Routledge
Taylor & Francis Group

Emerging Markets Finance and Trade

ISSN: 1540-496X (Print) 1558-0938 (Online) Journal homepage: www.tandfonline.com/journals/mree20

Effectiveness of Fiscal and Monetary Policies in Promoting Environmental Quality: Evidence from Five Large Emerging Economies

Chi Keung Lau, Gupteswar Patel, Mantu Kumar Mahalik, Bimal Kishore Sahoo & Giray Gozgor

To cite this article: Chi Keung Lau, Gupteswar Patel, Mantu Kumar Mahalik, Bimal Kishore Sahoo & Giray Gozgor (2024) Effectiveness of Fiscal and Monetary Policies in Promoting Environmental Quality: Evidence from Five Large Emerging Economies, Emerging Markets Finance and Trade, 60:1, 203-215, DOI: 10.1080/1540496X.2023.2210716

To link to this article: https://doi.org/10.1080/1540496X.2023.2210716

EMERGING MARKETS FINANCE AND TRADE
2024, VOL. 60, NO. 1, 203–215
https://doi.org/10.1080/1540496X.2023.2210716

Effectiveness of Fiscal and Monetary Policies in Promoting Environmental Quality: Evidence from Five Large Emerging Economies

Chi Keung Lau[a], Gupteswar Patel[b], Mantu Kumar Mahalik[b], Bimal Kishore Sahoo[c], and Giray Gozgor[d,e,f]

[a]School of Hospitality Administration, Zhejiang Yuexiu University of Foreign Languages, Shaoxing, China; [b]Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur, Midnapur, India; [c]School of Humanities, Social Sciences & Management, Indian Institute of Technology Bhubaneswar, Jatni, India; [d]School of Management, University of Bradford, Bradford, UK; [e]Faculty of Political Sciences, Istanbul Medeniyet University, Istanbul, Turkey; [f]Adnan Kassar School of Business, Lebanese American University, Beirut, Lebanon

ABSTRACT
Growing climate change concern invites policy responses from all corners. Governments and central banks in emerging market economies pose interests in environmental urgencies. This paper reexamines fiscal and monetary policies' effects on environmental quality in five large emerging economies (Brazil, Russia, India, China, and South Africa) from 1990 to 2018. Effects of population, economic growth, and technology on CO_2 emissions are also estimated. According to the Pooled Mean Group-Autoregressive Distributed Lag estimations, Panel Fully Modified Ordinary Least Squares, and Driscoll-Kraay estimations, expansionary fiscal and monetary policies significantly improve environmental quality. Technology also promotes environmental quality. However, economic and population growth degrade the natural environment in the long run. The paper also discusses potential policy implications.

KEYWORDS
Emerging economies; fiscal policy; monetary policy; environmental quality; technology

JEL
E62; E52; Q53; C23

1. Introduction

Human activities and how economies grow are the leading factors of environmental degradation in the 21st century. The economic growth and the environmental protection debate are more prominent in emerging market economies as they drive global growth rates. On the path of economic expansion, consumers and producers raise the energy demand, causing environmental degradation (Chen et al. 2020). Further, emerging economies are facing more significant financial risks in terms of the highest inflations in decades, energy market uncertainty, rising interest rates and cost of borrowings, weak macroeconomic fundamentals, and capital outflows. These economic problems pose economic uncertainty, volatilely impacting energy markets and environmental implications (Ren et al. 2022a, 2022b, 2023; Sarker, Bouri, and Marco 2023; Syed and Bouri 2022). These economies must implement suitable monetary and fiscal policies to tackle these challenges of environmental degradation and energy insecurity. These two economic policies can enhance the quality of the natural environment through green financing of the economies (Boneva, Ferrucci, and Mongelli 2022; Mahmood et al. 2022; Wang, Fu, and Ren 2022; Zeraibi et al. 2022). Finding an appropriate policy mix will help to achieve sustainable economic growth, investment in technology, and better living for the growing

CONTACT Gupteswar Patel gpatel@iitkgp.ac.in Department of Humanities and Social Sciences, Indian Institute of Technology Kharagpur, Midnapur, West Bengal, India; Giray Gozgor g.gozgor@bradford.ac.uk School of Management, University of Bradford, Richmond Road, Bradford BD7 1DP, UK

population in emerging economies by mitigating the environmental pressure. Moreover, developing economies compete with advanced countries for trade promotion (Gozgor 2017). Still, an effective solution to climate change policy uncertainty is yet to come (Ren et al. 2022a; Shang et al. 2022).

The BRICS (Brazil, Russia, India, China, and South Africa) represent emerging economies appropriately. The BRICS economies are the largest among emerging and significant fastest-growing economies globally (Gozgor 2014). With 32% of the World's Gross Domestic Product (GDP) (World Bank 2023), they still have the priority to fight against fundamental and critical economic problems like poverty, inequality, and unemployment, for which economic growth is a prerequisite (Wu et al. 2022). According to Figures 1 and 2, along with the GDP growth, the per capita carbon emissions are also rising in these economies more than the global average from 1990 to 2018, contributing 29% to worldwide carbon dioxide emissions (World Bank 2023). In New Delhi Statement on Environment

