ISSN (Print): 2788-8320 ISSN (Online): 2788-8339

JOURNAL OF SOCIAL RESEARCH DEVELOPMENT
www.jsrd.org.pk editor@jsd.org.pk

GREEN TECHNOLOGICAL INNOVATION AND FINANCIAL INCLUSION, A WAY TOWARDS GREEN ECONOMY: EVIDENCE FROM BRICS ECONOMIES

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KEYWORDS

Green Economy, Inclusive Wealth, Green Technological Innovation, Renewable Energy Consumption, Financial Inclusion

ARTICLE HISTORY

Date of Submission: 12-06-2026
Date of Acceptance: 15-07-2026
Date of Publication: 17-07-2026

ABSTRACT

In this modern world, the emergent challenges of climate change, environmental degradation and natural resource depletion has enunciated the importance of transition to green economy. UNEP (United Nations Environmental Program) proposed green economy as a reliable and efficient path in order to achieve sustainable development. Green economy ensures wellbeing and social equity without compromising the environment. Thus, it considered as a catalyst to achieve sustainable development agenda 2030.The main aim of this study is to empirically investigate the role of green technological innovation, renewable energy consumption and financial inclusion to promote green economy. This study focused the analysis on BRICS countries and will utilize the data from 2006 to 2025 for the modeled variables. This study will employ the Augmented Mean Group (AMG) and pooled mean group (PMG) to investigate the long-run impacts of green technological innovation, renewable energy consumption, and financial inclusion on green economy in BRICS nations. Moreover, to check the robustness of the results this study will employ the Fully Modified Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS). The findings of this study revealed that BRICS economies can transit to green economy through integration of green technological innovation, renewable energy consumption, and financial inclusion along with the environmentally sustainable growth strategies into their long-term development policies. These results emphasized the importance of taking measures to tackle climate change impacts especially on emerging economies.

2026 Journal of Social Research Development

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DOI https://doi.org/10.59075/jsrd.v7i5.627

Volume/Issue **7(5), 2026, 189-230**

Introduction

Twenty first century evinced the extraordinary economic growth with rapid industrial expansion, technological innovation and growing urbanization (Gu & Liu, 2024). Although these unprecedented achievements improved the living standards of people but they all come up at the

cost of environment (Bruyninckx et al., 2024). The excessive use of non-renewable energy resources such as fossil fuels deteriorate the natural resources through increased greenhouse emissions into atmosphere (Khan, Aremu, Razak, Premaratne, & Sattar, 2025). Greenhouse gas (GHG) emissions leads to biodiversity loss and environmental degradation which shifted the world's attention towards sustainable development (Filonchyk, Peterson, Zhang, Hurynovich, & He, 2024).

Climate change considered as a precarious challenge of today's world (Vu & Nguyen, 2024). Among the numerous drivers of climate change, carbon emissions got more attention because they considered as the major source of greenhouse gases (Elegbeleye, Oguntona, & Elegbeleye, 2025). Fossil fuels such as coal, oil, and natural gas burn for energy production, transportation and industrial activities releases a large amount of CO_2 into atmosphere (Shanmugam, 2023).

A 2030 global agenda by United Nations, Sustainable Development Goals (SDGs), emphasized to safeguard the wellbeing of current as well as future generations along with environmental preservation (Krannich & Reiser, 2023). SDGs provide a reliable framework to address the worlds' most significant challenges of poverty, unemployment, inequality, environmental degradation and frequent climate change impacts (Kundu & Gupta, 2024). Moreover, SDGs guarantee sustainable economic growth through laying special emphasis on environmental concerns along with innovation and industrialization. In order to promote sustainable development, SDGs ensures the efficient and reliable way towards global collaboration (Zhou & Etzkowitz, 2021).



Figure 1: Visualization of SDGs, Source; Institute of Development Studies

Moreover, literature evinced that it is also remained a difficult task to assess the exact measure to sustainable development (Jaiswal, Gupta, & Tiwari, 2023). Traditional measures of economic development such as Gross Domestic Product (GDP), GDP per capita and the Human Development

Index (HDI) have been loudly criticized because they ignored the environmental concerns (Hickel, 2020). Other measures such as Sustainable Development Index (SDI) and carbon emissions, also come up with certain limitation (Brulé, 2022). These measures didn't account for natural resource depletion, environmental degradation and future generation welfare (Xu & Zhao, 2023).

In this regard, to gauge the environmental concerns along with the social wellbeing and economic prosperity, researchers shifted their attention towards green economy (Daniek, 2020). United Nations Environmental Program (UNEP) refers green economy as the economy which ensures the human wellbeing without compromising the environment (Adamowicz, 2022). Traditional economic means focused on the economic growth but didn't account for environmental degradation (Adejumo, 2020). Green economy refers as the economy which ensures economic growth along with environmental preservation (Adamowicz, 2022).

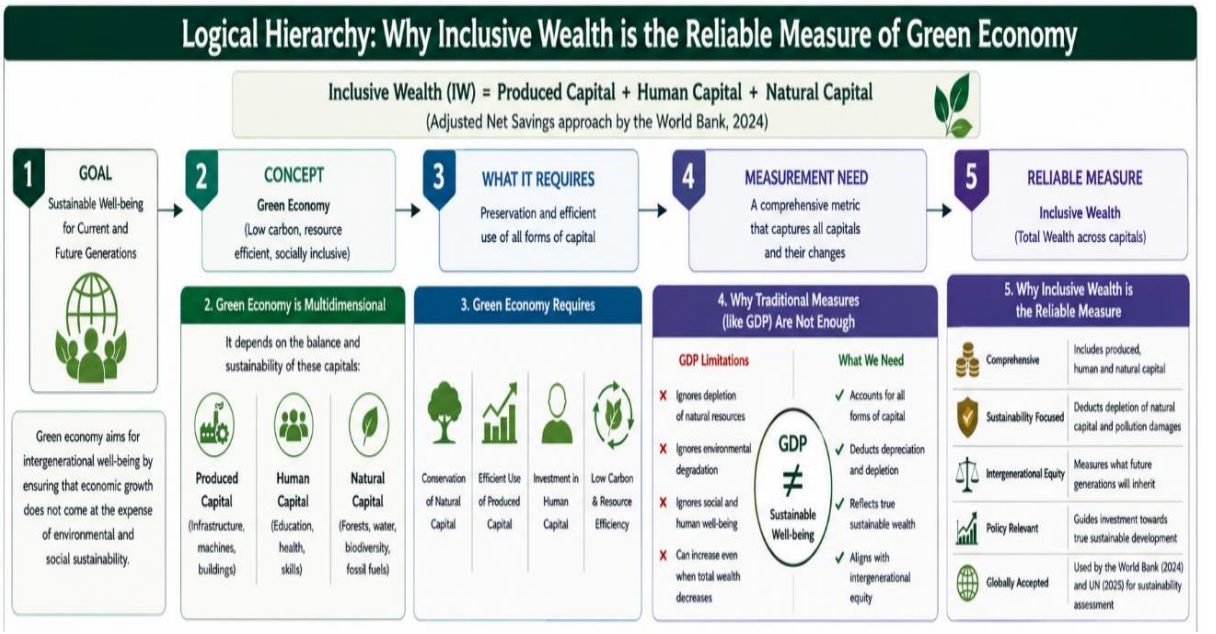


Figure 2: Inclusive Wealth as a Reliable Measure to Green Economy, Source; Author's Own

Green Economy as an economic approach seeks to achieve economic development while ensuring environmental sustainability, efficient resource utilization, and social well-being (Mikhno, Koval, Shvets, Garmatiuk, & Tamošiūnienė, 2021). Unlike conventional economic growth, which primarily focuses on increasing production and income (Rostow, 2020). The Green Economy emphasizes the decoupling of economic progress from environmental degradation and excessive natural-resource consumption (Kostić, Kostić, & Milićević, 2025). Green economy become the main driver to sustainable development because it encompasses the resource efficiency and social inclusiveness along with environmental conservation (Adamowicz, 2022).

In 2012, United Nations Environmental Program (UNEP) presented a report, Inclusive Wealth Report, which introduced the concept of inclusive wealth (Managi, Bhattacharya, & Bhattacharya, 2023). Inclusive wealth is considered as all-encompassing measure to green economy as it inculcates the produced capital, human capital and natural capita all along in a single matrix (Managi et al., 2023).

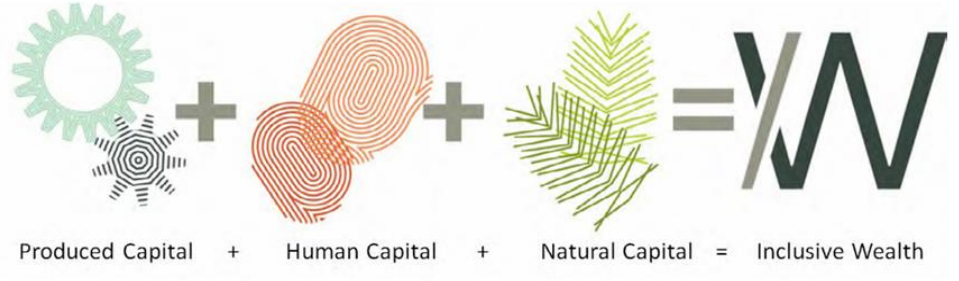


Figure 3: Components of Inclusive Wealth, Source; UNEP

Inclusive wealth contributes to achieve 11 sustainable development goals directly and indirectly (Kousar, Ahmed, Abid, & Haluza, 2025). Raising environmental concerns especially in the context of BRICS countries which consists of 11 nations that are named as Brazil, China, India Indonesia, Russia, Egypt, Ethiopia, Iran Saudi Arabic, United Arab Emirates and South Africa (Bliznetskaya, Chernokulsky, & Kirgizova-Barskaya, 2025).

These economies collectively accounts for 40% of global population, one-third of world's GDP (Gross Domestic Product) and 45% to 50% contributor to carbon emissions (Dell'Aversano, Villante, & Anatone, 2026). Rapid expansion of urban population, industrialization, and inefficient energy consumption of these countries shifted the attention of researchers towards guard the environmental conservation in BRICS economies (Yang, Ibrahim, Ajide, & Al-Faryan, 2024). Their influential contribution to globe caused the transition towards green economy (Yang et al., 2024).

Moreover, the main purpose of this study is to empirically investigate the role of green technological innovation, renewable energy consumption and financial inclusion in order to promote green economy. This study focused the analysis on BRICS countries and will utilize the data from 2006 to 2025 for the modeled variables.

Significance of the study

Significance of this study is as;

The study fills the gap in Green Economy literature through empirically investigate the Green Technological Innovation (GTI), Renewable Energy Consumption (REC), and Financial Inclusion (FI) as significant determinants of Inclusive Wealth. This study contributes to the literature through

usage of Inclusive Wealth (IW) as more reliable measure to Green Economy rather than solely rely on traditional indicators such as GDP and CO_2 emissions etc.

Literature Review

This study presented the thematic literature review through bibliometric analysis.

Bibliometric Analysis

Bibliometric analysis is basically utilized to examine the research eminence within a specific field through analyze the publications in existing literature (W. Hassan & Duarte, 2024). This technique examined the past and present publications trends and explore the future research agendas (Di Zio, Tontodimamma, Del Gobbo, & Fontanella, 2023). Citation, co-authorship, co-citation, and co-word analysis are used as sub in order to conduct bibliometric literature review (Di Zio et al., 2023).

Data Source and Research Design

The date is gathered from an efficient and reliable database, Web of Science (WOS). Table 1 explained the search string of data collection through selected database and WOS particularities.

Table 1: Search String.

WOS Database	ALL
Time Period	Up to December, 2025
Search Field	Green Economy
Search Keywords	"Green Economy" or "Green Economic Growth" or "Green Economic Development" or "Sustainable Economic Development" or "Low carbon economy" or "Green energy Transition" or "Sustainable Prosperity."
Citation Topics	All
Document Type	Articles
Language	English

Source: Author's own calculations

Results

Publication Trends

The figure shows the evolution of research on the green economy and its determinants or drivers.

