International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2025, 15(3), 184-195.

Drivers of the Load Capacity Factor in New İndustrialized Countries: Economic Growth, Financial Development and Urbanization on Load Capacity Factor

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Received: 30 November 2024 **Accepted:** 11 March 2025 **DOI:** https://doi.org/10.32479/ijefi.18988

ABSTRACT

This study examines the effects of economic growth, financial development, and urbanization on the load capacity factor (LCF) for Newly Industrialized Countries (NICs) over the period 1991-2021. In this context, we analyzed the relationship between the variables using the Fixed Effects Driscoll-Kraay and Fixed Effects Panel Quantile estimators. The estimation results indicate that across all quantiles (low, medium, and high levels of environmental degradation), economic growth has a positive effect on LCF, while the squared term of economic growth has a negative effect. Urbanization and renewable energy consumption positively impact LCF, whereas financial development and labor force participation rates have negative effects. The positive effects of urbanization and renewable energy consumption on LCF become more pronounced in higher quantiles. Conversely, the negative impact of labor force participation on LCF is stronger in higher quantiles. The negative effect of financial development on LCF, however, becomes statistically insignificant at higher quantiles.

Keywords: Economic Growth, Financial Development, Urbanization, Load Capacity Factor, Newly Industrialized Countries
JEL Classifications: E01, C33, N90, C32

1. INTRODUCTION

The ultimate goal of economic activities is to meet people's needs and desires, thereby improving societal welfare (Şimşek and Bursal, 2019; Acheampong et al., 2022). Following the Industrial Revolution, increasing human activity has facilitated the synchronized expansion of urbanization, economic development, and financial growth. While national development policies have supported production growth, employment, and social welfare, they have also encouraged excessive consumption of natural resources. The United Nations Environment Programme (2024) predicts that global natural resource consumption will increase by 60% by 2060 compared to 2020 levels (UNEP, 2024).

Moreover, rapid economic growth and increasing urbanization require intensive energy consumption, leading to a dramatic rise in greenhouse gas (GHG) emissions into the atmosphere. High urbanization, growing traffic, and industrialization have accelerated environmental degradation (Qian, 2024). According to the Intergovernmental Panel on Climate Change (IPCC, 2023), global GHG emissions continued to rise between 2010 and 2019 due to unsustainable energy use, land use, and land-use changes, as well as unequal historical and ongoing contributions from different regions and countries through their consumption and production patterns. These factors are also among the primary drivers of global climate change.

Climate change is one of the biggest barriers to the sustainability of the planet's natural resources and is responsible for many extreme weather events today. According to the United Nations Environment Programme (2023b), over 90% of natural disasters, including drought and desertification, wildfires, pollution, and floods, are linked to weather and water conditions. The National Oceanic and Atmospheric Administration (NOAA, 2025) reported that in 2024, the United States experienced 27 confirmed weather/climate disasters, each causing losses exceeding $1 billion. Climate extremes disproportionately affect developing countries. For instance, the total damage caused by the 2022 floods in Pakistan was estimated to exceed $14.9 billion, with total economic losses reaching $15.2 billion (World Bank, 2025). Meanwhile, between June and September 2023, 18.8 million people in Indonesia were affected by drought (CRED, 2024). For this reason, environmental sustainability goals are of critical importance within the United Nations' 2030 Sustainable Development Goals (SDGs) for developing countries. Over the past decade, these countries have seen a 50% increase in economic size, a 40% rise in industrial production, and a 2.6% growth in energy demand (International Energy Agency-IEA, 2024). Particularly, upper-middle-income countries, including NICs, have increased their share of global GDP from 14% in 1970 to 29% in 2020 (United Nations Environment Programme UNEP, 2024). However, despite their growing share of global GDP, developing countries still have a long way to go to achieve their SDGs. Estimates suggest that these countries need to invest between $3.3 trillion and $4.5 trillion annually in critical areas such as basic infrastructure, food security, climate change mitigation and adaptation, healthcare, and education (UNCTAD, 2014). In this regard, prioritizing sustainable growth and development policies is essential. Financial development can play a crucial role in providing the necessary resources for SDG achievement and supporting environmental sustainability in developing countries (Xu et al., 2022; Annor et al., 2024; Caglar et al., 2024; Adebayo et al., 2025).

Financial development is a multidimensional concept that positively influences economic growth through macroeconomic channels (Çetin et al., 2022). Moreover, it can promote economic growth by increasing savings and borrowing options and reallocating capital (Levine et al., 2000: 32). Growth serves as a catalyst for financial development, and as economic growth increases, financial development also expands (Demetriades and Hussein, 1996). Financial development can also contribute significantly to the promotion of renewable energy technologies and the provision of necessary capital for transitioning to a low-carbon economy (Adebayo et al., 2024). The deepening of financial systems can facilitate access to financial markets, green technologies, advanced expertise, and efficient energy use, potentially helping to reduce CO_2 emissions and thus support environmental quality (Shahbaz et al., 2013; Shahzad et al., 2022).

This study examines the effects of economic growth, financial development, and urbanization on environmental sustainability in NIC countries. Since the 1980s, NIC countries have undergone a rapid development process. High growth rates, export-led growth, a young and large workforce, and a dynamic domestic market are key characteristics of these nations. However, rapid industrialization and economic expansion in NIC countries have also brought about significant environmental challenges. Policies prioritizing growth in these nations have led to excessive exploitation of natural resources, increasing pressure on ecosystems.