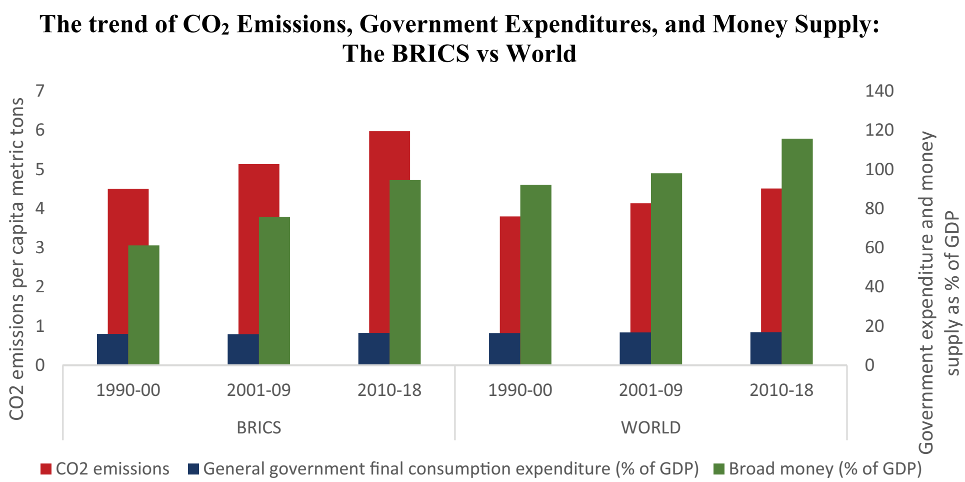

Figure 1. This graph on carbon emissions per capita, government consumption expenditure and money supply across BRICS (Brazil, Russia, India, India, China, and South Africa) vs World are plotted using the data from World Development Indicators. Though per capita carbon emissions are rising from 1990-00 to 2010-18, it has been higher in BRICS than at the global level. Source: World Bank (2023).

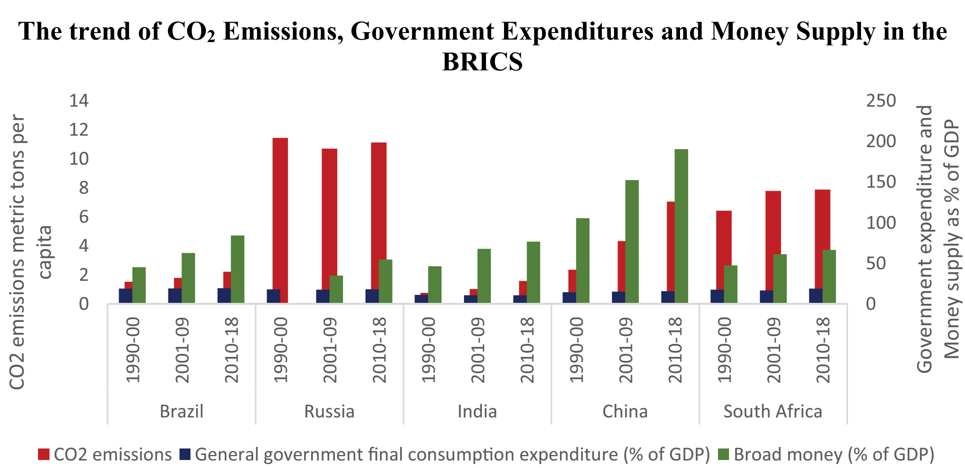

Figure 2. This graph on carbon emissions per capita, government consumption expenditure and money supply among BRICS economies is plotted using the data from World Development Indicators. Though the tendency of per capita carbon emissions are mixed from 1990-00 to 2010-18, it has been higher in Russia, South Africa and China than in India and Brazil. Source: World Bank (2023).

2021,[1] the BRICS countries have pledged to make an inclusive and ecologically sustainable future by adhering to the Rio declaration. The BRICS Environmentally Sound Technology (BEST) calls for a holistic approach to tackling the climate emergency by focusing on adaptation, financing, mitigation, and technology (Zhang, Sha, and Xu 2021). Like all economies, the BRICS countries have government (fiscal) and central bank (monetary) tools to finance economic growth. These tools are crucial for maintaining the balance between development and the environment, which is more challenging for emerging economies like the BRICS. On the other hand, BRICS countries have performed poorly in protecting environmental health and managing ecosystem vitality.[2] This issue appeals to the coalition to find innovative techniques and practical tools to fight the menace of environmental degradation, which needs further research on the BRICS countries incorporating the instruments vital for fine-tuning between ecological protection and economic progress.

Recently, the Russian-Ukrainian war has aggravated the environmental emergency in multiple ways. The war harms biodiversity and the quality of air, soil, and water (Rawtani et al. 2022). Also, due to humanitarian concerns that arose from the conflict, environmental protection issues have been overlooked (Pereira et al. 2022). Further, turbulent foreign exchange markets, global supply chain disruption, volatile oil prices, and threats to energy security are coming as by-products. These are putting tremendous challenges not only ecologically but also in economic policies (monetary and fiscal) point of view.

The aggravating environmental problem calls for the integration of economic and environmental policies. The attributes common to both subjects should be taken together in a comprehensive analysis to understand the nexus between economic policies and the environment more deeply. Economic policies aim to achieve economic opulence and technological advancement to ensure a better living for a growing population. However, economic prosperity comes with an environmental cost. Our paper contributes to the literature by modeling all these related economic policies and environmental attributes together in a panel framework for five major emerging economies, BRICS.[3] This framework is an extension of the IPAT (i.e. environmental impact, population, affluence and technology) theory. Long-run panel data methods are used with robust standard errors for empirical investigation. Our study finds beneficial impacts of monetary and fiscal expansions on the quality of the natural environment in BRICS economies. The positive impacts of monetary and fiscal policies on environmental quality are found in the adverse impacts of GDP, population growth, and technology's favorable impact.

In terms of policy, these findings suggest that policymakers in BRICS economies should give utmost importance to the monetary and fiscal policies because of their beneficial impact on the natural environment. Moreover, policymakers should not ignore the role of technology as it promotes environmental quality. Both economic growth and population are important determinants of environmental degradation. Therefore governments in BRICS economies need to re-structure growth functions by including green energy and providing environmental education to the growing population for environmental protection.

The remainder of this study is structured as follows. Section 2 reviews the related studies. Section 3 describes the data set, elaborates on the theoretical formulation, and discusses the empirical model. Section 4 explains the estimation strategy. Section 5 analyses the results and prescribes policies. Section 6 concludes.

