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Research Topic

Carbon Emissions, Economic Growth and Healthcare Expenditure: An Empirical Investigation

Abstract

Keywords: SDG 3 (Health and Wellbeing), SDG 8 (Decent Work and Economic Growth), SDG 13 (Climate Action), Carbon Emissions, Economic Growth, Healthcare Expenditure, Panel Data, Group of 21 Countries (G-21), Panel Cointegration, Generalized Methods of Moment (GMM), Spatial Econometrics, Cross-sectional Dependence, Granger Causality, Slope Heterogeneity, Endogeneity, Scientometric Literature Review.

Carbon emissions are one of the most important gases under the greenhouse gases (GHGs). Climate change and greenhouse gas emissions are important problem at global level in today's scenario. In this study we have more focus on carbon emissions due to anthropogenic activities as well as natural activities. Sustainable development goals (SDGs) are the focus of this research. SDG 3 (health and wellbeing), SDG 8 (decent work and economic growth), and SDG 13 (climate action) have been underachieved in nearly all the G-21 nations till date. Economic-health-environment nexus will help establish policies in carbon taxation, healthcare budgeting, and sustainable growth strategies.

The study begins with an exploratory review of existing research using automated text analytics techniques. This approach helped efficiently identify and summarize the relationships between carbon emissions, economic growth, and healthcare expenditure, improving both the speed and clarity of the literature review process.

Research Gaps

The thesis is an attempt to address the following research gaps:

1. The majority of research considers the interrelation among carbon emissions, economic growth, and health expenditure in a bivariate setting. But the three-way interaction in a simultaneous setting is under researched at the global that is at a multi-country level. It thus addresses SDG 3, SDG 8 and SDG 13 simultaneously. Environmental and health aspects are seldom incorporated into the connection between growth and emissions in existing literature, and thus a gap arises concerning understanding the synergies and trade-offs between human well-being, economic growth, and sustainability.
2. Past studies of emissions, growth, and health expenditure have generally employed either static panel data or single-equation models to the exclusion of the dynamic relationship. There have been very few applications of dynamic panel GMM techniques to identify feedback relationships, variable persistence, and adjustment mechanisms over long periods, which hamper the establishment of causality and policy implications.
3. Country-specific studies of factors affecting carbon emissions, economic growth, and health are scarce with limited evidence of cross-country spillover, especially the spatial effects that is based on physical distance between neighbouring countries, from carbon emissions or economic activity in among G-21 nations on neighbouring or economically connected countries.

Research Questions

1. Do short-run and long-run causal mechanisms exist between carbon emissions, economic growth, and health expenditure?

2. Does previous year's carbon emissions impact current year's carbon emissions across the nations during the period 2000-2022, after controlling for country specific individual effects and other time invariant regressor?
3. Do spatial spillover effects have any localized impacts on carbon emissions, economic growth, and healthcare expenditure?

Research Objectives

Panel data of G-21 countries for the period of 2000-2022 is utilized to achieve the following objectives:

1. Analyze the connectedness between carbon emissions, economic growth, and healthcare expenditure.
2. Examine the dynamic relationship between carbon emissions, economic growth, and healthcare expenditure.
3. Investigate spatial spillover effects of carbon emissions, economic growth, and healthcare expenditure between the countries.

Data

A brief information on the dataset and the technique for analysis is provided below:

Data source: World development indicators (WDI)

<https://databank.worldbank.org/source/world-development-indicators>

Time period: 2002-2022

Region of study: G-21 countries

Variables of the study: Carbon Dioxide Emissions Per Capita Metric Ton; GDP Per Capita Constant US\$ 2015; Healthcare Expenditure Per Capita Current US\$

Research Methodology

The following research methodology have been used for the three objectives, a brief description of the same is provided below;

Methodological Framework for Objective 1

To examine the relationship between CO₂ emissions, economic growth and healthcare expenditure. We analyzed panel data for seventy-one countries. There is huge variation between GDPs per capita and Health expenditure per capita. Some countries are very poor some are very prosperous that's why to bring the gap between the countries we use both values in logarithm form. CO₂ per capita does not converted in log because CO₂ emissions pattern of all the countries is same. The panel data methodology is the appropriate technique especially in the presence of slope heterogeneity and non-stationarity data and also recognises the cross-sectional dependence between the panels. The methodology includes panel unit root tests, panel cointegration tests and the estimations of long run average relations.

Methodological Framework for Objective 2

The study used Generalized methods of moments (GMM) to know the dynamic relationship between carbon emissions, economic growth and healthcare expenditure of G-21 nations. To analyze the dynamic relationship between carbon emissions, economic growth and healthcare expenditure of G-21 countries, this study utilizes panel data covering 2000-2022. To address the issues of endogeneity, dynamic relationships, and individual heterogeneity, the Generalized Method of Moments (GMM) is adopted as the primary estimation approach.

Methodological Framework for Objective 3

The study uses spatial econometric models; Spatial lag model (SLM), Spatial error model (SEM) and Spatial autoregressive model with autoregressive disturbances (SARAR), to capture a relationship between the variables based on proximity of geographical locations. Analyzing the relationship between the variables using spatial econometric models becomes useful especially for taking informed decision that are crucial for making relevant policies. To check whether spatial econometric models are appropriate.