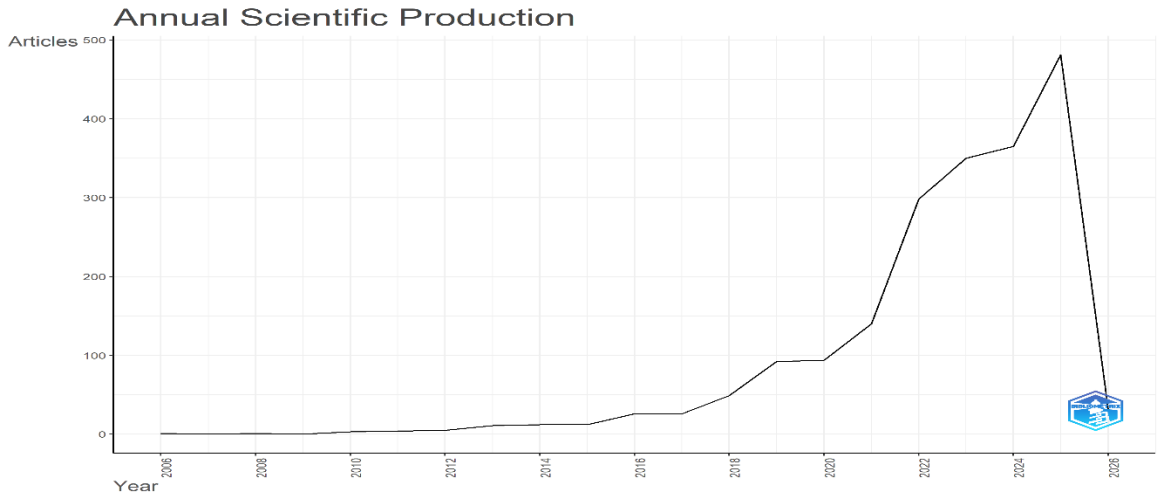


Figure 4: Annual Publication Trend

Citation Analysis

A sub-analysis under bibliometric analysis is called co-citation analysis in which the top publications are ranked on the basis of unit of analysis that are document, authors, organizations and countries (Yang Li, Xu, Wang, & Wang, 2020). This analysis depicts the tabular and visual representation of each unit of analysis.

Document Citation

The minimum number of citation of a document is 3. Out of total 2,000 documents 1,492 meet the threshold. The number of citation links calculated for each of the 1,492 documents. The selected 1,492 documents are with largest numbers of links. Top 10 articles are detailed in table. Table 2 detailed the top 10 influential articles ranked by citations. Figure 5 represents the networking visuals of top 10 documents which are ranked by citation and their influential contribution and significant work in the field of Green Economy.

Table 2: Top 10 documents ranked by citation.

Sr.	Authors	Title	Links	Citations
1	Ibn-Mohammed (2021)	A critical analysis of the impacts of covid-19 on the global economy and ecosystems and opportunities for circular economy strategies.	3	543
2	Zhou (2022a)	The impact of fintech innovation on green growth in china: mediating effect of green finance.	23	479

3	Liu (2022e)	Digital economy development, industrial structure upgrading and green total factor productivity: empirical evidence from china's cities.	15	348
4	Ding (2022b)	Digital economy, technological innovation and high-quality economic development: based on spatial effect and mediation effect.	5	296
5	Nawaz (2021)	Nexus between green finance and climate change mitigation in n-11 and BRICS countries: empirical estimation through difference in differences (did) approach.	6	276
6	D'Amato (2021)	Integrating the green economy, circular economy and bio economy in a strategic sustainability framework.	6	270
7	Demirel (2019)	Born to be green: new insights into the economics and management of green entrepreneurship.	3	256
8	Fernandez (2021)	Green growth versus economic growth: do sustainable technology transfer and innovations lead to an imperfect choice?	21	235
9	Tolliver (2021)	Green innovation and finance in Asia.	10	231
10	Bina (2013)	The green economy and sustainable development: an uneasy balance?	11	229

Source: Author's own calculations

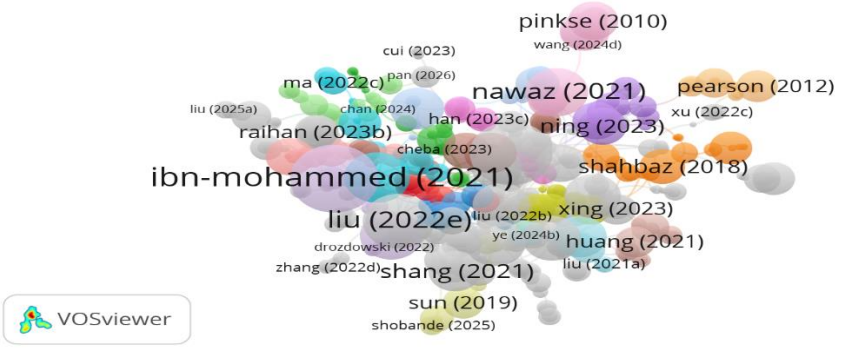


Figure 5: The Network Visualization of Documents Citation Analysis

Authors Citation

The minimum number of the document of an author is 1 and the minimum number of citation of an author is 0 as threshold criteria. 3,943 meet the threshold level from the total of 6,434 authors. For every of 3,943 authors the total strengths of linked citations with other authors will be calculated. 1000 selected authors are with the greatest total link strength.

Figure 6 show the networking visual representation of authors. This graph depicts the interconnected research nature between these selected authors in this particular field of green economy.

Authors' Production Over the Time

The figure shows the publication activity and research continuity of leading researchers in the field.

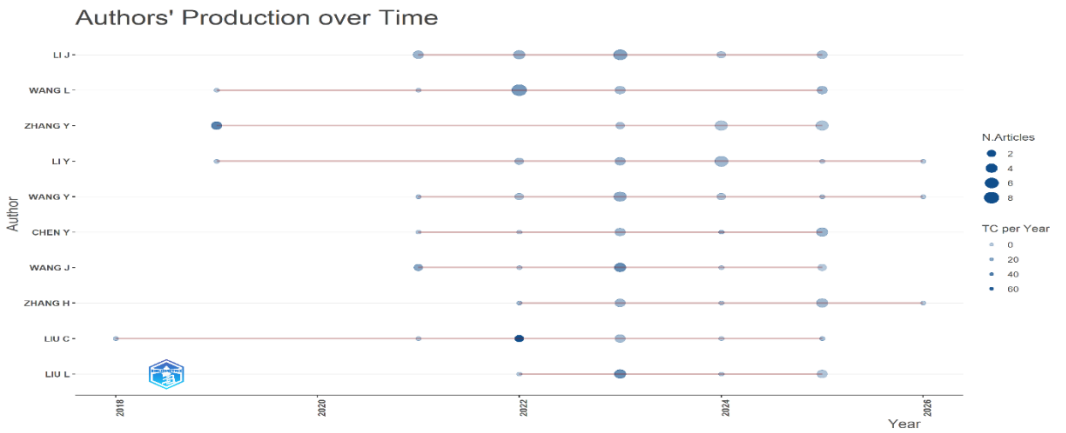


Figure 6: Authors' Production Over the Time.

Figure 7 shows the top co-authors that collaborate among themselves and represented numerous researches over the time.

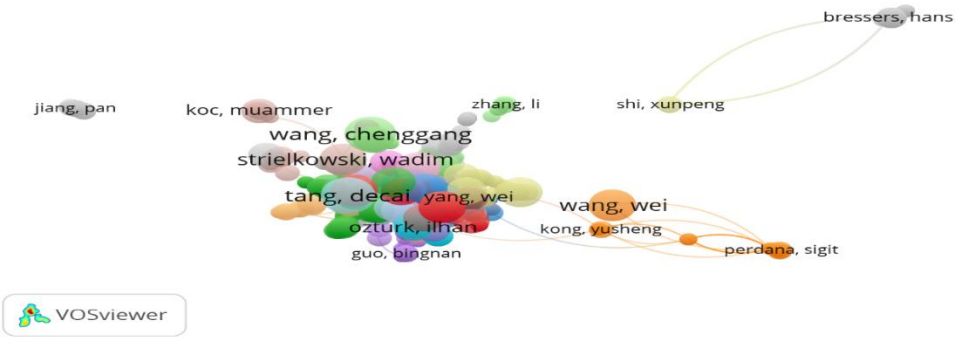


Figure 7: The Network Visualization of Authors Citation

Organizations Citation

The minimum number of documents of an organization is 5 and the minimum number of citation of an organization is 1 as a threshold criterion. 173 organizations meet the threshold level from the total of 2,346 organizations. All the total strength of the citation links with other organizations is calculated for each 173 organizations. The organizations with greatest total link strength is selected.

Table 3 demonstrate the top 10 organizations ranked through the average citation. This ranking shows the researcher's involvement and resourceful impacts of these organizations in the particular field of green economy. Figure 8 show the networking visual representation of the top 10 organizations which are ranked through average citation. The graph shows the collaborative nature of research between these institutions across numerous particular regions of the world.

Table 3: Top 10 Institutions Ranked by Average Citation

Sr.	Countries	Total Link Strength	Documents	Citations	Average Citations
1	University of Kebangsaan Malaysia	20	10	1021	102.1
2	Chinese Acad Social Science	2	5	346	69.2
3	University of Beira Interior	30	5	324	64.8
4	Chinese University of Hong Kong	11	5	313	62.6
5	Fudan University	41	13	736	56.6154
6	University of Leeds	4	5	265	53
7	University of Lisbon	10	6	292	48.6667
8	Natl Econ University	6	5	242	48.4
9	University of Hong Kong	12	6	277	46.1667
10	Changan University	11	7	318	45.4286
11	China Med University	12	6	271	45.1667
12	University of Southampton	7	6	268	44.6667
13	Hong Kong Polytech University	13	7	311	44.4286

14	Shanghai University of Finance & Economics	44	16	699	43.6875
15	Montpellier Business School	7	6	262	43.6667

Source: Author's own calculations

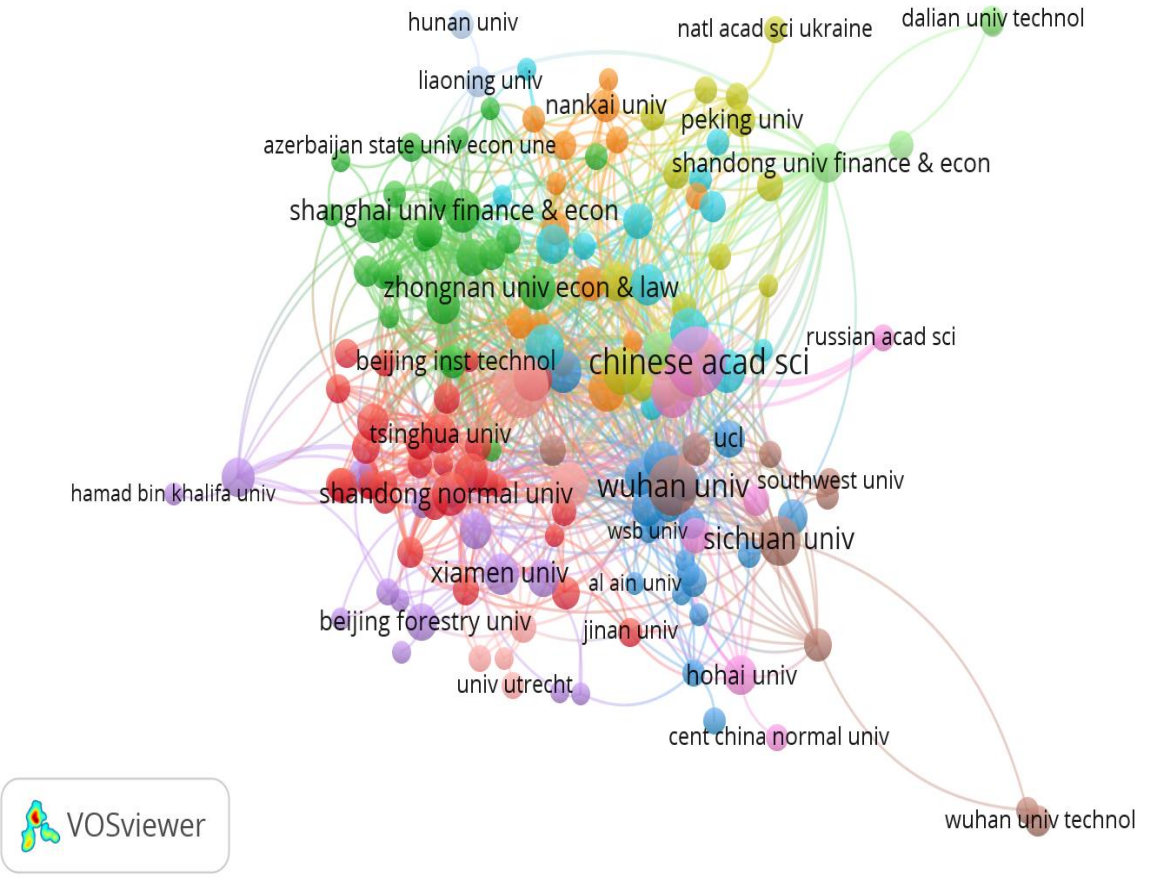


Figure 8: The Network Visualization of Institutions Citation Analysis

Over The Time Production by Institutions

Figure 9 depicts the visual representation of top universities that contribute majorly over the time.

