



## Balancing Growth and Sustainability: A Review of Green Investment, ICT Development, and Economic Growth in China's Environmental Transition

Muhammad Usman Mughal<sup>1</sup>, Faiz-Ul-Qudoos<sup>2</sup>, Saif Ur Raman<sup>3</sup>, Sadia Idress<sup>4</sup>

### Abstract

The research describes the impact of green investment, information and communication technology (ICT) development on the growth of carbon emissions in the Chinese economy from 1985 to 2023. Specifically, the study exposes that green investment (GIN) and ICT development play an important role to identify the issue of higher CO<sub>2</sub> levels in China. Whereas, increased economic growth leads to environmental deficiency through huge carbon emissions. Moreover, the Granger-causality results indicate an association between green investment, ICT development, economic growth, and its square value. The study offers the policy implications based on its findings and recognizes several limitations. Firstly, the study mainly focuses on CO<sub>2</sub> emission trends in China, neglecting other regional economies. On the other hand, few important factors such as governmental interference in carbon emission control, environmental principals, and controlled process and procedure are overlooked. Thirdly, the empirical findings flaw in robustness checks. Lastly, economic uncertainty may also contribute to environmental pollution. Future research should address these limitations to offer meaningful insights and contribute to the literature.

**Keywords:** Green Investment, ICT Development, Economic Growth & Environmental Sustainability

### 1. Introduction

This research provides detailed analysis of the relationship between economic growths (EG), environmental degradation (ED), information and communication technologies (ICTs), and green investments (GIs) in the context of China's economy. The authors explore the substantial challenges in response of the rapid economic growth, especially in terms of environmental damage, as evidenced by the flow in carbon emissions (Saeed et al., 2024; Sadia Bint Raza et al., 2024; Parveen et al., 2024). The China is determined to reduce CO<sub>2</sub> emissions per unit GDP as a matter of urgency and it most important to address the environmental concerns along with the economic development. The research effectively integrates empirical evidence and theoretical frameworks to underscore the complexity of the relationship between the variables such as EG, ICTs, GIs, and CO<sub>2</sub> emissions (Amin et al., 2024). By identifying the conflict in existing literature, the study aims to provide an understanding through the application of the Quantile ARDL approach, which adds value to the procedural contribution of the research (Rabbia Syed, Sehrish Arshad, 2024; Zubair et al., 2024; Song et al., 2024; Ali & Audi, 2016; Ali et al., 2021; Ali et al., 2022).

Furthermore, the paper highlight the role of ICTs and GIs in mitigating environmental degradation, offering a balanced perspective by acknowledging both their potential benefits in enhancing energy efficiency and their potential drawbacks in increasing energy consumption and carbon emissions furthermore, the discussion on the growth trend in high-tech industries and the promotion of green investments adds depth to the analysis, demonstrating the multifaceted strategies needed to achieve sustainable economic development (Shen et al., 2024; Shahid et al., 2023; Arshad et al., 2024; Ali et al., 2021). Overall, this research contributes valuable insights into the complex relationship between economic growth, technological advancements, environmental sustainability, and policy involvements in the context of China's economy. It offers a comprehensive analysis supported by empirical evidence, making it a valuable contribution to the literature on sustainable development and environmental economics (Irfan et al., 2023; J. Saeed et al., 2024; Ahmad Shahid et al., 2023; Ashiq et al., 2023; Audi & Ali, 2017; Audi et al., 2024).

### 2. Literature Review

A thorough review of literature associated to the relationships between green investment (GI) and carbon emissions (CO<sub>2</sub>), information and communication technologies (ICTs) and carbon emissions (CO<sub>2</sub>), and economic growth (EG) and carbon emissions (CO<sub>2</sub>) in the context of environmental sustainability has elaborated (Tanveer Ahmad Shahid, 2023; Nazik Maqsood, 2024). The authors have done admirable working in combining a wide range of studies, providing a comprehensive overview of the current state of research in these areas. (T. A. Shahid, 2024; (Maqsood1 et al., 2023). The review begins by discussing the importance of GI as an environmentally friendly source of investment, with researchers highlighting its potential to reduce greenhouse gas emissions without impeding consumption and production. Through a review of studies by (Minhas et al., 2024; Abro et al., 2024; Rahman & Bakar, 2019) and others, the authors establish the significance of GI in promoting green economic growth and mitigating/reducing CO<sub>2</sub> emissions. Furthermore, the inclusion of studies emphasizing the role of green financial technology and green financial institutions adds gravity to the discussion, showcasing the multifaceted approaches to promoting environmental sustainability by adopting the financial mechanisms (Ahman et al., 2023; A. U. Shahid et al., 2022; Ur Rahman & Bakar, 2018; Audi et al., 2020).

In the same way, the literature review on ICTs and CO<sub>2</sub> emissions presents a balanced perspective on the topic, acknowledging conflicting findings in existing research. By citing studies such as (Zulfiqar et al., 2022; Chaudhary et al., 2023; Ur Rahman & Bakar, 2019) and others, the authors illustrate both the potential benefits of ICTs in reducing CO<sub>2</sub> emissions through technological advancements and the potential drawbacks associated with increased energy consumption and electronic waste generation. The review effectively highlights the complexities of the ICT-CO<sub>2</sub> relationship, setting the stage for further enquiry in the study (Dawood et al., 2023; Zhao et al., 2023; Li et al., 2022).

