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Demographic Stress and Ecological Footprint: An Application in Newly Industrialized Countries

Demografik Stres ve Ekolojik Ayak İzi: Yeni Sanayileşen Ülkelerde Bir Uygulama

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ABSTRACT

This research examines the long-term and short-term impacts of demographic stress on the ecological footprint in Newly Industrialized Countries (NICs). The Panel ARDL study indicates that urban absorption capacity positively impacts the ecological footprint in both the short and long run. As urban areas enhance their capacity to accommodate greater populations and intensified economic activities, resource consumption and waste generation escalate, exerting further pressure on natural systems. Conversely, rural population expansion diminishes the ecological footprint in many nations but exhibits no impact in others, whereas the Human Development Index typically exacerbates ecological pressure. These findings emphasize the essential influence of demographic characteristics and developmental stages on environmental sustainability, highlighting the necessity for tailored national policy.

Keywords: Demographic stress, Urban absorption capacity, Ecological footprint, Panel ARDL model, Sustainability.

JEL Codes: Q56, C33, O18

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ÖZ

Bu çalışma, Yeni Sanayileşen Ülkelerde (YSÜ) demografik stresin ekolojik ayak izi üzerindeki uzun ve kısa vadeli etkilerini incelemektedir. Panel ARDL analizi, kentsel emme kapasitesinin hem kısa hem de uzun vadede ekolojik ayak izini olumlu yönde etkilediğini göstermektedir. Kentsel alanlar daha fazla nüfusu ve yoğunlaşan ekonomik faaliyetleri barındırma kapasitelerini artırdıkça, kaynak tüketimi ve atık üretimi artarak doğal sistemler üzerinde daha fazla baskı oluşturmaktadır. Kırsal nüfus artışı, bazı ülkelerde ekolojik ayak izini azaltırken bazılarında hiçbir etki göstermemekte, İnsani Gelişme Endeksi ise beklenildiği olarak ekolojik baskıyı artırmaktadır. Bu bulgular, demografik değişkenlerin ve kalkınma düzeyinin çevresel sürdürülebilirlik üzerindeki kritik önemini ortaya koymakta ve ülkelere özel politikaların gerekliliğine işaret etmektedir.

Anahtar Kelimeler: Demografik stres, Kent emilim kapasitesi, Ekolojik ayakizi, Panel ARDL modeli, Sürdürülebilirlik

JEL Kodu: Q56, C33, O18

Introduction

The ecological footprint (EFP) is an environmental metric that quantifies the productive biological area necessary to replenish consumed resources and assimilate the resultant waste, reflecting the impact of human activities on ecosystems (Kang et al., 2014; Yong et al., 2010). This hypothesis was initially presented by William Rees in 1992 and subsequently expanded upon by his student, Mathis Wackernagel. The methodology encompasses several elements, including carbon footprint, food footprint, and water footprint, offering an extensive perspective on the environmental impact of a society and/or a person (Galli, 2015; He et al., 2016). Comparing the Ecological Footprint (EFP) with the notion of biocapacity, which denotes the ability of resources to regenerate and assimilate waste, facilitates an understanding of the extent of environmental degradation within an ecosystem. An Ecological Footprint (EFP) that surpasses biocapacity signifies resource depletion and ecological overshoot (Agioutantis et al., 2013; Venetoulis & Talberth, 2008).

In assessing the environmental consequences of consumption patterns, optimizing resource allocation, and enhancing awareness of environmental deterioration, EFP emerges as a vital indicator. Furthermore, by providing a quantifiable method to measure sustainability, it allows policymakers to examine environmental consequences and pinpoint areas for enhancement (Abduh et al., 2020; Ann & Noreen, 2022; Biekša, 2016). These attributes render EFP a crucial instrument for comprehending and tackling sustainability issues.

