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RESEARCH ARTICLE

The nexus of sectoral-based CO_2 emissions and fiscal policy instruments in the light of Belt and Road Initiative

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Abstract

Climate change due to global warming is becoming a major global issue over the past few decades. The emission of carbon dioxide (CO_2) and other greenhouse gasses cause global warming. Most carbon emissions come from energy sectors, whereas transportation, industrial, and residential sectors are among the chief contributors. The present study investigates the effect of fiscal policy instruments, economic development, and foreign direct investment (FDI) on the sectoral emissions in Belt and Road Initiative (BRI) countries. The data used in this study is taken from the World Development Indicators (WDI) for the period between 2000 and 2018. Dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) have been used to analyze the long-run impact of fiscal policy instruments, economic development, and FDI on CO_2 emissions from transportation, energy, and industrial sectors. Furthermore, the pairwise Dumitrescu and Hurlin panel causality test was used to authorize the causal relationship among the variables under consideration. The results reveal that fiscal policy instruments, per capita gross domestic product, FDI, and CO_2 emissions show a strong correlation in the industrial, electrical, and transportation sectors. Furthermore, it is shown that public spending is a more reliable tool to reduce CO_2 emissions in the transportation and industrial sectors in the BRI region. This study provides useful information for policy-makers on taking preventive and corrective measures to reduce CO_2 emissions in different sectors and promote sustainable development.

Keywords Sectoral CO_2 emissions · Fiscal policy instruments · Belt and Road Initiative

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Introduction

Environmental protection and climate change have become a topic of concern over the past several decades. An increase in the emission level of CO_2 and other greenhouse gasses (GHG) is the main reason for global warming, which causes climate change. Many scientists have recognized CO_2 emission as a significant global warming source through the greenhouse effect (Mallick and Tandi 2015). CO_2 emission does notable damage to the climate and causes a severe human health issue, making the climate quite fragile, leading to environmental degradation (Ratti and Vespignani 2016). According to the Intergovernmental Panel on Climate Change (IPCC 2019), CO_2 emission is the main contributor to climate change. Its proportion is much higher than that in a pre-industrial era. Human activities contribute about 80% of the total global greenhouse gasses (IPCC 2019).

According to the international energy agency (IEA 2018), various sectors such as the energy industry, transportation, residential, and industrial sectors are producing CO_2 emissions, out of which electricity and heat production with almost

40% of the total emissions contribute the most. Transportation, industrial, and residential heating emissions are also significant contributors, with a 25% share from transportation, 18% from the manufacturing industry, and 6% from residential heating (IEA 2018). Energy is an essential factor for the world's economy on production and consumption (Heede 2014). Energy demand increases in the transportation, industrial, and residential sectors every year (Asumadu-Sarkodie and Owusu 2016). Most of the world's transport energy comes from petroleum-based fuels, mainly gasoline and diesel, and the prevalent use of these fuels resulted in an increasing global CO_2 emission level (Azomahou 2005). Many studies found that this remarkable increase in energy usage caused disasters and calamitous damages (Yasmeen et al. 2019; Hafeez et al. 2018; Çetin and Ecevit 2017). The power sector is the main contributor to Shanghai's CO_2 emissions, China (Du et al. 2018). Green energy is vital to save the environment and to reduce CO_2 emissions; Ikram et al. (2021) found in their study that China's renewable-based energy generation by 2026 will be higher than that of the USA. They found a downward trend in CO2 emissions, with more substantial declines by 2026 in the USA than in China.

Jamel and Maktouf (2017) found that GDP and CO_2 emissions are strongly associated with each other and asserted that a bidirectional causal relationship exists between environmental degradation, economic growth, energy consumption, and environmental degradation in European and developed countries. Baloch et al. (2018) also found out that there is a strong relationship between economic growth and CO_2 emissions. Economic development associated with energy use at the global level applies intense pressure on environmental quality and energy demand (Hafeez et al. 2018, 2019). Abdouli and Hammami (2017) analyzed the impact of economic growth, population density, and FDI inflows on CO_2 emissions and found out that an increase in per capita GDP improves the environmental quality, and an increase in FDI reduces CO_2 emissions (Sung et al. 2018). From the past few decades, researchers, policy-makers, industry experts, and various government agencies worldwide have paid significant attention to CO_2 emissions and finding ways to mitigate climate change (Rehman et al. 2020).

Belt and Road Initiative (BRI), started by the Chinese president in 2013, is a remarkable initiative for connecting China with the rest of the world. The project includes more than 70 countries so far, accounting for 39% of the world's total land area, 65% of the total global population, and 40% of the entire world's gross domestic product. It is the world's largest economic platform, promoting global economic growth by strengthening economic cooperation in over 900 initiated projects with an investment volume of 850 billion dollars (Fung Business Intelligence Centre 2016). China believes in the equality of all countries, large, and small, and we do not believe some countries should lead others; rather than talking about leadership, we should be talking about responsibility (Wang Yi, Chinese Foreign Minister). Belt and Road Initiative (BRI) is a major strategic component of China's "go global" policy. That is why all participating countries willingly support the BRI in edifying their infrastructure, regional development, and sustainable development (Hafeez et al. 2018). BRI seems noteworthy for economic development, but it is also a cause for concern when considering the ecological consequences (Bilgili et al. 2016; Khan et al. 2017). In the economic development race, one should not forget that economic growth and development are the main factors behind climate change (Hafeez et al. 2018; Uddin et al. 2017; Kasman and Duman 2015).

The motivation of this study is that, nowadays, climatic issues are very scorching topics. BRI countries will increase energy consumption to initiate construction, transportation, infrastructure, and industry-related new projects, which are directly linked to climate change.

FDI inflow is crucial because BRI needs money to start BRI projects, to meet the requirement for new machinery, construction, and many other projects. Furthermore, this will increase energy demand, energy production, and a significant cause of climate change (Iwata et al. 2012). With the industrial activities, energy demand, energy production, economic growth, transportation, construction, and consumption, the proportion of BRI countries in CO_2 emissions will increase. Therefore, BRI countries should have to pay attention to those sectors that are directly linked with climatic issues along with economic development. In this regard, the sector-wise carbon emission of BRI countries from 2000 to 2017 is shown in Fig. 1, which clarifies the trends of CO2 emission from three different sectors of the economy: electricity and heat production, transport, and manufacturing industry and construction sector.

