Cuadernos de Economía (2023) Volume 46, Issue 132, 14-21

Asociación Cuadernos de economía

Cuadernos de economía

www.cude.es

ARTÍCULO

The Role of Green Spaces, Technological Innovation, and Environmental Taxes on Environmental Sustainability in Iraq

Majeed, Omar Hameed[1*], Saja Fadhil Jawad[2], Azhar Hasan Ali[3]

[1] University of Baghdad, College of Administration and Economics, Department of Economics, Baghdad, Iraq
Email: omer.hameed@coadec.uobaghdad.edu.iq
ORCID: https://orcid.org/0000-0002-2337-5310
[2] University of Baghdad, College of Administration and Economics, Department of Economics, Baghdad, Iraq
Email: saja.f@coadec.uobaghdad.edu.iq
ORCID: https://orcid.org/0009-0002-0276-5384
[3] University of Baghdad, College of Administration and Economics, Department of Economics, Baghdad, Iraq
Email: dr.azharhasan@coadec.uobaghdad.edu.iq
ORCID: https://orcid.org/0000-0001-5220-7570

Jel Codes:

Keywords:
Green Spaces, Technological Innovation, Environmental Taxes, Renewable Energy Consumption, Inflation, Environmental Sustainability

Abstract: In recent times, global attention has increasingly focused on the critical issue of environmental sustainability, owing to escalating environmental degradation exacerbated by the utilization of green spaces and technological innovation. This phenomenon necessitates thorough examination, prompting the present study to scrutinize the impact of various factors, namely green spaces, technological innovation, environmental taxes, renewable energy consumption (REC), inflation, and economic growth (EG), on environmental sustainability within the context of Iraq. Secondary data extracted from the World Development Indicators (WDI) spanning the period from 1991 to 2022 served as the foundation for this investigation. Methodologically, the study employed the dynamic autoregressive distributed lag (ARDL) approach to assess the interrelationships among the specified variables. The findings of the study unveiled positive associations between green spaces, technological innovation, environmental taxes, REC, inflation, economic growth, and environmental sustainability in Iraq. These results offer valuable insights for policymakers, guiding the formulation of strategies aimed at realizing environmental sustainability through the judicious utilization of green spaces, technological innovation, and environmental taxes.

Author Correspondence: omer.hameed@coadec.uobaghdad.edu.iq

https://doi.org/10.32826/cude.v46i132.1201

Introduction

The ascendancy of environmental sustainability to a paramount position on the global agenda has been propelled by the increasingly evident repercussions of environmental degradation (Falih Chichan & Alabdullah, 2021). Amidst a rich cultural and historical legacy, Iraq grapples with unique environmental challenges. Prolonged conflict, coupled with escalating urbanization and industrialization, exerts significant strain on the nation's natural resources and ecosystem (Hassan, 2023). Consequently, an imperative exists to thoroughly examine and implement efficacious measures to alleviate environmental degradation, facilitating a trajectory towards a sustainable future. This research endeavours to scrutinize the impacts of technological innovation, the establishment of green spaces, and the implementation of environmental taxes on environmental sustainability within the Iraqi context. The study aspires to furnish evidence-based recommendations for policymakers, urban planners, and stakeholders in Iraq, fostering a more sustainable environment through an examination of the intricate interrelationships among these variables.

Iraq's prevailing environmental challenges stem from its intricate socio-political history. Prolonged conflict and financial constraints have impeded the nation's capacity for sustained growth and environmental preservation. According to Lafta and Al-Nuaimi (2019), the consequences of conflict, encompassing infrastructure destruction, unregulated resource extraction, and population displacement, have exacerbated environmental challenges in Iraq. A critical concern revolves around the degradation of air quality and water resources. Insufficient waste management practices, industrial pollutants, and outdated technologies contribute to alarming levels of air pollution and water contamination in various regions of the country. Furthermore, Schillinger et al. (2020) observed that excessive withdrawal of water from rivers and aquifers, coupled with inadequate wastewater treatment, has significantly degraded water quality and availability. Concurrently, addressing biodiversity loss and the deterioration of natural habitats emerges as a pressing imperative. Urbanization and intensified agriculture have precipitated ecosystem decline, imperilling indigenous flora and fauna. Furthermore, the scarcity of green spaces in urban locales exacerbates the overall reduction in environmental quality and human well-being (Lafta & Al-Nuaimi, 2019).

