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Green financial development improving energy efficiency and economic growth: a study of CPEC area in COVID-19 era

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Abstract

This study seeks to evaluate the effect of green financial development, improving energy efficiency and economic growth on Covid-19 tenure. For this, the CPEC area is recommended to look into. Present study revealed the energy economic negative repercussions of Covid-19 impacts. It is assumed that, in China and Pakistan, economic expansion, trade openness, financial development, and urbanization coexist. To verify the postulated impacts of economic activity on the environment, we do Johansen cointegration, error correction, and Granger causality tests. We discovered that economic growth, energy consumption, trade openness, financial development, and urbanization had a long-term relationship to CO2 emissions in Pakistan. Urbanization is the only macroeconomic factor with a detrimental effect on carbon emissions. As with China, no cointegration is found across variables, but unidirectional causality from energy consumption and economic growth to economic growth is established. Economic growth, energy consumption, and trade openness also each have bidirectional causal effect on financial development. According to statistical data, along with significant projected economic development in CPEC countries, policymakers and regulators are urged to strengthen environmental protection laws in China and Pakistan.

Keywords: Green financial development, Energy Financing, Energy Efficiency, Economic growth, Covid-19 crises, Capital formation

1. Introduction

Economic growth has been driven by increasing energy consumption, primarily from fossil fuels (e.g., natural gas, oil, and coal), which has resulted in increased greenhouse gas (GHG) emissions in recent decades. China, as the world's largest energy producer, uses approximately 25 percent of the world's total energy (Iqbal et al, 2021), creating ever-increasing environmental problems. As a consequence, altering the energy market is essential for supporting long-term, stable economic growth (Mohsin et al, 2021; Anh Tu et al, 2021). (Mohsin et al, 2021; Anh Tu et al, 2021). The main objectives of transitioning the energy market, which cannot depend completely on tight internal control, are to increase the use of non-fossil fuels and decrease carbon emissions. The sector needs help from the environmental protection industry outside of the nation (Alemzero et al, 2021). (Alemzero et al, 2021). For example, environmental management businesses may incorporate ecologically friendly technology and specialist equipment that can be utilised in every step of the oil industry, including mining, refining, power plants, and delivery.

The goal of China's plan was to guarantee that the environmental protection and energy conservation initiative (EPI) had a major place in the country's industries by the year 2020. When it comes to establishing the ECEP, renewable finance (such as green bonds and green loans) are helpful alternatives. Yet compared to traditional manufacturing, it poses unique difficulties in a developing country. Green funds, in particular, has a high investment degree of risk, a lengthy period to become liquid, and a large quantity of money to start. About the shortage of finance capital, the development of the ECEP business may be hampered. Because of this, limiting the funds available and establishing a viable financial market are impeding the change of the energy industry from taking place. Via equity sector financing and environmentally friendly methods, money is mobilised to assist promote entrepreneurship and new enterprises in the industry. The Chinese government has issued a variety of laws to support and enable the green finance industry to develop healthily and rapidly (see Table 1). (see Table 1). In addition, the government offers financing especially to help ECEP industries ' banks fund the ECEP companies through financing the financial markets Unsound issues, in addition to having strict threshold requirements, are two additional difficulties for EBEs. Green policies and markets are important for governments

and capital market players.

Global industrial revolution introduced the carbon emission issue and global warming as a result (Longhofer and Jorgenson, 2017). The carbon based energy inputs i.e. coal, natural gases, oil represent primary source of carbon emissions (WDI Statistics, 2017). (WDI Statistics, 2017). According to the IAEA, the energy sector was responsible for 68% of all carbon emissions during the first decade of the 21st century. These gases included methane and nitrous oxide. China-Pakistan Economic Corridor (CPEC) has emerged as one of the decade's most outstanding megaprojects with more than half of its investment in 19 energy projects (Asian Development Bank Report, 2018). It is a third-world nation with a history of economic depression (Zhang, Fan and Chang, 2011). This power crisis exacerbated the industrial sector (Wang and Li, 2016), which reduced agricultural profits, value added exports, foreign investments, and increased unemployment (Jiang, et al., 2017). As a result, poverty soared, GDP plummeted, and inflation followed suit (Siddique and Wazir, 2016). The China-Pakistan Economic Corridor [CPEC] was focused on new coal, solar, and wind power projects to satisfy increased energy demand in Pakistan (Abid and Ashfaq, 2015).

There are three ways for green investment and financial development. saving and spending (capital creation) The financial sector serves as a marketplace for demand and supply to be compatible. Indirect financing (green loans) is used to gather idle money and convert them into venture capital for large-scale and long-term projects, especially in the environmental protection sector. Equity data provides investors with risk tolerance and budgetary limitations when making investment decisions. The increased efficiency of saving-to-investment transfer allows financial firms to increase their financial instruments and knowledge supply. The second source of capital distribution is The connection between credit supply and demand affects the borrowing price in the stock sector, according to the basic rule. We engage in riskier investments in order to get higher dividends, which results in efficient asset distribution.

Furthermore, the stock sector may take a look at the various businesses and initiatives and identify business-strength benefits that are easier to fund. When this happens, the industry's "lemon sector" arises, which helps the industry overall. risk control is the third channel The financial markets use accounting data to disclose the risk level of ECEP businesses to minimise irresponsible behaviour on one side and reduce the costs of

information available for investors on the other. Reallocation of risk involves the movement of funds from risk-averse to risk-seeking investors.