2. Literature Review

Chishti et al. (2021) consider the BRICS economies and use the data from 1985 to 2014 to test the long-run association between fiscal and monetary policy and carbon dioxide emissions. Their results prescribe that expansionary fiscal policy (increase in tax revenue as % of GDP) raises CO_2 emissions, whereas contractionary fiscal policy reduces it. Yuelan et al. (2019) find similar results in China by focusing on the data from 1980 to 2016. They observe that fiscal policy instruments (government revenues and expenditures) positively contribute to China's environmental degradation. The authors use the data from 1980 to 2016 within a non-linear ARDL framework. Mahmood et al. (2022) obtained the same results for Golf cooperation countries (GCC).

On the other hand, there are mixed results by Katircioglu and Katircioglu (2018) that highlight the significant relationship between fiscal policy development and the level of carbon dioxide emissions in Turkey. The authors use the data from 1960 to 2013 and the Environmental Kuznets Curve (EKC) hypothesis to confirm that an increase in EKC-induced fiscal aggregates, i.e., total government spending leads to decreased carbon dioxide emissions. The conditional Error Correction Model and Granger Causality tests also confirm that expansionary fiscal policies can be implemented effectively to mitigate environmental hazards.

Regarding the relationship between monetary policy and carbon dioxide emissions, the study by Chishti et al. (2021) discussed above propounds that, like fiscal policies, expansionary monetary policy deteriorates the environment quality. In contrast, the contraction in findings is reduced when the real interest rate is used as a proxy for monetary policy. Qingquan et al. (2020) obtained similar findings with data ranging from 1990 to 2014 in 14 Asian economies tested with the Panel FMOLS and the Panel DOLS estimations. The authors find a positive relationship between expansionary monetary policy (fall in the real interest rates) and carbon dioxide emissions. However, contractionary monetary policy contributes to environmental quality protection. Overall, there is limited empirical literature on the deteriorating effect of expansionary monetary policy on environmental quality. However, Mahmood et al. (2022) found a positive impact of expansionary monetary policy on the environmental quality by reducing territory-based and consumption-based carbon emissions in Gulf Corporation Council (GCC) countries from 1990–2019.

The existing literature determines how county size (measured by population) affects ecological quality. Salman et al. (2019) find that population is detrimental to the quality of the environment in seven ASEAN countries. The authors use the Panel Quantile Regression method for the data from 1990 to 2017. Their policy prescription asks for population control for a sustainable environment. For 30 Chinese provinces, Li, Hong, and Peng (2019) used data from 2004 to 2016 to analyze the impact of population growth on carbon dioxide emissions. A global study comprising 182 countries by Wang and Zhang (2021) also propounds that population growth degrades the quality of the environment.

Literature on the association between economic growth and carbon emissions is rich and based on the EKC hypothesis. Many studies support the existence of the hypothesis that economic growth deteriorates the environment initially up to a certain level of income and then reduces carbon emissions and hence promotes environmental protection (Apergis, Gozgor, and Lau 2021; Dong, Sun, and Hochman 2017; Gozgor 2018; Gozgor, Lau, and Lu 2018). However, Esso and Keho (2016) show that per capita GDP income positively affects carbon dioxide emissions in 16 Sub-Saharan African countries.

Technology and innovation are also critical in addressing climate change-induced calamities. For instance, Jiao, Jiang, and Yang (2018) used data from 29 Chinese provinces from 2000 to 2013 to find technology's inhibitory role on carbon dioxide emissions. Hao et al. (2021) also observed a similar result. Salman et al. (2019) find the negative impact of technology innovation on carbon dioxide emissions; therefore, technology benefits the environment's quality.

In the literature, a comprehensive study that undertakes the impacts of monetary and fiscal policies in an economic, demographic, and technological framework is missing. Further, how domestic economic policies can be used for environmental protection is vividly discussed in empirical research. Still, it remains unexplored for the BRICS economies. This study contributes to existing studies by addressing such research gaps in the context of BRICS economies. The simple reason for choosing BRICS economies for the empirical analysis is that five countries in the BRICS region are growing by leaps and bounds besides having different socioeconomic and political characteristics.

Moreover, these economies also drive pollution because of increasing economic activities that depend upon the use of fossil fuels. Besides, these economies are also globalized on the trade and financial fronts. This issue is the basis of our motivation to empirically understand the determinants of environmental quality in the BRICS region.

3. Data, Theoretical Formulation, and Empirical Model

3.1. Data

Our paper gauges the effects of national economic policies, fiscal and monetary, economic growth, population, and technology on the environmental quality in Brazil, Russia, India, China, and South Africa (the BRICS). The two significant independent policy variables, government final consumption expenditure and broad money, are incorporated as proxies for fiscal and monetary policies, respectively. We examine the influence on efficiencies of the policy variables in impacting the environment. The rationale behind employing alternative energy to represent technology is that it includes non-carbohydrate energy (clean energy does not generate carbon dioxide), which needs a vast range of improved technologies for production to decrease emissions. So to accelerate clean energy innovation, scaling technology is critical.

3.2. Theoretical Formulation

The IPAT framework assessed the significant factors affecting the natural environment and driving climate change. The framework is presented as follows:

$$I = PAT \tag{1}$$

The expansion of the expression is $I= P\times A\times T$. I is an indicator of environmental pressure, P is population, A is affluence, and T is technology. This framework is widely followed and easy to understand also. However, with growing literature and knowledge in the domain, other factors related to the impact on environmental quality are studied in line with the IPAT system and are modified as required. For instance, York, Rosa, and Dietz (2003) produced the STIRPAT framework to add stochastic nature to the analysis. The extended model can be rewritten to include fiscal policy (government expenditure, G) and monetary policy (broad money, M) having an impact on carbon emissions (CO_2). This model is expressed as follows with an error term as follows:

$$CO_2 = \alpha P^{\beta_1} A^{\beta_2} T^{\beta_3} G^{\beta_4} M^{\beta_5} e \tag{2}$$

For estimation purposes, Eq. (2) can be transformed into log-linear form as follows:

$$lnCO_2 = \alpha + \beta_1 lnP + \beta_2 lnA + \beta_3 lnT + \beta_4 lnG + \beta_5 lnM + lne \tag{3}$$

We incorporate our objective to assess the effects of monetary and fiscal policy on the quality of the environment. Carbon dioxide emissions, fiscal policy by government expenditure, monetary policy by money supply, population by total midyear population, affluence by GDP per capita, and technology by alternative energy consumption measure environmental pressure.