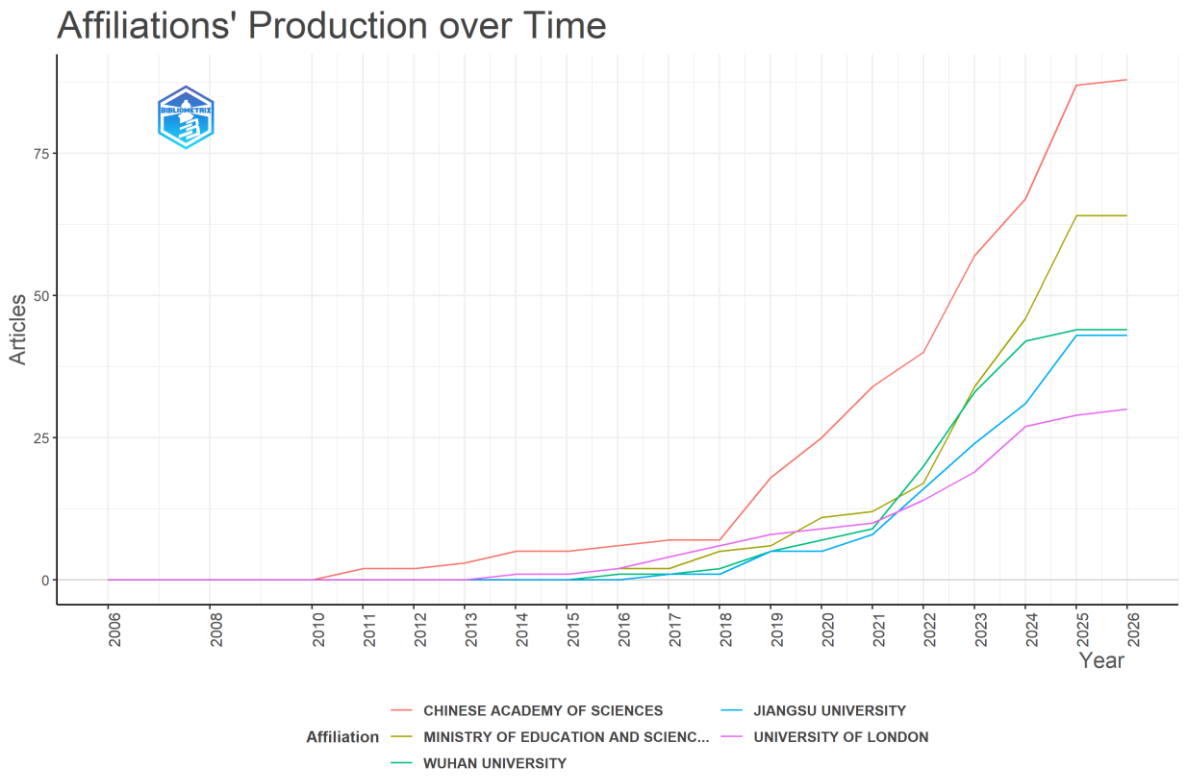


Figure 9: Visualization of Institution's production over the time.

Countries Citation

Countries citation analysis shows all the countries published their work on Green Economy. The minimum number of documents a country published is 1 and minimum number of citations of a country is also, as a threshold. 173 countries meet the threshold criteria from the total of 2,346 countries. The total strengths of citation links with all other countries calculated for each of 115 countries. These 115 selected countries are with the largest total link strength.

Table 4 depicts the top 10 countries ranked by average citation and show the scholarly contribution in the field of Green Economy in different countries across the world. Figure 10 depicted the network visualization of top 10 countries ranking depends upon the total link strength.

Table 4: Top 10 countries ranked by average citation.

Sr.	label	Total link strength	Documents	Citations	Average citations
1	Kosovo	2	1	159	159
2	Wales	2	4	342	85.5

3	U Arab Emirates	85	18	1431	79.5
4	Nigeria	39	16	1062	66.375
5	Tanzania	5	2	111	55.5
6	Denmark	11	13	716	55.0769
7	Turkey	94	19	1016	53.4737
8	Japan	47	20	1052	52.6
9	Slovenia	59	6	312	52
10	Finland	33	16	803	50.1875
11	Austria	25	14	701	50.0714
12	Malaysia	170	52	2468	47.4615
13	Sweden	21	21	932	44.381
14	Scotland	21	23	1006	43.7391
15	Italy	143	65	2733	42.0462

Source: Author's own calculations

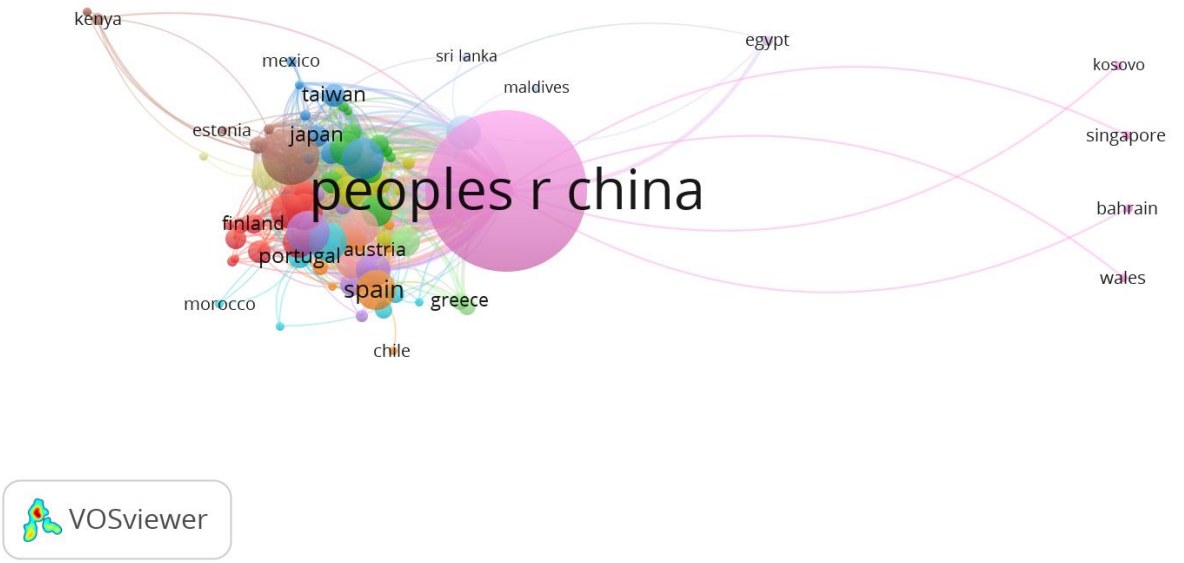


Figure 10: The Network Visualization of Countries Citation Analysis

Over The Time Production by Countries

Figure 11 depicts the visual representation of top countries that contribute majorly over the time.

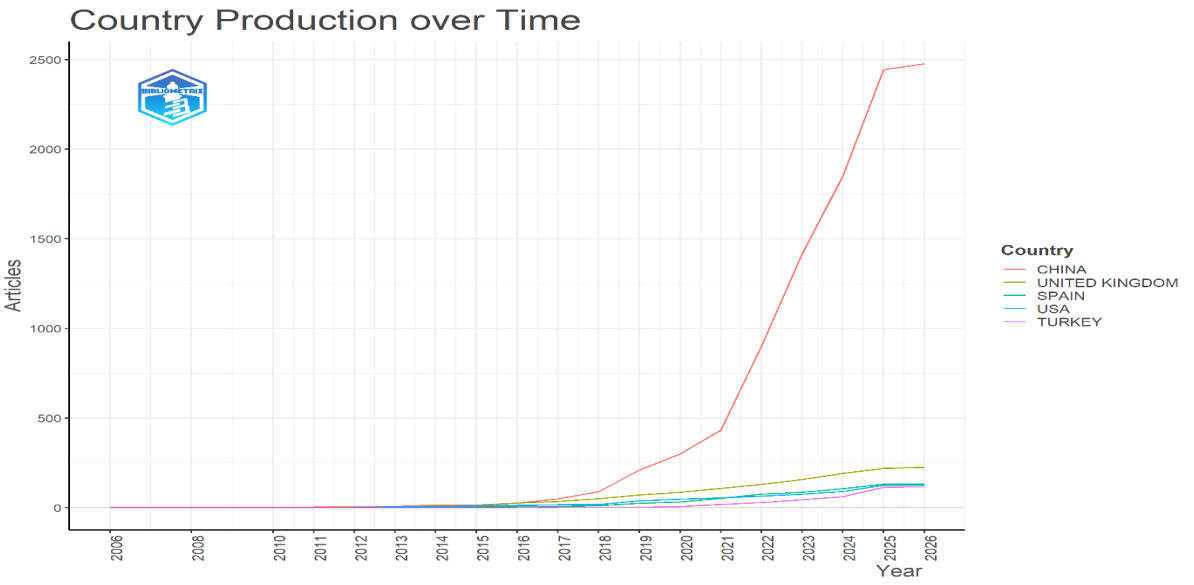


Figure 11: Visualization of Countries' Production Over the Time

Co-authorship Analysis

Co-authorship analysis depicts that how authors, organizations and countries interconnected to produce their significant work in the specific field which would result into betterment of the world respectively (Zhu & Liu, 2020).

Authors co-authorship Analysis

The minimum number of documents of an author is 1 and the minimum number of citation of an author is also 1, as a threshold criterion. 3,397 meet the threshold criteria from the total of 4,078 authors. For every 3,397 authors, the total strength of co-authorship links with all other authors is calculated. These authors have greatest total link strength. For overall mapping 1000 authors are selected.

Figure 12 depicts the networking visualization of authors co-authorship analysis. The largest cluster consists of 17 authors who collaborated respectively and prevalent in the field of Green Economy. Table 5 shows the top 10 co-authors ranked by average citation.

Table 5: Top 10 co-authors ranked by average citation

Sr.	Authors	Total link strength	Documents	Citations	Average citations
1	Shuai, Chenyang	7	2	261	130.5
2	Tan, Yongtao	7	2	261	130.5
3	Wu, Ya	7	2	261	130.5
4	Shabbir, Malik Shahzad	4	1	100	100
5	Tabash, Mosab Iqbal	4	1	100	100
6	Adedoyin, Festus Fatai	5	3	299	99.6667
7	Zakari, Abdulrasheed	5	5	446	89.2
8	Anser, Muhammad Khalid	4	2	167	83.5
9	Amin, Azka	2	2	134	67
10	Chen, Xi	11	4	255	63.75
11	Sharif, Arshian	7	3	190	63.3333
12	Gyamfi, Bright Akwasi	3	3	157	52.3333
13	Asongu, Simplice A.	1	2	103	51.5
14	Usman, Muhammad	4	2	100	50
15	Adebayo, Tomiwa Sunday	5	3	141	47

Source: Author's own calculation

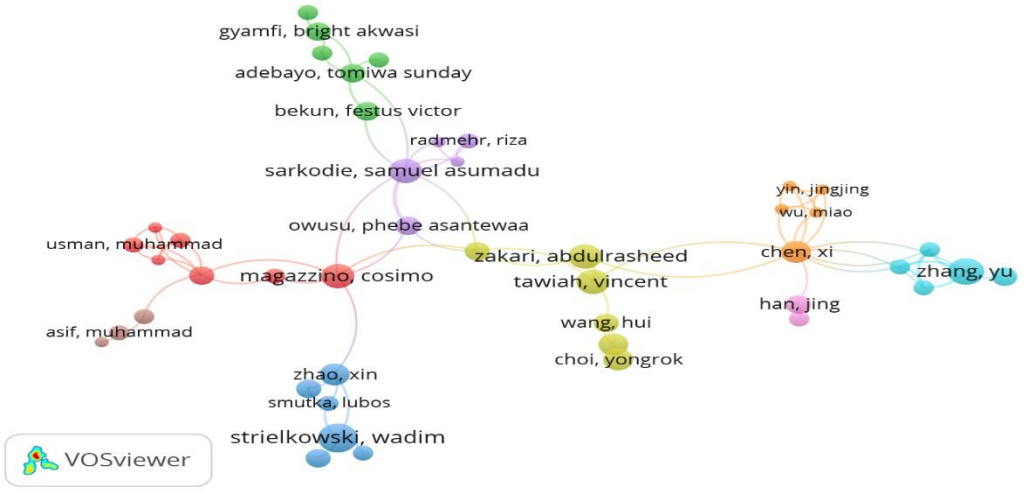


Figure 12: The Network Visualization of Authors Co-Authorship Analysis

Table 6: Authors Co-authorship Clusters

Cluster	Numbers	Co-authors
1(Red)	17	Obst, Carl, Delargy, Orlaith, Farrell, Catherine Anne Stout, Jane C., Coleman, Lisa, Eigenraam, Mark, Kinsella, Stephen, Norton, Daniel, O'donoghue.
2(Green)	15	De Sousa, Celio, Fatoyinbo, Lola, Larsen, Trond, Portela, Rosimeiry, Gaddis, Keith D., Garteh, Jerry, Honzak. Whapoe, Zargou Elijah, Wright, Timothy Max, Yonmah, Jerry
3(Blue)	12	Agarwala, Matthew, Bass, Steve, Bassi, Andrea M., Coyle, Diane, Dvarskas, Anthony.
4(Yellow)	11	Ancona, Zachary H., Bagstad, Kenneth J., Bana, Mediatrice, Ingram,, Jane Carter, Kagabo, Desire, Lange, Glenn-Marie.
5(Purple)	10	Polasky, Stephen, Daily, Gretchen C., Gao, Xiaolong, Li, Cong, Ouyang.
6(Sky Blue)	8	Masozera, Michel, Alavalapati, Janaki R. R., Banerjee, Onil, Cicowiez, Martin, Dudek.
7(Orange)	7	Borrelli, Pasquale, Jones, Arwyn, Montanarella, Luca, Panagos, Panos, Robinson, David A., Tye, Andrew, Obst, Carl G.
8(Brown)	7	Uwera, Claudine, Graveland, Cor, Munyawera, Swaib, Ngabirame, Gabriel, Nishimwe, Grace, Rugema, Didier Milindi, Stage, Jesper
9(Pink)	5	Aronson, James, Woodworth, Paddy, Hein, Lars, Dimopoulos, Panayotis, Kokkoris, Ioannis P.