The graph shows an increasing trend in each sector's emission before and after the BRI started. However, the most substantial contributor to climate change is the electricity and heat production sector, with almost 50% of total carbon emissions in BRI countries. Twenty-five percent of total carbon emissions in BRI countries are from the industrial sector, which includes oil plants, natural gas power plants, coal plants, cement factories, oil refineries, iron and steel manufacturing units, and natural gas-processing plants, whereas 15% emissions are due to the transport sector and other sectors cause the remaining 10%. BRI is initiating electricity, transport, and industry-related projects (Source: https://www.beltroad-initiative.com/projects/), hence making it very important to think about mitigating CO_2 emissions caused by these sectors. Hafeez et al. (2018), Istaiteyeh (2016), and Ozcan and Ari (2015) found in their studies that monetary policy can affect economic development and that energy consumption can directly cause climate change. Fiscal policy affects environmental quality, and the energy sector and governments can increase their revenues by imposing environmental taxes,

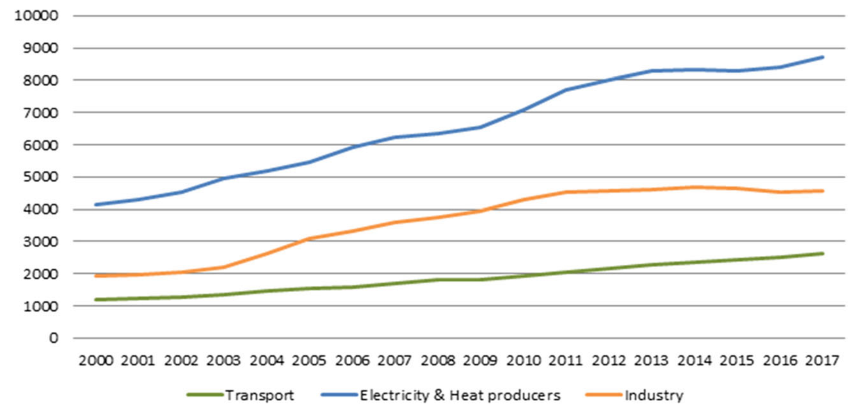

Fig. 1 Sector-wise CO2 emission in BRI countries. Source: International Energy Agency (IEA 2018)

as suggested by Rausch (2013). Halkos and Paizanos (2016) found that fiscal aggregates have a significant impact on CO2 emissions in the USA. Yuelan et al. (2019) suggested that governments should focus on public awareness programs as many people do not know the incredible impact of different things that lead to environmental degradation, and citizens' feelings about environmental degradation can play a pivotal role in enhancing the environmental quality. Several EU and OECD countries (Brazil, Canada, Denmark, Europe, Finland, Ireland, Norway, New Zealand, and so on) levied taxes like environmental tax, energy taxes, transport taxes, and pollution resource taxes. The taxes are contained in energy taxes, transport taxes, pollution taxes, and resource taxes. Environmental tax revenues depend on the applicable environmental taxes, tax rates, exceptions in different sectors, and the use of the tax base. In BRI countries, there is a gap for these kinds of taxes and policy implications for different sectors of the economy.

This study will fulfill the literature's significance and gap to determine the relationship between fiscal policy instrument (government expenditures and tax revenues), economic growth, and FDI on sectoral CO_2 emissions in BRI countries. The objectives of the study are twofold. First, we want to explore how fiscal policy instruments (tax revenues and government expenditures) can help mitigate sectoral-based CO2 emissions in the BRI region. Secondly, analyzing the impact of climate change and FDI, energy usage, economic growth, and fiscal instruments to help policy-makers choose environmentally friendly fiscal policy instruments for different sectors in BRI countries. Further contributions to the previous literature are as follows. First, we incorporate the latest data available to elaborate the relationship between considered variables by utilizing state of the art panel data econometric techniques such as fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) to analyze the long-run linkages among energy demand, FDI, tax revenues, government expenditures, and CO_2 emissions from transportation sector, manufacturing and construction sector, and energy sector. Secondly, the study addresses cross-sectional dependency issues. Both Pedroni's and Fisher Johansen's co-integration tests are used next to investigate co-integration. At the same time, Kao residual co-integration test is performed to validate long-run results from Pedroni and Fisher Johansen co-integration test results. Lastly, heterogeneous panel causality is performed to explore the short-run results. The rest of the paper is structured as follows: literature is discussed in the "Literature review" section. The "Data and methodology" section explains the dataset, variable description, and econometric models. The "Empirical results" and "Discussion" sections explain the results of cross-sectional dependence, panel unit root along with structural breaks, panel co-integration, long-run estimates, short-run causality, and individual country long-run results. Finally, the findings of the study and policy suggestions from the outcomes are explained in the "Conclusion" and Policy implications" sections.

Literature review

A large amount of literature exists wherein efforts have been made to check the influence of different variables on environmental degradation and climate change through various approaches. According to a World Health Organization (WHO) report, air pollution is a significant cause of premature deaths in developing countries; the figure is around 88% of 3.7 million per annum. The environmental issues caused by human activities such as transportation, industrialization, energy production, energy consumption, population growth, and urbanization increase pollution and environmental degradation. To mitigate the level of CO_2 emission and climate change, the United Nations Framework Convention for Climate change (UNFCCC) in 2015 assented to decrease the temperature by 2°C than in the pre-industrial era by 2020 (Dogan and Seker 2016). Consequently, climate change and environmental degradation have become hot topics globally, and countries are planning to focus on renewable energy production (Solaymani et al. 2015).

An economy can achieve its sustainable development goal if the energy demand is fulfilled by a mixture of renewable and non-renewable sources. Many researchers have found a causal relationship between energy use and economic development (Gökmenoğlu and Taspinar 2016; Zeb et al. 2014). Energy consumption is the main factor of global warming and pollution (Hafeez et al. 2018; Istaiteyeh 2016). Traditional non-renewable energy consumption leads to economic growth and increased CO_2 emission (Zhang et al. 2017). Likewise, Bhattacharya et al. (2017) examined 85 industrial countries and found a negative relationship between renewable energy use and CO_2 emission. A study of the Nigerian economy was conducted by Ali et al. (2016) to assess the impact of energy consumption, urbanization, GDP growth, and commercial openness on CO_2 emission. The results show that energy use has a direct and significant relationship with CO_2 emission. With the increase in energy consumption in Nigeria, their environmental quality deteriorated. The study results (Saidi and Hammami 2016) showed a bidirectional causal relationship between energy consumption and CO_2 emissions.