The Load Capacity Factor (LCF), which is the ratio of biocapacity to ecological footprint, measures the extent to which a country uses its natural resources sustainably. LCF is widely used to assess ecological balance and the renewal capacity of resources (Xu et al., 2022; Latif and Faridi, 2023; Raihan et al., 2023; Ridwan et al., 2024; Nuta et al., 2024; Özkan et al., 2024; Wang et al., 2024; Yıldırım et al., 2024; Adebayo et al., 2024).

The econometric relationship between economic growth, financial development, and urbanization with LCF was analyzed within the framework of the Load Capacity Curve (LCC) hypothesis. The traditional Environmental Kuznets Curve (EKC) hypothesis, proposed by Grossman and Krueger (1995), suggests that rapid growth in the early stages of economic development increases environmental degradation. However, after reaching a critical threshold, economic development supports technological efficiency and environmentally friendly production, leading to a decline in environmental degradation. This implies an inverted U-shaped relationship between economic development and environmental degradation.

Unlike the EKC hypothesis, which focuses solely on the relationship between development and environmental degradation, the LCC hypothesis examines the link between biocapacity usage and ecological footprint alongside economic development and environmental degradation. The LCC hypothesis aims to reveal the impact of economic development on ecosystem carrying capacity and environmental sustainability. According to this hypothesis, rapid economic development initially increases natural resource consumption and pressure on ecosystems. However, after a critical threshold, sustainable economic development policies and the spread of environmental technologies positively influence LCF, forming a U-shaped relationship. This research aims to contribute to the literature in several ways. First, it focuses on the economic and financial dynamics of environmental sustainability in NIC countries. Using a broad and up-to-date econometric methodology, in-depth analyses were conducted, and heterogeneous effects were identified through causality tests. The effects of economic growth, financial development, and urbanization on LCF at different quantile levels were examined for NIC countries. Second, the study investigates the extent to which economic development policies in these nations impact environmental sustainability. Third, it explores the role of financial development in supporting environmental sustainability. Fourth, unlike many empirical studies, this research identifies the causal relationships between variables in the presence of cross-sectional dependence (CSD). The study provides key policy implications and recommendations based on its findings.

The study is structured into five sections. The first section is the introduction. The second section presents the conceptual framework of the relationship between the variables. This section discusses empirical literature, highlighting the study's contributions and points of differentiation. The third section introduces the dataset, along with the econometric methods and tests used in the analysis. The fourth section interprets the findings obtained from the econometric analyses. Finally, the fifth section, the conclusion, discusses the study's results and provides policy implications.

2. LITERATURE REVIEW

This section examines the relationship between economic growth, financial development, and urbanization with LCF in three different sub-dimensions. Within this framework, the conceptual framework of the relationship between the variables is presented. Secondly, the empirical literature is reviewed. In the last section, it is explained that the study overlaps and decomposes with empirical literature.

2.1. Economic Growth and LCF

For governments, achieving rapid and sustainable economic growth is one of the most critical macroeconomic policy priorities. This is because rapid growth is generally associated with increased production and employment, technological advancements, and societal welfare. Since the 1950s, the world has experienced significant economic development. Between 1970 and 2020 alone, global GDP grew at an annual average rate of 3%, outpacing global population growth (United Nations Environment Programme, 2024). The International Monetary Fund (IMF, 2025) forecasts that global growth, which stood at 3.3% in 2023 and 3.2% in 2024, will reach 3.3% in 2025 and 2026. This period of rapid economic growth has been accompanied by intensive energy consumption and excessive natural resource exploitation. Although the COVID-19 pandemic in 2020 caused a temporary slowdown in global economic activity, global energy demand increased by 4% in 2021 compared to the previous year (IEA, 2021). While the share of fossil fuels in total global energy consumption declined from 82% in 2013 to 80% in 2023, they still dominate economic activity (IEA, 2024). According to the U.S. Energy Information Administration (2024), approximately 74% of human-induced GHG emissions in the U.S. come from burning fossil fuels for energy consumption. The traditional Environmental Kuznets Curve (EKC) hypothesis suggests a strong connection between economic development and environmental degradation. According to this approach, in the early stages of growth, economic expansion requires high levels of energy and resource consumption, leading to increased environmental degradation. However, after reaching a certain income level, individuals begin to prioritize environmental quality over increased consumption, leading to higher spending on environmental mitigation. As a result, environmental quality starts improving alongside economic growth (Everett et al., 2010). In contrast, the Load Capacity Curve (LCC) hypothesis places greater emphasis on the relationship between biocapacity utilization and ecological balance. By offering a broader perspective than the traditional EKC hypothesis, it provides important insights for policymakers on ecological balance and environmental sustainability.