Therefore, equation (3) can be expanded to include the proxies for both policy variables. The expanded *IPAT* or *I2PAT* model (Impact=Policy×Population×Affluence×Technology) is presented in the successive section with the data description. (Lu et al. 2021; Zhu et al. 2022).

3.3. Empirical Model

For empirical investigation, carbon dioxide emissions (CO_2) are modeled with government expenditures (*GEXP*) and money supply (*MS*) as independent variables along with population (*POP*), economic growth (*GDP*), and technology (*TECH*) as control variables. An increase in government spending raises the production and consumption of commodities and services in the economy, leading to a rise in both production-based and consumption-based carbon dioxide emissions. Therefore, we expect a positive relationship between carbon emissions and government expenditures (Chishti et al. 2021; Yuelan et al. 2019). Similarly, an expansionary monetary policy may augment carbon-intensive production and consumption and degrade environmental quality. The limited literature also suggests that money supply and carbon emissions move in the same direction (Qingquan et al. 2020). Population growth is expected to increase (Salman et al. 2019). Economic growth is hypothesized to contribute to the quality of the environment if the increased national income is spent on greening the economy (Gozgor 2018). The general form of the equation to be estimated can be presented as follows.

$$CO_2 = f(GEXP, MS, POP, GDP, TECH) \tag{4}$$

+ + + - -

Values for the variables are converted to natural log form to make the distributions smooth and directly interpret the coefficients as approximate proportional changes in the importance of variables. The natural log econometric form of Eq. (4), i.e., an expanded IPAT model, is as follows.

$$\mathrm{lnco2_{it}} = \alpha + \beta_1 \mathrm{lngexp_{it}} + \beta_2 \mathrm{lnms_{it}} + \beta_3 \mathrm{lnpop_{it}} + \beta_4 \mathrm{lngdp_{it}} + \beta_5 \mathrm{lntech_{it}} + \varepsilon_{it} \tag{5}$$

4. Estimation Strategy

4.1. Preliminary Tests

The summary statistics represent the behavior of the variables under consideration. The econometric methods deduce the inferences from the estimations. For the unit root test, Im, Pesaran, and Shin (2003) test has an advantage over other methods in testing the presence of unit root in the data series of the variables in a panel data analysis. It allows for individual unit root pro the cases by specific augmented Dickey-Fuller regression for each cross-section. The null hypothesis for the test is the presence of a unit root, and the alternative view assumes stationarity in the data series. This test is more potent than other unit root tests as it allows for heterogeneity. The next is to test for the presence of cointegration among variables. Pedroni (1999) postulates a test for cointegration that incorporates heterogeneous intercepts and trend coefficients for each cross-section. Under the null hypothesis of no cointegration among the variables, the residuals will be integrated as I(1). Kao (1999)'s test is based on the same fundamental framework as Pedroni's approach.

4.2. Long-Run Estimations

A fundamentally viable technique for panel data estimation is the PMG-ARDL model. In panel data regression having personal effects, general regression estimation of ARDL models is problematic due to the correlation between the mean-differenced explanatory variables and the error term. The PMG-ARDL propounded by Pesaran, Shin, and Smith (1999) is more suitable in our case. The model considers the cointegration framework of the standard ARDL model and extends it to a panel set by allowing the heterogeneous intercepts, short-run coefficients, and cointegrating terms across the cross-sections. The FMOLS technique is deployed to confirm the PMG-ARDL model estimation results. The FMOLS estimates the long-run association between the cointegrating equation and stochastic regressors. The FMOLS estimator has the property of asymptotical unbiasedness. Furthermore, the estimator uses preliminary estimates of the residuals' symmetric and long-run covariance matrices, making it more reliable (Gozgor and Paramati 2022).

The study uses standard errors for coefficients pooled OLS regression propounded by Driscoll and Kraay (1998) for the robustness of the results. Because these standard errors are robust in the presence of cross-sectional and time series dependence, this technique uses a nonparametric approach for estimating standard errors that do not restrict the number of panels and cross-sections. Further, it is the robust standard error when corrected for heteroskedastic and autocorrelation.

5. Results and Discussion

5.1. Preliminary Analysis

Data description is provided in Table 1. The preliminary analysis begins with interpreting the descriptive statistics presented in Table 2.

The summary statistics show that for the variables other than *GEXP* and *GDP*, the mean is greater than the median, depicting a positive skewness in the series and represented by the positive skewness coefficients of CO_2, *MS*, *POP*, and *TECH*. Furthermore, a considerable difference exists between all the variables' maximum and minimum values. This difference is conducive for the econometric analysis because explaining the variations in the dependent variables is favorable when independent variables have variations in their respective data series. The values of standard deviations against each variable are the same. The kurtosis values are less than 3 for all the variables, except *MS*, CO_2, *GEXP*, *POP*, *GDP*, and *TECH* follow the platykurtic series (higher than normal). MS follows the leptokurtic series (lower than normal).

The correlation matrix in Table 3 shows that GEXP and GDP are positively correlated with CO_2, which implies CO_2 moves in the same direction as GEXP and GDP. Conversely, CO_2 moves opposite to MS, POP, and TECH. Because the more correlated the explanatory variables are with each other, the bigger the value of standard errors. Lower standard error coefficients in the estimated models (in subsequent result discussion) minimize the risk of multicollinearity. This issue is not valid for our empirical analysis.

Table 1. Data description.