According to Ma et al. (2019), the establishment of green spaces within urban areas plays a pivotal role in enhancing environmental quality and fostering community well-being. Access to parks, gardens, and outdoor areas not only positively impacts the physical and mental health of the populace but also contributes to biodiversity conservation and the amelioration of air quality (Hunter et al., 2019). Emphasizing the construction and preservation of green spaces is vital for sustainable urban growth in rapidly urbanizing Iraq. However, effective integration requires meticulous urban planning and adept policy implementation. Bush (2020) identifies the necessity for collaboration among government agencies, urban planners, and local communities to strategically position, ensure accessibility, and adequately maintain green spaces. The incorporation of green infrastructure, including vegetative roofs and flexible pavements, proves beneficial. Simultaneously, technological innovation has emerged as a potent tool in addressing environmental challenges (Shao et al., 2020). Enhancing resource efficiency, minimizing pollution, and fostering sustainable practices across diverse industries can be achieved through the development and implementation of advanced technologies. In the context of Iraq, integrating innovation into energy production, waste management, and industrial processes holds significant potential for advancing environmental sustainability. The exploration of renewable energy sources, such as solar and wind power, presents a substantial opportunity to diversify Iraq's energy portfolio and diminish reliance on fossil fuels (Khan et al., 2023). Moreover, the adoption of energy-efficient technologies in manufacturing and transportation has the potential to yield substantial reductions in greenhouse gas emissions. Also, innovative water treatment and sanitation solutions according to Schillinger et al. (2020), can help relieve pressure on water resources, maintaining their availability for future generations.

Contrarily, Shahzad (2020) asserts that environmental taxes serve as a potent policy instrument for internalizing adverse effects linked to resource utilization and pollution. Governments can incentivize the adoption of sustainable practices among firms and individuals through the imposition of taxes on activities with detrimental environmental consequences (Klymenko, 2019). The enactment of effective environmental taxation legislation in Iraq can contribute to internalizing the expenses associated with environmental degradation, supporting conservation initiatives, and encouraging sustainable resource management. Additionally, revenue generated from environmental taxes can be redirected toward endeavours fostering environmental sustainability, including renewable energy initiatives, forest restoration programs, and pollution mitigation technologies. However, a meticulous design and application of these taxes are imperative to prevent undue burdens on vulnerable communities and potential hindrances to economic growth (Shahzad, 2020).

This research aims to comprehensively evaluate the effects of green spaces, technological innovations, and environmental taxes on environmental sustainability within the Iraqi context. Firstly, the investigation aims to elucidate the role of green spaces in mitigating environmental degradation and enhancing overall sustainability by assessing the ecological and societal benefits derived from their establishment and maintenance. Secondly, the study endeavours to scrutinize the impact of technological innovation on environmental sustainability, emphasizing domains such as energy, waste management, and industrial processes. The research's objective is to identify and emphasize specific technologies and practices with the potential to significantly enhance Iraq's natural environment. Furthermore, the study intends to assess the impact of environmental taxation laws in Iraq on resource management and pollution reduction. This involves a thorough examination of existing tax frameworks, their implementation, and potential areas for enhancement to align with sustainable practices.

Several knowledge gaps are evident in the existing literature. Primarily, there is a conspicuous absence of comprehensive studies delving into the interplay among green spaces, technological innovation, and environmental taxes in the specific context of Iraq. Existing research tends to focus on individual components rather than their collective impact on environmental sustainability. Additionally, there is a discernible dearth of empirical evidence concerning the application and efficacy of environmental taxes in Iraq, impeding a thorough understanding of their current influence on sustainable practices and resource management. Furthermore, there exists a need for a meticulous exploration of technological advancements tailored to Iraq's distinctive socioeconomic

and environmental landscape, addressing the nation's unique opportunities and challenges. Further investigation is warranted into the socioeconomic ramifications of implementing green spaces, technological innovations, and environmental taxes in Iraq, including an analysis of potential economic benefits, distributional effects, and implications for various population segments, particularly vulnerable communities.