An essential aspect of comprehending sustainability is the carrying capacity of ecosystems. This idea, directly associated with population dynamics, denotes the maximum number of persons and their related consumption levels that the ecosystem can sustain without deterioration (Abernethy, 2001). The actions of a worldwide population surpassing eight billion exert strain on natural resources and result in ecological issues. The reduction of biological diversity, habitat degradation, and increasing pollution levels exemplifies difficulties that pose substantial threats to ecosystem health (Baumann, 2018; Lin et al., 2018). Assessing the impact of population expansion on economic development and advancement complicates the evaluation of the sustainability concerns it presents. Urbanization policies may lead to unequal resource use, negatively impacting the carrying capacity of cities (Alberti, 2005). From this viewpoint, it is imperative to implement both national and local development strategies that align with ecological limits. Policymakers must prioritize ecological principles, particularly in resource management and consumer behavior (East, 2020; Ross, 2009).

The world population has more than doubled in the past fifty years, exerting significant pressure on natural resources and ecosystems. The increase in population has directly led to a rise in urbanization rates in numerous countries, redirecting infrastructural and resource demands towards urban regions (Geddes et al., 2012). Urbanization entails the transformation of natural landscapes into urban environments, resulting in habitat destruction and heightened pollution levels. Furthermore, swift urban expansion leads to increased energy usage and garbage generation, which further intensifies environmental deterioration (Mohammed et al., 2023). Furthermore, insufficient infrastructure and suboptimal urban development can exacerbate ecological degradation. Rapid urban population expansion exacerbating environmental challenges is more prevalent in developing nations (Geddes et al., 2012; Warner et al., 2010). Addaney et al. (2018) assert that the swift rate of urbanization can exceed the management capabilities of cities, both economically and ecologically, rendering insufficient infrastructure a critical issue.

The ability of cities to accommodate population expansion is crucial for sustainability. Cities with substantial absorption capacity are less prone to infrastructural deficiencies, hence reducing the adverse environmental effects of population growth. Cities with low absorption capacity encounter challenges in controlling resource flows, potentially resulting in swift resource depletion. It is essential to regulate urbanization to concurrently attain economic development and environmental preservation, thereby averting resource deterioration.

Demographic stress refers to the degree of population growth concentrated in urban areas, measured by the ability of cities to accommodate incoming populations. Demographic stress presents numerous issues, especially for Newly Industrialized Countries (NICs). Increasing urban populations elevate the need for infrastructure, energy, and services, thus resulting in heightened resource consumption. Moreover, an oversupply of labor, inadequate housing, traffic congestion, and environmental degradation may pose significant challenges for Newly Industrialized Countries (NICs) pursuing sustainable growth (Shahbaz et al., 2016; Shahbaz & Lean, 2012).

The capacity of a city to accommodate an increasing population is intricately connected to its proficiency in leveraging knowledge and technology. In cities that implement green technologies, the environmental consequences associated with urbanization can be alleviated, therefore fostering a more sustainable framework (Walz & Marscheider-Weidemann, 2011). The concept that economic progress and environmental conservation can coexist is examined through the lens of Ecological Modernization Theory (EMT). This method aims to elucidate how the ecological consequences of economic and technological advancement can be mitigated. The ecological footprint of metropolitan regions can be diminished by renewable energy systems, sustainable industrial practices, and intelligent urban planning (Cheng et al., 2023; Xu et al., 2022). Biodiversity offset strategies are employed to alleviate the environmental effects of urbanization. The primary objective of this strategy is to mitigate adverse effects while enhancing favorable environmental results in other domains (Miller et al., 2015). Instances of such practices encompass development rights trade and habitat banking. Consequently, institutions or organizations that inflict negative effects are held accountable for safeguarding other ecosystems and compensating for the harm caused (Lodhia et al., 2018; Santos et al., 2015). From the standpoint of EMT, the adverse ecological effects of urbanization can be mitigated using green technology by emphasizing avoidance, minimization, and offsetting. This can promote the development of resilient cities adept at addressing challenges such as climate change and resource depletion.