Variable	Acronym	Unit	Description
Carbon Dioxide Emissions	CO_2	Metric ton per capita	CO_2 emissions come from burning fossil fuels and cement manufacturing during solid, liquid, and gas fuels and gas flaring.
Government Expenditures	GEXP	General government final consumption expenditure (% of GDP)	All current government expenditures for purchases of goods and services, employees' compensation and expenditures on national defense and security,
Money Supply	MS	Broad money (% of GDP)	The sum of currency outside banks; demand deposits excluding the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.
Population	POP	Total population	The total population counts all residents irrespective of citizenship or legal status at midyear.
Economic Growth	GDP	GDP per capita (constant 2015 US$ prices)	GDP per capita is gross domestic product divided by midyear population.
Alternative Energy Technology	TECH	Alternative and nuclear energy (% of total energy usage)	Non-carbohydrate energy (clean energy) does not emit carbon dioxide when generated. It comprises hydropower and nuclear, geothermal, and solar power.

Note: This table presents the descriptions and definitions of the variables taken in the study for empirical analysis.
Source: World Development Indicators, World Bank (2023).

Table 2. Summary statistics.

	CO_2	GEXP	MS	POP	GDP	TECH
Mean	4.420	15.85	73.51	606,000,000	4681.5	5.382
Median	2.530	16.79	61.77	191,000,000	5122.3	2.772
Maximum	11.64	20.92	190.8	1,370,000,000	9621.5	13.79
Minimum	0.644	9.802	23.90	143,000,000	527.51	0.919
Std. Dev.	3.491	3.119	39.88	518,000,000	2851.0	4.410
Skewness	0.655	−0.551	1.429	0.331	−0.095	0.919
Kurtosis	2.032	2.034	4.151	1.208	1.719	2.171
Observation	114	114	114	114	114	114

Note: This table reports the summary statistics for both dependent and independent variables to obtain descriptive natures of the variables.

Table 3. Correlation matrix.

	CO_2	GEXP	MS	POP	GDP	TECH
CO_2	1					
GEXP	0.440	1				
MS	−0.065	−0.173	1			
POP	−0.446***	−0.776***	0.679***	1		
GDP	0.568***	0.859***	−0.1256	−0.735***	1	
TECH	−0.069	0.665***	−0.276***	−0.579***	0.721***	1

Note: This table reports the correlation coefficients among the variables under consideration. *** indicates $p < .01$.

Table 4. Panel unit root tests.

Im et al., (2003) Test		
Variable	I(0)	I(1)
lnco2	0.248	−2.792***
lngexp	−2.929***	-
lnms	−0.653	−5.576***
lnpop	−3.589***	-
lngdp	2.003	−3.627***
lntech	0.621	−4.921***

Note: This table gives the results of the panel unit root test to obtain the integrating property of the variables. *** indicates $p < .01$.

The result of the unit root testing done with the Im, Pesaran, and Shin (2003) method is presented in Table 4.

The test result shows that levels lngexp and lnpop are stationary at level. Conversely, lnco2, lnms, lngdp, and lntech are stationary at the first level. Therefore, the variables represent combinations of I (0) and I(1) processes suitable for cointegration tests.

Different t-statistics of the two tests and their respective p-values are indicated in Table 5.

All the t-statistics of the Kao (1999) test are significant at the non-rejection level of confidence to reject the null hypothesis of no cointegration and to confirm cointegration among the variables under consideration. Similarly, two out of three statistics of the Pedroni (1999) test are significant to suggest the presence of cointegration. So, it can be said that carbon dioxide emissions have a long-run association with fiscal policy and monetary policy variables along with population, affluence, and technology in the BRICS economies.

Table 5. Cointegration tests.

Null Hypothesis: No Cointegration	
Kao (1999) *Test for Cointegration*	
Modified Dickey-Fuller t	−2.512***
Dickey-Fuller t	−2.398***
Augmented Dickey-Fuller t	−2.354***
Unadjusted Modified Dickey-Fuller t	−2.272**
Unadjusted Dickey-Fuller t	−2.323**
Pedroni (1999) *Test for Cointegration*	
Modified Phillips-Perron t	2.522***
Phillips-Perron t	1.825*
Augmented Dickey-Fuller t	0.504

Note: This table presents the results of the cointegration tests done over the model specified in Section 3.3. *** $p < .01$, ** $p < .05$ & * $p < .1$.

5.2. PMG-ARDL and FMOLS Estimations: Robustness Checks

The long-run results of the PMG-ARDL and FMOLS. The estimates are represented in Table 6.

The results depict that the policy variables (i.e. fiscal and monetary policies) negatively affect carbon dioxide emissions and benefit the natural environment. This finding is consistent with the study of Katircioglu and Katircioglu (2018), who obtain a similar relationship between government spending and carbon dioxide emissions. The primary possible reason for such determination in the BRICS economies is their commitment to climate change mitigation and environmental quality protection. It is now emerging as a leading global force for a natural cause. The BRICS economies have active mechanisms both at the policy and technology levels. The BRICS economies have pledged to articulate the government's financial support to devote to renewable energy sources and green technologies initiatives and achieve individual carbon neutrality targets (Fang et al. 2022). These initiatives thrust green financing of the BRICS economies by the respective governments and ministries. Besides this, a double coincidence is working to reduce carbon emissions through increased government expenditure. It is simultaneously raising fossil fuels' prices and pumping emerging market economies. The BRICS economies are spending more, flowing toward the search for alternative clean energy sources to deal with the rising price of fossil fuels. Therefore, government spending is creating scope for environmental protection.

Furthermore, a more significant government expenditure through subsidies is helping the energy transition in line with the BRICS countries' commitment to achieving the Rio Declaration's goal. These governments subsidize producing and consuming goods and technologies like solar panels and windmills. Another explanation for the positive environmental health impact of government spending can be greening social sector protection, where the government spends more to ensure basic amenities of life for its citizens. The provision of LPG cylinders and LED bulbs are two prominent examples.