<sup>1</sup> MS Scholar, Faculty of Economics and Commerce, The Superior University, Lahore, Pakistan, [usmankhan2509@gmail.com](mailto:usmankhan2509@gmail.com)

<sup>2</sup> M.S. Scholar Department of Commerce and Finance, Superior University Lahore, Pakistan, [faizulqudoos1987@gmail.com](mailto:faizulqudoos1987@gmail.com)

<sup>3</sup> Associate Professor, faculty of Economics and Commerce, Superior University, Lahore, Pakistan, [saifrao12@gmail.com](mailto:saifrao12@gmail.com)

<sup>4</sup> School of Economics, Banking and Finance, University Uatra Malaysia, [midrees485@gmail.com](mailto:midrees485@gmail.com)

Furthermore, the review of literature on EG and CO<sub>2</sub> emissions provides insight into the ongoing debate surrounding the environmental implications of economic growth. Through a comprehensive analysis of studies by (Shahzadi et al., 2023; Rahman et al., 2022; Zahra et al., 2023) and others, the authors highlight inconsistency findings regarding the relationship between EG and CO<sub>2</sub> emissions. The review emphasizes the need for further investigation into this connection, particularly through the application of unique methodologies (Ullah et al., 2023; Audi & Ali, 2023).

Overall, this section of the research establishes a strong grip of existing research and effectively sets the stage for the subsequent empirical analysis. The involvement of diverse perspectives and studies improves the discussion, offering valuable insights into the complexities of promoting environmental sustainability amidst economic growth and technological advancement (Awan et al., 2023; Qureshi et al., 2022; Javaid et al., 2023; Audi & Ali, 2023).

### **3. Research Method**

The study employs an innovative approach known as Quantile Autoregressive Distributed Lag (QARDL) procedure to examine the non-linear linkage between carbon dioxide (CO<sub>2</sub>), green investment (GI), information and communication technology (ICT) development, economic growth, and the square of economic growth. The authors justify the use of this approach by highlighting the non-linear nature of the variables under investigation and emphasize the benefits of QARDL over traditional linear methods. The review provides a clear explanation of the QARDL methodology and its advantages with regards to the non-linear relationships between variables. By citing studies such as (Saif Ur Rahman, Salyha Zulfiqar Ali Shah) and demonstrating its application in previous research by (Khawaja Hisham Ul Hassan, 2021) the authors establish the credibility and efficacy of QARDL in exploring the complex interactions between CO<sub>2</sub> emissions, green investment, ICT development, and economic growth.

Furthermore, the review highlights the ability of QARDL to analyze the varying impact of time series data across different quantiles, providing insights into the heterogeneity of effects across different segments of the distribution. This approach adds depth to the analysis by uncovering nuances in the relationship between variables that may be masked in traditional linear models. The inclusion of the Wald test to assess the reliability of the quantile coefficients further strengthens the methodological accuracy of the study, ensuring robustness in the estimation of both long-run and short-run associations (Bakar, 2019).

Moreover, the review contrasts the traditional linear Autoregressive Distributed Lag (ARDL) framework with the QARDL model, providing a clear understanding of the methodological shift and its implications for the analysis of non-linear relationships. Overall, the review effectively communicates the rationale behind the choice of QARDL methodology and its advantages in capturing the non-linear dynamics of the variables under investigation. By grounding the methodological approach in previous research and highlighting its benefits, the authors set a strong foundation for the empirical analysis in the subsequent sections of the study.

### **4. Results and Discussion**

The findings presented in the study provide a detailed analysis of the relationships between carbon emissions (CO<sub>2</sub>), green investment (GI), information and communication technology (ICT) development, economic growth (GDP), and the square of economic growth (GDP<sup>2</sup>) in the context of China. The study indicates that GDP<sup>2</sup> has the highest mean score, followed by GDP, CO<sub>2</sub>, and ICT development, while green investment exhibits the lowest mean score, suggesting relatively lower focus by the Chinese government on green investment during the study period. The study also observes significant and positive impacts of GDP on CO<sub>2</sub> emissions across various quantiles, indicating a positive relationship between economic growth and environmental pollution (Hafiza et al., 2022). Additionally, the negative significance of GDP<sup>2</sup> in higher quantiles suggests that the square of economic growth contributes to reducing carbon emissions. Overall, the findings contribute to a deeper understanding of the complex interactions between economic growth, green investment, ICT development, and carbon emissions in China, providing valuable insights for policymakers and researchers alike.

### **5. Conclusion and policy suggestion**

The current study employs the to investigate the relationships between green investment, ICT development, economic growth, and carbon emissions in China from 1985 to 2023. The study findings reveal significant reversion to the between the explanatory variables and carbon emissions, with green investment and ICT development playing significant roles in reducing carbon emissions. This highlights the importance of investing in green projects and advancing ICT infrastructure as solutions to combat environmental degradation. However, the positive impact of GDP on carbon emissions suggests that economic growth may exacerbate environmental pollution, underscoring the need for sustainable development policies. The study provides valuable insights for policymakers and stakeholders concerned with sustainable development in China (Naz et al., 2022).

It underscores the importance of integrating environmental considerations into economic policies and prioritizing investments in green technologies and infrastructure. The suggestion to devise policy-level solutions based on different quantiles for the study variables offers a practical approach to addressing environmental challenges. However, the study also acknowledges several limitations, including the focus solely on China's CO<sub>2</sub> emissions, neglecting other regional economies, and the omission of factors such as governmental influence, environmental regulations, and economic uncertainty (Shahzadi, Ali, et al., 2023).

Addressing these limitations in future research would enhance the robustness of the findings and contribute to a more comprehensive understanding of the factors influencing carbon emissions and environmental sustainability. Overall, the study contributes to the existing literature by applying a novel methodology to examine the complex relationships between economic growth, green investment, ICT development, and carbon emissions in China, and offers valuable implications for sustainable development policymaking.

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