The issues stemming from population expansion have been extensively examined in academic discourse from a Malthusian viewpoint. When current resources are insufficient to satisfy population demands, shortages and disease-related issues may result in a Malthusian crisis (Madsen et al., 2019; Sakanko & David, 2018). This fundamental perspective continues to be a prevalent issue today, as unchecked population expansion is frequently contended to present considerable challenges for food security and environmental sustainability (Bergstrom, 2022; Rachel Edwards, 2013). Izza (2023) asserts that, to ensure environmental sustainability, population increase must correspond with the environment's carrying capacity. Although advancements in technology and resource management may temporarily alleviate the adverse environmental effects of population increase, it is contended that a cyclical crisis will ultimately arise in the long term (Galor & Weil, 2000; Madsen et al., 2019).

EMT posits that technical breakthroughs may mitigate the impact of population expansion on environmental sustainability, whereas the Malthusian perspective regards these impacts as temporary enhancements. NICs hold a vital role in discussing both methodologies. This study integrates several scholarly viewpoints on the connection between industrialization and ecological sustainability, highlighting both the possible advantages and adverse consequences of this phenomenon. The phenomenon of industrialization increases urbanization and the rapid increase of urban populations, exerting significant pressure on the environment. Thus, a city's ability to accommodate population growth—regarding both physical and social factors—becomes essential, emerging as a fundamental component of sustainable development. This study significantly contributes to the literature by examining urban carrying capacity and its environmental implications, specifically with Newly Industrialized Countries (NICs). The subsequent sections will initially examine the literary arguments, proceed to the empirical analysis and findings, and culminate in a concluding comment.

Literature Review

The correlation between accelerating urbanization and ecological footprint (EFP) in Newly Industrialized Countries (NICs) has been a significant study focus regarding sustainability. The literature indicates a widespread agreement on the detrimental effects of urbanization on ecological systems. The urbanization process is linked to habitat degradation, diminished biodiversity, and the urban heat island effect (Li et al., 2021; Chen, 2024). Additionally, the reduction of agricultural land and the deterioration of ecosystems are emphasized as major repercussions of urbanization (Wang et al., 2016; Xiong et al., 2012). Numerous research studies have highlighted the influence of urbanization on localized climatic alterations (Nguyen et al., 2019; Geng et al., 2022).

A substantial body of scholarship substantiates the perspective that industry, with urbanization, intensifies environmental degradation. Heavy metal contamination, atmospheric and aquatic pollution, and heightened demand of natural resources are identified as direct consequences of swift urbanization and industrialization (Li, 2018; Sakti, 2024). Furthermore, Andjarwati et al. (2020) have demonstrated that industrialization leads to increased energy consumption and COE emissions, thereby exacerbating environmental degradation. Rapid urbanization and industrialization in developing nations, namely, are documented to induce water scarcity and soil degradation (Muoria et al., 2019). The increase in carbon emissions and the depletion of natural spaces are notable ecological repercussions of industrialization (Latue, 2023).

The correlation between economic expansion and environmental degradation has been thoroughly examined in scholarly literature. Numerous studies demonstrate that urbanization amplifies the ecological footprint, and technology advancements cannot entirely mitigate these detrimental impacts (Sahoo & Sethi, 2021; Wang et al., 2016). Financial development and economic expansion are directly correlated with environmental degradation, particularly regarding the increase in CO_2 emissions (Jreisat, 2021; Shahbaz et al., 2016). Sustainable industrial development and the industrial ecology framework advocate measures to harmonize economic growth with ecological sustainability (Chiu & Geng, 2004; Finnveden et al., 2009).

The literature emphasizes the significance of circular economy methods in attaining environmental sustainability. Industrial zones can promote economic growth but may also jeopardize ecological integrity, prompting recommendations for sustainable solutions such as eco-industrial parks that improve resource efficiency (Bao-Lin & Luo, 2021; Parto, 2000). Regional policy and environmental management methods must facilitate sustainable development (You, 2023). In this context, the incorporation of life cycle assessment techniques into industrial processes and the enhancement of environmental policies are widely recommended strategies (Finnveden et al., 2009; Sârbu et al., 2020).