Source: Author's own calculations

Organizations Co-Authorship Analysis

The minimum number of documents of an organization is 6 and the minimum number of the citations of an organization is 1, as threshold criteria. 81 meet the threshold criteria from the total of 1,929 organizations. For each 81 organizations, the total strength of co-authorship analysis with other organizations is calculated. 1000 organizations are selected with the total link strengths.

Figure 13 depicts the networking visuals of organizations co-authorship analysis and explored which countries collaborates largely in the field to contribute Green Economy. Table 7 shows the organizations co-authorship clusters.

Cluster	Organization		countries	
	N	Representative Organizations	N	Countries

1(Red)	14	World Bank, University of Melbourne, University of Sussex, University of Oxford, University of Minnesota	21	Austria, Belgium, Canada, Colombia, Denmark, Ethiopia, Finland, France, Germany, Greece, Italy, Japan, Kazakhstan, Kenya, Netherlands, Norway, Romania, Spain, Switzerland, Serbia, Sweden
2(Green)	13	University of Amsterdam, London Schlool of Economics and Political Science, UCL	14	Czech Republic, England, Georgia, Hungary, Iran, Latvia, Lithuania, Oman, Peru, Poland, Russia, Slovakia, Ukraine
3(Blue)	12	University of Manchester, University of Ghana, Kings Coll London	12	Australia, Egypt, Ireland, Kuwait, New Zealand, Peoples Republic of China, Scotland, Slovenia, Taiwan, Thailand, Vietnam
4(Yellow)	11	University of South Africa, University of Cape Town, Coventry University, Covenant University	11	Ecuador, Ghana, Nigeria, Pakistan, South Africa, Saudi Arabia, UAE, Uzbekistan, Tunisia
5(Purple)	12	Leiden University, British Geol Survey, Utrecht University	9	Azerbaijan, Brazil, Cyprus, Indonesia, Lebanon, Portugal South Korea, Turkey
6(Sky Blue)	12	University of Surrey, University of Johannesburg, Middlesex University	4	Bangladesh, India, Jordan, Malaysia
7(Orange)	12	London School of Economics, Harvard University, MIT, University of London	3	Mexico, Qatar, USA
8(Brown)	51	Stockholm University, Cambridge University, Delft University of Technology		

Source: Author's own calculations

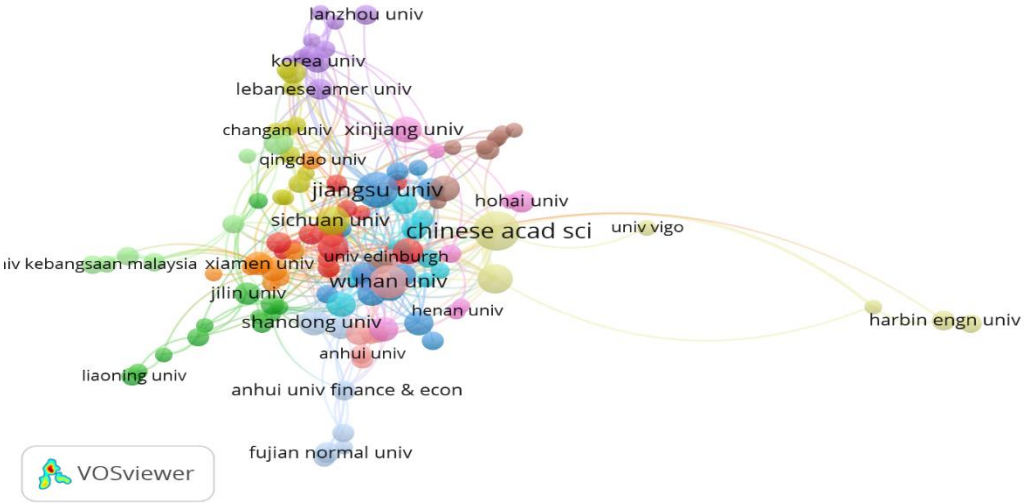


Figure 4: The Network Visualization Of Organizations Co-Authorship Analysis

Countries co-authorship Analysis

The minimum number of a documents of a country is 10 and the minimum number of citations of a country is 1, as threshold criteria. 49 meet the threshold criteria from the total of 122 countries. For every of 49 countries, the total strength of co-authorship links with other countries. These countries have greater total link strengths.

Figure 14 depicts the networking visuals of the countries co-authorship analysis. Table 8 shows the countries co-authorship clusters. The largest cluster shows England as a top country with 57 links and 378 documents.

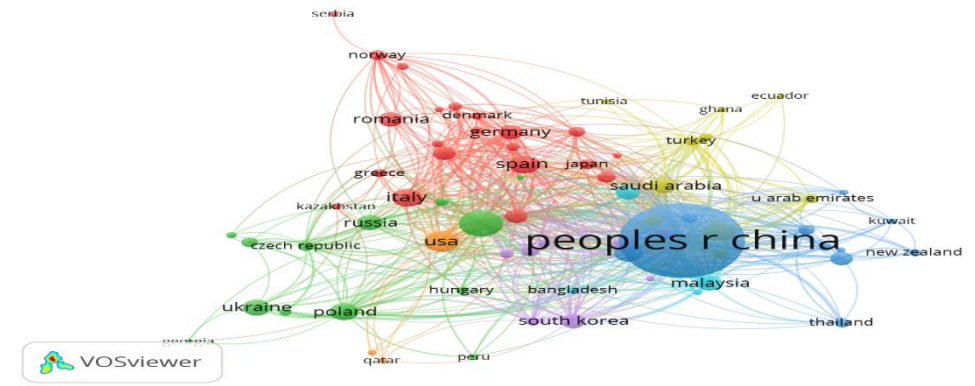


Figure 54: The Network Visualization Of Countries Co-Authorship Analysis

Co-Citation Analysis

Another sub-analysis under bibliometric analysis is called co-citation analysis. Co citation analysis discovered the hotspot themes of evolutionary trends in existing literature under the field of green economy (Robledo-Giraldo et al., 2023).

The minimum number of citation is selected 20 of the cited reference, as threshold criteria. Only 93 cited references from the total 94,110 meet the threshold criteria. For each 94,110 cited references total strength of co-citation links with other possible cited references is calculated. Afterwards, only 1000 cited references are selected and all came up with the greatest total link strength.

Figure 15 depicts the network visual representation of co-citation analysis and presented the hotspot themes. Co-citation Analysis discovered the 4 thematic clusters which are explained with their colors and representative publications. Table 8 depicts these 4 clusters along with their labels, names and representative publications respectively.

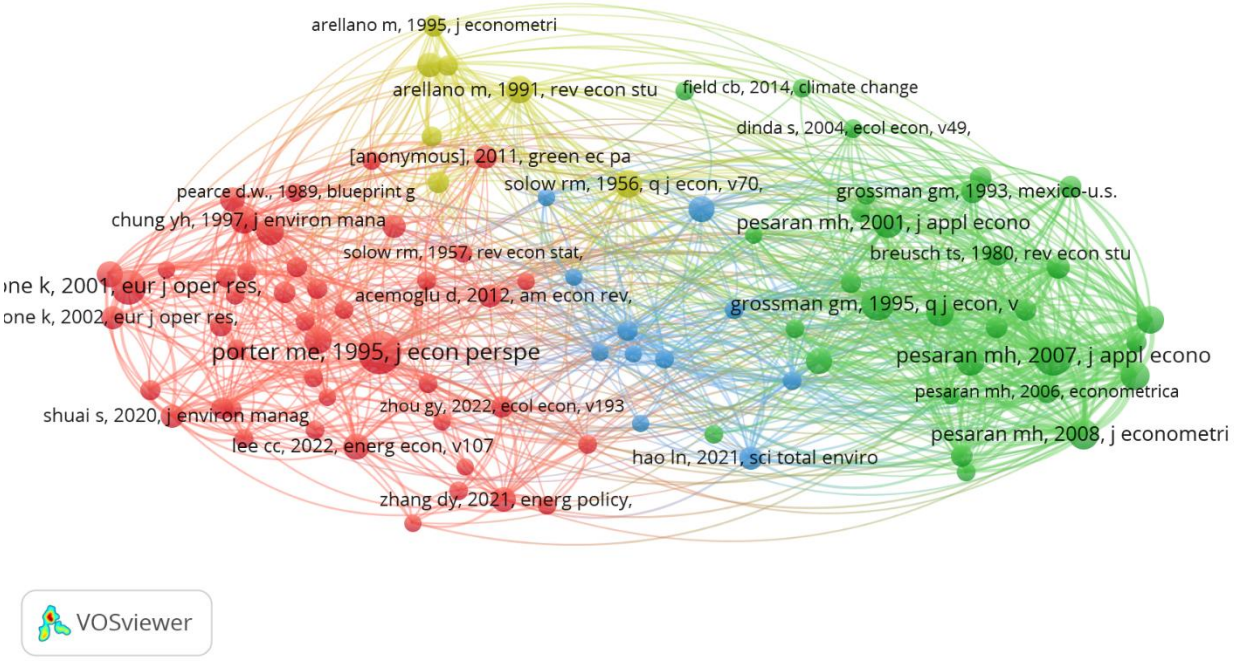


Figure 6: The Network Visualization Of Co-Citation Analysis And Hotspot Themes

Table 8: Co-citation Clusters.

Cluster	Existing Themes	Number	Representative Publications
1(Red)	Green Productivity, Economic Growth and Sustainable Development	43	(Iftikhar, Ullah, & Pinglu, 2024), (Ullah & Pinglu, 2024), (B. Wu, Ding, Xie, & Zhang, 2024), (Liu, Yao, Latif, Aslam, & Iqbal, 2022), (Ying Li & Fang, 2023), (Huang, 2024), (Wang, Zheng, Chen, & Wang, 2024)
2(Green)	Energy consumption, Climate Change and Environmental Sustainability	30	(Barker, 2019), (Change, 2015), (Dipietro & Anoruo, 2006), (George, McGahan, & Prabhu, 2012), (Gupta & Vegelin, 2016), (Managi & Kumar, 2018), (Yamaguchi, Islam, Managi, & Sciences, 2019)
3(Blue)	Resource Efficiency, Carbon emissions and environmental degradation	11	(Gillwald, 2000), (Osuri, 2015), (Ngoa & Song, 2021), (Efobi, Tanankem, & Asongu, 2018), (Gordon, 1976), (Phalen, Osellame, & Anderson, 2014)
4(Yellow)	Endogenous growth, human capital and technological progress	7	(Cerny, 1994), (Shrivastava, 2007), (Bördin & Engsfelt, 2016), (Ezeocha, 2024), (Shevchenko), (Ciurlau & Florea Ianc, 2020), (Asongu & Odhiambo, 2019), (Chelidze, Abutidze, & Gelitashvili, 2025),

Source: Author's own calculations

Co-word Analysis

The minimum number of the co-occurrence of a keyword is 5 for threshold criteria. Total 562 publications meet the threshold criteria from the total of 7,313 keywords. For each of the 100 keywords the total strength of co-occurrence associations with other keywords is calculated. The selected keywords represented as they all are with the largest total link strength.

Figure 16 shows the network visual representation of co-word analysis which depicts the clusters with the emerging trends. Table 9 shows 7 co-word clusters with their names, labels and representative keywords respectively.

Word Cloud

Figure 17 depicts the visual representation of most occurred words utilized in specific publications in the field of Green Economy.