Despite theoretical predictions, empirical literature presents complex findings regarding economic growth and environmental sustainability. Pata and Işik (2021), in their study using the ARDL model for China, found that increases in income, energy intensity, and resource rent led to a decline in LCF, while human capital improved environmental quality in the long run. Nurgazina et al. (2022), analyzing the impact of economic growth and energy consumption on environmental degradation in China for the period 1979-2019 using the ARDL method, provided evidence that economic growth and energy consumption increased environmental degradation. The researchers showed that population growth due to urbanization increased CO_2 emissions in the short term but improved environmental conditions in the long run. Shang et al. (2022), in their study estimating the effects of economic expansion on load capacity factors in ASEAN countries for the period 1980-2018, found that in the long run, renewable energy consumption and health expenditures played a significant role in improving load capacity factors, while economic growth produced negative effects. Kartal et al. (2023), analyzing the impact of financial development, economic growth, nuclear and renewable energy consumption on CO_2 emissions, ecological footprint, and LCF for the U.S. over the period 1965:1-2018:4 using the Bootstrap Fourier Granger Causality Quantile approach, estimated that nuclear and renewable energy, as well as financial development, reduced ecological degradation, whereas economic growth negatively affected ecological quality. Raihan et al. (2022), using the ARDL method for Mexico over the period 1971-2018, found that economic growth, fossil fuel consumption, and urbanization decreased LCF and, consequently, reduced environmental quality. Caglar et al. (2024), examining the relationship between economic growth and ecological welfare for Turkey over the period 1986-2022 using the extended ARDL estimator, demonstrated that the LCC hypothesis was valid for Turkey. Similarly, Çamkaya (2024), using ADF, ADL, and FMOLS techniques for Turkey over the period 1961-2022, estimated that the LCC hypothesis was valid in the country but argued that income levels were not yet sufficient to improve environmental quality. Deng et al. (2024), in their study covering the period 1998-2018 for ten selected countries using CS-ARDL and PMG-ARDL estimators, estimated that the LCC hypothesis was valid in both the short and long run and confirmed the U-shaped relationship between GDP and LCF. Duran and Saqib (2024), analyzing the relationship between LCF and environmental quality for G20 economies over the period 1993-2021 using CS-ARDL and AMG estimators, provided evidence of a sustainable harmony between economic activities and environmental welfare. Özkan et al. (2024), applying the ARDL method for India over the period 1980–2020, revealed that financial development, economic growth, and technological innovation had a dynamic negative effect on LCF, while energy efficiency had a positive dynamic impact on environmental quality. Samour et al. (2024), using Driscoll-Kraay and Moment Quantile Regression methods for European economies over the period 2004-2018, found that technological innovation and economic growth negatively affected LCF, whereas renewable energy and financial inclusion promoted LCF. Wang et al. (2024), in their study covering the period 1990-2018 for BRICS countries, confirmed the validity of both the traditional EKC and LCC hypotheses. Xu et al. (2022), using the ARDL method for Brazil over the period 1970-2017, found that economic growth, non-renewable, and even renewable energy consumption reduced LCF. Yıldırım et al. (2024), in their study for BRICS countries over the period 1992-2020, demonstrated a U-shaped relationship between economic development and environmental quality. Adebayo et al. (2024), employing the Wavelet Kernel-Based Regularized Least Squares (WKRLS) method for the U.S. over the period 1980-2021, showed that economic growth, trade openness, foreign direct investment inflows, and natural resource use negatively impacted ecological quality (LCF) in the short, medium, and long run.

2.2. Financial Development and LCF

Financial development is critical to the efficient use of resources in an economy and to sustaining economic development. Similarly, increased economic development may encourage the development and deepening of financial markets. This relationship can be explained within the framework of the Supply-first and Demand-following hypotheses proposed by Patrick (1966). While the supply-first approach argues that financial development causes economic growth, the demand-following view suggests that economic growth stimulates financial development. These two hypotheses also imply that financial development affects environmental sustainability directly and indirectly through economic development. By encouraging the large-scale investments needed for carbon mitigation, financial markets can facilitate access to green finance needed for climate change adaptation and mitigation (United Nations Framework Convention on Climate Change-UNFCCC, 2025). Financial development can stimulate the development of environmentally friendly industries by providing the international financing needed for renewable energy investments and green technologies. With a well-managed financial sector, inbound foreign investment can boost local research and development (R and D) efforts, which can positively contribute to lower overall ecological pollution levels (Shahbaz et al., 2013; Kirikkaleli and Adebayo, 2021; Jahanger et al., 2022). Moreover, financial development can contribute to improving environmental quality by enhancing energy security (Adebayo et al., 2024). Improving energy sector efficiency can reduce funding rates and facilitate procurement practices (Charfeddine, 2017). The contribution of financial development to environmental sustainability can also be realized through supporting a low-carbon and sustainable economic growth process. Increased growth in an economy where investments can be channeled into low-carbon and efficient areas can promote environmental sustainability.

Empirical literature on financial development and environmental sustainability presents two opposing views. The first group of studies suggests that financial development improves environmental quality and supports environmental sustainability, whereas the second group of studies finds that financial development contributes to environmental degradation. Shahbaz et al. (2020), in their study on the United Arab Emirates (1975-2014) using regression and Toda-Yamamoto causality analysis, found that financial development increased CO_2 emissions. Liu et al. (2022), analyzing E7 countries (1990-2018) using the CS-ARDL technique, showed that financial development increased the ecological footprint, thereby reducing ecological quality. However, the researchers also found that financial development promoted environmental sustainability through the human capital channel. Latif and Faridi (2023), in their study covering 48 Asian economies (1996-2020) using the GMM technique, estimated the impact of financial development on LCF and found that Asian countries exhibited an inverted U-shaped financial market-based EKC. Raihan et al. (2023) provided evidence that the adoption of renewable energy sources and financial globalization had positive effects on LCF in both the long and short run. Annor et al. (2024), using the GMM technique for 47 economies (1990-2021), found that the development of financial institutions significantly reduced LCF, thereby exacerbating the harmful environmental effects of green energy. However, the development of financial markets in Africa significantly improved environmental quality, moderating the link between green energy and LCF in a positive way. Degirmenci et al. (2024), applying RCCE and AMG methods for E7 countries (1991-2019), found that increasing financial development improved environmental quality (LCF) in Russia and India. Javed et al. (2024), in their study on G7 countries (1990-2019) using the CS-ARDL procedure, found that financial development and natural resource rent significantly reduced LCF, increasing environmental degradation. Ridwan et al. (2024), analyzing BIMSTEC countries (2000-2022) using Driscoll-Kraay and Panel Quantile Estimators, found that financial inclusion decreased LCF. Bilgili et al. (2025), investigating the relationship between financial development and CO_2 emissions in the U.S. (1990-2022) using time-frequency analyses, found that the financial sector reduced CO_2 emissions within a 5-8-year frequency band across different sub-sample periods.