In summary, the literature widely agrees that demographic stress hastens environmental degradation via urbanization and industrialization. Increasing population density and swift urban growth exert pressure on biological systems, leading to habitat destruction, diminished biodiversity, and elevated carbon emissions. To alleviate the detrimental impacts of economic expansion on environmental sustainability, the implementation of appropriate environmental legislation and sustainable development strategies is essential. The research indicates the imperative to devise novel ideas and execute ecological management strategies successfully to avert additional environmental degradation. Otherwise, the swift exhaustion of natural resources and the peril to long-term environmental sustainability, propelled by escalating demographic pressures, will become unavoidable.

Data, Method and Findings

This research investigates the correlation between population stress and the ecological footprint in Newly Industrialized Countries (NICs). The demographic stress data for the period from 1990 to 2021 were computed using the methods outlined in the yearly Global Food Security Index reports issued by The Economist Impact. This methodology defines a country's demographic stress level through two principal indicators: population growth rate and urban absorption capacity. The urban absorption capacity, accounting for urban population growth, measures resource distribution efficiency and is determined by deducting the urban population growth rate from real GDP per capita (The Economist Impact, 2021).

In the analysis, demographic stress in NICs is indicated by the population growth rate and the urban absorption capacity ratio, with the Human Development Index employed as a control variable. Table 1 presents the data sources and descriptive statistics utilized in this investigation.

Table 1. Dataset and Descriptive Statistics

Variables	Description			Data Source	
lnefp	Logarithmic Ecological Footprint			Global Footprint Network	
lnrpg	Logarithmic Rural Population Growth			World Bank	
lnuacap	Logarithmic Urban Absorption Capacity			World Bank	
lnhdi	Logarithmic Human Development Index			World Bank	
	Mean	**Std. Dev.**	**Min.**	**Max.**	**Observation**
lnefp	0.7690	0.4978	-0.3856	1.6193	320
lnrpg	-0.0994	0.8645	-1.7401	1.7239	320
lnuacap	0.3554	1.6345	-3.6442	3.0105	320
lnhdi	-0.4076	0.1296	-0.8439	-0.1743	320

Note. Urban Absorption Capacity was calculated by the author using World Bank data.

The descriptive statistics indicate a moderate degree of variation among the variables, with the greatest dispersion observed in urban absorption capacity (lnuacap), suggesting substantial disparities among countries in their abilities to handle urban population increase in relation to economic resources. The ecological footprint (lneco) has both positive and negative logged values, indicating that while certain NICs have footprints below the overall average, others considerably surpass it. The growth of rural populations (lnrpg) typically centers around marginally negative values; nonetheless, the extensive range suggests that some countries encounter decreasing rural populations while others see significant growth. Conversely, the logarithmic Human Development Index (lnhdi) demonstrates comparatively limited variation, indicating that although gaps in human development among these countries exist, they are less significant than the differences in urban absorption capacity. Collectively, these numbers indicate significant variability among NICs in managing demographic pressures, resource utilization, and developmental results.

Homogeneity Test

In panel data analysis, it is crucial to ascertain whether the slope coefficients of the series exhibit homogeneity. Based on the assumption of homogeneity, appropriate unit root tests are selected for the panel data. If the assumption of homogeneity is invalid for the panel dataset, heterogeneous panel unit root tests should be utilized (Tatoğlu, 2017). Pesaran & Yamagata (2008) introduced the delta test statistic to assess the homogeneity of the series, and Table 2 displays the findings.

Table 2. Homogeneity Test

	T-Stats.	Prob.
Δ	9,694	0.000
$\Delta_{adj.}$	10,553	0.000

The delta test for assessing slope homogeneity in linear panel data models posits the null hypothesis of homogeneous slopes ($\beta_i = \beta$), and the alternative hypothesis of heterogeneous slopes ($\beta_i \neq \beta$) (Pesaran & Yamagata, 2008). The test findings in Table 2 indicate that the p-values for both Δ and Δadj.are less than 0.05. Consequently, the null hypothesis is rejected, and the alternative hypothesis—suggesting that the slope coefficients are heterogeneous—is accepted.