To establish Pakistan as a stable country by having strong ties on a One-Road, One-Belt socioeconomic initiative (Hali, Shukui and Iqbal, 2015). The original study on CPEC primarily investigated its potential benefits for economic growth (Syed and Tariq, 2018); however, more recent findings of the Asian Development Bank showed a rise in greenhouse gas emissions due to coal-based electricity production projects. coal-based power stations are being used as a significant source of newly produced energy in CPEC projects (Shahzad et al, 2017). Carbon-based energy production is the primary contributor to CO2 emissions from the past (WDI Statistics, 2017). The most concerning aspect of CPEC is the lack of any environmental cost benefit analysis (Asian Development Bank Report, 2018).

CPEC involves China and Pakistan, who are already grappling with environmental problems. Despite growing industrial activity in coal and gas-based energy units, as well as rising per capita income, Pakistan's contribution to global carbon emissions is just around 0.4 percent (Shahazad et al, 2017). Manufacturing output has risen, using more energy and producing more CO2 (Shahazad et al, 2017; Behera and Dash 2017; Sadorsky, 2010). Furthermore, China has many multiplier impacts on manufacturing, transportation, and other economic sectors, due to its huge population (Schandl et al, 2016). China's home atmosphere deteriorates as a result (Wang and Li, 2016). immediate cause for worry (Zhang, Fan and Chang, 2011). (Jian, Xie and Tang, 2017). Having numerous projects on CPEC, this region is a key focal point for rapid economic development in the near future (Syed and Tariq, 2017).

Higher economic development predicts rising levels of pollutants like carbon dioxide and sulphur dioxide. However, with improved management, mankind can overcome environmental challenges (Ameer and Munir, 2016). There is evidence which demonstrates that economic development, free trade, and urbanisation all put strain on the environment, and consequently harm natural resources (Zaman et al, 2015). In addition, trade operations have caused fuel use to rise, because it is widely used in transportation and energy projects (Chang, Lewis and Lin, 2008). increasing industrial operations (Islam et al, 2013) expanded local and international trade activities, providing financing facilities for electricity generation (Sadorsky, 2010) especially in the CPEC project, emissions are on the rise

(Longhofer and Jorgenson, 2017). The study has following objectives:

- To test the role of green investment and financial development on energy efficiency of CPEC based countries
- To investigate the impact of green investment and financial development on economic growth of CPEC based countries through energy efficiency.
- To investigate the comparative significance of some control variables like CO_2 emissions, energy consumption, urbanization and trade openness in empirical model of recent study.

In at least three ways, this article adds to the literature. First, we offer policymakers with quantitative data on the geographic-heterogeneous financing advantages that arise from CPEC-based nations, which demonstrate dynamic increases in financing efficiency. Finally, we use stock market performance in terms of direct finance (green bonds) and indirect financing via the banking sector to examine the efficiency of various financial markets and explore which market matters most (e.g., green loans). Lastly, we focus on boosting financial efficiency by better equipping the financial market process with tests for more influential macro and micro variables, as well as delineating the link between two networks, firm danger and firm return.

2. Literature Review

CPEC will have a positive impact on the financial sector, since it plays a crucial part in all the activities that will be increased owing to CPEC projects. foreign investment and commercial activities will boost the banking operation (Abbasi and Riaz, 2016). Increased CO2 emissions in a developing economy: an enhanced. Financial growth certainly does not come without drawbacks (Nabi et al, 2018; Nasir and Rehman, 2011). The effect of financial development and economic expansion on CO2 emissions was studied alongside Pakistan. To identify long-term associations in economic and financial variables, the ARDL technique was used. An Error Correction Model (ECM) was used to evaluate the short-run effects; together with Granger causality test and VAR model, an ECM was used to examine the influence of financial and economic variables on carbon emissions. During the period of 1971 to 2011, with a sub-period of 1988 to 2011 (time in which financial sector was

liberated). While GDP per capita rose, it was at a time when emissions were in a decreased state, revealing a causal relationship between GDP per capita and carbon emissions (Nabi et al, 2018).

Pollution is usually has been characterised as a danger to the atmosphere. The profitability of the industry is at risk because of this. Instead of seeing pollution as a waste of energy, Porter and van der Clas (1995) believe that contamination be seen as a simple industrial inefficiency. Therefore, everything that increases industrial productivity is a green investment. everything—resources, waste treatment, water, industrial safety, biodiversity protection, and climate change mitigation and adaptation (Krushelnytska, 2018; Lindenberg, 2014). Literary resources are now hard to come by. Several case studies show how green investment benefits the environment and reduces carbon emissions. Columbia University researchers investigated the connection between green investment and renewable energy, and found that they had different degrees of usefulness (SDGs). Promoting green growth by using green bonds, green equities, and carbon market instruments will assist the development goals. In order to promote green growth, we must strengthen the profile of green finance by making investments in ecologically beneficial climate change initiatives via a climate change fund.