2.3. Urbanization and LCF

Urbanization is a social transformation that emerges as a result of the concentration of people and economic activities and the physical expansion of urban areas (Ochoa et al., 2018). The proportion of the global population living in urban areas increased from 37% in 1970 to 56% in 2020 (United Nations Environment Programme, 2024a). Several factors drive urbanization, including economy, trade and industrialization, infrastructure facilities, advanced communication systems, geographical location, administrative centers, higher education institutions, tourist attractions, an attractive environment, and climate conditions (Ahmed, 2014). Moreover, the urbanization process brings significant benefits such as economic growth, wealth, employment, education, innovation, prosperity, and social structures (Ochoa et al., 2018; Zhang and Ye, 2020). However, the rapid expansion of urbanization and spatial sprawl today has led to a sharp increase in population and economic activities in urban areas. It is estimated that by 2050, 70% of the world's population will live in urban areas (Ebisu et al., 2016: 751). Urban sprawl is associated with the loss of high-quality agricultural land, traffic congestion, carbon emissions, and environmental degradation (Shen et al., 2011; Ochoa et al., 2018; Sun et al., 2020). Additionally, inadequate infrastructure, unplanned urbanization, the loss of green spaces to concrete structures, traffic congestion, water, air, and noise pollution, and rapid population growth pose major challenges to sustainable urbanization (Deniz, 2009; Tan and Lu, 2019). Latief et al. (2022), using the GMM method, analyzed the impact of selected variables on the ecological footprint of Mediterranean Union countries (2001-2016). They found that the urban population had an inverted U-shaped relationship with environmental degradation in lower-middle-income and upper-middle-income countries. Xu et al. (2022) found that urbanization had no effect on LCF, whereas financial globalization had a positive impact on LCF. Raihan et al. (2023) showed that urbanization in Mexico reduced LCF and worsened environmental quality. Ridwan et al. (2024), on the other hand, found that urbanization increased LCF, thereby improving environmental quality. Tran et al. (2023), examining ASEAN countries (1995-2020) using OLS, FMOLS, and CCR methods, found that higher renewable energy consumption and long-term urbanization reduced environmental degradation. Çamkaya

(2024) estimated that urbanization in Turkey reduced LCF and deteriorated environmental quality. Degirmenci et al. (2024) found that urban expansion had a positive impact on LCF and The data on biocapacity per capita and ecological footprint (ghareduced LCF. Feng et al. (2024), applying the ARDL procedure for Thailand (1984-2018), found that natural resources, political risk, and urbanization decreased LCF, while biomass increased LCF. Nuta et al. (2024), using FGLS and PCSE estimators, analyzed selected Asian and European economies and estimated that urbanization increased CO_2 emissions and environmental degradation in both regions.

3. METHODOLOGY AND DATA

3.1. Data

This study examines the effects of financial development and urbanization on environmental degradation for Newly Industrializing Countries (NICs) over the period 1991-2021. The NIC countries are Brazil, China, Indonesia, India, Malaysia, Mexico, the Philippines, South Africa, Thailand, the Philippines, South Africa, Thailand and Turkey. NIC countries, which are likely to be classified as developed countries in the near future, therefore converge to developed countries more than other developing countries. They also contribute more to environmental degradation than other developing countries. In the study, the load capacity factor (LCF) was used as an indicator of environmental degradation. LCF is the ratio of per capita biocapacity to per capita ecological footprint. The variables used in the study are shown in Table 1. Real GDP per capita (USD), urbanization rate (annual % change) and financial development (ratio of broad money supply to GDP) are used as core explanatory variables in the estimated model. At the same time, renewable energy consumption (ratio of total final energy consumption) and labor force participation rate (% of total population) are taken as control variables.

The data on biocapacity per capita and ecological footprint (gha) used in the calculation of the LCF were obtained from the Global Ecological Footprint Network (GFN), while the other series were obtained from the official World Bank database. In the estimated model, the natural logarithm of GDP per capita and the quadratic value of the natural logarithm of this variable were taken to test the LCC hypothesis.

3.2. Econometric Method

The econometric relationship between the variables in the study is analyzed by following the empirical literature (Tan and Lu, 2019; Ahmed et al., 2019; Ahmed and Wang, 2019; Saud et al., 2020; Nathaniel, 2021; Kihombo et al., 2021; Xu et al., 2022). In this framework, the relationship function between LCF and explanatory variables is constructed as follows:

$$LCFit = f(LnGDP_{it}, LnGDP2_{it}, URB_{it}, FIN_{it}\, REN_{it}, L_{it}) \tag{1}$$

Where LCF represents the load capacity factor, which is the dependent variable. LnGDP, LnGDP2, URB, FIN, REN and L represent economic growth and the square of growth, urbanization rate, financial development, renewable energy consumption and labor force participation rate included in the quadratic model to test the LCC hypothesis. Here i and t represent the unit and time dimension in the panel data model. The linear representation of the panel data model showing the panel data relationship between the variables is as follows:

$$LCF_{it} = \beta_0 + \beta_1 LnGDP_{it} + \beta_2 LnGDP^2_{it} + \beta_3 URB_{it} + \beta_4 FIN_{it} + \beta_5 REN_{it} + \beta_6 L_{it} + \varepsilon_{it} \tag{2}$$