Cross-Sectional Dependence Test

Pesaran (2004) introduced the CD test, which assesses cross-sectional correlation by analyzing the residuals derived from the ADF regression. In contrast to the Breusch-Pagan LM test, the CD test typically demonstrates superior performance in Monte Carlo simulations when T is adequately big and N approaches infinity (Tatoğlu, 2018). The Pesaran CD test for cross-sectional dependence is presented in Equation (1).

$$CD = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{j\neq i+1}^{N}\hat{\rho}_{ij}\right)} \qquad (1)$$

In Equation (1), N denotes the number of cross-sectional units in the panel data, while $\hat{\rho}_{ij}$ represents the correlation coefficient between units i and j (Pesaran, 2004). The results of the CD test—whose null hypothesis states that there is no cross-sectional correlation among the units—are presented in Table 3.

Table 3. Cross-Sectional Dependence Test

Variables	CD-Test	Prob.
lnefp	10,709	0,0000
lnrpg	16,369	0,0000
lnuacap	12,309	0,0000
lnhdi	36,122	0,0000

Table 3 indicates that if the p-values for the CD test findings are below 0.05, the null hypothesis is rejected, signifying the existence of cross-sectional dependence among the units. In this context, the p-values for all variables in the analysis are below 0.05, indicating the presence of cross-sectional dependency. Therefore, we will utilize second-generation unit root tests to assess stationarity due to the cross-sectional dependence of the variables.

Unit Root Tests

Following the determination of heterogeneous slope coefficients and cross-sectional dependence among the units in the panel dataset, the second-generation unit root test, referred to as the Pesaran CADF test, was employed on the variables.

Table 4. Unit Root Test

	CADF	
Variables	**Constant**	**Constant&Trend**
lnefp	-2.871[a]	-1.565
Δlnefp	-9,299[a]	-7,854[a]
lnrpg	0.218	-0.666
Δlnrpg	-5,849[a]	-5,674[a]
lnuacap	-3.696[a]	-2.162[a]
lnhdi	-0.995	-0.925
Δlnhdi	-8,952[a]	-8,582[a]

Note. The symbol "a" denotes 1% statistical significance. The Pesaran CADF test was conducted at the 99% confidence level. Accordingly, the critical Z values for the variables are -2.55 for the model with only a constant and -3.06 for the model with a trend.

Table 4 displays the results of the unit root tests for the variables. The CADF test statistics indicate that urban absorption capacity is stationary in both constant-only and trend-inclusive models, while the ecological footprint is stationary only at its level form in the constant-only model. Evidence of unit roots was identified at the levels of the other variables, with stationarity achieved alone after applying the first difference. We will examine both long-term and short-term associations using the Panel ARDL model, given that the variables display varying orders of integration.

Panel ARDL Model

Distributed lag panel data models utilize three estimators: the Mean Group (MG), the Pooled Mean Group (PMG), and the Dynamic Fixed Effects (DFE) estimators (Pesaran et al., 1999). The Mean Group estimator, which imposes no constraints on the parameters of the ARDL model, accommodates variation in both short- and long-run coefficients among units, provided the time series dimension is extensive enough (Pesaran & Smith, 1995). In contrast, the PMG estimator permits variation in short-term coefficients and error variances among units while enforcing homogeneity on long-term parameters (Pesaran et al., 1999). Under the DFE estimator, the cointegration coefficient is constrained to be uniform throughout the entire panel, while the connections among the within-group variables are allowed to differ (Rafindadi, 2013). To ascertain the most suitable estimator among these alternatives, the Hausman (1978) test must be performed (Pesaran et al., 1999).This study examines the long-term and short-term links between ecological footprint and population stress in Newly Industrialized Countries (NICs). We present the equations developed for the analysis below.