Expansionary monetary policy through an increase in money supply significantly affects the quality of the environment in the BRICS countries. The finding opposed the studies of Chishti et al., (2021) for BRICS and Qingquan et al. (2020) for Asian economies. The positive impact of the money supply on the environment can be attributed to the following three factors. The immediate reason may be that the BRICS markets are biased against carbon-intensive companies.[4] This evidence refers to money flow toward the less carbon-intensive economic and financial entities. Another possible reason for the money supply's green contribution is the commercial banks' credit rationing. Commercial banks are the prime intermediaries between the central banks and producers and consumers who bring finance to them. Credit rationing of the banks toward less carbon dioxide-intensive production and consumption appears to be a significant contributor to the beneficial impacts of increased money supply on the natural environment. Like expansionary fiscal policy, a higher money supply can contribute to environmental protection through the double coincidence channel. As money chases new opportunities, higher economic liquidity will likely go after new investment opportunities like producing electric vehicles and renewables to combat the rising conventional fuel prices (Lu et al. 2022).

Table 6 depicts the negative impact of population growth on the natural environment. This study's population is the most significant contributor to environmental quality degradation. The finding aligns with the results of Salman et al. (2019) for ASEAN countries. Both production-based and

Table 6. Long-run estimates results.

Dependent Variable: lnco2	The PMG-ARDL Estimation		The FMOLS Estimation	
Explanatory Variable	Coefficient	Standard Error	Coefficient	Standard Error
lngexp	−0.497**	0.228	−0.380**	0.157
lnms	−0.1303**	0.050	−0.220***	0.062
lnpop	5.094***	0.449	0.462***	0.172
lngdp	1.775***	0.237	0.950***	0.074
lntech	−0.257**	0.119	−0.267***	0.080

Note: This table provides estimated coefficients and standard errors of long-run estimates from the empirical analysis. *** $p < .01$ & ** $p < .05$.

Table 7. Results of Driscoll-Kraay Standard Errors.

Dependent variable: lnco2		
Explanatory variables	Coefficients	Robust standard errors
Lngexp	−0.835*	0.394
Lnms	−1.242**	0.341
Lnpop	0.645**	0.209
Lngdp	2.185***	0.164
lntech	−1.322***	0.087

Notes: This table gives the coefficients with robust standard errors. These estimates are useful for the robustness and consistency of the results. *** $p < .01$, ** $p < .05$ & * $p < .1$.

consumption-based carbon emissions increase with population increases. The fundamental reason for such a result is that a larger population means more natural resources and environmental exploitation. Furthermore, the gross ecological footprint rises with growth in the population size at least to secure basic amenities of life for all.

From our analysis, economic growth (affluence) negatively affects the environment's quality. This finding is consistent with Esso and Keho's (2016) study of African countries. The EKC kind of analysis explains the relation more convincingly in existing studies. Historically, affluence is achieved through exploiting and excessively utilizing the natural environment. Transportation, manufacturing, and real estate contribute significantly to economic prosperity and environmental degradation.

The evidence about alternative energy consumption (technology) fixes it as a driving force for environmental quality protection. The science behind this is that alternative energy sources are non-hydrocarbon and do not generate CO_2 emissions. This result is in line with the findings of Hao et al. (2017), Jiao, Jiang, and Yang (2018), and Salman et al. (2019).

The results from the previous sections must be robust to stand on the study's novelty and for further addition to the literature. The results of Driscoll-Kraay's standard error estimates reported in Table 7 are consistent with our benchmark analysis. Government expenditures, money supply, and alternative energy consumption reduce carbon dioxide emissions. Conversely, a unit rise in population size and per capita GDP raises carbon dioxide emissions.

5.3. Policy Implications

Given these findings, the paper has some crucial policies to suggest for climate change mitigation in BRICS economies. Since fiscal spending protects the natural environment, it should not be undermined by the policymakers in BRICS economies. Moreover, clean energy sources should continue to be incentivized and subsidized with enormous fiscal spending. In light of this, we suggest establishing a statutory body that can serve the purpose.

Similarly, we find the beneficial impact of monetary policy on environmental quality in BRICS economies. Therefore, ecologically viable credit rationing should be implemented and continued. While pumping the economies, central banks must regulate the money flows to divert it to finance green energy tools and environmentally suitable production techniques. A coordinated lending scheme by commercial banks can go a long way in setting the market's tone toward ecologically sustainable financial practices in the wake of the rising money supply.

Finally, our paper calls for improved population control measures and promoting environmentally suitable human practices to protect nature. Both regulatory and economic tools can serve the said purpose. Reducing the per capita carbon footprint should be the BRICS countries' immediate target for long-term carbon neutrality. Carbon-intensive production and consumption should be discouraged to minimize the detrimental effect of human affluence realized through increased GDP per capita. Lastly, the immediate and driving initiative to tackle the problem of carbon dioxide emissions is the steady rise in clean energy consumption. The BRICS governments should promote it at every level.

6. Conclusion

This study aims to assess fiscal and monetary policy's impact on environmental quality degradation in an expanded IPAT framework, i.e. the I2PAT model in the BRICS economies in a panel setting stretching from 1990 to 2018. The model considers the effects of population, economic growth, alternative energy consumption, and policy variables. Cointegration tests confirm long-run associations among the variables. Estimators of the PMG-ARDL and the FMOLS models provide the direction and magnitude of the associations between the series. The detailed discussion of the results validates the comprehensive IPAT framework to incorporate the effects of fiscal and monetary policies on environmental degradation in BRICS. The effects of the guidelines can also characterize the environmental effects of population, affluence, and technology. This evidence constitutes the I2PAT model, Impact=Policy×Population×Affluence×Technology. The significant finding of the study is that an expansion of fiscal and monetary policies contributes to the conservation of the natural environment by reducing carbon dioxide emissions. An increase in population size and economic growth degrades the environment quality, and a rise in alternative energy consumption protects the environment.