Results and empirical findings

The second chapter is about determining and understanding the long-term relationship between SDG 3, SDG 8 and SDG 13 using the variables carbon emissions, economic growth and healthcare expenditure. The first hypothesis of first objective was rejected as cross sectional dependence was found across countries for the time period 2000 to 2022 suggesting that carbon emissions, economic growth and healthcare expenditure have an impact on other countries carbon emissions, economic growth and healthcare expenditure. This indicates the fact there could be a long run relationship between these variables for the G-21 countries. In addition to testing cross sectional dependence, it is also important to check slope heterogeneity, so that robust panel data models could be appropriately created. The presence of slope heterogeneity was found in the panel data indicating that different countries have different relationships between carbon emissions, economic growth and healthcare expenditure. In light of this, both Pedroni and Westerlund panel cointegration tests were conducted which validates the presence of long-run cointegration between variables, indicating a persistent relationship between carbon emission, economic growth, and healthcare spending in the long run. The results of the cointegration tests were validated by the mean group (MG) models. Further Dumitrescu Hurlin (D-H) Granger non-causality test reveals strong Granger causality among the variables. This result emphasizes long-term planning and therefore the relevant agencies should propose a sophisticated plan for sustainable development based on technology and clean energy resources. There is a need for environmental regulations to have cleaner environment.

Now coming to the third chapter wherein to test the null hypothesis System GMM model was employed to examine the dynamic relationship between CO₂ emissions per capita, GDP per capita, and health expenditure per capita of G-21 nations between 2000 and 2022. The findings reveal a high persistence in emissions over time, whereby the level of current emissions is determined by past levels. This implies that the level of current emissions is inertia in environmental degradation, an implication that long-term policies will be more effective. The system GMM model also reiterates the significance of long-term structural transformations for sustainable future. To achieve these results three GMM models namely Anderson Hsiao, Difference, System GMM were build. The system GMM was found to be most appropriate models for the analysis. The validation of the system GMM were also conducted using Sargan and Hansen overidentification test. These tests confirmed that the model is appropriately identified with no overidentification.

The third research question: Do spatial spillover effects have any localized impacts on carbon emissions, economic growth, and healthcare expenditure? was investigated in chapter four. The research examines the relationship between carbon emissions, economic growth, and healthcare spending in terms of spatial proximity through the application of spatial econometrics models (SLM, SEM, and SARAR). In conducting the research, seventy G-21 countries were used to gauge their spatial proximity. Geographical and spillover effects between the countries were measured through spatial econometrics. Spatial econometrics models were indicated by the research since there were considerable results in diagnostic LM tests with indications of spatial dependence. SLM model shows that CO₂ emissions in the past periods negatively influence present period CO₂ emissions of other nations, indicating that nations have adopted policies that have positively affected carbon emissions. SLM reflects a very strong and significant GDP effect, whereas SEM provides plausible estimates with a positive health expenditure and GDP effect. SARAR strikes a balance between spatial lag and error dependencies and provides meaningful coefficient estimates. The presence of spatial cross-sectional dependence necessitates the use of spatial econometric model. These results are further augmented by the finding of the diagnostic LM tests, which confirm the use of spatial econometric models.

Policy Insights

Based on the empirical findings of the three objectives following policy proposals that combines cross-sectional dependence, slope heterogeneity, spatial spillover, long-run cointegration, and the

dynamic GMM. Since carbon emissions are persistent as the lagged values of carbon emissions are significant structural levers such as power-sector decarbonization, industrial electrification, clean transport needs to be prioritised over one-off measures and instead adopt state carbon-price floors or tighter intensity standards when GDP growth exceeds the certain threshold. Since cross sectional dependence and spatial spillovers have been detected across countries therefore it requires coordinated cross border frameworks such as mutually recognized carbon markets or price floors, aligned Measurement, Reporting, and Verification (MRV) standards, selective carbon border adjustments with revenue recycling to lower-income partners, joint climate-health funds, and regional early-warning systems for air quality and heat risks. Because slope heterogeneity is present that means no one size fits all policy measures be adopted. Advance economies should accelerate deep decarbonization and decarbonize health systems via net-zero hospital standards and low-carbon procurement; emerging economies should prioritize reliable renewables, grid upgrades, clean cooking, and green healthcare build-out financed by concessional/blended capital and results based payments. Cointegration implies a long-run equilibrium among growth, health spending, and emissions embed climate and health externalities in medium-term fiscal frameworks, earmark part of carbon revenues for health adaptation and pollution control, and mandate lifecycle carbon accounting across medical supply chains.

Limitations of the Study

From this thesis we have found that there are various limitations and directions for future studies on carbon emissions, economic growth, and health expenditure in G-21 nations. These include applying panel data for connectedness, GMM for dynamic relationships, and spatial proximity analysis. So many limitations for upcoming research are given below:

- The current research is limited to the relationship between three variables, vis-à-vis carbon emissions, economic growth, and healthcare expenditure.
- The research only addresses issues that are geographically limited to G-21 countries.
- The analysis is limited to the country's level while comparison could have been drawn based on regional trading blocs.

Scope for Further Research

This study is based on various scopes of research that are given below:

- This study is based on carbon emissions, economic growth, and healthcare expenditure. However, researchers may include some other relevant economic variables based on the research purpose.
- This study is based on only one set of countries that are included in G-21. We can also conduct similar research, such as SAARC, BRICS+, etc.
- This research can further be enhanced by dividing countries on the basis of income and then doing similar research based on existing or other variables.