positive association between GDP and the healthcare sector while the negative association between CO2 emission and the healthcare sector. A small number of researchers also investigated the association between healthcare expenditure and CO2 emission and found a positive and causal association. The investigation is based on panel data (Li et al, 2021; Saleem et al 2019; Shabbir et al., 2021; Yikun et al, 2021; Chaabouni et al. 2016; Jun et al, 2021; Khan et al, 2021a, b, c, d; Muhammad et al., 2021; Arslan et al 2021); rapid per capita income growth was found, from 1980 to 2000 the growth of per capita was stable, and after 2000 an increasing trend was seen in per capita growth.

Examine the energy issues confronting society from a worldwide governance point of view. It contends that an idea of "worldwide energy governance," interpreted as meaning global aggregate activity endeavors attempted to oversee and convey energy assets and gives power services, offers a significant and helpful structure for evaluating energy-related difficulties. The research starts by investigating the ideas of governance, worldwide governance, and worldwide energy governance. It at that point inspects a portion of the current organizations set up to set up and do rules and standards overseeing worldwide energy issues and depicts the scope of institutional plan choices accessible to policymakers.

have pointed out several factors that drive the world energy market future; these variables include population and economic growth rate, the intensity of energy and technology used for the process of production, available alternative sources of energy, and environmental hazards which arise due to emission of harmful gasses.

Methodology

This study includes twenty-two (22) emerging and developed economies, such as "Australia, Belgium, Canada, France, India, Italy, Hong Kong, Germany, Japan, South Korea, Malaysia, Netherlands, Pakistan, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, the United Arab Emirates, the UK, the USA" and other countries (general countries) are used as FPI sources to investigate the impact of "sustainable economic growth" channels on foreign private investment. The independent variable of this study is FPI, which includes "foreign direct investment" (FDI) and "foreign portfolio investment" (FPI) from these 22 countries, while "sustainable economic growth is the dependent variable, energy consumption and carbon dioxide emissions are the instrumental variables for our research. However, trade, exchange rate, and GDP growth rate are policy variables." The proxy for the dependent variable ("sustainable economic growth") is considered GDP. All data sets are from the "World Development Indicators" (WDI). This study consists of data set from 2000 to 2019. In addition, this review assesses the worth of interests in our uneven board informational collection using irregular impacts from generalized least squares (GLS).

$$GDP_{it} = \alpha + \beta_1 FPI_{it}\text{Values} + \beta_2 X_{it} + \varepsilon_{it} \quad (1)$$

$$GDP_{it} = \alpha + \beta_1 FPI_{it}\text{Count} + \beta_2 X_{it} + \varepsilon_{it} \quad (2)$$

In above equations, two models are explained as FPI value model and FPI as count model, whereas X_{it} denotes all the instrumental and policy variables of our study. After adding Eqs. 1 and 2, we get Eq. 3.

$$GDP_{it} = \alpha + \beta_1 FPI_{it} + \beta_2 CO2_{it} + \beta_3 EC_{it} + \beta_4 TRADE_{it} + \beta_5 G.GDP_{it} + \beta_6 EX_{it} + \varepsilon_{it} \quad (3)$$

where FPI_{it} is the value of FPI in year t ($t = 1,\ldots T$) from country ($i = 1,\ldots I$). This study has implied the Poisson and negative binomial models. Cameron and Trivedi (2013), Li et al. (2021), Arif et al. (2020), Shabbir and Yaqoob (2019), and Hilde (2011) explained the "better understanding regarding adverse binomial methodology." Furthermore, this analysis comprises and tests on below two hypotheses.

Hypothesis 1: "It is expected that FPI can positive affective toward the country's economic growth, which could be sustainable pollution haven hypothesis across the countries."

Hypothesis 2: "There is an inverted U-shaped environmental Kuznets curve (EKC) association between CO2 emissions, energy consumption, and GDP growth."