The study poses future scope of research with certain limitations. As this is a panel setting, conclusions and policies cannot be attributed to individual BRICS countries. In so doing, individual time series analysis can be carried out. The IPAT model can be further expanded to incorporate other prominent factors, and the behavior of the policy variables can be assessed in the presence of these factors. Additionally, research can be done with various combinations of proxies for fiscal and monetary policies with different suitable techniques.

Notes

1. 7th Meeting of the BRICS Environment Ministers, New Delhi, India August 27, 2021.
2. The Environmental Performance Index (EPI) gives a data-driven record of the state of sustainability around the world. The index provides a measure at a national scale of how close countries are to established environmental policy targets (https://epi.yale.edu/).
3. The issue addressed in this study allows us to collect the relevant variables for the estimation but the lack of data availability is one of the issues, and therefore five country sample analysis is the basis of our study.
4. This idea is drawn from the argument of Schoenmaker (2021) finds that the European Central Bank's asset and collateral portfolio for monetary policy operations is overweight in high carbon companies.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

Apergis, N., G. Gozgor, and C. K. M. Lau. 2021. Globalisation and environmental problems in developing countries. *Environmental Science and Pollution Research* 28 (26):33719–21. doi:10.1007/s11356-021-14105-z.

Boneva, L., G. Ferrucci, and F. P. Mongelli. 2022. Climate change and central banks: What role for monetary policy? *Climate Policy* 22 (6):770–87. doi:10.1080/14693062.2022.2070119.

Chen, T., G. Gozgor, C. K. Koo, and C. K. M. Lau. 2020. Does international cooperation affect CO_2 emissions? Evidence from OECD countries. *Environmental Science and Pollution Research* 27 (8):8548–56. doi:10.1007/s11356-019-07324-y.

Chishti, M. Z., M. Ahmad, A. Rehman, and M. K. Khan. 2021. Mitigations pathways towards sustainable development: Assessing the influence of fiscal and monetary policies on carbon emissions in BRICS economies. *Journal of Cleaner Production* 292:126035. doi:10.1016/j.jclepro.2021.126035.

Dong, K., R. Sun, and G. Hochman. 2017. Do natural gas and renewable energy consumption lead to less CO_2 emission? Empirical evidence from a panel of BRICS countries. *Energy* 141:1466–78. doi:10.1016/j.energy.2017.11.092.

Driscoll, J. C., and A. C. Kraay. 1998. Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics* 80:549–60. doi:10.1162/003465398557825.

Esso, L. J., and Y. Keho. 2016. Energy consumption, economic growth and carbon emissions: Cointegration and causality evidence from selected African countries. *Energy* 114:492–97. doi:10.1016/j.energy.2016.08.010.

Fang, J., G. Gozgor, M. K. Mahalik, H. Mallick, and H. Padhan. 2022. Does urbanisation induce renewable energy consumption in emerging economies? The role of education in energy switching policies. *Energy Economics* 111:106081. doi:10.1016/j.eneco.2022.106081.

Gozgor, G. 2014. Aggregated and disaggregated import demand in China: An empirical study. *Economic Modelling* 43:1–8. doi:10.1016/j.econmod.2014.07.033.

Gozgor, G. 2017. Does trade matter for carbon emissions in OECD countries? Evidence from a new trade openness measure. *Environmental Science and Pollution Research* 24 (36):27813–21. doi:10.1007/s11356-017-0361-z.

Gozgor, G. 2018. A new approach to the renewable energy-growth nexus: Evidence from the USA. *Environmental Science and Pollution Research* 25 (17):16590–600. doi:10.1007/s11356-018-1858-9.

Gozgor, G., C. K. M. Lau, and Z. Lu. 2018. Energy consumption and economic growth: New evidence from the OECD countries. *Energy* 153:27–34. doi:10.1016/j.energy.2018.03.158.

Gozgor, G., and S. R. Paramati. 2022. Does energy diversification cause an economic slowdown? Evidence from a newly constructed energy diversification index. *Energy Economics* 109:105970. doi:10.1016/j.eneco.2022.105970.

Hao, Y., N. Ba, S. Ren, and H. Wu. 2021. How does international technology spillover affect China's carbon emissions? A new perspective through intellectual property protection. *Sustainable Production and Consumption* 25:577–90. doi:10.1016/j.spc.2020.12.008.

Im, K. S., M. H. Pesaran, and Y. Shin. 2003. Testing for unit roots in heterogeneous panels. *Journal of Econometrics* 115 (1):53–74. doi:10.1016/S0304-4076(03)00092-7.

Jiao, J., G. Jiang, and R. Yang. 2018. Impact of R&D technology spillovers on carbon emissions between China's regions. *Structural Change and Economic Dynamics* 47:35–45. doi:10.1016/j.strueco.2018.07.002.

Kao, C. 1999. Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics* 90 (1):1–44. doi:10.1016/S0304-4076(98)00023-2.

Katircioglu, S., and S. Katircioglu. 2018. Testing the role of fiscal policy in the environmental degradation: The case of Turkey. *Environmental Science and Pollution Research* 25 (6):5616–30. doi:10.1007/s11356-017-0906-1.

Li, L., X. Hong, and K. Peng. 2019. A spatial panel analysis of carbon emissions, economic growth and high-technology industry in China. *Structural Change and Economic Dynamics* 49:83–92. doi:10.1016/j.strueco.2018.09.010.

Lu, Z., G. Gozgor, M. K. Mahalik, H. Padhan, and C. Yan. 2022. Welfare gains from international trade and renewable energy demand: Evidence from the OECD countries. *Energy Economics* 112:106153. doi:10.1016/j.eneco.2022.106153.

Lu, Z., M. K. Mahalik, H. Padhan, M. Gupta, and G. Gozgor. 2021. Effects of age dependency and urbanization on energy demand in BRICS: Evidence from the machine learning estimator. *Frontiers in Energy Research* 9:749065. doi:10.3389/fenrg.2021.749065.