Iwata et al. (2012) found a direct relationship between environmental degradation, energy usage, capital stock, and urbanization. Bidirectional relation has been found between CO_2 emissions and energy use, GDP growth, and financial development in Asian countries. Alam et al. (2014) revealed in their study that real income is the leading cause of CO_2 emission as real income and energy consumption lead to climate change due to industrialization. Jamel and Maktouf (2017) found that GDP and CO_2 emissions are positively and strongly associated with each other and showed a bidirectional causal relationship between environmental degradation and economic growth, energy consumption, and environmental degradation in European and developed countries. Panel research conducted by Aye and Edoja (2017) examined the relationship between economic growth, energy consumption, and environmental degradation in 31 emerging economies. Their results indicate that economic growth has an inverse effect on CO_2 emissions in countries with a low growth regime but a positive effect on CO_2 in countries with a high growth regime. In their study, Sung et al. (2018) have shown a path-dependent mechanism that means that the CO_2 emissions in the current period depend on the previous period's CO_2 emissions. They indicated that with its efforts to minimize CO_2, the government should be consistent and effective because it will help meet the promise to reduce China's carbon intensity in the future as well. The Chinese government is trying to move its industrial model from a carbon-based system to a sustainable one by investing in areas that minimize electricity demand and increase energy quality and encourage renewable energy technology. They suggested that FDI policy should generate stable and constructive short- and long-term elasticity concerning the use of foreign capital to facilitate industrial activities that do not affect the environment. The government should develop and enforce policy measures that force Chinese companies to receive FDI to use and share environmentally sound technology.

Additionally, industrialization is continuously increasing energy use, which leads to climate change and environmental degradation (Shanthi et al. 2018). According to the international energy agency (2018), electricity demand reached 90 billion kWh in 2016. A clean environment is considered an essential pillar of sustainable development in developing countries. To achieve sustainable development, the effective utilization of scarce resources is important (Bakhsh et al. 2017). Chandio et al. (2019) found in their study that industrial development positively affects CO_2 emissions. Various researchers considered this issue and examined the industrial sector in various countries. Sözen et al. (2016) focused on the manufacturing industry and found that it is a significant contributor to Turkey's climate change.

The UK residential sector consumes around 500 million MWh per year (Cuéllar-franca and Azapagic 2012). The construction industry is considered a major contributor to socio-economic development and is also a major consumer of energy and natural resources (Asif and Muneer 2007). The construction industry requires a vast quantity of materials, which leads to an immense consumption of energy resources and a massive release of pollutant emission (Hammond and Jones 2008). Monahan and Powell (2011) compared the embodied carbon and energy analysis of modern methods of construction in the housing sector and found that construction is a substantial contributor to global CO_2 emissions. There is consent that electricity generation capacity will increase by around 25 GW over the next two decades, while many power stations, mainly coal and nuclear plants, will reach the end of their life span. This requires a new investment of an amount equivalent to about one-third of today's generation capacity. The use of renewable technologies such as hydro, on-, and off-shore wind and marine (wave and tidal) devices to generate electricity with low or zero carbon emission has grown rapidly in the UK. The aim of their study is to examine the economic and environmental impact of the energy sector in the UK. The computable general equilibrium model (CGE) is used to show that the development of the energy sector has beneficial impacts in terms of reducing greenhouse gas emission and substantial impact on GDP, employment, and the environment (Allan et al. 2008; Flynn et al. 2007). Lehr et al. (2008) found out that increasing awareness of climate change leads to a new assessment of CO_2 mitigation and also showed the positive impact of the energy sector on employment. Flynn et al. (2007) suggested that renewable energy plants like wind energy farms increase employment opportunities and decrease greenhouse gas emissions. The promotion of electricity produced with renewable resources is on high priority of the European countries.

The transport sector remains one of the main causes of CO_2 emissions in most countries, with a consistent share of 10% of the total CO_2 emissions over the last 25 years (Shahbaz et al. 2015). Previous studies have explained the contribution of the transport sector in increasing environmental degradation worldwide. Chandran and Foon (2013) proved that transport energy consumption caused CO_2 emissions and analyzed the climate-change-related variations of CO_2 emissions. Furthermore, online shopping reduces greenhouse gas emissions from passenger transport (Liu et al. 2017). Gasoline-powered vehicles are responsible for 32.6% of road transport-induced CO_2 emissions, followed by light gasoline-powered freight vehicles, diesel-powered freight vehicles, and diesel intercity buses, which contribute to CO_2 emissions by 25, 12, and 11.3%, respectively (Solís and Sheinbaum 2013). Furthermore, Andreoni and Galmarini (2012) used the decomposition analysis to analyze the drive behind CO_2 emissions in European countries' transport sector. The results affirmed that growth is the main factor influencing CO_2 emissions in both aviation and water transport in the EU-27. CO_2 emissions from transport are intertwined with economic growth, and the non-linear effect of economic growth on CO_2 emissions is consistent (Alshehry and Belloumi 2016). Economic growth would lead to a reduction in emissions in the transport sector, and the rate of reduction could further be increased by running other initiatives, such as a promotion of public transport.

Rehman et al. (2021) used a non-homogenous discrete grey model (NDGM) to estimate sector-wise GHG emissions for Pakistan's five main sectors. Moreover, to evaluate the growth of GHG, they used the synthetic relative growth rate (SRGR) and the synthetic doubling time model (SDTM). They found a growing trend in the forecasting of GHG emissions between 1990 and 2016 in all five sectors. However, the findings suggest that improvements in land use and the forestry and mining industries are more likely to be the factors for potential rises in GHG emissions, led by the agricultural, electricity, and waste sectors. In another research performed by Rehman et al. (2020), using grey relation analysis (GRA), they calculated a grey association between energy usage, population, GDP per capita, and CO_2 within the transport, manufacturing, and household sectors. They found that CO_2 emissions, per capita gross domestic product, population, and energy use are highly intertwined in all industries. In comparison, the population adds further to the intensification of CO_2 emissions in Pakistan's transport industry.

A complicated country-level relationship between ISO 14001 certification, renewable energy consumption, access to electricity, agriculture, and CO_2 emissions within the South Asian Association for Regional Cooperation (SAARC) countries has been analyzed (Ikram et al. 2020). The results from GRA and second synthetic grey relational analysis (SSGRA) revealed that among all SAARC countries, India has substantial CO_2 emission issues. Furthermore, they found reductions in emissions from renewable energy consumption and the adoption of ISO 14001 certification in these countries. In another study, performed by Ikram et al. (2021), they performed an accurate model for forecasting and assessing CO_2 emissions and the production of renewable electricity by using an optimized discrete grey model (ODGM), non-homogeneous discrete grey model (NDGM), and variable speed and adaptive structure grey model (VSSGM) to estimate the future trends of CO_2 emissions and renewable electricity production for the USA and China. The study results found that China's renewable-based electricity generation will be higher than that of the USA by 2026. They also discovered a downward trend in CO2 emissions, with more substantial decreases in the USA than in China.