Here β0 and β1 represent constant slope and coefficient parameters. ε is the error term in the model. In the framework of the research, the presence of horizontal cross-section dependence (HSD) problem in the series is analyzed using the LM test proposed by Breusch and Pagan (1980). The test statistic is given below (Pesaran, 2015):

$$\lambda LM = T \sum_{(i=1)}^{(N-1)} \sum_{(j=i+1)}^{N} \hat{p}_{ij}^2 \tag{3}$$

It is calculated as follows. Where $\hat{p}_{ij}^2$: is the correlation coefficient of residual i,j (between the residuals of units i and j) $\hat{p}_{ij}$

$$\hat{p}_{ij} = \hat{p}_{ji} = \frac{\sum_{t=1}^{T} \hat{v}_{it} \widetilde{v_{jt}}}{\left(\sum_{t=1}^{T} \hat{v}_{it}\right)^{1/2} \left(\sum_{t=1}^{T} \hat{v}_{j^t}\right)^{1/2}} \tag{4}$$

In the next step after determining the existence of RLS in the series, the stationarity of the series is examined using the Karavias and Tzavalis (2014) panel unit root test. The test statistic, which offers two models, can be used to test the null hypothesis of random walk against the alternative hypothesis of a stationary series with a break in the intercepts (means) of the series in the first model (Chen et al., 2022):

$$H_0: y_{i,t} = y_{i,t-1} + \mu_{i,t}$$

$$H_1: y_{i,t} = \varphi y_{i,t-1} + (1-\varphi)\,[\alpha_{1,i} I(t \leq b) + \alpha_{2,i} I(t > b)] + \mu_{i,t} \tag{5}$$

The second model tests the null hypothesis of random walk with deviations against the alternative of a trend-stationary panel process with a break in the intercepts and linear trends at time b:

$$H_0: yi,\ t = yi,\ t\text{-}1 + \beta i + \mu_{i,t} \tag{6}$$

and

$$H_1: y_{i,t} = \varphi yi,\ _{t-1} + \varphi\,[\beta_{1,t} I(t \leq b) + \beta_{2,t} I(t > b)] + (1-\varphi)\,[\alpha_{1,t} I(t \leq b) + \alpha_{2,i} I(t > b)] + (1-\varphi)\,[\beta_{1,i} tI(t \leq b) + \beta_{2,i} tI(t > b)] + \mu_{i,t} \tag{7}$$

In this study, the panel data relationship between the variables is estimated using fixed effect Driscoll and Kraay (1998), Two Stage Least Squares (STLS) and Fixed Effect Panel Quantile estimators. The quantile estimator proposed by Koenker and Bassett (1978) was proposed by Koenker (2004) for panel data. The representation of the Fixed Effect Panel Quantile estimator showing the regression relationship between variables is as follows (Cheng et al., 2019):

$$QYi,\ t\ (\tau|Xi,\ t) = \alpha(\tau)'Xi,\ t + \beta i,\ i=1.,\ N,\ t=1,\ldots,\ T \tag{8}$$

Next, the causality relationship between the LCF and the explanatory variables is analyzed using the Juodis et al. (Juodis et al., 2021) panel Granger causality test. The model to be estimated for the JKS (2021) Granger causality analysis is given below (Juodis et al., 2021):

$$y_{i,t} = \phi_{0,_i} + \sum_{p=1}^{P} \phi_{p,iyi,t-p} + \sum_{q=1}^{Q} \beta_{q,ixi,t-q} + \varepsilon_{i,t} \tag{9}$$

4. RESULTS

Within the framework of the research, descriptive statistics of the series are analyzed first. Descriptive statistics are shown in Table 2. The average value of LCF was found to be 0.827. LCF <1 means that the countries under study consume more than the renewable capacity of natural resources. The maximum and minimum values of LCF are calculated as 4.430 and 0.225. The average values of economic growth and the square of this variable are 8.356 and 70.387, the maximum values are 9.506 and 90.377, and the minimum values are 6.276 and 39.393. The average urbanization rate in the research countries is 2.543%. The maximum and minimum values of the urbanization rate are 5.123 and 0.705. The average value of the financial development series is 75.770%, and the maximum and minimum values are 211.891% and 21.357%. The rate of renewable energy consumption in NIC countries was found to be 24.742%. In these countries, energy consumption is mostly met from traditional energy sources. Labor force participation rates are 65.730% on average in these countries. The maximum labor force participation rate was 83.797% and the minimum was 48.551%. As shown in Table 2, there is a normal distribution problem in all series. The panel data set is a balanced panel data set consisting of 310 observations (N_xT).

As seen in Table 2, the prob values of the Jarque-Bera test statistics are below the 5% significance level in all series ($P < 0.05$). The quantile distribution plots shown in Figure 1 indicate that there are outlier observations in the series and therefore there is a normal distribution problem.

The presence of the NPD problem in the research series is analyzed using the Breusch and Pagan (1980) LM test. The test results are presented in Table 3. The prob values of LM statistics are below the 5% significance level for all series. Therefore, the stationarity of the series was analyzed using the Karavias and Tzavalis (2014) panel unit root test, which provides reliable results in the presence of the NEB and takes structural breaks into account. The results of the analysis are presented in Table 4. The test statistics calculated for all series are lower than the Bootstrap critical values. Therefore, it can be said that all series are stationary at level. On the other hand, LCF, urbanization rate and financial development series were found to have experienced a break in 1992, labor force participation rate in 2012 and other series in 2020. We first estimated the econometric relationship between the series that were found to be stationary in level by using the fixed effect Driscoll and Kraay (1998) standard errors (Driscoll-Kraay FE) and two-stage ECT estimators. The results of the analysis are shown in Table 4. The results of Driscoll-Kraay FE and Two-Stage ECM estimation show that the effect of economic growth on LCF is positive. On the other hand, the effect of the square of economic growth on LCF is negative. Since an increase in the LCF value implies an increase in environmental quality, the opposite finding is obtained for the NIC sample (an inverted U relationship).