Investing in socially and ecologically aware development, private expenditure helps to a low-emitting economy, and globally. Furthermore, the author provides further financing requirements for renewable energy. There are no private financing available to developing countries for renewable energy initiatives. They investigated the ramifications of green financial technology, particularly. To be efficient, sustainable development and support the Paris Agreement, you must utilise financial technology and green finance. In a similar line, Hongo (2019) devoted attention to carbon pricing in order to encourage renewable energy. Recovering biomass is essential for green growth. Green finance has to use carbon sequestration in order to succeed. They also push for public-private partnerships to develop low-carbon infrastructure. When it comes to nations with long-term institutions and governments, the public-private partnership will endure.

Energy resources are vital for national growth and development. resources needed for human survival, better quality of life, and greater economic growth (Baloch, 2018). CPEC's

massive investment in energy-based projects will lead to an increased demand for electricity in the area (Asian Development Bank, 2018). Multiple studies have connected energy use to CO2 emissions. Using time series data from 1971 to 2011, it was shown that increasing financial and commercial openness is accompanied with increasing energy consumption in Pakistan. Instead of researching the connection between energy efficiency and carbon emissions, this study found that the value and threshold of energy use are important. arguing that present economic development isn't enough to alleviate carbon emissions increases (Shahzad et al, 2018).

To identify the most significant energy efficiency components, Chang and Lewis (Chang, Lewis and Lin, 2008) utilised structural decomposition method. Using sector-specific data, they concluded that road building, petrochemical, iron and steel sectors are significant sources of energy efficiency and CO2 emissions. Another research showed long-term relationships of energy consumption, urbanisation, and energy efficiency with CO2 emissions based on data from Southeast Asian nations from 1980 to 2012. With regard to their levels of income, 17 regional nations were split into three sub-regions. The main energy efficiency, urbanisation, and CO2 emissions' long-term connection was investigated using integration tests. When fossil fuel energy consumption was substituted with primary energy consumption, no connection was found among the variables in the panel of high and low-income nations. Instead, significant relationships were discovered in middle-income nations in the panel. Westerlund cointegration test was used to test for cointegration in the whole sample of nations; this was confirmed for medium and low-income countries, but for high-income countries, no cointegration was proven among primary energy efficiency, CO2 emissions, and urbanisation. These findings indicate that wealthy nations tend to put more effort into environmental preservation since their environments are more prone to contamination (Behera and Dash, 2017).

CPEC's main goal is to foster economic development. Economic development and its connection to environmental risks remains a divisive topic, but enhancing harmful emissions cannot be ignored (Zhang, Wang and Wang, 2018). Through the use of the STIRPAT model, economic growth, trade liberation, and urban population were linked to

increases in CO2 and SO2 emissions. Data for the years 1980 to 2014 were collected for this purpose. CO2 and SO2 emissions have a substantial impact on GDP growth. Error correction model revealed a long-term causal relationship between free trade and carbon emissions, while economic growth only had a direct relationship (Ameer and Munir, 2016). Also, CO2 emissions and economic growth were related in South African nations. The time series findings covering the 1965-2006 timeframe supported long-term and short-term links among variables. suggestions suggested standardising economic development levels to minimise pollution in South Africa (Apergis et al, 2010).

This commercial openness would extend to countries like Europe, Africa, and Asia as well as China and Pakistan (Antweiler, Copeland and Taylor, 2001). Trade openness is a major predictor of negative environmental effects and carbon emissions. Technology impact, scale effect, and composition effect are all affected by trade openness. In general, as technology advances, carbon emissions drop while international commerce increases. In scale effect, free trade activities and trade production grow, but there are environmental consequences as well. Many developing nations choose investing in lower-capital-intensive projects even at the expense of increasing water and air pollution (Shahzad et al, 2017; Trade and Development Report, 2016). Overcrowding cities occurs due to the high number of people moving to urban regions from rural locations. Agricultural lands are converted into industrial and residential areas, thus reducing farmland in the suburbs of major cities (Yeh and Liao, 2017). CPEC may contribute to more urban growth as infrastructure and energy projects begin. More people and energy use lead to greater pollution in the environment (Shahbaz et al, 2018). Yeh & Liao (2017) studied how population and economic growth influence CO2 emissions.

3. Methodology

3.1 Data

The research was carried out in China and Pakistan that constitute the partners of this mega project. The quarterly data were obtained from World Development Indicators (WDI) and Economic Intelligence Unit (EIU) for the period starting from 1971 to 2017. As the aim of this study is to investigate the potential impediments that CPEC can pose to environment,

we have chosen the macroeconomic variables that are linked to economic development in general as well as for which we have found literature evidence of their link to potential CPEC projects. The rationale behind selection of this period is that major industrial development began in 1970s in the CPEC region. Furthermore, CPEC that initiated in 2013, though its projects are in phase of development yet 5 years data post CPEC advent is well enough to signal the future trends. Logarithms of all variables were used to ensure coherence. General form of model is:

$$GFD_t = \beta_0 + \alpha_1 EE_t + \alpha_2 Y_t + \alpha_3 CO_{2t} + \alpha_4 U_t + \alpha_5 T_t + £_t \quad (1)$$

$$EE_t = \beta_0 + \alpha_1 EG_t + \alpha_2 Y_t + \alpha_2 CO_{2t} + \alpha_{53} U_t + \alpha_4 T_t + £_t \quad (1.1)$$

GFD = Green financial development
CO_2= Carbon Dioxide Emission
EC = Energy Consumption
Y = Economic Growth
U = Urbanization
T = Trade openness
£ = Error term
t = Time series analysis

Energy efficiency is calculated by dividing the energy obtained from energy inputs sources used for the consumption of energy outputs. Energy consumption (EE) is measured by kg of oil equivalent per capita; gross domestic product per capita (current US $) is used as a proxy for economic growth; financial development (FD) is measured through domestic credit to private sector as percentage of gross domestic product; trade openness is measured from import plus exports as percentage of gross domestic product and percentage of urban population in total population as a proxy of urbanization. In order to measure CO_2 emissions total per capita greenhouse emissions were used.