In the subsequent sections of this study, an in-depth exploration of pertinent literature, elucidation of the research methodology, and a comprehensive empirical analysis will be undertaken to assess the validity of the proposed hypotheses. The aim is to furnish a comprehensive understanding of the substantial influence exerted by green spaces, technological innovations, and environmental taxes on environmental sustainability in the context of Iraq.

Literature Review

According to Al Issa et al. (2023) research, green areas are essential for maintaining environmental stability on a local and global level. These verdant areas, encompassing gardens, parks, woodlands, and wetlands, function as natural reservoirs of biodiversity, providing habitat and sustenance for a diverse array of organisms. Cascone et al. (2019) contend that green spaces function as carbon sinks, mitigating the impact of climate change by absorbing carbon dioxide from the atmosphere. Additionally, these areas contribute to the improvement of air quality and the establishment of healthier, cleaner urban environments by purging pollutants and releasing oxygen into the air. Furthermore, Bibri et al. (2020) indicates the crucial role of green spaces in alleviating the impact of extreme weather events like floods and storms. Their porous surfaces, adept at absorbing rainfall, mitigate the likelihood of urban flooding caused by runoff. Moreover, green areas play a pivotal role in temperature regulation through the facilitation of evapotranspiration (Cascone et al., 2019). Urban heat island effect in densely populated areas is mitigated by green spaces, offering natural cooling. These areas enhance comfort and sustainability by shading buildings and lowering surface temperatures, crucial in the face of climate change-induced rising global temperatures (Al Issa et al., 2023).

Green spaces have enormous social and psychological benefits in addition to their ecological relevance (Enssle & Kabisch, 2020). Green spaces improve mental and physical health by providing areas for leisure and relaxation. According to Astell-Burt and Feng (2019), they're linked to lower stress, better cognitive performance, and an enhanced quality of life. These spaces act as havens in urban settings, offering escapes from daily stress and fostering a connection with nature. Additionally, they serve as hubs for cultural events, promoting community togetherness. Overall, green spaces are crucial for environmental stability, leveraging ecological, social, and psychological benefits to create resilient and sustainable urban environments (Enssle & Kabisch, 2020).

In addition, Shao et al. (2020) technological innovations exert a profound influence on environmental stability, particularly in contexts characterized by concurrent imperatives of sustainable development and rapid urbanization, such as in Iraq. Advanced technologies provide a spectrum of viable solutions to address Iraq's environmental challenges. Notably, the incorporation of renewable energy sources, such as wind and solar power, into Iraq's energy portfolio offers a means to diversify energy generation, diminishing reliance on fossil fuels and subsequently mitigating greenhouse gas emissions. Additionally, the implementation of innovative strategies for energy-efficient industrial operations holds the potential for substantial reductions in pollutants, thereby contributing to an enhanced environmental quality (Shao et al., 2020). Advancements in sanitation and wastewater treatment technology are crucial for mitigating water pollution, preserving this vital resource for future generations (Zhu et al., 2023). Technical advancements in trash management have the potential to transform Iraq's waste management strategies, reducing environmental impact by minimizing landfills, lowering methane emissions, and embracing advanced recycling and waste-to-energy technologies (Zhu et al., 2023). Smart urban planning technologies, such as intelligent infrastructure and efficient transport systems, enhance resource management and reduce the ecological impact of cities. Additionally, precision agriculture technologies in the agricultural industry maximize resource utilization, minimizing chemical inputs and water consumption (Bhakta et al., 2019).