Galli et al. (2012), Nathaniel et al. (2019), Nathaniel (2021), Zhu et al. (2023), Raihan et al. (2023), Guloglu et al. (2023) and Yıldırım et al. (2024). Accordingly, since the growth process

Table 1: Research variables

Dependent variable	Description	Type	Data source
LCF	Load capacity factor	The ratio of biocapacity per capita to ecological footprint per capita.	GFN
Core explanatory variable			
LnGDP	GDP per capita (US Dollar)	Natural logarithm is taken.	World Bank
URB	Urbanization rate	Annual percentage rate of change is taken.	World Bank
FD	Financial development	The ratio of broad money supply to GDP is taken.	World Bank
Control variable			
REN	Renewable energy consumption	The ratio of renewable energy consumption to total final energy consumption.	World Bank
L	Labor force participation rate (ILO estimation)	Percentage of the total population aged 15-64.	World Bank

Table 2: Descriptive statistics

Statistics	LCF	LnGDP	$LnGDP^2$	URB	FD	REN	L
Mean	0.827	8.356	70.387	2.543	75.770	24.742	65.730
Median	0.504	8.595	73.875	2.339	63.214	21.950	63.983
Max.	4.430	9.506	90.377	5.123	211.891	58.400	83.797
Min.	0.225	6.276	39.393	0.705	21.357	2.000	48.551
Standard Deviation	0.916	0.751	12.149	0.961	42.455	14.814	7.931
Skewness	2.589	−0.766	−0.609	0.911	1.053	0.340	0.290
Kurtosis	8.345	2.738	2.418	3.265	3.540	1.884	2.549
Jarque-Bera	715.367	31.229	23.594	43.800	61.158	22.062	6.969
Prob.	0.000	0.000	0.000	0.000	0.000	0.000	0.030
Observation	310	310	310	310	310	310	310

Figure 1: Quantile graph for research variables

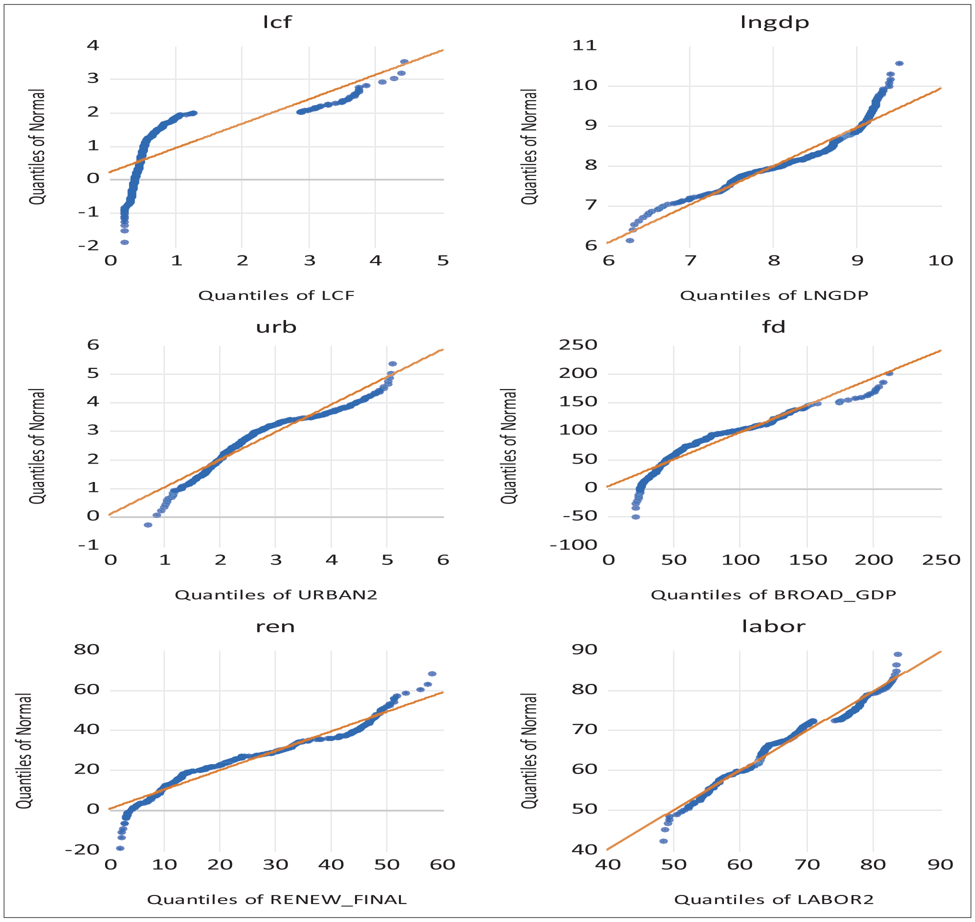

Table 3: CSD analysis

Variables	LM Stat.	Prob
LCF	874.822	0.000
LnGDP	1198.554	0.000
$LnGDP^2$	1195.119	0.000
URB	545.362	0.000
FD	734.004	0.000
REN	554.962	0.000
L	298.745	0.000