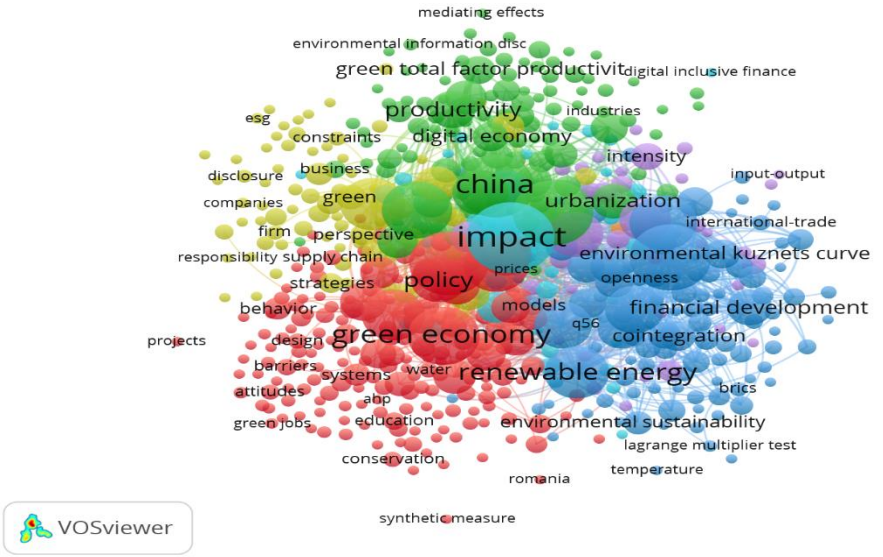


Figure 7: The Network Visualization Of Co-Word Analysis And Emerging Trends

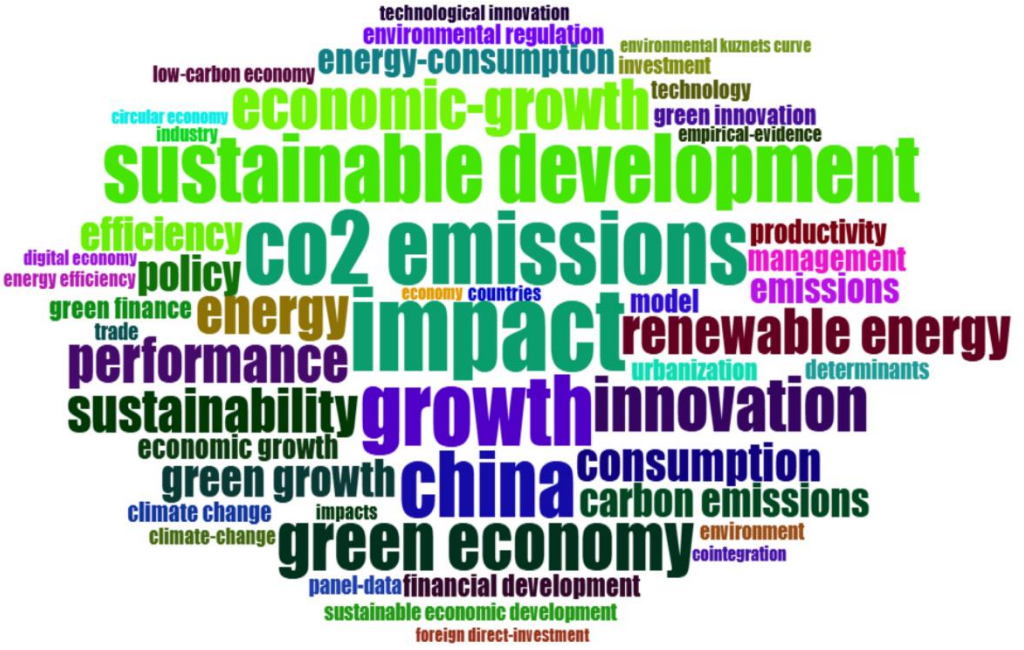


Figure 8: Visualization of Word Cloud

Table 10: Co-word Clusters With Emerging Themes.

Cluster	Themes	Number	Representative Keywords
1(Red)	Technological Innovation, Digital Inclusion And Green Economic Efficiency	186	Green economy, sustainability, climate change, sustainable development, energy, green transition, emissions, policy, renewable energy sources, circular economy.
2(Green)	Economic Transformation, Low Carbon Economic Efficiency And Environmental Protection	112	Green total factor productivity (GTFP), green economic development, environmental regulation, industrial structure, spatial spillover, digital economy, technological innovation, environmental efficiency, urbanization, carbon emission efficiency.
3(Blue)	Economic Diversification, Green Energy Transition And Green Growth	105	Economic growth, CO_2 emissions, renewable energy, environmental quality, environmental Kuznets curve (EKC), green growth, trade openness, financial development, foreign direct investment (FDI), natural resources.
4(Yellow)	Green Innovation, Environmental Management And Economic Sustainability	74	Green innovation, green financing, environmental performance, corporate sustainability, ESG performance, corporate social responsibility, environmental innovation, green investment, technological innovation, corporate governance.
5(Purple)	Carbon Emissions, Energy Transition And Environmental Degradation	46	Carbon emissions, carbon neutrality, carbon intensity, energy consumption, renewable energy development, environmental degradation, land-use change, transportation, economic policy uncertainty, technical progress.

6(Sky Blue)	Financial Inclusion, Technological Innovation And Environmental Sustainability	46	Green finance, green credit, digital inclusive finance, carbon emission reduction, technological progress, technology innovation, environmental policy, financial inclusion, digital transformation, sustainable economic development.
7(Orange)	Income Inequality And Green Market Transition	10	Income inequality, green market transition, green economy, green finance, environmental sustainability, renewable energy, green innovation, carbon emissions, social equity, sustainable development.

Source: Author's own calculations

Hypothesis of Study

Following are the hypothesis based on conceptual frameworks

H1: Green Technological Innovation plays significant role in order to promote Green Economy.

H2: Renewable Energy Consumption plays significant role in order to promote Green Economy.

H3: Financial Inclusion plays significant role in order to promote Green Economy.

Conceptual Framework

Conceptual framework encompasses the dependent, independent variable, and the control variables used in this study. Green economy (GE) is considered as the dependent variable which is measured through inclusive wealth.

Green Technological Innovation (GTI), Renewable Energy Consumption (REC) and Financial Inclusion (FI) taken as the independent variable, while Foreign Direct Investment (FDI), Gross Domestic Product (GDP), Trade Openness (TO) and Urbanization (URP) are taken as the control variables in the study. Figure 18 represents the conceptual framework used in this study.

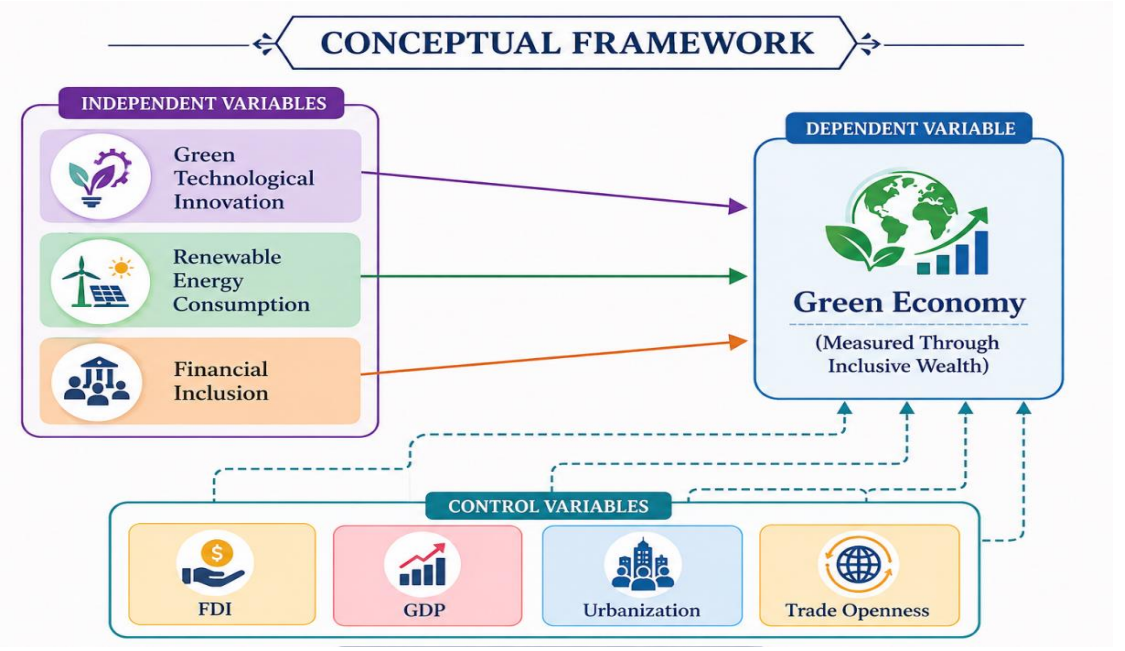


Figure 18: Conceptual Framework, Source: Author's own

Research Gap

Table 11 depicts the research gap of this study;

Table 11: Gap in Existing Literature

Gap Category	Existing Literature	Contribution
Measurement of Green Economy	Most of studies used traditional indicators to measure green economy such as; Green Growth Green Growth Index Environmental Performance Index Green Total Factor Productivity	This study utilized inclusive wealth as a comprehensive measure to green economy.
Lack of Empirical Studies	Only a few studies are available which established that inclusive wealth should be used to measure green economic efficiency.	This study provide empirical evidence of taking inclusive wealth as a complete matrix to measure green economy.

Policy Variables	Only a study considered the role of financial inclusion to promote inclusive wealth in top seven emerging countries.	This study investigates the role of financial inclusion to promote green economy specifically in BRICS economies.
Unexplored Variables	Only a few studies examined the role of technological innovation to strengthen the impacts towards inclusive wealth.	This study introduced green technological innovation and renewable energy consumption as new policy variable to promote green economy.
Geographical Limitations	Most of the research is conducted on China.	This study analyzed the BRICS member countries.
Bibliometric and Content Analysis	Only a few studies presented bibliometric analysis done green economy but separately	This study provide bibliometric analysis on green economy as a part of literature review.

Source: Author's own calculations

Methodology

Theoretical Framework

Following theories provides the theoretical grounds;

1. Endogenous Growth Theory
2. Hartwick Rule

Hartwick Rule

In 1977 Hartwick introduced the Hartwick's Rule which provides an important theoretical foundation for sustainable development by emphasizing the maintenance of an economy's overall capital stock over time (Colonescu & Ghosh, 2025). The theory therefore shifts attention from short-term income and production towards the **long-term preservation of total wealth**, which closely relates to the concept of Inclusive Wealth (McLaughlin, 2026).

Endogenous Growth Theory

Endogenous Growth Theory, primarily associated with Romer (1986) and Lucas (1988) (Şerban, 2020). This theory explains long-run economic growth through factors generated within the economic system, particularly **technological innovation, knowledge accumulation, human capital, and investment (Rubin, 2025)**.

Data Span and Countries Selection

In order to accomplish the specific purpose of this study, we gathered the data from 2006 to 2025 of BRICS countries which consists of 11 nations that are named as Brazil, China, India Indonesia, Russia, Egypt, Ethiopia, Iran Saudi Arabic, United Arab Emirates and South Africa. The selection of top seven emerging economies for study has unique validations. These economies collectively account for 40% of global population, one-third of world's GDP (Gross Domestic Product) and 45% to 50% contributor to carbon emissions (Owojori & Anwana, 2025). These economies plays important role as they have achieved faster economic growth as compare to other developing countries (Uzar, 2022).

Detail Formation and Selection of Variables

Table 13 in the appendix shows the description and data source of all the variables used in this study. Green Economy (GE) is taken as dependent variable which is measured through inclusive wealth. Inclusive wealth consists on Produced Capital (PC), Human Capital (HC) and Natural Capital (NC).

Model Specification

This study regresses the following model;

$$GE = \beta_0 + \beta_1 GTI_{it} + \beta_2 REC_{it} + \beta_3 FI_{it} + \beta_4 GDP_{it} + \beta_5 FDI_{it} + \beta_6 TO_{it} + \beta_7 URP_{it} + \varepsilon_{it} \quad (1)$$

Equation 1 shows that Green Economy (GE) is dependent variable. Green Technological Innovation (GTI), Renewable Energy Consumption (REC) and Financial Inclusion (FI) are considered as the independent variables. And Foreign Direct Investment (FDI), Gross Domestic Product (GDP), Trade Openness (TO) and Urbanization (U) are taken as the control variables in the study. While ε_{it}, considered as the error term.

Results and Discussion

Descriptive Statistics

Table 14 shows the results of descriptive statistics.

Table 14: Descriptive Statistics

Variables	Std. Dev.	Mean	Median	Maximum	Minimum
GE	0.314358	0.644214	0.724655	1.000000	0.000000
GTI	0.288620	0.477839	0.483189	1.000000	0.000000
REC	0.313573	0.356514	0.296296	1.000000	0.000000
FI	0.317581	0.620248	0.712575	1.000000	0.000000
FDI	0.288545	0.457240	0.443718	1.000000	0.000000
GDP	0.261019	0.532551	0.527291	1.000000	0.020410
TO	0.293677	0.461493	0.447728	1.000000	0.000000
URB	0.324158	0.560426	0.588564	1.000000	0.000000
URP	0.324158	0.560426	0.588564	1.000000	0.000000

Source: Author's own calculations

Cross-sectional Dependence Test

Table 15 shows the results of cross sectional dependence tests. The p-value of Breusch Pagan LM, Pesaran Scaled LM and Pesaran CD test is 0.0000 so, we reject the null hypothesis which confirms the presence of cross sectional dependence. While the Table 6 only shows the results of Pesaran CD cross sectional dependence test of all the variables individually.

Table 15: Results of Cross-sectional Dependence Tests

Test	Statistic	Prob.
Breusch-Pagan LM	183.4269	0.0000
Pesaran Scaled LM	17.37442	0.0000
Pesaran CD	4.952898	0.0000

Source: Author's own calculations

Heat Map

Figure 20 shows the heat map of correlation coefficients which depicts how variables are correlated with each other within the given range of 0 to 1.