Variables' data were normalized in order to address the unit measurement differences by taking natural log.

$$LnGFD_t = \beta_0 + \alpha_1 LnEE_t + \alpha_2 LnY_t + \alpha_3 Ln\ CO_{2t} + \alpha_4 LnU_t + \alpha_5 LnT_t + £_t \quad (2)$$

$$LnEE_t = \beta_0 + \alpha_1 LnEG_t + \alpha_2 LnY_t + \alpha_2 LnCO_{2t} + \alpha_{53} LnU_t + \alpha_4 LnT_t + £_t \quad (2.1)$$

Here, $LnEE_t$ is the logarithm transformation of energy consumption (EE), LnY_t is the logarithm transformation of economic growth (Y), $LnFD_t$ is the logarithm transformation of financial development (FD), LnU_t is the logarithm transformation of urbanization (U), LnT_t is the logarithm transformation of trade openness (T), $LnCO_2$is the logarithm form of carbon dioxide emission (CO_2) while t represents that data are time series, beta (β) andalpha (α) show the parameters which require to estimate and £ denotes error term.

4. Results and Discussion

This section of the study provides empirical findings obtained by using cross-section dependence test, heterogeneous slope parameters test, (Pesaran, 2007), Bai and Carrion-I-Silvestre (2009) panel unit root tests,(Westerlund and Edgerton, 2008), (Banerjee and Carrion-iSilvestre, 2017) panel cointegration test, cross-sectionally augmented autoregressive distributed lags (CS-ARDL), augmented mean group (AMG) and common correlated effect mean group (CCEMG) for longrun and short-run results estimations. All the values given in Table 1 are in log and per-capita form. It covers the average value of carbon emissions, green investment and financial development, economic growth and energy efficiency for each CPEC country. A panel unit root tests such as (Pesaran, 2007) and (Bai and CarrionI-Silvestre, 2009) results are given as below, aas (Pesaran, 2007) test deals with heterogeneity and cross-section dependence. The null hypothesis support unit root or non-stationarity issue in series, while the alternative suggest otherwise as (Pesaran, 2007) results, indicate that all the variables such as carbon emissions, green financial development, energy efficiency and economic growth are stationary at level, i.e. I (0). These results reject the null hypothesis at a mix significance level, i.e. 1%, 5% and 10%.

4.1 Unit root estimation

In first step, it is necessary to investigate the presence of unit root in time series data as recommended by (Nasir and Rehman, 2011). To check the properties of integration, Augmented Dickey Fuller test has been used (Behera and Dash, 2017) In Augmented Dickey-Fuller test, if the probability values of variables are greater than 0.05, it indicates presence of unit root in the data. Furthermore, if the absolute critical values at level of 1%, 5% and 10% are greater than the absolute values of Augmented Dickey Fuller statistics (t-statistics) than data are considered as non-stationary (MacKinnon, 1988). The panel unit root is cross-sectionally measured with ADF given as:

$$\Delta Z_{it} = \delta_i + \pi_{iZ_{i,t}} + \theta_{Zt-1} + \sum_{l=0}^{p} \theta ii \, \Delta Z_{t-1} + \sum_{l=0}^{p} \gamma ii \, \Delta Z_{t-1} + \varepsilon_{it} \qquad (3)$$

Table 1 represents result of unit root in both datasets of China and Pakistan at level stage and at first difference stage. Results indicate a unit root in data at level stage because all variables' absolute critical values are greater than the absolute values of t-statistics in intercept as well as in 'trend and intercept'. Augmented Dickey Fuller (ADF) test has been applied to examine the stationary of data at first difference. Results show that data became stationary after taking first difference. The t-values of all variables are greater than their critical values at level of 5%. Furthermore, probability values of all variables are also significant because they are less than or equal to 0.05.

Table 1 Unit root test

		Level				First Difference			
		Intercept		Trend & Intercept		Intercept		Trend & Intercept	
China	$LNEC_t$	1.34	-2.93	-0.79	-3.52	-6.49*	-2.93	-6.88*	-3.52
	$LNEG_t$	2.51	-2.93	-0.36	-3.52	-5.02*	-2.93	-4.52*	-3.52
	LNT_t	-2.82	-2.93	-1.77	-3.52	-4.69*	-2.93	-5.06*	-3.52
	$LNFD_t$	-0.60	-2.93	-2.22	-3.52	-5.97*	-2.93	-5.89*	-3.52