Table 4: Karavias-Tzavalis panel unit root test

Variables	Test statistic	Bootstrap critical value	Prob	Break
LCF	−13.892	7.118	0.000	1992
LnGDP	−18.333	10.897	0.000	2020
$LnGDP^2$	−18.666	12.407	0.000	2020
URB	−10.354	3.058	0.000	1992
FD	−13.918	4.910	0.000	1992
REN	−14.209	4.863	0.000	2020
L	−2.683	−2.424	0.000	2012

***, ** and * represent significance at P≤0.01, P≤0.05 and P≤0.10 levels

was mostly supported by non-carbon-intensive sectors in the initial phase of development, natural resource consumption and the regeneration capacity of the ecosystem were positively affected. However, in the later stages of development, higher consumption of energy and natural resources led these countries to exceed the carrying capacity of the ecosystem and increased environmental degradation. In this respect, the results of the study reveal the opposite findings of the LCC hypothesis in terms of the relationship between economic growth and environmental degradation. Similarly, the estimation results show that financial development and labor force participation rate negatively affect the LCF and increase environmental degradation. On the contrary, we found that urbanization and renewable energy consumption positively affect LCF and promote environmental quality. In this respect, our results suggest that renewable energy and urbanization policies have a critical role in environmental sustainability and sustainable development for the study countries.

The Driscoll-Kraay FE and Two-stage ECT estimators may produce biased results in forecasts with non-normally distributed series with outlier observations. For this reason, we use the Fixed Effect (FE) Panel Quantile estimator to robust the results of the analysis. The FE Panel Quantile estimator produces highly consistent and reliable results when non-normally distributed variables are used. The estimation results are presented in Table 6. The results of the analysis confirm the Driscoll-Kraay FE and Two-Stage ECT estimators (Table 5). According to the results of the analysis, the effect of economic growth on LCF in all quantiles (low, medium and high levels of environmental degradation) is positive, while the effect of growth squared is negative. The effects of urbanization and renewable energy consumption on LCF are positive, while the effects of financial development and labor force participation rates are negative. The positive effects of urbanization and renewable energy consumption on LCF are amplified in high quantiles (high level of environmental quality). In contrast, the strength of the negative impact of the labor force participation rate on LCF increased in high quantiles. The negative impact of financial development on LCF became statistically insignificant in high quantiles. In this respect, it is revealed that prioritizing smart and planned urbanization and clean energy policies for the study countries increases the compatibility between environmental policies and these policies in the long run.

In the next stage of the study, the causality relationship between the variables was estimated using the JKS (2021) panel Granger causality analysis (Table 7). The results of the analysis show that there is causality from economic growth and financial development to LCF. On the other hand, there is no causality from other variables to LCF. Table 8 presents the results of the univariate JKS (2021) causality analysis. According to the results of the analysis, there is bidirectional causality between urbanization and LCF. In this respect, it can be said that environmental policies and urbanization policies are compatible in the study countries. The results show that there is unidirectional causality from financial development and labor force participation rate to LCF and from LCF to renewable energy consumption. On the other hand, no causality was observed between economic growth and LCF.

Table 5: Driscoll-Kraay Fe and two stage least squares estimation

Variables	Driscoll-Kraay FE			Two stage least squares		
	Coefficient	Std. Err.	Prob	β	Std. Err.	t-Stat.
LnGDP	1.068	0.408	0.028**	1.356	0.417	3.251***
$LnGDP^2$	−0.063	0.027	0.045**	−0.081	0.024	−3.320***
FD	−0.003	0.000	0.008***	−0.004	0.000	−6.051***
URB	0.063	0.019	0.011***	0.069	0.013	5.317***
REN	0.010	0.001	0.000***	0.009	0.002	4.200***
L	−0.018	0.004	0.001***	−0.018	0.003	−4.859***
WALD-F (χ^2)	206.15					
PROB	0.000***					
ÜLKE	10					
GÖZLEM	310					
R^2	0.463					
Diagnostic Tests						
Hausman (χ^2)	30.39 (0.000)					
Pesaran	2.259 (0.023)					
Green wald (χ^2)	3309.90 (0.000)					
Baltagi-WU LBI	0.393					
Durbin-Watson	0.262					
$F_{BİRİM}$	408.03 (0.000)					

***, ** and * represent significance at P≤0.01, P≤0.05 and P≤0.10 levels

Table 6: FE panel quantile estimation

Variables	Qτ						
	0.10	0.20	0.40	0.50	0.60	0.70	0.80
LnGDP	1.170***(0.372)	1.138***(0.283)	1.086***(0.226)	1.063***(0.250)	1.043***(0.291)	1.023***(0.343)	1.003***(0.406)
LnGDP2	−0.069***(0.024)	−0.067***(0.018)	−0.064***(0.014)	−0.062***(0.016)	−0.061***(0.018)	−0.060***(0.022)	−0.059**(0.026)
URB	0.047*(0.027)	0.052***(0.020)	0.060***(0.016)	0.063***(0.018)	0.066***(0.021)	0.069***(0.025)	0.073***(0.029)
FD	−0.004*(0.002)	−0.003**(0.001)	−0.003**(0.001)	−0.003**(0.001)	−0.003 (0.001)	−0.002 (0.002)	−0.002 (0.002)
REN	0.009***(0.003)	0.009***(0.002)	0.009***(0.001)	0.010***(0.002)	0.010***(0.002)	0.010***(0.003)	0.010***(0.003)
L	−0.015**(0.007)	−0.016***(0.005)	−0.018***(0.004)	−0.019***(0.005)	−0.019***(0.006)	−0.020***(0.007)	−0.021***(0.008)