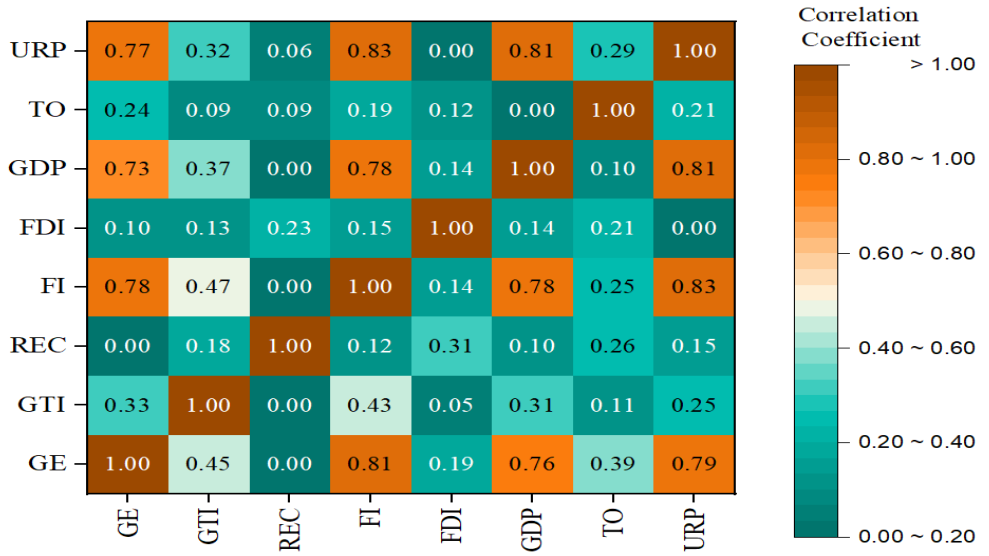


Figure 20: Heat Map, Source: Author's own

Table 16 in appendix shows the interpretation of heat map.

Unit Root Tests

Interpretation of CIPS

All variables are non-stationary at level except FDI which become stationary at 1% significance level. While all variables become stationary at first difference with different level of significance at constant. All variables show non-stationarity at level except FDI which shows stationarity at 1% significance level. And all variables become stationary at first difference. All the variables are integrated at I (0) and I (1) which shows the mix order of integration at constant and trend.

Table 17: Pesaran CD & Unit Root Tests

Var.	CIPS					CADF			
	Pesaran CD-test	With Constant		With Constant & Trend		With Constant		With Constant & Trend	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
GE	16.21	-2.297*	-3.258	-1.263*	-3.281*	-2.298*	-2.053	-1.262*	-2.141
GTI	6.01	-2.986	-5.069*	-3.068	-5.012*	-2.244	-3.542*	-2.443	-3.577*
REC	9.86	-2.209	-4.534*	-3.243	-4.64*5	-1.743	-2.774*	-2.166	-2.800*
FI	7.84	-3.916*	-5.716*	-4.029	-5.736*	-1.472*	-4.010*	-0.335	-1.495*
FDI	0.96	-2.797	-5.391*	-3.562	-5.465*	-1.517	-3.647*	-2.216	-3.733*
GDP	20.72	-0.755	-3.562*	-2.511	-3.736	-0.651	-2.573*	-2.148	-2.918*
TO	0.14	-1.338	-4.21*5	-2.778	-4.391*	-1.246	-3.712*	-3.238*	-3.994*
URP	25.17	-1.615*	-2.209	-1.938*	-2.671	-2.117	-2.209**	-2.597	-2.653

Source: Author's own calculations, *, **, *** shows significance level at 1%, 5%, less than 10%. Note: All values show significance at 1%.

Interpretation of CADF

All variables are non-stationary at level except FDI which become stationary at 1% significance level. While all variables become stationary at first difference with different level of significance at constant.

All variables shows non-stationarity at level except FDI which shows stationarity at 1% significance level. And all variables become stationary at first difference. All the variables are integrated at I (0) and I (1) which shows the mix order of integration at constant and trend.

Long Run Co-Integration Test

Table 18 shows the results of cointegration tests. The maximum p-values of fisher, Pedroni and KAO test are less than 0.05. As p-value is less or equal to 0.05 we reject the null hypothesis.

Table 18: Fisher, Pedroni and KAO Co-Integration Tests

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Trace Test		Max-Eigen Test	
	Fisher Stat.*	Prob.	Fisher Stat.*	Prob.
None	97.65	0.0000	97.65	0.0000
At most 1	365.3	0.0000	278.0	0.0000
At most 2	216.7	0.0000	132.0	0.0000
At most 3	128.0	0.0000	93.15	0.0000
At most 4	70.66	0.0000	53.97	0.0000
At most 5	45.91	0.0003	45.91	0.0003

Pedroni Residual Cointegration Test

Alternative hypothesis (H1): common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.132213	0.4474	-1.334722	0.9090
Panel rho-Statistic	0.498348	0.6909	0.803431	0.7891
Panel PP-Statistic	-8.287968	0.0000	-10.60290	0.0000
Panel ADF-Statistic	-4.169362	0.0000	-5.213351	0.0000

Alternative hypothesis (H1): individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	1.832322	0.9665
Group PP-Statistic	-15.59585	0.0000
Group ADF-Statistic	-5.213508	0.0000

Kao Residual Cointegration Test: Null Hypothesis: No cointegration

Test	t-Statistic	Prob.
ADF	-3.757861	0.0001

Source: Author's own calculations

Augmented Mean Group (AMG)

Table 19 shows the results of AMG estimators, which depicts that all the modeled variables are statistically significant.

One percent increase in green technological innovation, renewable energy consumption, financial inclusion, GDP, trade openness and urbanization on average caused the inclusive wealth will be increased by 6.6885%, 3.2604%, 5.678%, 19.44%, 8.134% and 21.8% in the long run respectively. While One percent increase in FDI on average caused the inclusive wealth will be decreased by 1.34% in the long run.

Table 19: Results of AMG and PMG of Main Model

Variable Names	Dependent Variable = GE		
	PMG		AMG
	Long run Estimates	Short run Estimates	Long run Estimates
GTI	0.113254*	-0.022073*	0.0668855*
	(0.058353)	(0.034152)	(0.056814)
REC	0.036027*	-0.022129***	0.0326047***
	(0.066790)	(0.069487)	(0.0290754)
FI	0.414141**	0.203230**	0.0567857***
	(0.090699)	(0.110388)	(0.004146)
FDI	0.153594*	-0.030322**	-0.0134316
	(0.057001)	(0.017062)	(0.0017242)
GDP	0.091575**	0.137325***	0.1944073**
	(0.082093)	(0.171085)	(0.1211503)
TO	0.253327**	0.050818	0.0813404***
	(0.075233)	(0.033363)	(0.0714538)
URP	0.397467**	2.025468	0.2185799**
	(0.091881)	(2.114147)	(0.0437581)
_cons		0.255033***	0.6068855*
		(0.110873)	(0.2076814)
COINTEQ01		0.136300*	0.0326047
		(0.113691)	(0.0290754)
__00000R_c			0.0000757**
			(0.0004146)

Source: Author's own calculations, *, **, *** shows significance level at 1%, 5%, less than 10% while standard errors are in ().

Pool Mean Group (PMG)

Table 19 shows the results of PMG estimators both in short and long run, which depicts that all the modeled variables are statistically significant as the given p-value for all the variables which ensures the significance of variables.

One percent increase in green technological innovation, renewable energy consumption, financial inclusion, FDI, GDP, trade openness and urbanization on average caused the inclusive wealth will be increased by 11.32%, 3.602%, 41.4141%, 15.35%, 9.157%, 25.33% and 39.74% the long run respectively.

On the flip side, one percent increase financial inclusion, GDP, trade and urbanization on average caused the inclusive wealth will be increased by 20.32%, 13.73%, 5.08% and 39.74% in the short run. While one percent increase in green technological innovation, renewable energy consumption and FDI on average caused the inclusive wealth will be decreased by 2.20%, 2.212% and 3.03%the short run respectively.

FMOLS and DOLS

In order to check the further robustness this study employed FMOLS and DOLS. And the table 7 shows the results of FMOLS and DOLS.

Table 20: Results of FMOLS and DOLS

	FMOLS		DOLS	
Variables	Coefficient	P-value	Coefficient	P-value
GTI	-0.099709***	0.0933	0.119841	0.2564
	(0.090696)		(0.104982)	
REC	-0.300783*	0.0001	-0.239526*	0.0076
	(0.072455)		(0.087932)	
FI	0.331630*	0.0089	0.124371**	0.0414
	(0.125188)		(0.157410)	
FDI	-0.124771**	0.0602	0.454560*	0.0136
	(0.086278)		(0.180842)	
GDP	0.144793*	0.0343	-0.069132**	0.05538
	(0.140485)		(0.116372)	
TO	0.159055**	0.0592	0.352664*	0.0004
	(0.083665)		(0.097058)	
URP	0.377989*	0.0054	0.290038***	0.0949
	(0.133982)		(0.172014)	

Source: Author's own calculations, *, **, *** shows significance level at 1%, 5%, less than 10% while standard errors are in ().

Discussion

The results indicated that Green Technological Innovation (GTI), Renewable Energy Consumption (REC) and Financial Inclusion (FI) are positively associated with Inclusive Wealth in the long run. GTI has positive and significant coefficients in both PMG and AMG, while its short-run coefficient is negative which suggests that the benefits of green innovation may take time to materialize because of initial research, investment, and technological adjustment costs. Similarly, REC shows a positive and significant long-run relationship with Inclusive Wealth in both estimators, whereas its short-run effect is negative. This may reflect the substantial initial costs of renewable-energy infrastructure and the gradual realization of environmental benefits.

Moreover, figure 21 shows that Financial Inclusion, has positive effects in both the short and long run, indicating that improved access to financial services can facilitate investment, entrepreneurship, and the accumulation of human and produced capital. Among the control variables, GDP, Trade Openness, and Urbanization generally exhibit positive and significant long-run relationships with Inclusive Wealth. GDP shows a consistently positive effect across PMG and AMG, suggesting that higher economic activity and income can provide greater resources for investment in produced and human capital.

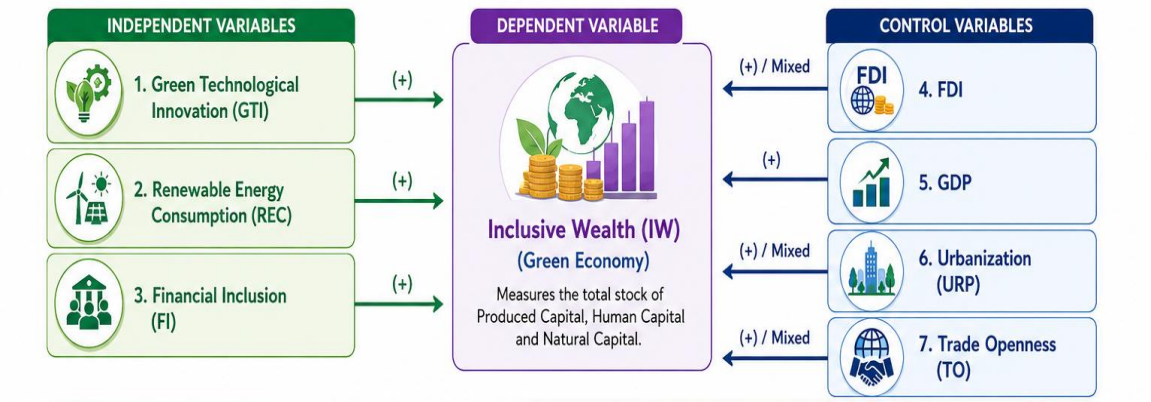


Figure 21: Role of Independent and Control Variables Towards Green Economy, Author's own

Overall, the results suggest that green innovation, renewable energy, financial inclusion, economic growth, trade openness, and sustainable urbanization can contribute to long-term improvements in Inclusive Wealth, while the benefits of green transformation may involve short-run adjustment costs and the contribution of FDI depends considerably on the nature and environmental quality of foreign investment.

Conclusion

The main aim of this study is to investigate the role of green technological innovation, renewable energy consumption and financial inclusion to ensure the green economy in the context of selected BRICS economies. This study used panel data which consists on available BRICS nations from 2006 to 2025. Literature review of this study consists on bibliometric analysis which substantiate this study and capture the attention of researchers towards green economy provisions. Bibliometric literature review is significant because it has given the emerging trend and the future research agendas in the field of green economy and sustainable development.

Empirical analysis used Augmented Mean Group (AMG) and Pooled Mean group (PMG) in order to examine the long run relationship between modeled variables. The findings of this study revealed the existence of cross sectional dependence. This study used Augmented Mean Group (AMG) technique to get the long run estimates which revealed that green technological innovation, renewable energy consumption and financial inclusion positively impact the inclusive wealth. Pooled Mean Group (PMG) also validates the positive contribution of green technological innovation, renewable energy consumption and financial inclusion towards inclusive wealth.

However, the negative short-run effects of green technological innovation and renewable energy consumption suggest that the transition towards a greener economy may involve initial investment and adjustment costs before generating long-term benefits. The effect of FDI remains comparatively mixed across estimators which indicates that its contribution to inclusive wealth depends on the nature and environmental quality of foreign investment.