Technological advancements provide crucial tools for data gathering and analysis in environmental monitoring. Remote sensing technologies, for example, enable tracking changes in land use, deforestation, and other key environmental indicators (Nguyen et al., 2021). Data-driven approaches empower policymakers to make informed decisions regarding land management and conservation initiatives (Bhakta et al., 2019). Utilizing Geographic Information Systems (GIS) facilitates global environmental trend analysis, aiding targeted interventions in areas of utmost necessity (Atay Kaya & Kut Görgün, 2020). While technological advancements hold potential for supporting environmental stability in Iraq, it's essential to prioritize sustainability and ethical technology implementation. This includes ensuring accessibility for all societal segments, particularly disadvantaged groups, and giving priority to the ethical handling and disposal of electronic waste generated by technological progress.

Moreover, Shahzad (2020) implementing environmental taxes emerges as a valuable policy tool to significantly enhance environmental stability. Governments can incentivize sustainable practices by levying taxes on activities causing negative environmental impacts, like pollution and resource depletion. According to Klymenko (2019), strategically devised environmental taxation policies hold considerable promise when instituted in Iraq, addressing the pressing issue of environmental degradation. The generated tax revenues can be allocated to vital environmental conservation endeavours, including afforestation initiatives, renewable energy projects, and the implementation of pollution-reducing technologies. Additionally, Wolde-Rufael and Mulat-Weldemeskel (2023) research indicates that the internalization of environmental degradation costs can be significantly facilitated through the imposition of environmental taxes. By assigning a monetary value to the negative externalities associated with activities such as resource exploitation and pollution, environmental taxes induce individuals and companies to contemplate the environmental repercussions of their actions. This alteration in financial incentives stimulates the adoption of greener practices and technologies, thereby reducing the overall environmental impact (Bibri et al., 2020).

Effectively instituting environmental taxes in Iraq has the potential to alleviate the strain on critical resources, such as water and air quality. According to Wang and Yu (2021), environmental taxes can spur efficiency gains and innovation by targeting sectors and behaviours with disproportionate contributions to pollution and resource

depletion. Imposing taxes on emissions from transportation and industrial processes is one method to promote cleaner technology and reduce air pollution (Klymenko, 2019). Similarly, levying taxes on water-intensive operations can incentivize more mindful water usage and prompt the adoption of water-saving technologies in both industry and agriculture.

The use of renewable energy has the power to drastically improve environmental stability (Al-Kayiem & Mohammad, 2019). A transformative force, Iraq can significantly reduce greenhouse gas emissions by transitioning from fossil fuels to renewable sources like solar, wind, and hydroelectric power. This shift is vital in addressing climate change and mitigating the adverse environmental impacts associated with conventional energy production. Moreover, Khan et al. (2023) argues that bolstering a robust renewable energy sector can reduce a country's vulnerability to unpredictable global energy markets, thereby enhancing energy security and resilience. The diversification of the energy portfolio with renewables not only generates employment opportunities but also boosts local businesses, promoting economic stability (Al-Kayiem & Mohammad, 2019). Crucially, renewable energy technology holds the potential to meet Iraq's growing power generation requirements sustainably, especially with the expansion of urban areas and the population. Leveraging its abundant renewable energy resources, Iraq can contribute to global climate change mitigation efforts and ensure a more sustainable energy future. However, for a seamless transition and optimal environmental benefits, the effective integration of renewable energy into the energy landscape demands meticulous planning, substantial investment, and a supportive policy framework (Khan et al., 2023).

In a country like Iraq, economic growth can positively impact environmental stability. According to Adedoyin et al. (2020), a flourishing economy can provide the necessary funds to endorse sustainable technologies and initiatives for environmental preservation. a robust economy facilitates the establishment of stringent environmental laws and enforcement measures, ensuring ecologically responsible practices by companies and sectors. Additionally, economic growth supports research and development in green technologies, fostering environmentally friendly practices across various industries (Hsu et al., 2021). Al-Kayiem and Mohammad (2019), emphasize that as the economy expands, research funds for energy-efficient technology, waste management, and renewable energy sources increase, resulting in reduced environmental pollution and the adoption of cleaner production techniques.