Several studies examined how laws, policies, and schemes can affect environmental quality. Fiscal policy instruments are significant to manage the demand side of the economy through government spending and taxation, and the governments of most countries spend a large portion of the GDP through fiscal policy (Halkos and Paizanos 2013, 2016; Yuelan et al. 2019). Feng et al. (2018) analyzed the impact of environmental governance on municipal party secretary's political turnover using panel data of 113 cities from 2002 to 2013.

From the above literature review, it can be concluded that fiscal policy instruments are fundamental to tackle the problem of increasing sectoral-based CO_2 emissions along with FDI, economic growth. There is no study in the literature that used taxation and government expenditure as fiscal policy instruments to assess their association with sectoral CO_2 emissions in BRI countries. This study bridges the literature gap by using these fiscal policy instruments to elaborate the impact of fiscal policy on CO_2 emissions from different sectors of the economy in BRI countries.

Data and methodology

Data and description of variables

Carbon dioxide emissions are directly linked with energy consumption, energy production, industrial activities, and transportation (Al-mulali and Foon Tang 2013). Due to the BRI project, there will be an increase in these activities, ultimately increasing CO_2 emissions. The selected participants, as per data availability, of BRI, are reported in Table 1. To overcome these negative externalities, the role of fiscal policy is significant. Fiscal policy involves changing the level of government expenditures and taxes to "persuade" the economic activities. Hence, this study assesses fiscal policy instruments' impact on sectoral emissions from transport, electricity production, and manufacturing industry and construction sectors, and foreign direct investment and economic growth. This study's datasheet includes data of CO_2 emissions from the manufacturing and construction sectors, transportation sector, and electricity and heat production sector, FDI, real GDP

Table 1 BRI countries selected for the study

#	Country	#	Country	#	Country	#	Country	#	Country
1	Albania	9	Czech Rep.	17	Iran	25	Moldova	33	Russia
2	Bangladesh	10	Estonia	18	Jordan	26	Mongolia	34	Singapore
3	Belarus	11	Egypt	19	Kazakhstan	27	Myanmar	35	Slovak Rep
4	Bosnia	12	Georgia	20	Kuwait	28	Nepal	36	Slovenia
5	Bulgaria	13	Hungary	21	Latvia	29	Pakistan	37	Sri Lanka
6	Cambodia	14	India	22	Lebanon	30	Philippines	38	Thailand
7	China	15	Indonesia	23	Lithuania	31	Poland	39	Turkey
8	Croatia	16	Israel	24	Malaysia	32	Romania	40	Ukraine

growth rate, tax revenue, and government expenditures. The data is extracted from the World Development Indicators (2018).

Variables description

The variable's description is reported in Table 2. CO_2 emissions from the manufacturing and construction industry, transport sector, and electricity production sector have been taken as Rehman et al. (2020) also used the same variables. Gross domestic product has been taken into account as a variable for economic growth in the form of GDP per capita growth annual percentage from World Development Indicators as many scholars (Hafeez et al. 2020; Hafeez et al. 2018) have used them. Data on government expenditure and tax revenue as a percentage of GDP has been used as fiscal policy instruments (Halkos and Paizanos 2013, 2016; Yuelan et al. 2019).

Econometric model specification

The first step is to check whether there is a cross-sectional dependence within the variables or not, by employing Pesaran's CD test. After that, we employed the relevant stationarity test of the variables, i.e., whether these variables are integrated at level I(0) or at the first difference I(1). After checking the stationarity of the variables, the co-integration methods were applied to check whether there is a long-run relationship existing between the variables. Then, the study used DOLS and FMOLS to estimate the short- and long-run relationships. Since the main aim of this study is to analyze the impact of fiscal policy instruments, economic development, and foreign direct investment on sectoral-based CO_2 emissions by following the studies of Hafeez et al. (2018, 2020) and Yuelan et al. (2019), the functional forms of the estimated models are as follows:

$$\mathrm{EHCO2it} = \mathrm{f}\ (\mathrm{FDIit}, \mathrm{GDPcit}, \mathrm{GEit}, \mathrm{TRit}, \mathrm{Uit}) \tag{1}$$

$$\mathrm{MICO2it} = \mathrm{f}\ (\mathrm{FDIit}, \mathrm{GDPcit}, \mathrm{GEit}, \mathrm{TRit}, \mathrm{Uit}) \tag{2}$$

$$\mathrm{TCO2it} = \mathrm{f}\ (\mathrm{FDIit}, \mathrm{GDPcit}, \mathrm{GEit}, \mathrm{TRit}, \mathrm{Uit}) \tag{3}$$

The econometric forms of the estimated models (1 to 3) are as follows:

$$\mathrm{EHCO2it} = \lambda\mathrm{i} + \delta\mathrm{i} + \beta1\mathrm{iFDIit} + \beta2\mathrm{iGDPcit} + \beta3\mathrm{iGEit} + \beta4\mathrm{iTRit} + \mu\mathrm{it1} \tag{4}$$

$$\mathrm{MICO2it} = \lambda\mathrm{i} + \delta\mathrm{i} + \beta5\mathrm{iFDIit} + \beta6\mathrm{iGDPcit} + \beta7\mathrm{iGEit} + \beta8\mathrm{iTRit} + \mu\mathrm{it2} \tag{5}$$

$$\mathrm{TCO2it} = \lambda\mathrm{i} + \delta\mathrm{i} + \beta9\mathrm{iFDIit} + \beta10\mathrm{iGDPcit} + \beta11\mathrm{iGEit} + \beta12\mathrm{iTRit} + \mu\mathrm{it3} \tag{6}$$

In Eqs. (4) to (6), "i" indicates the specific BRI country and "t" indicates time. λ_i and δ_i are referred to specific country effects and trends in the model, respectively. The parameters from β1 to β4, β5 to β8, and β9 to β12 in Eqs. (4), (5), and (6) are the long-run estimates of FDI, GDP, government expenditures, and tax revenues, respectively.

Empirical results

The cross-sectional dependency test results are reported in Table 3 and inferred that the *p* value of each model is greater than 0.05, which is the critical value for all the models. So, it can be concluded that we cannot reject the null hypothesis that there is no transversal dependency.

Panel unit root tests

Cross-sectional dependency test results confirm no such dependency in the data. So, we applied panel unit root tests to verify the order of integration of variables, which are LLC (Levin, Lin and Chu 2002), IPS (Im, Pesaran and Shin 2003), Breitung's (2001) Test, and ADF Fisher (1999) unit root tests. The unit root test results are presented in Table 4 and suggest that all the variables used in all the three models are stationary at the level because all the under-considered variables rejected the null hypothesis of unit root and are integrated at the level.