LR Eq:

$$lnefp_{it} = \beta_0 + \sum_{i=1}^{k} \beta_{1i} lnefp_{t-i} + \sum_{i=0}^{l} \beta_{2i} lnuacap_{t-i} + \sum_{i=0}^{m} \beta_{3i} lnrgp_{t-i} + \sum_{i=0}^{n} \beta_{2i} lnhdi_{t-i} + \varepsilon_{it}$$

SR Eq:

$$\Delta lnefp_{it} = \delta_i (lnefp_{t-i} - \gamma_{1t} lnuacap_{it} - \gamma_{2t} lnrgp_{it} - \gamma_{3t} lnhdi_{it}) + \sum_{i=1}^{k-1} \theta_{1i} \Delta lnefp_{t-i} + \sum_{i=0}^{l-1} \theta_{2i} \Delta lnuacap_{t-i} + \sum_{i=0}^{m-1} \theta_{2i} \Delta lnrgp_{t-i} + \sum_{i=0}^{n-1} \theta_{2i} \Delta lnhdi_{t-i} + u_{it}$$

Equations (2) and (3) respectively represent the long-run and short-run relationships. In these equations, k, l, m, and n denote the lag lengths, determined based on the lowest AIC values. The operator Δ refers to the differencing operator, while ε_tand u_t represent the error terms. Finally, in Equation (3), the parameter δ_i corresponds to the error correction term, which must be negative (between -1 and 0) and statistically significant for the long and short-run coefficients to converge (Blackburne & Frank, 2007).

Before estimating the Panel ARDL model, the optimal lag length must be determined. In the present analysis, where the maximum number of lags was set to six, the model with the lowest AIC value was identified as one in which k=l=m=n=1. Accordingly, both MG and PMG estimators are implemented using the Panel ARDL(1,1,1,1) specification.

Table 5. Panel ARDL(1,1,1,1) Model Results

	MG		PMG		DFE	
LR	**Coef.**	**Z-stat**	**Coef.**	**Z-stat**	**Coef.**	**Z-stat**
lnuacap	0.0459	2.10[b]	0.0409	4.52[a]	0.0231	1.68[c]
lnrgp	-0.0198	-0.18	-0.0550	-2.52[b]	-0.0082	-0.18
lnhdi	1.0245	2.41[b]	0.7703	5.58[a]	1.5211	6.35[a]
		Vector Error Corection				
Ect	-0.4279	-3.86[a]	-0.3250	-4.85[a]	-0.3265	-7.84[a]
SR						
Δlnuacap	0.0147	7.89[a]	0.0154	6.59[a]	0.0159	4.44a
Δlnrgp	0.0712	0.89	0.0771	1.30	0.0154	0.54
Δlnhdi	1.7222	1.77[c]	1.9004	1.96[b]	5.5775	16.74[a]
c	0.5714	2.85[a]	0.3844	3.47[a]	0.4121	6.54[a]
	Hausman			χ^2 Prob.		
	MG& PMG			0,8282		
	DEF&PMG			0.9991		
	Ect	Δlnuacap	Δlnrgp	Δlnhdi	c	
Brazil	-0.0919	0.0071[b]	-0.0248	0.3345	0.1107	
China	-0.1054[a]	0.0038	0.2257[b]	-0.5317	0.1664[a]	
India	-0.1872[b]	0.0130[a]	0.1020	0.6647	0.0734[c]	
Indonesia	-0.3476[a]	0.0204[a]	-0.0101	0.1868	0.2386[b]	
Malaysia	-0.7787[a]	0.0288[a]	-0.0239	2.5201	1.2139[a]	
Mexico	-0.3774[a]	0.0143	0.5602[b]	6.4144[a]	0.4726[a]	
Philippines	-0.1442	0.0184[b]	-0.0295	8.4414[a]	0.0407	
South Africa	-0.3027[b]	0.0110	0.0140	1.0405	0.4763[b]	
Thailand	-0.5067[a]	0.0148[a]	-0.0313	-0.5915	0.5219	
Türkiye	-0.4085[a]	0.0227[a]	-0.0105	0.5248	0.5294[a]	

Note. The symbols "a", "b" and "c" represent 1%, 5% and 10% significance levels, respectively.