	LNU_t	0.48	-2.93	-2.76	-3.52	-8.14*	-2.93	-8.08*	-3.52
	$LNCo_{2t}$	0.96	-2.93	-1.07	-3.52	-5.45*	-2.93	-5.55*	-3.52
Pakistan	$LNEC_t$	-1.91	-2.93	0.72	-3.52	-4.82*	-2.93	-5.39*	-3.52
	$LNEG_t$	-0.08	-2.93	-2.20	-3.52	-5.67*	-2.93	-5.56*	-3.52
	LNT_t	-1.98	-2.93	-2.59	-3.52	-8.35*	-2.93	-8.22*	-3.52
	$LNFD_t$	-1.43	-2.93	-1.56	-3.52	-5.58*	-2.93	-5.52*	-3.52
	LNU_t	1.40	-2.93	-2.05	-3.52	-2.16*	-2.93	-7.01*	-3.52
	$LNCo_{2t}$	-0.73	-2.93	-1.56	-3.52	-3.94*	-2.93	-9.21*	-3.52

4.2 Cointegration estimation

To check the long run relationship among macroeconomic variables; $LNEC_t$ (energy consumption), LNY_t (economic growth), $LNFD_t$ (financial development), LNT_t (trade openness), LNU_t (urbanization) and $LNCO_{2t}$ (carbon dioxide emissions), Johansen cointegration test has been used. The assumption of one co-integration suggests that all variables must be integrated at first order. ADF test has confirmed this condition in case of China and Pakistan that all series are integrated at I(1). In Johansen Cointegration test, trace and maximum Eigen statistics are compared with their critical values at level of 5%. Moreover, null hypothesis has been rejected if the critical values of hypothetical co-integration equations are less than their trace and maximum Eigen values. Finally null hypothesis represents that there is no co-integration among variables. To obtain the short-run and long-run estimate results, this study shall employ the newly developed approach called cross-sectionally augmented autoregressive distributed lags model (CS-ARDL) by (Chudik et al., 2013) measured in equation (4) and the transformed version is given in equation (5):

$$Y_{it} = \vartheta_i + \sum_{l=0}^{p} yilY_{t-1} + \sum_{l=0}^{q} \theta ilXi_{t-1} + \varepsilon_{it} \qquad (4)$$

$$Y_{it} = \vartheta_i + \sum_{l=0}^{p} yilY_{t-1} + \sum_{l=0}^{q} \theta ilXi_{t-1} + \sum_{l=0}^{q} \vartheta ilZi_{t-1} + \varepsilon_{it} \quad (5)$$

Johansen co-integration test was applied to find out the long run association among determinants. Table 2 represents the results of co-integration in both datasets of China and Pakistan separately. It is an assumption in Johansen cointegration test that at least one cointegration equation must exist to confirm the long-run relationship among variables. Four cointegration equations have been found in trace test and two cointegration equations have been found in maximum Eigen test in case of Pakistan. In addition, co-integration is found among variables in case of Pakistan in line with the results indicated in the study of (Shahbaz et al., 2017). On the other hand, no long-run relationship is traced in case of China.

4.3 Error correction model estimation

Error correction model of Sargan, (1964) is applied to examine the coefficients of the model. ECM defined the long-run and short-run combined impact of macro-economic variables on CO_2 emission. The ECM is empirically modeled as:

$$Y_{it} = \vartheta_i + \left[y_{i,t-1} - \varnothing X_{it}\right] - \sum_{l=0}^{p} yilY_{t-1} + \sum_{l=0}^{q} \theta ilXi_{t-1} + \sum_{l=0}^{q} \vartheta ilZi_{t-1} + \varepsilon_{it} \quad (6)$$

Table 3 represents the short-run and long-run effects of macro-economic variables (energy consumption, economic growth, financial development, trade openness and urbanization) on endogenous variable (carbon dioxide emissions). The result indicates causal effect, such that a 1% increase in DLNEC tends to increase 0.80% $DLNCO_2$ in the short-run (probability value 0.0141 significant at <5%). It shows energy consumption has significant and positive effect on CO_2 in the short-run. The probability value of DLNY is less than the significance level of 0.05 that substantiate the relationship in short-run. Similarly, the probability value

of DLNFD is also significant in the short-run because 0.0470 is greater than the significance level of 0.05. Therefore, in case of DLNY and DLNFD, results cannot be interpreted in the short-run. The causal effect indicates that a 1% increase in DLNT tends to increase 0.12% $DLNCO_2$ in the short-run.

Table 2.Johansen Co-integration Test

	H_0	Eigen Value	Trace Statistic	0.05 Critical Value	Probability	Max-Eigen Statistic	0.05 Critical Value	Probability
China	R = 0	0.61	92.63	95.75	0.08	39.58	40.07	0.046
	R ≤ 1	0.43	53.05	69.81	0.50	23.64	33.87	0.048
	R ≤ 2	0.29	29.41	47.85	0.74	14.56	27.58	0.007
	R ≤ 3	0.17	14.84	29.79	0.79	8.03	21.13	0.90
	R ≤ 4	0.14	6.81	15.49	0.59	6.62	14.26	0.53
	R ≤ 5	0.04	0.191	3.84	0.66	0.19	3.84	0.66
Pakistan	R = 0	0.76	149.84*	95.75	0.000	60.04*	40.07	0.0001
	R ≤ 1	0.57	89.79*	69.81	0.0006	35.08*	33.87	0.0358
	R ≤ 2	0.43	54.71*	47.85	0.0099	23.04	27.58	0.1715
	R ≤ 3	0.38	31.66*	29.79	0.0301	19.84	21.13	0.0750
	R ≤ 4	0.19	11.83	15.49	0.1653	9.026	14.26	0.2840
	R ≤ 5	0.06	2.80	3.84	0.0940	2.80	3.84	0.0940