Table 2 Variables description

Variable	Description	Symbols	Data source
Manufacturing and construction industry CO_2 emissions	Percentage of total fuel consumption	$MICO_2$	WDI
Transport CO_2 emissions	Percentage of total fuel consumption	TCO_2	WDI
Electricity and heat production CO_2 emissions	Percentage of total fuel consumption	$EHCO_2$	WDI
GDP	GDP per capita growth (annual %)	GDP	WDI
Foreign direct investment	Foreign direct investment, net inflows (% of GDP)	FDI	WDI
Government expenditures	Percentage of GDP	GE	WDI
Government revenues	Percentage of GDP	TR	WDI

Source: World Development Indicator

It is clear from the results given in Table 4 that the variables related to emission based on sectors are stationary at the level since their *p* value is less than the critical value 0.05. Furthermore, government expenditures, tax revenues, foreign direct investment, and economic growth also rejected the null hypothesis of the unit root test and integrated at the level, which implies that the selected variables are stationary, and we can move towards regressing the panel data. While elaborating the order of integration in the panel data, unexpected shocks and structural changes cannot be considered in traditional unit root tests.

Panel co-integration tests and long-run equilibrium

We applied the co-integration test from the Pedroni panel (1999, 2004) to confirm the long-term relationship. Pedroni's test includes seven statistical values to decide whether there is a long-term relationship between the series. These values include the panel v statistic, the panel rho statistic, the panel PP statistic, the panel ADF statistic, the group rho statistic, the group PP statistic, and the group ADF statistic. The empirical results of the Pedroni test are shown in Table 5. The results validate the long-term relationships between sectoral CO_2 emissions, FDI, per capita income, and fiscal policy instruments in BRI countries. The results reported in Table 5 suggest rejection of the null hypothesis, which means that there is no co-integration in the equation. To be rejected, the majority of statistics must have a significance value of less than 5%. Results show that out of seven statistic values, four are significant in each of the three models. T-stat and *p* values have been given in the table. The Pedroni panel co-integration tests provide evidence of a long-term relationship between sectoral emissions, fiscal policy instruments, economic growth, and foreign direct investment.

The study also applied the Johansen and Fisher panel co-integration test, developed by Maddala and Ã (1999), and presented in Table 6 to confirm the Pedroni test results based on Johansen's co-integration test (Johansen 1988).

Furthermore, to validate the combined Pedroni and Fisher-Johanson co-integration results, the Kao residual co-integration test is also applied and reported in Table 7. The Kao residual co-integration test results showed that all the variables in the three models have a long-term relationship. All three tests suggested that there is a long-term relationship between sector-based CO_2 emission and all of the independent variables in BRI economies.

Results of dynamic OLS and fully modified OLS

The co-integration test confirms whether there is a long-term relationship or not. The next step after the co-integration test is to apply the dynamic ordinary least squares (DOLS) and the fully modified ordinary least squares (FMOLS) to estimate the

Table 3 Results of cross-sectional dependence

Null hypothesis: no cross-sectional dependence	Rejection criteria: statistic (p < 0.05)
Model 1	−1.656767 (0.0976)
Model 2	−0.140562 (0.8882)
Model 3	−0.531493 (0.5951)

Table 4 Results of unit root tests

Variables	LLC	Breitung	IPS	ADF
$MICO_2$	0.0000***	0.0000***	0.0000***	0.0002***
TCO_2	0.0000***	0.0000***	0.0000***	0.0000***
$EHCO_2$	0.0000***	0.0000***	0.0000***	0.0000***
FDI	0.0009***	0.0001***	0.0349**	0.0722*
GDPc	0.0000***	0.0000***	0.0000***	0.0001***
GE	0.0000***	0.0735*	0.0013***	0.0025***
TR	0.0001***	0.2105	0.0077***	0.0105***

*** Significant at 1% level of significance

** Significant at 5% level of significance

* Significant at 10% level of significance

Table 5 Results of Pedroni co-integration test

Within dimension		Between dimension	
Model 1 (electricity and heat sector emissions)			
Panel v-statistic	0.826392 (0.2043)	Group rho-Statistic	6.668968 (1.000)
Panel rho-statistic	4.465919 (1.0000)	Group PP-Statistic	−15.10145 (0.000)***
Panel PP- statistic	−6.844460 (0.000)***	Group ADF-Statistic	−4.122379 (0.000)***
Panel ADF-statistic	−3.352843 (0.004)***		
Model 2 (manufacturing industry and construction CO_2 emissions)			
Panel v-statistic	−3.045796 (0.9988)	Group rho-statistic	6.244216 (1.000)
Panel rho-statistic	4.270462 (1.000)	Group PP-statistic	−12.63999 (0.000)***
Panel PP-statistic	−8.103198 (0.000)***	Group ADF-statistic	−8.789033 (0.000)***
Panel ADF-statistic	−9.070623 (0.000)***		
Model 3 (Transport CO_2 emissions)			
Panel v-statistic	1.308620 (0.0953)*	Group rho-statistic	5.352999 (1.000)
Panel rho-statistic	2.635906 (0.9958)	Group PP-statistic	−6.474850 (0.000)***
Panel PP-statistic	−9.100600 (0.000)***	Group ADF-statistic	−8.075230 (0.000)***
Panel ADF-statistic	−11.74794 (0.000)***		

*** Significant at 1% level of significance

** Significant at 5% level of significance

* Significant at 10% level of significance

long-term dynamics along with the nature of causality (Pedroni 2004) for panel data from the BRI region. Although the fully modified ordinary least squares (FMOLS) method is more preferable to the dynamic ordinary least squares (DOLS) and ordinary least squares (OLS) method in case of endogeneity problems (Pedroni 2000, 2001, 2004), we do not rely exclusively on the empirical findings of FMOLS. Hence, we apply DOLS and FMOSL for all