Table 1 Descriptive statistics

Variables	Observations	Mean	S.D	Minimum	Maximum
FPI	440	0.061	0.322	0.001	1.121
GDP	440	0.001	0.003	0.003	1.930
Trade	440	0.034	0.011	0.002	0.512
CO2	440	0.023	0.032	0.013	0.525
EC	440	0.029	0.042	0.011	0.521
G.GDP	440	0.003	0.041	0.003	1.234
EX	440	0.211	0.523	0.081	2.021

Descriptive analysis

The purpose of such descriptive statistics is to interpret and summarize data in a formal way. This test further tells us the usage of parameters and tests within parameters. The table of means explains the average between the variables. Table 1 shows the "values of GDP, foreign private investment (FPI), trade, carbon dioxide emissions, energy consumption, per capita GDP growth rate, and exchange rate."

Correlation analysis

Table 2 provides the association among the dependent and all independent variables ("values of GDP, foreign private investment (FPI), trade, carbon dioxide emissions, energy consumption, per capita GDP growth rate, and exchange rate"). The GDP (0.011), trade (0.011), CO2 (0.050), EC (0.020), G.GDP (0.031), and EX (0.131) have positive relationship with foreign private investment (FPI). The gross domestic product values is positively associated with trade (0.412), CO2 (0.443), EC (0.049), G.GDP (0.043), and EX (0.313). The trade is positively correlated with CO_2 and exchange rate, while the trade is negatively correlated with energy consumption and G.GDP. The CO_2, energy consumption, per capita GDP growth rate, and exchange rate have positive relationship with each other.

Table 3 shows generalized least squares (GLS) and negative binomial model estimations (NBME) through two models such as FPI value model and FPI count model, respectively. All the values in both models show statistical significant and positive impact on each other. However, FPI value model is more effective and reliable findings as relatively compared with FPI count model on base on *F*-statistics.

Table 4 represents the primary penal VAR estimation by using GMM, and the coefficient suggests that there exists a positive association between CO2 emission, healthcare expenditure, energy production, population growth, and life expectancy; moreover, the first three variables are leading variables while the rest are control variables. The result shows that CO2 emission and healthcare expenditure have

Table 2 Correlation analysis among variables

Pearson's correlations	1	2	3	4	5	6	7
1 FPI	1.000						
2 GDP	0.011	1.000					
3 Trade	0.011	0.412	1.000				
4 CO2	0.050	0.443	0.534	1.000			
5 EC	0.020	0.049	−0.046	0.732	1.000		
6 G.GDP	0.031	0.043	−0.038	0.112	0.324	1.000	
7 EX	0.131	0.313	0.522	0.602	0.712	0.824	1.000

Table 3 Generalized least squares and negative binomial model estimations

Years (2000–2019)	FPI value model	FPI count model
FPI	0.615**	0.712***
	(0.271)	(0.245)
GDP	0.522***	0.142***
	(0.024)	(0.073)
Trade	0.103	0.153*
	(0.973)	(0.084)
CO2	0.132	1.232
	(0.173)	(0.871)
EC	0.023	−0.234
	(0.471)	(0.456)
G.GDP	0.411	0.336
	(0.611)	(0.412)
EX	0.511	0.751
	(0.605)	(0.363)
Constant	35.821	10.321
	(31.051)	(16.223)
Number of observations	440	440
F-statistics	14.523	11.317
p value	0.000	0.000
Adjusted R2	0.185	
LLH		−110.368
AIC		1.811

* is represented 1 percent level of significance

** is represented 5 percent level of significance

*** is represented 10 percent level of significance

a direct and significant relationship at a $p < 0.01$ level of significance.

The findings highlight that a 1% increase in CO2 emission causes a 0.45% increase in healthcare expenditure that means that a higher CO2 emission rate refers to environmental deprivation, which causes an increase in healthcare expenditure. The higher CO2 emission is also due to increased energy production, which causes environmental pollution and making people sick that ultimately increases healthcare expenditure. Hence, the estimated results support that there also exists a bidirectional association between healthcare expenditure and CO2 emission rate, and the results are significant at a 0.01 level of significance (Table 5). However, some variables of our study findings are similar with Khan et al. (2021a, b, c, d) and Lyu et al. (2021).

Conclusion and policy implications

It is concluded from the study that the foreign investment has a positive impact on economic growth in short run and long run, respectively. Perhaps it might be because of good economic policies from government of China or the amount of investment increases over time. FPI has also some moral hazards that receipt country usually dependent on investment, aid and donor countries can exploit them by putting some restrictions or harsh terms. So countries should rely on their own resources and chose those policies which provide favors in growth level.