Commercial openness substantially contributes to CO2 emissions, as previously shown by (Shahzad et al, 2017). Simultaneously, a 1% rise in DLNU reduces DLNCO2 by 8.69% in the short-term. urbanisation in the short-term (2016), according to Kais and Sami Mostly, it is because of a shift in technology that the CO2 emission has decreased. An increase of 1% in LLNEC will result in a concomitant rise of 0.93% in DLNCO2 in the long-term. The existing research further substantiates the LLNEC has a longstanding relationship with CO2

emissions (Yeh and Lia, 2017; Yang et al, 2018; Abbasi and Riaz, 2016). those who studied the impact of financial development on carbon emissions (Nabi et al, 2018). A 1% rise in LLNT leads to a 0.17% increase in DLNCO2 over time. Accordingly, LLNT has a strong long-term connection with CO2 emission, which validates previous research (Bahera and Dash, 2017; Sadorsky, 2010). According to our theory, free trade activities lead to environmental damage. This signifies that third world capitalists choose to manufacture pollution-intensive products at the cost of causing negative environmental consequences, in the hopes of greater profit margins (Copeland and Taylor, 2004). Developed country irresponsible investors simultaneously invest in third world countries where they may run environmental polluting businesses without hindrance. so that they may make high ROIs that aren't feasible in their home nations due to stringent environmental safety regulations (Abdulai and Ramcke, 2009).

Table 3 ECM technique outputs

Variables	Co-efficient	Standard Error	t-Statistic	Probability
C	-11.96662*	1.602878	-7.465706	0.0000
DLNEC	0.808875*	0.305552	2.647259	0.0141
DLNY	0.154666*	0.133277	2.410166	0.0453
DLGFD	0.123212*	0.074177	2.312923	0.0470
DLNT	0.123329*	0.058992	2.090611	0.0473
DLNU	-8.689130*	4.360491	-1.992695	0.0578
LLNEC	0.932149*	0.292619	3.185536	0.0040
LLNY	0.307134*	0.037870	2.388382	0.0422
LLGFD	0.276595*	0.062017	2.235051	0.0288
LLNT	0.168462*	0.054218	3.107094	0.0048
LLNU	1.491089*	0.393066	3.793481	0.0009

In Table 2, our results demonstrate that over time, LLNU and DLNCO2 have a long-term

connection; this shows that for every 1% rise in LLNU, there is a corresponding increase of 1.49% in DLNCO2. It's clear that urbanisation is also a significant contributor to environmental carbon emissions, according to previous research (Copeland and Taylor, 2004). Agricultural land in Pakistan is progressively transforming into residential colonies and industrial zones according to the study of Shahzad et al. (2017). This transformation is causing a shift from environmentally-friendly conditions to a multitude of pollutants (see table 3, table 4 and table 5 respectively), which may pose a risk to human health and animals in the region (Ouyang and Lin, 2017). Ecological Modernization Theory contends that as a result of modernization, different activities have created environmental damage while modernising. However, these problems may be reduced by further modernisation, which includes using technical cleaning and effective filtering systems (Esso, and Keho, 2016).

Table 4 Regression Results

Estimators	Values	Estimaters	Values
R-square	0.887448	Mean dependent variable	0.026231
Adjusted R-square	0.835861	Standard deviation dependent variable	0.054476
Standard error of regression	0.022070	Akaike statistic	-4.527970
Sum squared residual	0.011690	Schwarz statistic	-4.000130
Log likelihood	93.50346	Hannan-Quinn statistic	-4.343740
F-statistics	17.20309	Durbin Watson Statistic	2.558287
Probability value (F-statistics)	0.000000		

Table 5 Granger Causality Test

Null Hypothesis	F-stat	Significance
Energy efficiency does not granger cause CO_2 emissions	4.29444*	0.0449
CO_2 emissions does not granger cause energy efficiency	1.25619	0.2692
Energy efficiency does not granger cause economic growth	3.04697**	0.0888
Economic growth does not granger cause energy efficiency	1.21970	0.2762

Green financial development does not granger cause energy efficiency	1.28867	0.2880
Energy efficiency does not granger cause green financial development	2.04739	0.1438
Trade openness does not granger cause CO_2 emission	1.27737	0.2911
CO_2 emission does not granger cause trade openness	0.40938	0.6671
Urbanization does not granger cause CO_2 emission	1.32171	0.2793
CO_2 emission does not granger cause urbanization	0.32956	0.7214
Economic growth does not granger cause energy consumption	5.36015*	0.0260
Energy consumption does not granger cause economic growth	3.40726**	0.0725
Financial development does not granger cause energy consumption	1.04488	0.3622
Energy consumption does not granger cause financial development	1.57635	0.2207
Trade openness does not granger cause energy consumption	0.16734	0.8466
Energy consumption does not granger cause trade openness	0.02819	0.9722
Urbanization does not granger cause energy consumption	0.60397	0.5521
Economic growth does not granger cause urbanization	0.28295	0.7552
Financial development does not granger cause economic growth	2.28535	0.1163
Economic growth does not granger cause financial development	3.28475*	0.0489
Trade openness does not granger cause economic growth	2.75636**	0.0769
Economic growth does not granger cause trade openness	1.26052	0.2957
Urbanization does not granger cause economic growth	0.93362	0.4024
Economic growth does not granger cause urbanization	0.11681	0.8901
Trade openness does not granger cause financial development	4.13279*	0.0242
Financial development does not granger cause trade openness	6.99198*	0.0027
Urbanization does not granger cause financial development	5.32538*	0.0264
Financial development does not granger cause urbanization	0.00861	0.9266
Urbanization does not granger cause trade openness	1.52938	0.2304
Trade openness does not granger cause urbanization	0.12286	0.8848