Table 6 Results of Fisher-Johanson combined co-integration test

Null hypothesis: no co-integration	Rejection criteria: $p < 0.05$	
Hypothesized no. of CE(s)	Fisher Stat from trace test (p value)	Fisher Stat from max-eigen test (p value)
Model 1 (electricity and heat sector emissions)		
None	1538 (0.0000)***	1107 (0.0000)***
At most 1	718.3 (0.0000)***	502.6 (0.0000)***
At most 2	315.4 (0.0000)***	250.4 (0.0000)***
At most 3	144.2 (0.0000)***	131.0 (0.0003)***
At most 4	112.0 (0.0106)***	112.0 (0.0106)***
Model 2 (manufacturing industry and construction CO_2 emissions)		
None	396.1(0.000)***	396.1(0.000)***
At most 1	1356(0.000)***	2213(0.000)***
At most 2	518.0(0.000)***	397.8(0.000)***
At most 3	209.4(0.000)***	162.5(0.000)***
At most 4	112.7(0.009)***	112.7(0.009)***
Model 3 (transport CO_2 emissions)		
None	1513 (0.0000)***	1111. (0.0000)***
At most 1	707.6 (0.0000)***	539.4 (0.0000)***
At most 2	281.2 (0.0000)***	211.1 (0.0000)***
At most 3	141.9 (0.0000)***	122.8 (0.0015)***
At most 4	118.0 (0.0037)***	118.0 (0.0037)***

*** Significant at 1% level of significance

Table 7 Results of Kao residual co-integration test

Null hypothesis: no co-integration	Rejection criteria: $p < 0.05$
Model 1 (electricity and heat sector emissions)	4.053108 (0.0000)***
Model 2 (manufacturing industry and construction CO_2 emissions)	−1.539397 (0.0619)*
Model 3 (transport CO_2 emissions)	−1.535973 (0.0623)*

*** Significant at 1% level of significance

** Significant at 5%

* Significant at 10%

models. The results of the FMOLS estimates authenticate the impact of all independent variables on the sectoral-based emissions.

Results of DOLS and FMOLS for all three models are represented in Tables 8, 9, and 10. The first model results show that FDI affects, positively and significantly, the CO_2 emissions from the electricity and heat production sector in BRI economies. From the results, it can be inferred that a 1% increase in FDI will increase electricity and heat sector emission by 0.249679% according to DOLS results and 0.1182% according to FMOLS results.

For economic growth, the results indicate that an increase in per capita income leads to an increase in CO_2 emission from the electricity and heat production sector by 0.392751% according to DOLS and 0.188138% according to FMOLS. Economic growth per capita's effect on CO_2 emissions is statistically significant, at the 5% level of significance, as its probability is less than 0.05; the results are similar to Ahmed et al. (2019), Abdouli and Hammami (2017), Cetin and Ecevit (2017), and Ozcan and Ari (2017).

The value of the coefficient of FMOLS is 0.201415, which shows that if the government increases its expenditure by 1%, it will be the reason for a 0.201415% increase in CO_2 emission from the electricity and heat production sector. The results are similar to those of Yuelan et al. (2019) and Halkos and Paizanos (2013). The coefficient of tax revenues is statistically negative and significant in the long run, which shows that as the tax revenues increase, the CO_2 emissions from the electricity and heat production sector decrease. The value of the coefficient of DOLS is −0.747678 in the long run, and the value of the coefficient of FMOLS is −0.302533, which shows that if a government increases the taxes by 1%, it will reduce the CO_2 emission from the electricity and heat production sector by 0.747678% according to DOLS and by 0.302533 according to FMOLS.

The second model results show that FDI has a negative and statistically significant effect on CO_2 emissions from the manufacturing industry sector in BRI economies. The results concluded that a 1% increase in FDI would decrease the industrial sector's emissions by 0.032104% and 0.002930%, according to DOLS and FMOLS results, respectively.

For economic growth, the results indicate that an increase in per capita income will lead to an increase in CO_2 emission from the industrial sector by 0.375925% according to DOLS and 0.058765% according to FMOLS. Economic growth per capita is statistically significant at the 5% level of significance.

The value of the coefficient of DOLS is 0.159558, which shows that if a government increases its expenditure by 1%, it will reduce industrial emissions by 0.159558%. FMOLS results show that a 1% increase in government expenditures will reduce the manufacturing industry and construction sector emissions by 0.191143.

The coefficient of tax revenues is also statistically significant in the long run, which shows that as the government

Table 8 Long-run dynamics of the first model

Model 1 (electricity and heat sector emissions)

Variables	Dynamic OLS		Fully modified OLS	
	Coefficients	Prob.	Coefficients	Prob.
FDI	0.249679	0.0264**	0.118202	0.0015***
GDP per capita	0.392751	0.0237**	0.188138	0.0000***
Govt. expenditures	−0.059083	0.8727	0.201415	0.0000***
Tax revenues	−0.747678	0.0056***	−0.302533	0.0000***

*** Significant at 1% level of significance

** Significant at 5% level of significance

Table 9 Long-run dynamics according to the second model

Model 2 (manufacturing industry and construction CO_2 emissions)

Variables	Dynamic OLS		Fully modified OLS	
	Coefficients	Prob.	Coefficients	Prob.
FDI	−0.032104	0.0007***	−0.002930	0.0975*
GDP per capita	0.375925	0.0000***	0.058765	0.0335**
Govt. expenditures	−0.159558	0.0000***	−0.191143	0.0035***
Tax revenues	0.095388	0.0332**	0.161102	0.0084***

*** Significant at 1% level of significance

** Significant at 5% level of significance

Table 10 Long-run dynamics according to the third model

Model 3 (transport CO2 emissions)				
Variables	Dynamic OLS		Fully modified OLS	
	Coefficients	Prob.	Coefficients	Prob.
FDI	−0.857910	0.0002***	−0.076599	0.0000***
GDP per capita	1.031638	0.0014***	0.276599	0.0392***
Govt. expenditures	−0.188961	0.4972	−0.407655	0.0000***
Tax revenues	1.590777	0.0000***	0.286457	0.0000***

*** Significant at 1% level of significance

** Significant at 5% level of significance

increases its tax revenues, it will increase the CO2 emissions from the manufacturing and construction sectors. The value of the coefficient of DOLS shows that if a government increases the taxes by 1%, it will increase the CO_2 emissions from the manufacturing industry and construction sector by 0.095388% according to DOLS and by 0.161102% according to FMOLS.

The third model shows that FDI has statistically significant adverse effects on CO_2 emissions from the BRI economies' transport sector. The results show that a 1% increase in FDI will decrease emissions from the transportation sector by 0.857910% or 0.076599%, according to DOLS and FMOLS results, respectively. The findings support that FDI improves the environment by incorporating clean technology and experience in the transport sector, which provides tangible benefits for the host country.

For economic growth, the results indicate that an increase in per capita income will lead to an increase in CO_2 emissions from the transport sector by 1.031638% according to DOLS and 0.276599% according to FMOLS. Economic growth per capita is statistically significant at a 1% level of significance. A gasoline-powered vehicle is responsible for 32.6% of CO_2 emissions, followed by light gasoline-powered freight vehicles, diesel-powered freight vehicles, and diesel intercity buses, contributing to CO_2 emissions by 25%, 12%, and 11.3%, respectively (Solís and Sheinbaum 2013).