***, ** and * represent significance at P≤0.01, P≤0.05 and P≤0.10 levels

Table 7: JKS Panel granger non-causality analysis

Dependent variable: LCF		HPJ wald testi	152.283
	Coefficient	Prob.	0.000***
		Standard Error	Prob.
LLnGDP≠>LLCF	0.051	0.030	0.094*
LURB≠>LLCF	0.012	0.009	0.172
LFD≠>LLCF	−0.001	0.000	0.000***
LRENEW≠>LLCF	−0.001	0.002	0.503
LL≠>LLCF	0.0008	0.001	0.955
BIC Kriteri	Lags=1, BIC= −1724.884a	Lags=2, BIC= −1710.414	
LM	72.79 (0.000)		
LM adj	5.621 (0.000)		
LM CD	2.796 (0.000)		

***, ** and * represent significance at P≤0.01, P≤0.05 and P≤0.10 levels. Here, a shows the appropriate delay length

Table 8: JKS panel granger non-causality analysis (Univariate analysis)

Null hypothesis (H0)	HBJ Wald Test	Prob.	Jack knife estimator results	
			Coefficient	Prob.
LLnGDP⇏LLCF	0.004	0.943	−0.002	0.944
LURB⇏LLCF	3.494	0.061*	0.019	0.062*
LFD⇏LLCF	24.190	0.000***	−0.001	0.000***
LRENEW ⇏LLCF	0.902	0.342	−0.002	0.342
LL⇏LLCF	4.770	0.029**	−0.003	0.029**
LLCF ⇏LLnGDP	0.187	0.666	−0.007	0.667
LLCF ⇏LURB	4.520	0.033**	0.417	0.033**
LLCF⇏L_1FD	10.839	0.028**	−5.129	0.398
LLCF⇏L_2FD			5.916	0.560
LLCF⇏L_3FD			−3.492	0.445
LLCF⇏L_4FD			−0.154	0.972
$LLCF_2$⇏L_1RENEW	262.426	0.000***	0.003	0.997
$LLCF_2$⇏L_2RENEW			2.476	0.004***
$LLCF_2$⇏L_3RENEW			−4.617	0.000***
LLCF⇏L_1L	691.712	0.000	−0.713	0.415
LLCF⇏L_2L			−2.113	0.202
LLCF⇏L_3L			−0.247	0.907
LLCF⇏L_4L			−1.039	0.491

***, ** and * represent significance at P≤0.01, P≤0.05 and P≤0.10 levels

5. CONCLUSION, DISCUSSION AND SUGGESTIONS

This study examined the effects of economic growth, urbanization and financial development on environmental sustainability in NIC countries. LCF was used to represent environmental degradation. LCF, which is calculated by dividing biocapacity by ecological footprint, reflects the self-renewal and carrying capacity of the ecosystem. Therefore, an LCF >1 indicates that environmental sustainability is achieved in an economy. NIC countries converge more to developed countries than other developing countries. The average LCF value for these countries is calculated as 0.827 (LCF <1). In this respect, it can be said that the average consumption rate of natural resources in NIC countries for the period in question is above the carrying capacity of the ecosystem.

The results of Driscoll-Kraay FE and Two-Stage ECM estimation show that economic growth positively affects LCF in the initial stage of development, while it decreases LCF and increases environmental degradation in the following period. The results of Latif and Faridi (2023) confirm our findings. Moreover, our findings reject the LCC hypothesis for NIC countries. The findings reveal that for the countries under study, the growth process negatively affects environmental sustainability by increasing pressure on natural resources. Similarly, financial development and labor force participation rate are found to increase environmental degradation by negatively affecting LCF. Contrary to the negative results of Huilan et al. (2022), the present study finds positive effects of urbanization rate and renewable energy consumption on LCF. In this context, our results show that renewable energy and urbanization policies have a critical and important role on environmental sustainability and sustainable development for the study countries. Raihan et al. (2022), Udemba et al. (2022) and Rasool et al. (2022) support our results. Our FE Panel Quantile estimation results validate the Driscoll-Kraay FE and Two-Stage ECT estimators. Our results show that in all quantiles (low, medium and high levels of environmental degradation) the effect of economic growth on LCF is positive, while the effect of the square of economic growth is negative. Therefore, the implementation of policies that promote environmentally friendly production and green growth in the study countries is crucial for economic and environmental sustainability. The analysis reveals that urbanization and renewable energy consumption have a positive effect on LCF, while financial development and labor force participation rates have a negative effect. The positive effects of urbanization and renewable energy consumption on LCF are larger in high quantiles (high level of environmental quality). In contrast, the strength of the negative impact of labor force participation rate on LCF was found to be higher in high quantiles.

The negative effect of financial development on LCF is statistically insignificant in high quantiles. In this respect, it is revealed that prioritizing smart and planned urbanization and clean energy policies for the research countries increases the compatibility between environmental policies and these policies in the long run. In the next phase of the study, the causality relationship between economic growth, urbanization and financial development is examined using the JKS (2021) panel Granger causality test. Our results show that there is unidirectional causality from economic growth and financial development to LCF. In this context, it can be said that growth policies and financial development are important determinants of environmental policies. On the other hand, there is no causality from other variables to LCF. The results of the univariate analysis showed that there is bidirectional causality between urbanization and LCF. In this respect, it can be said that environmental policies and urbanization policies are harmoniously integrated in the study countries. Our results show that there is unidirectional causality from financial development and labor force participation rate to LCF and from LCF to renewable energy consumption. Labor force is one of the main drivers of environmental policies in the study countries. Environmental policies have a significant impact on clean energy policies. On the other hand, no causality is observed between economic growth and LCF.

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