Mahmood, H., A. H. Adow, M. Abbas, A. Iqbal, M. Murshed, and M. Furqan. 2022. The fiscal and monetary policies and environment in GCC countries: Analysis of territory and consumption-based CO2 emissions. *Sustainability* 14 (3):1225. doi:10.3390/su14031225.

Pedroni, P. 1999. Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics* 61 (S1):653–70. doi:10.1111/1468-0084.61.s1.14.

Pereira, P., F. Bašić, I. Bogunovic, and D. Barcelo. 2022. Russian-Ukrainian war impacts the total environment. *Science of the Total Environment* 837:155865. doi:10.1016/j.scitotenv.2022.155865.

Pesaran, M. H., Y. Shin, and R. P. Smith. 1999. Pooled mean group estimation of dynamic heterogenous panels. *Journal of the American Statistical Association* 94 (446):621–34. doi:10.1080/01621459.1999.10474156.

Qingquan, J., S. I. Khattak, M. Ahmad, and L. Ping. 2020. A new approach to environmental sustainability: Assessing the impact of monetary policy on CO_2 emissions in Asian economies. *Sustainable Development* 28 (5):1331–46. doi:10.1002/sd.2087.

Rawtani, D., G. Gupta, N. Khatri, P. K. Rao, and C. M. Hussain. 2022. Environmental damages due to war in Ukraine: A perspective. *Science of the Total Environment* 850:157932. doi:10.1016/j.scitotenv.2022.157932.

Ren, X., Y. Dou, K. Dong, and Y. Li. 2022b. Information spillover and market connectedness: Multi-scale quantile-on-quantile analysis of the crude oil and carbon markets. *Applied Economics* 54 (38):4465–85. doi:10.1080/00036846.2022.2030855.

Ren, X., J. Li, F. He, and B. Lucey. 2023. Impact of climate policy uncertainty on traditional energy and green markets: Evidence from time-varying granger tests. *Renewable and Sustainable Energy Reviews* 173:113058. doi:10.1016/j.rser.2022.113058.

Ren, X., X. Zhang, C. Yan, and G. Gozgor. 2022a. Climate policy uncertainty and firm-level total factor productivity: Evidence from China. *Energy Economics* 113:106209. doi:10.1016/j.eneco.2022.106209.

Salman, M., X. Long, L. Dauda, C. N. Mensah, and S. Muhammad. 2019. Different impacts of export and import on carbon emissions across 7 ASEAN countries: A panel quantile regression approach. *Science of the Total Environment* 686:1019–29. doi:10.1016/j.scitotenv.2019.06.019.

Sarker, P. K., E. Bouri, and C. K. L. Marco. 2023. Asymmetric effects of climate policy uncertainty, geopolitical risk, and crude oil prices on clean energy prices. *Environmental Science and Pollution Research* 30:15797–807. doi:10.1007/s11356-022-23020-w.

Schoenmaker, D. 2021. Greening monetary policy. *Climate Policy* 21 (4):581–92. doi:10.1080/14693062.2020.1868392.

Shang, Y., D. Han, G. Gozgor, M. K. Mahalik, and B. K. Sahoo. 2022. The impact of climate policy uncertainty on renewable and non-renewable energy demand in the United States. *Renewable Energy* 197:654–67. doi:10.1016/j.renene.2022.07.159.

Syed, Q. R., and E. Bouri. 2022. Impact of economic policy uncertainty on CO2 emissions in the US: Evidence from bootstrap ARDL approach. *Journal of Public Affairs* 22 (3):e2595. doi:10.1002/pa.2595.

Wang, Z. R., H. Q. Fu, and X. H. Ren. 2022. The impact of political connections on firm pollution: New evidence based on heterogeneous environmental regulation. *Petroleum Science* 20 (1):636–47. doi:10.1016/j.petsci.2022.10.019.

Wang, Q., and F. Zhang. 2021. The effects of trade openness on decoupling carbon emissions from economic growth–evidence from 182 countries. *Journal of Cleaner Production* 279:123838. doi:10.1016/j.jclepro.2020.123838.

World Bank. 2023. *World development indicators*. Washington, DC: World Bank.

Wu, W., L. Wang, Y. O. Erzurumlu, G. Gozgor, and G. Yang. 2022. Effects of Country and geopolitical risks on income inequality: Evidence from Emerging Economies. *Emerging Markets Finance and Trade* 58 (15):4218–30. doi:10.1080/1540496X.2022.2070002.

York, R., E. A. Rosa, and T. Dietz. 2003. STIRPAT, IPAT and ImPACT: Analytic tools for unpacking the driving forces of environmental impacts. *Ecological Economics* 46 (3):351–65. doi:10.1016/S0921-8009(03)00188-5.

Yuelan, P., M. W. Akbar, M. Hafeez, M. Ahmad, Z. Zia, and S. Ullah. 2019. The nexus of fiscal policy instruments and environmental degradation in China. *Environmental Science and Pollution Research* 26 (28):28919–32. doi:10.1007/s11356-019-06071-4.

Zeraibi, A., Z. Ahmed, K. Shehzad, M. Murshed, S. P. Nathaniel, and H. Mahmood. 2022. Revisiting the EKC hypothesis by assessing the complementarities between fiscal, monetary, and environmental development policies in China. *Environmental Science and Pollution Research* 29 (16):1–16. doi:10.1007/s11356-021-17288-7.

Zhang, P., Y. Sha, and Y. Xu. 2021. Stock market volatility spillovers in G7 and BRIC. *Emerging Markets Finance and Trade* 57 (7):2107–19. doi:10.1080/1540496X.2021.1908256.

Zhu, S., Y. Tang, X. Qiao, W. You, and C. Peng. 2022. Spatial effects of participation in global value chains on CO2 emissions: A global spillover perspective. *Emerging Markets Finance and Trade* 58 (3):776–89. doi:10.1080/1540496X.2021.1911801.