Moreover, foreign direct investment and gross domestic investment have positive impact in short run and long run, respectively. Moreover, the policies should encourage which increases investment from foreign countries and it has more impact on growth level rather than investment because when foreign direct investment is linked with capital utilization, research and development, technological improvements, and easy market access it increases growth.

The findings of the panel VAR coefficients determined that all variables have a causal relationship; healthcare expenditure and CO2 emission comprise a bidirectional and positive relationship. In contrast, energy production and CO2 emission and energy production and trade expenditure have a positive but unidirectional association. The purpose of this research is to point out the attention of higher authorities to find the causes of pollution and find alternative means of energy resources that are environmentally friendly and enhance economic activity. Moreover, better energy resources not only improve the production capacity and preserve the ecosystem which leads toward a clean environment that also enhances the quality of life and increases life expectancy. Hence, the main objective of this research is to determine the alternative energy

Table 4 Main estimation of panel VAR

Response of	Response to						
	FPI	GDP	CO2	EC	TRADE	G.GDP	EX
FPI_{t-1}	0.0272*	0.4893***	0.9759***	0.0002*	−0.0140**	0.001*	−0.012*
	(0.0165)	(0.0933)	(0.1000)	(0.0001)	(0.0063)	(0.000)	(0.004)
GDP_{t-1}	0.3465***	0.4506***	0.4931	−0.0051***	0.3678***	−0.003**	0.3671**
	(0.1233)	(0.1697)	(0.7068)	(0.0008)	(0.0578)	(0.005)	(0.058)
$CO2_{t-1}$	0.3396***	0.6692***	0.4007	0.0014***	0.0209	0.004**	0.021
	(0.0880)	(0.1071)	(0.5050)	(0.0006)	(0.0379)	(0.005)	(0.039)
EC_{t-1}	0.3552	0.1573	−4.1124	−0.0066	1.2603	−0.004	1.213
	(9.9849)	(8.9972)	(29.306)	(0.0051)	(4.0375)	(0.011)	(4.015)
$TRADE_{t-1}$	0.5317***	−0.4719***	−0.0633	0.0042***	0.6503***	0.003**	0.651**
	(0.0638)	(0.0900)	(0.2845)	(0.0005)	(0.0213)	(0.001)	(0.043)
$G.GDP_{t-1}$	0.531**	−0.472**	−0.062	0.003**	0.651**	0.001**	0.651**
	(0.061)	(0.060)	(0.281)	(0.004)	(0.024)	(0.002)	(0.014)
EX_{t-1}	0.352	0.152	−4.115	−0.005	1.261	−0.002	1.101
	(9.981)	(8.992)	(29.32)	(0.003)	(4.032)	(0.004)	(4.017)
No. of countries	22	22	22	22	22	22	22

Standard errors informed in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 5 Results of hypothesis

Hypothesis	Decision
Hypothesis 1: "It is expected that FPI can positive affective toward the country's economic growth, which could be a sustainable pollution haven hypothesis across the countries."	Accepted
Hypothesis 2: "There is an inverted U-shaped environmental Kuznets curve (EKC) association between CO2 emissions, energy consumption, and GDP growth."	Accepted

resources in other words utilizing fossil energy, which is imperative for better life quality and economic development as well.

Three leading variables are used for research, but these variables are not fully utilized due to the number of reasons, for instance, FPI is used as a general term the sectorial division or the percentage rate of growth or some other proxy variables ignored the same for the CO2 emission rate and energy production. So the policies should be developed that encourages more to the investment including foreign direct investment rather than aid. However, the investment in human and physical capital can increase the labor force, which would be more productive in producing high quality products. But for this achievement correct polices should be implemented with the removal of corruption and mismanagement with the increase in the power of institutions and political stability.

Author contribution Dr. Mina has completed the data analysis part, Dr. Desti completed the "Introduction" section, Dr. Junrong completed the "Review of literature" section, Mr. Nasir wrote "Methodology" section, Mr. Malik Shahzad interpreted the data analysis section, Miss Kanwal wrote conclusion, and Dr. Mosab wrote abstract parts and formatted the paper as per journal requirements.

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Declarations

Ethics approval and consent to participate This study did not use any kind of human participants or human data, which require any kind of approval.

Consent for publication Our study did not use any kind of individual data such as video, images etc.

Competing interests The authors declare no competing interests.

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