Overall, the findings suggest that BRICS economies can strengthen sustainable wealth accumulation through integration of green innovation, renewable energy consumption, financial inclusion, and environmentally sustainable growth strategies into their long-term development policies. As these economies collectively account for 40% of global population, one-third of world's GDP (Gross Domestic Product) and 45% to 50% contributor to carbon emissions.

Policy Suggestions

- Policy recommendations are as follows;
- Green Technological Innovation should be incorporated in the policy framing of sustainable development in order to promote green economy.
- Renewable Energy Consumption must be inculcated specially to conserve environment in order to promote green economy.
- Financial Inclusion should be promoted in order to guarantee the green economy.

Study Limitations

Study limitations are as follows;

- Firstly, this study limits the empirical analysis on BRICS countries, which bounds the generalizability of the findings.
- Second, this study is conducted on macro level policy variables without incorporating the micro level impacts of such variables. So, it would difficult to get the real picture of policy implementation.
- Third, this study used the combine index of inclusive wealth as measure to green economy which couldn't depict that real implications of policy variables on produced, human and natural capital individually.

Future Research Directions

This study proposed following future research agendas themes based on co-word analysis by Bibliometric analysis which gives the researchers reliable directions for future research.

References

Adamowicz, M. (2022). Green deal, green growth and green economy as a means of support for attaining the sustainable development goals. Sustainability, 14(10), 5901.

Addo, S. H. (2016). The relationship between healthcare spending and gross domestic product: A study from a sample of African countries: Wayne State University.

Adejumo, O. O. (2020). Environmental quality vs economic growth in a developing economy: complements or conflicts. Environmental Science and Pollution Research, 27(6), 6163-6179.

Ağızan, K., Bayramoğlu, Z., & Ağızan, S. (2026). Price shocks without borders: Cross-sectional dependence and transmission of international agricultural prices to domestic markets. Agricultural Economics, 72(4), 225.

Al-Taai, S. H. H. (2021). Green economy and sustainable development. Paper presented at the IOP Conference Series: Earth and Environmental Science.

Appiah, K., Du, J., Yeboah, M., & Appiah, R. (2019). Causal correlation between energy use and carbon emissions in selected emerging economies—panel model approach. Environmental Science and Pollution Research, 26(8), 7896-7912.

Asongu, S. A., & Odhiambo, N. M. (2019). Mobile banking usage, quality of growth, inequality and poverty in developing countries. Information Development, 35(2), 303-318.

Barbier, E. B. (2018). Reconciling inclusive wealth and piketty: natural capital and wealth in the 21st century Inclusive Wealth Report 2018 (pp. 114-135): Routledge.

Barker, R. (2019). Corporate natural capital accounting. Oxford Review of Economic Policy, 35(1), 68-87.

Bayar, Y., Borozan, D., & Gavriletea, M. D. (2021). Banking sector stability and economic growth in post-transition European Union countries. International Journal of Finance & Economics, 26(1), 949-961.

Bliznetskaya, E., Chernokulsky, A., & Kirgizova-Barskaya, E. (2025). Vulnerability and Adaptation of BRICS Countries to Climate Risks: Challenges and Opportunities for International Cooperation. Herald of the Russian Academy of Sciences, 95(4), 500-513.

Bördin, O., & Engsfelt, P. (2016). The Digital Revolution: Structural transformation and changing demand of the banking industry.

Boubaker, S., Liu, Z., Mu, Y., & Zhan, Y. (2025). Carbon dioxide emissions and environmental risks: Long term and short term. Risk Analysis, 45(3), 523-543.

Brulé, G. (2022). Evaluation of existing indexes of sustainable well-being and propositions for improvement. Sustainability, 14(2), 1027.

Bruyninckx, H. H.-D., Hellweg, S., Schandl, S., Vidal, H., Razian, B., Nohl, H., . . . Miatto, Y. (2024). Global Resources Outlook 2024: Bend the trend-Pathways to a liveable planet as resource use spikes. United Nations Environment Programme.

Cabello-Solorzano, K., Ortigosa de Araujo, I., Peña, M., Correia, L., & J. Tallón-Ballesteros, A. (2023). The impact of data normalization on the accuracy of machine learning algorithms: A comparative analysis. Paper presented at the International conference on soft computing models in industrial and environmental applications.

Cerny, P. G. (1994). The dynamics of financial globalization: Technology, market structure, and policy response. Policy sciences, 27(4), 319-342.

Challoumis, C. (2024). Impact of Technological Change on Production. SSRN Electronic Journal.

Change, U. N. U. I. H. D. P. o. G. E. (2015). Inclusive Wealth Report 2014: Cambridge University Press.

Chelidze, M., Abutidze, G., & Gelitashvili, G. (2025). PECULIARITIES OF THE INFLUENCE OF GLOBALIZATION AND DIGITALIZATION ON THE BANKING SYSTEM. German International Journal of Modern Science/Deutsche Internationale Zeitschrift für Zeitgenössische Wissenschaft(96).

Choudhury, T., Kayani, U. N., Gul, A., Haider, S. A., & Ahmad, S. (2023). Carbon emissions, environmental distortions, and impact on growth. Energy Economics, 126, 107040.

Chudik, A., Mohaddes, K., Pesaran, M. H., & Raissi, M. (2016). Long-run effects in large heterogeneous panel data models with cross-sectionally correlated errors.

Ciurlau, L., & Florea Ianc, M. (2020). Modernization and restructuring in the Romanian banking system under the impact of globalization. Ann." Constantin Brâncuşi" Univ. Târgu Jiu Econ. Ser, 3, 137-142.

Colonescu, C., & Ghosh, S. (2025). Hartwick's Rule Revisited: Sustainability, Substitution, and Collapse. Substitution, and Collapse (October 31, 2025).

Conlon, K. C., Mallen, E., Gronlund, C. J., Berrocal, V. J., Larsen, L., & O'Neill, M. S. (2020). Mapping human vulnerability to extreme heat: A critical assessment of heat vulnerability indices created using principal components analysis. Environmental health perspectives, 128(9), 097001.

Daniek, K. (2020). Green economy indicators as a method of monitoring development in the economic, social and environmental dimensions. Nierówności społeczne a wzrost gospodarczy(62), 150-173.

Dar, K. H., Raina, S. H., Sajjad, S., & Showkat, M. (2025). Does environment and health impact economic growth in presence of asymmetries? Evidences from G7 economies using panel nonlinear ARDL. Journal of Economic and Administrative Sciences, 1-19.

Dell'Aversano, S., Villante, C., & Anatone, M. (2026). Decomposing CO2 Emissions with the Kaya Identity: Global Trends, National Dynamics, and Policy Implications. Sustainability, 18(3), 1627.

Dhawas, P., Dhore, A., Bhagat, D., Pawar, R. D., Kukade, A., & Kalbande, K. (2024). Big data preprocessing, techniques, integration, transformation, normalisation, cleaning, discretization, and binning Big data analytics techniques for market intelligence (pp. 159-182): IGI Global Scientific Publishing.

Di Zio, S., Tontodimamma, A., Del Gobbo, E., & Fontanella, L. (2023). Exploring the research dynamics of futures studies: An analysis of six top journals. Futures, 153, 103232.

Dipietro, W. R., & Anoruo, E. J. I. J. o. S. E. (2006). GDP per capita and its challengers as measures of happiness. 33(10), 698-709.

Djoukouo, A. F. D. (2021). Relationship between methane emissions and economic growth in Central Africa countries: Evidence from panel data. Global Transitions, 3, 126-134.

Efobi, U. R., Tanankem, B. V., & Asongu, S. A. (2018). Female economic participation with information and communication technology advancement: Evidence from Sub-Saharan Africa. South African Journal of Economics, 86(2), 231-246.

Ejaz, H., Zeeshan, H. M., Ahmad, F., Bukhari, S. N. A., Anwar, N., Alanazi, A., ... Abosalif, K. O. A. (2022). Bibliometric analysis of publications on the omicron variant from 2020 to 2022 in the Scopus database using R and VOSviewer. International Journal of Environmental Research and Public Health, 19(19), 12407.

Elegbeleye, I., Oguntona, O., & Elegbeleye, F. (2025). Green hydrogen: pathway to net zero green house gas emission and global climate change mitigation. Hydrogen, 6(2), 29.

Ezeocha, C. M. (2024). Digitalized Banking in a Globalized World: A Review of Nigeria's Digital Banking Transformation. African Journal of Management and Business Research, 16(1), 53-68.

Filonchyk, M., Peterson, M. P., Zhang, L., Hurynovich, V., & He, Y. (2024). Greenhouse gases emissions and global climate change: Examining the influence of CO2, CH4, and N2O. Science of The Total Environment, 935, 173359.

Fletcher, C., Ripple, W. J., Newsome, T., Barnard, P., Beamer, K., Behl, A., ... Field, C. (2024). Earth at risk: An urgent call to end the age of destruction and forge a just and sustainable future. PNAS nexus, 3(4), pgae106.

Fosten, J., & Nandi, S. (2023). Nowcasting from cross-sectionally dependent panels. Journal of Applied Econometrics, 38(6), 898-919.

George, G., McGahan, A. M., & Prabhu, J. (2012). Innovation for inclusive growth: Towards a theoretical framework and a research agenda. Journal of management studies, 49(4), 661-683.

Gillwald, A. (2000). Telecommunication policy and regulation for women and development. The Southern African Journal of Information and Communication, 2000(1), 1-14.

Gordon, F. E. (1976). Telecommunications: Implications for women. Telecommunications Policy, 1(1), 68-74.

Gu, J., & Liu, Z. (2024). A study of the coupling between the digital economy and regional economic resilience: Evidence from China. Plos one, 19(1), e0296890.

Gupta, J., & Vegelin, C. (2016). Sustainable development goals and inclusive development. International environmental agreements: Politics, law and economics, 16, 433-448.

Gyamfi, B. A., Onifade, S. T., Nwani, C., & Bekun, F. V. (2022). Accounting for the combined impacts of natural resources rent, income level, and energy consumption on environmental quality of G7 economies: a panel quantile regression approach. Environmental Science and Pollution Research, 29(2), 2806-2818.

Hassan, M. M. B., Ismael, H. O., & Haji, I. R. (2024). Measuring and Analyzing the Impact of Some Macroeco-nomic Variables on Exports in Emerging Countries for 2000-2020: A Panel Data Analysis. Zanco Journal of Human Sciences, 28(2), 279-300.

Hassan, W., & Duarte, A. E. (2024). Bibliometric analysis: a few suggestions. Current problems in cardiology, 49(8), 102640.

Hatemi-J, A. (2020). Hidden panel cointegration. Journal of King Saud University-Science, 32(1), 507-510.

Hickel, J. (2020). The sustainable development index: Measuring the ecological efficiency of human development in the anthropocene. Ecological Economics, 167, 106331.

Huang, L. (2024). Fintech inclusion in natural resource utilization, trade openness, resource productivity, recycling and minimizing waste generation: Does technology really drive economies toward green growth? Resources Policy, 90, 104855.

Iftikhar, H., Ullah, A., & Pinglu, C. (2024). From regional integrated development toward sustainable future: evaluating the Belt and Road Initiative's spillover impact between tourism, Fintech and inclusive green growth. Clean Technologies and Environmental Policy, 1-28.

Isfandyari-Moghaddam, A., Saberi, M. K., Tahmasebi-Limoni, S., Mohammadian, S., & Naderbeigi, F. (2023). Global scientific collaboration: A social network analysis and data mining of the co-authorship networks. Journal of Information Science, 49(4), 1126-1141.

Islam, M., & Managi, S. (2021). Global human capital: View from inclusive wealth Measuring human capital (pp. 39-54): Elsevier.

Issayeva, G., Zhussipova, E. Y., & Pazilov, G. A. (2025). An analytical study on the stability properties of energy consumption from fossil fuels: a panel stability test and zivot-andrews unit root test approach in the context of brics nations. International Journal of Energy Economics and Policy, 15(4), 1-10.

Jaiswal, R., Gupta, S., & Tiwari, A. K. (2023). Dissecting the compensation conundrum: a machine learning-based prognostication of key determinants in a complex labor market. Management decision, 61(8), 2322-2353.

Jamil, K., Liu, D., Gul, R. F., Hussain, Z., Mohsin, M., Qin, G., & Khan, F. U. (2022). Do remittance and renewable energy affect CO2 emissions? An empirical evidence from selected G-20 countries. Energy & Environment, 33(5), 916-932.

Jie, Y., & Lan, J. (2024). Dynamic linkages between human capital, natural resources, and economic growth—Impact on achieving sustainable development goals. Heliyon, 10(14).

Juodis, A., Karavias, Y., & Sarafidis, V. (2021). A homogeneous approach to testing for Granger non-causality in heterogeneous panels. Empirical economics, 60(1), 93-112.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. Journal of econometrics, 90(1), 1-44.

Kao, C., & Chiang, M.-H. (2001). On the estimation and inference of a cointegrated regression in panel data Nonstationary panels, panel cointegration, and dynamic panels (pp. 179-222): Emerald Group Publishing Limited.