Table 5 illustrates the long- and short-run connections between demographic stress and ecological footprint in NICs, with the selection of the Mean Group (MG) estimate against the Pooled Mean Group (PMG) estimator being based on the Hausman test statistic. Based on the p-value from the Hausman statistic, the PMG model, which suggests a homogenous long-run relationship among the variables, demonstrated greater efficiency and consistency compared to the MG estimator. Thus, the data should be analyzed in accordance with the PMG model outcomes.The PMG model indicates a positive long-term correlation between urban absorption capacity, which signifies population stress, and the ecological footprint. 1% increase in lnuacap results in a 4% increase in the ecological footprint. Furthermore, the Human Development Index has a favorable long-term correlation with the ecological footprint. Concurrently, as anticipated, the increase in the rural population adversely affects the ecological imprint. The model's error correction term, ranging from -1 to 0 (particularly -0.32), is statistically significant. This result indicates that about 32.5% of any short-run disequilibrium is rectified in the following period, suggesting that long-run equilibrium is attained in approximately three periods.The short-run coefficients for the overall panel indicate that urban absorption capacity and the Human Development Index are significant, but rural population increase is not statistically significant. The urban absorption capacity and the Human Development Index both positively influence the ecological footprint in the short term. Furthermore, it is feasible to analyze the short-term associations for each panel unit individually. With the exception of Brazil and the Philippines, the error correction term for the remaining nations is statistically significant at the 95% confidence level. In these nations, a favorable short-term correlation exists between urban absorption capacity and the ecological footprint, excluding Mexico and South Africa. Moreover, Mexico is the sole nation where the Human Development Index is notably significant in the short term. Ultimately, the rural population growth coefficient is relevant in the short term for only two nations—China and Mexico—where, in contrast to its adverse long-term impact, it amplifies the ecological footprint in the short run.

Conclusion

In Newly Industrialized Countries (NICs), population expansion and urbanization engender a complicated interplay between economic progress and environmental degradation. With the growth of urban populations, the demand for resources and infrastructure escalates, resulting in considerable environmental challenges. This conflict is particularly evident due to the swift urban expansion linked to population increase, which converts natural ecosystems into urban environments and intensifies ecological degradation.Urbanization and population increase in newly industrialized countries can promote economic progress, although they concurrently lead to significant environmental issues. The transformation of natural landscapes into urban areas exacerbates pollution, depletes resources, and elevates climatic threats. Consequently, effective urban planning and sustainable development initiatives are essential for alleviating these detrimental impacts. Achieving equilibrium between economic development and environmental conservation is essential for the enduring viability of Newly Industrialized Countries (NICs).Demographic stress seems to expedite environmental degradation via urbanization and industrialization in Newly Industrialized Countries (NICs). The PMG model findings indicate that urban absorption capacity exerts a positive and statistically significant long-term effect on the ecological footprint. This discovery suggests that urbanization intensifies the strain on natural resources, complicating the attainment of environmental sustainability. The impact of rural population growth on the ecological footprint is detrimental in certain countries and statistically insignificant in others, indicating that the effect of rural areas on the ecological footprint is regionally variable and requires distinct policies that integrate rural demographics with urbanization processes.The Human Development Index significantly influences the ecological footprint positively over the long run, indicating that elevated economic and social development correlates with increased use of environmental resources, necessitating comprehensive sustainability strategies. In the short-term analysis, urban absorption capacity significantly influences the ecological footprint. Nonetheless, although the immediate impacts of rural population expansion and human development may not consistently exhibit statistical significance, they can, in specific eras and nations, lead to heightened ecological strain.These findings highlight that demographic stress is a significant factor contributing to environmental deterioration in Newly Industrialized Countries (NICs) and that enhanced urbanization and industrialization policies are essential for attaining environmental sustainability. Modifying environmental management practices to accommodate regional variances is essential for the preservation of natural resources. Otherwise, the swift exhaustion of natural resources resulting from escalating demographic pressures, together with the ensuing long-term concerns about environmental sustainability, will be inevitable.

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