For fiscal policy instruments, the public spending coefficient is also statistically significant in the long term, demonstrating that transport emissions can be mitigated by using appropriate fiscal policy tools and instruments. The results show that as the government increases its spending, it will help decrease CO_2 emissions from the transportation sector. The results show that if the government increases its spending by 1%, it will reduce emissions from the transportation sector by 0.188961% according to DOLS and 0.407644% according to FMOLS. Tax revenues are also statistically significant in the longer run. An increase in government taxes increases CO_2 emissions from the transport sector. The value of the DOLS coefficient shows that if government taxes increase by 1%, CO_2 emissions from the transport sector increase by 1.590777% or 0.286457% according to DOLS and FMOLS, respectively.

Pairwise Dumitrescu and Hurlin panel causality test

The long-run results from FMOLS and DOLS signify the extrapolation. However, it is not adequate for policy-makers to authorize the causal relationship among the variables considered. To solve this issue, the heterogeneous panel causality test developed by Dumitrescu and Hurlin (2012) based on Granger causality tests has been applied to figure out the causal relationship among variables taken in the study for BRI. It also addresses the heterogeneity problem of data based on W-bar statistics and Z-bar statistics. The Dumitrescu and Hurlin panel causality test is suitable for short-term and long-term panel data to compute causality (Dumitrescu and Hurlin 2012). Table 11 represents the results of Dumitrescu and Hurlin panel causality for all the models. The results show that government expenditures and tax revenues cause climate change due to CO_2 emissions from the electricity and heat sectors. Moreover, GDP per capita and FDI homogeneously cause CO_2 emissions from the electricity and heat sector, and CO_2 emissions from the electricity and heat do homogeneously cause FDI.

The results of Dumitrescu and Hurlin panel causality indicate that FDI homogeneously causes manufacturing and industrial CO_2 emissions. GDP does homogeneously cause manufacturing and industrial CO_2 emissions as an increase in production increase the emissions. Government expenditures and tax revenues also result in homogeneous $MICO_2$; more specifically, the bidirectional causality is found between tax revenues and $MICO_2$. For the transportation sector, the Dumitrescu and Hurlin panel causality results show that GDP homogeneously causes transportation CO_2 emissions and transportation CO_2 emissions homogeneously cause GDP. Transportation CO_2 emissions homogeneously cause government expenditures, and tax revenues homogeneously cause transportation CO_2 emissions

Discussion

Cross-dependency is a common feature of the economies in this age of openness due to residual interdependence and the omission of common factors (Hafeez et al. 2019; Bekun et al. 2019). To avoid misleading results and to obtain more efficient results, cross-dependency tests are essential to be performed before panel unit root tests (Pesaran 2004, 2007). It is clear from the results that all the considered variables are cross-sectionally independent and stationary at level. The Pedroni, Johansen, and Fisher panel co-integration and the

Table 11 Results of pairwise Dumitrescu and Hurlin panel causality tests

Null hypothesis	W-bar Stat	Z-bar stat	*p* value
Model 1 (electricity and heat sector emissions)			
GDP does not homogeneously cause $EHCO_2$	2.50843	0.13207	0.0894*
$EHCO_2$ does not homogeneously cause GDP	3.23034	1.62206	0.1048
FDI does not homogeneously cause $EHCO_2$	3.28477	1.73440	0.0828*
$EHCO_2$ does not homogeneously cause FDI	3.46768	2.11193	0.0347**
GE does not homogeneously cause $EHCO_2$	4.09912	3.41519	0.0006***
$EHCO_2$ does not homogeneously cause GE	2.91058	0.96208	0.3360
TR does not homogeneously cause $EHCO_2$	4.62693	4.50457	0.0000***
$EHCO_2$ does not homogeneously cause TR	3.07043	1.29201	0.1964
FDI does not homogeneously cause GDP	4.28887	3.80683	0.0001***
GDP does not homogeneously cause FDI	2.29922	−0.29973	0.7644
GE does not homogeneously cause GDP	4.76058	4.78042	0.0000***
GDP does not homogeneously cause GE	2.82306	0.78144	0.4345
TR does not homogeneously cause GDP	2.71116	0.55050	0.5820
GDP does not homogeneously cause TR	3.60818	2.40191	0.0163***
GE does not homogeneously cause FDI	3.87795	2.95872	0.0031***
FDI does not homogeneously cause GE	5.37903	6.05687	0.0000***
TR does not homogeneously cause FDI	3.28589	1.73672	0.0824*
FDI does not homogeneously cause TR	5.04235	5.36198	0.0000***
TR does not homogeneously cause GE	3.09498	1.34268	0.1794
GE does not homogeneously cause TR	2.98352	1.11263	0.2659
Model 2 (manufacturing industry and construction CO2 emissions)			
FDI does not homogeneously cause $MICO_2$	3.89765	2.99936	0.0027***
$MICO_2$ does not homogeneously cause FDI	3.10370	1.36068	0.1736
GDP does not homogeneously cause $MICO_2$	3.13694	1.42929	0.0529**
$MICO_2$ does not homogeneously cause GDP	2.73626	0.60231	0.5470
GE does not homogeneously cause $MICO_2$	6.00135	7.34133	0.0000***
$MICO_2$ does not homogeneously cause GE	2.50376	0.12242	0.9026
TR does not homogeneously cause $MICO_2$	3.14079	1.43723	0.0900*
$MICO_2$ does not homogeneously cause TR	3.28895	1.74303	0.0813*
Model 3 (transport CO2 emissions)			
GDP does not homogeneously cause TCO_2	4.20374	3.63113	0.0003***
TCO_2 does not homogeneously cause GDP	3.59053	2.36548	0.0180**
FDI does not homogeneously cause TCO_2	3.04107	1.23141	0.2182
TCO_2 does not homogeneously cause FDI	2.76925	0.67038	0.5026
GE does not homogeneously cause TCO_2	3.18525	1.52900	0.1263
TCO_2 does not homogeneously cause GE	3.85221	2.90558	0.0037***
TR does not homogeneously cause TCO_2	4.32024	3.87157	0.0001***
TCO_2 does not homogeneously cause TR	2.66771	0.46080	0.6449

* Significant at 1% level of significance

** Significant at 5% level of significance

Kao residual co-integration tests confirmed a long-run relation between government expenditures, tax revenues, foreign direct investment, economic growth, and CO_2 emissions from three sectors.