Significance level: 0.05, 0.1***

Table 4 shows that the recognised significance level of all macroeconomic components is equal to the F-test probability value. The result of Adj. R2 shows that 84 percent change in

carbon dioxide emissions are explained owing to the given macroeconomic variables. It is stated that the estimated value of Durbin Watson (DW) is 2.56, and that model showed no serial association. The value F-statistic is 17.203 that indicates goodness of fit for our suggested model. The findings in Table 5 show that no co-integration is observed among variables in the dataset of China. So, we used Granger Causality testing as suggested to identify the short-run relationship among the various influences. Thus, because energy consumption results in CO2 emissions, it is concluded that unidirectional causation exists (Shahzad et al, 2017). Furthermore, previous studies did not find a link between urbanisation and CO2 emissions, both of which have been shown in prior research. As long as the economy continues to expand, CO2 emissions will increase. Previous research corroborate our findings, which is based on the EKC, which has already been utilised in prior investigations (Stern, 2004; Acaravci and Ozturk, 2010). For EKC, when the income level rises, there is an initial increase in CO2 emissions, but at a particular point in time this inversion will take place, resulting in a decrease in CO2 emissions. The primary shift in the curve is due to the recent advancement in technology.

Table 5's presented findings found no causal connection between CO2 emission and financial progress, as shown in prior research (Stern, 2004; Acaravci and Ozturk, 2010). However, research shows a bi-directional connection between economic development and energy use, as can be shown in the existing literature. Trade openness promotes economic growth, whereas economic growth has a unidirectional causal relationship with economic growth. As shown in earlier research, as trade openness increases, causality also shifts in the direction of economic development. Trade openness and financial development are shown to be bi-directional causes of urbanisation, whereas financial development and urbanisation are connected through urbanisation. However, no correlation was discovered between international trade openness and carbon emissions, as shown by the results of previous research.

4.4.Discussion

We used time series data from China and Pakistan to analyze the short-run and long-run relationship among macroeconomic variables and carbon emissions. The ADB report on

energy sector (ADBR, 2018) signaled the danger of increased environmental deterioration if the economic activities under CPEC are kept unchecked. The aim of this study was to link macroeconomic variables linked to economic development in relation to the advent of CPEC in the region and to determine the potential consequences on CO_2 emissions. In comparative analyses of variables for both datasets, interesting insights were revealed. The statistical results of both datasets showed different results for both countries owing to different economic conditions, financial standings and socioeconomic characteristics. The possible reason behind this contradiction is can be attributed to the prior evidence indicating that high income countries tend to develop more environmental protection policies to keep their environment clean from pollution as compared to low developed countries (Longhofer and Jorgenson, 2017; Wang, 2016; Behera and Dash, 2017).

In the data obtained from Pakistan, it was revealed that all macroeconomic variables had significant relationship with CO_2 emissions in long-run. Energy consumption was one of the contributors in increasing carbon emanations. The major factors were use of oil, gas, coal and liquid gases used in transportation and industrial production. Thus we argue that CPEC that has more than half of its investment in energy projects (ADBR, 2017) is a potential threat to environment in Pakistan. Secondly trade openness was linked significantly to increased carbon emissions. CPEC advent will open the door for trade in Asian, African and European region (Longhofer and Jorgenson, 2017). Trade openness can cause three types of impacts, first, technology impact cause decline in CO_2 emissions by improving overall technology. Secondly, scale effect enhances the trade volume and escalates the rate of carbon emanations. The composition effect, increase the proportion of non-friendly trade and contributes in deteriorating environment. So, the results indicate dominant scale and composition effect in case of Pakistan.

In addition, according to pollution heaven hypotheses the third world countries owing to their weak environmental protection regulations offer breeding ground for pollution intensive production and international industries locate their non-environmental friendly production in such nations. Pakistan is also facing same difficulties due to weak implementation of environment safety laws and lack of strict punishment for the violators. It has also been mentioned in literature that low income countries prefer to choose less capital intensive investments even on the cost of higher generation of water and air

pollution. So, the advent of CPEC projects also signal the danger of increased CO_2 emissions by indulging in unchecked trades and poor implementation of environmental laws.

Urbanization is found to have significant long-run impact on the environment. Major shifting of rural population towards urban areas has increased the health and environmental protection issues in Pakistan. The conversion of agriculture lands into the industrial zones and residential societies has obsolete green land. In addition the increased demand for energy also contributes to the linkage of urbanization with CO_2 emissions. CPEC will increase the urban development due to initiation of multiple infrastructure and energy based projects. The results confirm the notion that urbanization results in increased population and energy consumption that increase the level of harmful emissions in environment. The results imply that if the urbanization as a result of CPEC is not managed in an environmental friendly manner it can pose a serious concern for damaging environment.