Kasman, S., Kasman, A., & Turgutlu, E. (2006). Fisher hypothesis revisited: A fractional cointegration analysis. Emerging Markets Finance and Trade, 42(6), 59-76.

Kaur, P., Stoltzfus, J., & Yellapu, V. (2018). Descriptive statistics. International Journal of Academic Medicine, 4(1), 60-63.

Khan, R. Z., Aremu, M. I., Razak, L. A., Premaratne, G., & Sattar, A. (2025). Impact of renewable and non-renewable energy consumption, economic growth, and ICT on environmental degradation: Evidence from Asia Pacific Economic Cooperation countries. International Journal of Green Energy, 22(11), 2246-2262.

Kostić, V., Kostić, A., & Milićević, S. (2025). Green economy in natural capital management: Implications for sustainable development. TEME, 065-087.

Kousar, S., Ahmed, F., Abid, A., & Haluza, D. (2025). Inclusive wealth as a measurement of sustainable future: bibliometric analysis for past, present and future research agenda in biodiversity accounting and sustainable development. International Journal of Climate Change Strategies and Management, 17(3), 23-61.

Krannich, A.-L., & Reiser, D. (2023). United nations sustainable development goals 2030, the Encyclopedia of sustainable management (pp. 3862-3867): Springer.

Kulevicz, R. A., Porfirio, G. E. d. O., de Oliveira, O. S., Zavala Zavala, A. A., Silva, B. A. d., & Constantino, M. (2020). Influence of sustainability reports on social and environmental issues: bibliometric analysis and the word cloud approach. Environmental Reviews, 28(4), 380-386.

Kundu, D., & Gupta, D. (2024). Building a fairer future: joint actions for poverty, hunger and inequality reduction by G20 nations.

Kurniawan, R., Sugiawan, Y., & Managi, S. (2021). Economic growth—environment nexus: An analysis based on natural capital component of inclusive wealth. Ecological Indicators, 120, 106982.

Li, Y., & Fang, Y. (2023). Effect of digital finance on inclusive green growth through technological innovation. Innovation and Development, 1-20.

Li, Y., Xu, Z., Wang, X., & Wang, X. (2020). A bibliometric analysis on deep learning during 2007–2019. International Journal of Machine Learning and Cybernetics, 11(12), 2807-2826.

Liu, H., Yao, P., Latif, S., Aslam, S., & Iqbal, N. (2022). Impact of Green financing, FinTech, and financial inclusion on energy efficiency. Environmental Science and Pollution Research, 1-12.

Managi, S., Bhattacharya, A., & Bhattacharya, T. (2023). Inclusive Wealth Index: A Comprehensive Measure of LiFE Towards 'Net Zero'.

Managi, S., & Kumar, P. (2018). Inclusive wealth report 2018: Taylor & Francis.

McLaughlin, E. (2026). The Inclusive Wealth of Nations: Prosperity, Sustainability, and the Future of Economic Progress: Bloomsbury Publishing.

Mikhno, I., Koval, V., Shvets, G., Garmatiuk, O., & Tamošiūnienė, R. (2021). Green economy in sustainable development and improvement of resource efficiency. Central European Business Review (CEBR). 10(1), 99-113.

Neal, T. (2014). Panel cointegration analysis with xtpedroni. The Stata Journal, 14(3), 684-692.
Ngoa, G. B. N., & Song, J. S. (2021). Female participation in African labor markets: The role of information and communication technologies. Telecommunications Policy, 45(9), 102174.
Ofori, I. K., Figari, F., & Ojong, N. (2023). Towards sustainability: The relationship between foreign direct investment, economic freedom and inclusive green growth. Journal of Cleaner Production, 406, 137020.
Osuri, B. A. (2015). Factors determining women involvement in managerial positions within the telecommunication industry in Nairobi county, Kenya. University of Nairobi.
Owojori, O. M., & Anwana, E. (2025). Climate governance in the BRICS: pathways toward net-zero emissions. Discover Sustainability, 6(1), 359.
Pandey, A., Kiran, R., & Sharma, R. K. (2023). Investigating the determinants of financial inclusion in BRICS economies: Panel data analysis using fixed-effect and cross-section random effect. Sustainability, 15(2), 1603.
Pedroni, P. (1995). Panel cointegration. Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis, Indiana University.
Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. Empirical economics, 60(1), 13-50.
Pesaran, M. H., Ullah, A., & Yamagata, T. (2008). A bias-adjusted LM test of error cross-section independence. The econometrics journal, 11(1), 105-127.
Petrakis, P. E. (2020). Theoretical approaches to economic growth and development. An Interdisciplinary Perspective. Switzerland: National and Kapodistrian University of Athens, 26-544.
Phalen, P. F., Osellame, J., & Anderson, C. (2014). Women of influence: A case study of three telecommunications policymakers. Telecommunications Policy, 38(4), 333-343.
Prabhakar, A. C. (2026). The BRICS Coalition and a New Global Order: CRC Press.
Qing, L., Yao, Y., Sinisi, C.-I., Salman, A., Jaradat, M., Spinu, A. E., . . . Shabbir, M. S. (2024). Do trade openness, environmental degradation and oil prices affect green energy consumption? Energy Strategy Reviews, 52, 101342.
Rahmad Ramadhan, L., & Anne Mudya, Y. (2024). A comparative study of Z-score and min-max normalization for rainfall classification in Pekanbaru. Journal of Data Science, 2024(04), 1-8.
Robledo-Giraldo, S., Figueroa-Camargo, J. G., Zuluaga-Rojas, M. V., Vélez-Escobar, S. B., & Hurtado, P. L. D. (2023). Mapping, evolution, and application trends in co-citation analysis: a scientometric approach. Revista de Investigación, Desarrollo e Innovación, 13(1), 201-214.
Rolando, B., & Ingriana, A. (2024). Sustainable business models in the green energy sector: Creating green jobs through renewable energy technology innovation. International Journal of Economics And Business Studies, 1(1), 43-56.
Romero-Ávila, D., & Omay, T. (2022). Are CO2 emissions stationary after all? New evidence from nonlinear unit root tests. Environmental Modeling & Assessment, 27(4), 621-643.
Rostow, W. W. (2020). The stages of economic growth: A non-communist manifesto: Barakaldo Books.

Rubin, G. (2025). 1. Towards a history of endogenous growth theories: an introduction. Cahiers d'économie politique, 87(2), 10-42.

Şerban, O. (2020). From Endogenous Growth Theory to Knowledge Economy Pyramid-Comparative Analysis of Knowledge as an Endogenous Factor of Development. Paper presented at the International Conference Innovative Business Management & Global Entrepreneurship (IBMAGE 2020).

Shanmugam, G. (2023). Fossil fuels, climate change, and the vital role of CO2 Plays in Thriving people and plants on planet Earth. Bulletin of the Mineral Research and Exploration, 175(175), 167-175.

Sheikh, A., & Hassan, O. I. (2023). Impact of economic growth, energy use and research and development expenditure on carbon emissions: an analysis of 29 OECD countries. International Journal of Energy Economics and Policy, 13(1), 454-464.

Shevchenko, V. Y. INTERNATIONAL BANKING EVOLUTION: SYSTEMIC DIMENSIONS. by the Academic Council State University of Jan Kochanowski, 272.

Shrivastava, M. P. (2007). Banking Reforms and Globalisation: APH Publishing.

Soberon, A., Rodriguez-Poo, J. M., & Robinson, P. M. (2022). Nonparametric panel data regression with parametric cross-sectional dependence. The econometrics journal, 25(1), 114-133.

Ullah, A., & Pinglu, C. (2024). From Regional Integrated Development towards Sustainable Future: Evaluating the Belt and Road Initiative's Impact between Tourism, Fintech and Inclusive Green Growth.

Uzar, U. (2022). The connection between freedom of the press and environmental quality: an investigation on emerging market countries. Paper presented at the Natural Resources Forum.

Vines, D. (2015). Cooperation between countries to ensure global economic growth: a role for the G 20? Asian-Pacific Economic Literature, 29(1), 1-24.

Vu, A. N., & Nguyen, D. L. (2024). The gig economy: The precariat in a climate precarious world. World Development Perspectives, 34, 100596.

Vural, G. (2020). How do output, trade, renewable energy and non-renewable energy impact carbon emissions in selected Sub-Saharan African Countries? Resources Policy, 69, 101840.

Wadanambi, R., Wandana, L., Chathumini, K., Dassanayake, N., Preethika, D., & Arachchige, U. (2020). The effects of industrialization on climate change. J. Res. Technol. Eng, 1(4), 86-94.

Wang, C., Zheng, C., Chen, B., & Wang, L. (2024). Mineral wealth to green growth: Navigating FinTech and green finance to reduce ecological footprints in mineral rich developing economies. Resources Policy, 94, 105116.

Washington, S., Karlaftis, M. G., Mannering, F., & Anastasopoulos, P. (2020). Statistical and econometric methods for transportation data analysis: CRC press.

Westerlund, J., Hosseinkouchack, M., & Solberger, M. (2016). The local power of the CADF and CIPS panel unit root tests. Econometric Reviews, 35(5), 845-870.

Wu, B., Ding, Y., Xie, B., & Zhang, Y. (2024). FinTech and Inclusive Green Growth: A Causal Inference Based on Double Machine Learning. Sustainability (2071-1050), 16(22).

Wu, M.-L. (2020). Exploring the relationships among exchange rate, foreign investment and economic growth using time series econometric approaches: The case of China's Guangdong Province. Asian Journal of Economics, Business and Accounting, September, 11-23.

Xu, Y., & Zhao, F. (2023). Impact of energy depletion, human development, and income distribution on natural resource sustainability. Resources Policy, 83, 103531.

Yamaguchi, R., Islam, M., Managi, S. J. L. i. S., & Sciences, R. (2019). Inclusive wealth in the twenty-first century: a summary and further discussion of Inclusive Wealth Report 2018. 12(2), 101-111.

Yang, F., Ibrahim, R. L., Ajide, K. B., & Al-Faryan, M. A. S. (2024). Examining the ecological effects of energy transition, environmental technology, and structural change in BRICS economies: Implications for sustainable development. Energy Sources, Part B: Economics, Planning, and Policy, 19(1), 2419956.

Yavuz, E., Kılıç, E., & Mercan, N. (2025). Fiscal Sustainability in Emerging Markets: Panel Unit Root Approach with Smooth Structural Shifts and Common Factors. Ekonomi Politika ve Finans Araştırmaları Dergisi, 10(3), 1173-1190.

Zaman, A. (1995). On the inconsistency of the Breusch-Pagan test.

Zhao, S., Guo, Y., Sheng, Q., & Shyr, Y. (2014). Advanced heat map and clustering analysis using heatmap3. BioMed research international, 2014(1), 986048.

Zhou, C., & Etzkowitz, H. (2021). Triple helix twins: a framework for achieving innovation and UN sustainable development goals. Sustainability, 13(12), 6535.

Zhu, J., & Liu, W. (2020). A tale of two databases: the use of Web of Science and Scopus in academic papers. Scientometrics, 123(1), 321-335.

Zou, C. A. M. B. (2022). Controlling an infectious disease and sustainability: lessons from Hartwick's Rule.

APPENDIX

Table 21: Variables' Description and Data Sources

Variables	Description	Symbols	Measurements	Sub-measures	Sources
Dependent Variable					
	Green Economy	GE	Inclusive Wealth (Sum of produced capital, human capital and natural capital- Real chained 2019 US$)	*Produced Capital (PC)- Value of machinery, buildings, equipment and residential and non-residential urban land (Real chained 2019 US$). *Human Capital (HC)- Present value of future earnings for working population over their lifetimes (Real chained	WDI

				2019 US$). *Natural Capital (NC)- Valuation of renewable and non-renewable natural capital (Real chained 2019 US$).	
Independent Variables					
	1-Green Technological Innovation	GTI	Environment-related technologies	Green Patents	OECD
	2-Renewble Energy Consumption	REC	Renewable energy consumption (% of total final energy consumption)		WDI
	3-Financial Inclusion	FI	Financial inclusion index	1-Number of commercial bank branches per 100,000 adults 2- Number of ATMs per 1,000 km2 3- Outstanding deposits with commercial banks (% of GDP) 4- Outstanding loans from commercial banks (% of GDP)	IMF
Control Variables					
	1-Foreign Direct Investment	FDI	Foreign direct investment, net inflows (% of GDP)		WDI
	2-Gross Domestic Product	GDP	GDP (constant US$)		WDI
	3- Urbanization	URP	Urban population (% of total population)		WDI
	4-Trade openness	TO	Trade (% of GDP)		WDI

Source: Author's own calculations

Table 22: Heat Map Interpretation

Correlation Range	Color	Relation
0.0-0.2	Dark Teal	Highly Positive

0.2-0.4	Light Teal	Positive
0.4-0.5	Pale Teal	Moderate
0.5-0.6	Pale Mustard	Correlation
0.6-0.8	Mustard	Negative
0.8-1.0	Dark Mustard	Strongly Negative

Source: Author's own calculations