In the electricity and heat-producing sector of BRI countries, FDI is increasing, and it activates the production process, electricity generation, and heat process to fulfill the need of increased demand for electricity and heat, which causes climate change. Economic growth per capita's effect on CO_2 emissions is statistically significant, which shows that as the countries' GDP increases, that will increase the production process and demand for energy, industry, and construction. This is also because an increase in GDP will increase consumption and production in the electricity and heat-producing sectors. The CO_2 emission will also increase as these countries did not achieve EKC yet. As for the fiscal policy instruments, the coefficient of government expenditure using FMOLS shows a statistically significant and positive relationship in the long run, which shows an increase in the CO_2 emissions from the electricity and heat production sector as the government increases its expenditures. The coefficient of tax revenues is statistically significant and negative, which means fiscal policy instruments like government expenditures and tax revenues can help reduce the CO_2 emission from the electricity and heat production sector in the long run if applied appropriately.

The manufacturing industry and construction sector's findings support that FDI improves the environment by incorporating clean technology and expertise, which provides tangible benefits for the host country (Sung et al. 2018). An increase in the level of economic growth leads to the production of more goods and services, which is one reason behind increased CO_2 emissions from the industrial sector. The results are similar to Çetin and Ecevit (2017) and Ozcan and Ari (2017). The results show that as the government increases its expenditures, it will decrease the CO2 emissions from the manufacturing and construction sectors. For fiscal policy instruments, the coefficients of government expenditure and tax revenues are statistically significant in the long run; this shows that industrial emissions can be mitigated by using the best fiscal policy tools and instruments. The results validate that government expenditures are in the line of green industrial development. Governments need to reduce taxes from the manufacturing industry and the construction sector and also need to encourage industries to use clean energy and green technologies in the manufacturing process to reduce industrial CO_2 emissions.

An increase in population and economic growth leads to increased use of transportation hence increasing CO_2 emissions from the transportation sector. The results validate that government spending is in line with promoting green transportation and electric vehicles. The results show that to reduce the transportation sector's CO_2 emissions, government should reduce taxes on the transportation sector and should encourage people to use public transport and electric vehicles.

Conclusion

The massive increase in CO_2 emissions from different sectors of BRI countries is a great concern for policy-makers. This study is taking a step forward to assess the degree of association between fiscal policy instruments (government expenditures and tax revenues), FDI, GDP per capita, and CO_2 emissions in the transportation, industrial, electricity, and heat sectors from 2000 to 2018 for BRI region. The dynamic ordinary least squares and the fully modified least squares models were applied. The estimated outcomes showed that fiscal policy instruments like government expenditures and taxes could be used to successfully mitigate climate change caused by transport, manufacturing, construction, electricity, and heat sectors. Moreover, the results showed that foreign direct investment and economic growth also increase CO_2 emissions in these sectors. The outcomes showed that governments could use fiscal instruments (taxes and government expenditure) to reduce CO_2 emissions from the electricity and heat production sectors by imposing a tax on traditional electricity production methods and giving incentives for employing green technologies for production. For the manufacturing industry and construction sector model, results advocate that governments should promote and enhance the use of green technologies in the industrial and manufacturing sector by giving incentives and reducing the tax burden. The government needs to increase spending in the transportation sector to enhance the public transport system and reduce private transportation usage, thus reducing CO_2 emissions from the transportation sector. This shows that different policies need to be stipulated to mitigate CO_2 emissions from different sectors of the economy.

Policy recommendations

To reduce the adverse environmental impact of the electricity and heat-producing sectors, governments should focus on implementing policies to track coal-fired power production, thermal power, and gas-fired power as there is a unidirectional causality found from fiscal policy instruments to CO_2 from electricity and heat-producing sector. The effective development of renewable energy policies requires institutional coherence within and between BRI countries. Coordination and exchange of information between economies will improve the policies' effectiveness and help gain ground for renewable energy plans.

For all BRI countries, accessibility of data on specific demand for renewable energy, potential availability, exploitable level, price, and efficiency of renewable techniques is essential for stakeholders, including policy-makers, regulators, utilities, designers and distributors of technology, other potential buyers and researchers to take part in the growth, and advancement of renewable energy technologies. Economies must have a collective agreement to address the issue of energy security and environmental sustainability. Besides, governments should motivate zero-level emission policies for energy infrastructure within and between the BRI region. Effective campaigns by governments to establish renewable energy projects can attract more foreign direct investment in the renewable energy sector.

A causal association found in the outcomes means fiscal policy tools will reduce CO_2 emissions from the manufacturing and construction sectors. Government taxes on the manufacturing and construction sectors should be minimized. Businesses should also be encouraged to use renewable energy and advanced technology in the manufacturing phase to minimize industrial CO_2 emissions. Governments should launch capacity-building programs for policy and decision-making, management and regulatory design for project preparation, funding, growth, implementation, and assessment. In the manufacturing industry and the construction sector, increasing employees' skill set by preparation is also essential.

Governments should support public transportation and transit systems to reduce dependence on private vehicles such as cars and motorcycles, which will help reduce emissions in city areas. Effective population control policies should be introduced to increase the return to human capital, promote gender equality, and increase the availability of contraceptive methods. A decrease in population growth leads to an increase in per capita income growth and a direct reduction in CO_2 emissions. Production of energy-efficient and eco-friendly electrical appliances is essential for the economies to reduce the adverse impact of electricity on CO_2 and other emissions and contribute positively to environmental conservation.

As per our knowledge, this study is the first attempt to study the role of fiscal policy instruments in the context of different sectors of BRI countries. However, so far, the study does not cover the entire BRI panel dataset due to data unavailability. Besides, tax revenues are used as a proxy for environmental taxes and government expenditure as environmental subsidies and expenditures due to data unavailability on such taxes and subsidies in BRI countries. It was also challenging to obtain data on current fiscal policies in all BRI countries. Some future research directions are available as there are some limitations of this research; policies related to renewable, non-renewable energy, and energy efficiency can also be integrated into the BRI countries' different sectors as future directions. Furthermore, this study is limited by its consideration of the role of governance, as governance influences the implementation and improvement of policies. Therefore, future work is needed to consider the role of governance and remove these limitations.

Availability of data and materials The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Author contribution This idea was given by Muhammad Waqas Akbar and Peng Yuelan. Adnan Maqbool has collected the datasets, while Muhammad Waqas Akbar and Zeenat Zia have conducted the data analysis and wrote the complete paper. Lastly, Adnan Maqbool and Muhammad Saeed read and approved the final version.

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Declarations

Ethics approval and consent to participate We confirmed that this manuscript has not been published elsewhere and is not under consideration by another journal. Ethical approval and informed consent do not apply to this study.

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