Furthermore, economic growth and financial development were found to have impact on environment either in short-run as well as in long-run. Economic growth is amongst the major objectives of CPEC. Economic growth amplifies harmful emissions in case of increased use of energy resources in industrial sector. Pakistan is a developing nation that mainly relies on non-renewable fossil fuel based energy consumption in industries. It confirms the notion that energy inefficiency is the core of industrial production in third world nations that is responsible for linking increased production to environmental degradation. CPEC that will increase the economic activities in the region can put Pakistan at the future stake of increased emissions in case the renewable sources are not used.

Lastly, the positive association of financial development and CO_2 emission in Pakistan is the signal of non-promotion of renewable industry. CPEC will increase the opportunity to expand the industry and it is associated to increased requirement of credit facilities and financial series. In developing nations the financial institutions have lower tendency to offer credit facilities for environmental friendly and research based initiatives. That in turn only promotes the industrialization at the cost of environment. Thus, the poor policy regarding environmental protection can put Pakistan at the risk of environmental destruction.

No long-run relationship is traced among the predictors and endogenous variables in the dataset of China. Therefore, we used granger causality test to find out the short term causal relationship among variables. Our result indicates that energy consumption has a unidirectional causality to CO_2 emission. Similarly, a unidirectional causality is traced for economic growth towards carbon emission. This implies in short-run China has to bear carbon emissions as a result of increased energy consumption i.e. use of non-renewable sources. In China the increased pace of economic activities is also a responsible factor in increasing carbon emissions. On the other hand, no causal link is found between CO_2 emissions and financial development. It means in China the financial activities are promoting renewable energy resources and human incentive technologies of production, the role of financial institutions for research in environmental friendly endeavors is also active that has caused to neutralize impact of financial development on carbon emissions. However, bidirectional causal link is found between use of energy and economic growth in case of China. It has confirmed the prior notion of strong linkage in growth of economy and energy consumption. Such that, the increase in economic activities require fuel combustion for running factories and transport so the energy consumption is increased. The consumption of energy expands a transportation and manufacturing endeavor that expands economy.

Going forward, unidirectional causalities are traced from economic growth to financial development, trade openness to economic growth and urbanization to financial development. On the similar notion, expanded economic activities require financial resources that increase financial activities, the expansion of trade across borders give a surge to economic development. The shift of population in urban areas stirs industrial production and business operations by more labor force relying on financial development. A bidirectional causal link is found between free trade and financial development. Open trade builds competitive pressure and the local traders need more investment to survive that can be obtained from domestic financial institutions. Also the provision of credit for trade in turn improves the open trade by granting access to foreign markets. Contrarily, no causal effects are found between trade openness and urbanization and carbon dioxide emission.

The absence of linkage in macroeconomic variables and CO_2 emissions in China can be due

to several ground realities. The recent research studies signal the decoupling of economic activities and carbon emission in Chinese context. China is dealing with the dilemma of balancing economic expansion and maintaining a healthy environment; in this context the government has taken multiple actions to reduce the longer run impact of economic growth on environment. Till 2012 China was not able to decouple economic activities from hazardous impacts on environment, furthermore, energy consumption and economic activities were deemed as the prime elements causing carbon footprint in China. The introduction of 11^{th} five year plan was the turning point in reduction of carbon emission as a consequent of economic activities. The initiatives taken by Chinese government for changing the infrastructure of economy by making it more energy efficient are being implemented successfully. The government has increased the budget for development of environmental friendly research, started renewable energy endeavors and development along with phasing out the high carbon emission industrial plants. The Paris agreement was signed in 2015 as a commitment of reducing carbon emission till 2030. The energy efficiency has improved by 20% till end of 2016 as a result of less usage of fossil fuel based energy per unit of GDP. Furthermore, a scheme of trading has been introduced that encompass less CO_2 emissions and overall cleaner industry. This deli antes that in longer-run China is likely to control its carbon emission as a result of economic activities and the economic expansion as a result of CPEC is likely to foster a clean environment.

5. Conclusion and Policy Implications

This research investigated impact of economic activities on carbon emission in CPEC region. Unlike in Pakistan where macroeconomic variables had positive impact on carbon emission in long and short run; data set from China revealed only short-run association. This implies that Pakistan that is a third world country, should be cautious in undertaking the mega projects under CPEC to increase the economic growth without damaging environment by avoiding non-renewable energy sources. Furthermore, China that is a developed nation should focus on cutting off carbon emissions by strictly following the environmental protection agreements and polices to decouple the economic activities with

hazardous environment. However, suggested polices are given as below;

1. The policy makers in China as well as in Pakistan should pay attention to the non-renewable energy projects that might have harmful impacts on environment owing to excessive use of coal and oil based fuels, and resultant release of carbon emissions. It is recommended that socioeconomic and environmental policies should be revisited by encouraging the investments in only clean or renewable energy projects.
2. Going forward, CPEC projects should be focused on the installations of solar energy, fossil energy and wind energy power projects because these renewable energy projects are harmless for the environment. In this way, CPEC energy projects can have maximum positive impact on socioeconomic growth with minimal impact on damaging the environment.
3. These issues can be overcome through state interference for strict enforcement of environment safety laws and use of modern technologies for fuel waste management and efficient filtration process. Pakistan can exploit full benefits of CPEC in form of infrastructure development, provision of employment and development of industry only if it keeps strict environmental check.
4. Moreover, China should also pay attention to stick to its CO_2 emission reduction plan to avail the advantage of trade openness though One-Road One-Belt initiative with environmental conservation.

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