Furthermore, Adedoyin et al. (2020) research suggests that growing economies play a crucial role in supporting conservation initiatives and preserving natural areas. Economic expansion enables the allocation of funds for establishing and maintaining protected areas, afforestation projects, and wildlife conservation campaigns. Moreover, economic growth incentivizes the funding of sustainable land-use practices, encouraging long-term conservation efforts that yield positive impacts on both the environment and the economy (Atay Kaya & Kut Görgün, 2020).

According to Khan et al. (2022), a stable economic environment, contingent on controlled inflation and effective economic policies, can foster sustainable development. Managing the intricate interplay between inflation and environmental stability in Iraq necessitates a comprehensive strategy integrating economic and environmental factors. Notably, inflation can prove advantageous for specific environmental projects, particularly when it encourages investment in eco-friendly practices and technologies (Khan et al., 2022). Escalating costs of non-renewable resources incentivize the development and adoption of sustainable alternative energy sources like hydroelectric, solar, and wind power. Beyond reducing dependence on fossil fuels, this transition to renewable energy contributes to a decrease in greenhouse gas emissions, thereby fostering overall environmental stability (Klymenko, 2019). Moreover, minimal inflation may lead to increased funding allocation for environmental conservation initiatives (Bibri et al., 2020). Governments can utilize a portion of the additional funds generated through fees and taxes to finance initiatives aimed at pollution prevention, afforestation, and the preservation of natural areas. This supplementary funding plays a vital role in stabilizing the environment by supporting programs that may have otherwise received limited financial backing.

Research Methods

This research investigates the influence of green spaces, technological innovation, environmental taxes, REC, inflation, and EG on environmental sustainability in Iraq. Secondary data for the study were obtained from the WDI spanning the period from 1991 to 2022. The study formulates its analysis using the following equation (1):

$$ES_t = \alpha_0 + \beta_1 GS_t + \beta_2 TIN_t + \beta_3 ENT_{it} + \beta_4 REC_t + \beta_5 INF_t + \beta_6 EG_t + e_t \quad \textbf{(1)}$$

Where;
ES = Environmental Sustainability
t = Time Period
GS = Green Spaces
TIN = Technological Innovation
ENT = Environmental Taxes
REC = Renewable Energy Consumption
EG = Economic Growth
INF = Inflation

The primary variable of interest in this study is environmental sustainability, operationalized through the measurement of CO2 emissions (metric tons per capita). Additionally, three predictor variables were utilized: green spaces, quantified as forest area (% of land area); technological innovation, assessed by high technology exports (% of manufactured exports); and environmental taxes, measured as taxes on the environment (% of tax revenue). Furthermore, three control variables were incorporated: REC, expressed as REC (% of total energy consumption); inflation, gauged by consumer prices (annual %); and economic growth (EG), ascertained through GDP growth (annual percentage). The detailed specifications of these variables and their respective measurements are presented in Table 1.

Table 1: Variables with Measurements

S#	Variables	Measurement	Sources
01	Environmental Sustainability	CO2 emissions (metric tons per capita)	WDI
02	Green Spaces	Forest area (% of land area)	WDI
03	Technological Innovation	High technology export (% of manufactured exports)	WDI
04	Environmental Taxes	Taxes on environment (% of tax revenue)	WDI
05	Renewable Energy consumption	REC (% of total energy consumption)	WDI
06	Inflation	Inflation, consumer prices (annual %)	WDI
07	Economic Growth	GDP growth (annual percentage)	WDI

The examination of constructs is conducted through descriptive statistics, offering insights into the minimum and maximum values, the number of observations, mean values, and standard deviations. Furthermore, the study assesses the correlation among variables using a correlation matrix. Additionally, unit root tests, specifically the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, are employed to scrutinize the stationarity of the variables. The equation (2) guiding this examination is provided below:

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad (2)$$

Moreover, the study also checks the co-integration using (Westerlund & Edgerton, 2008) approach. The equations (3) and equation (4) are mentioned below:

$$LM_{\varphi}(i) = T\hat{\varphi}_i\,(\hat{\tau}_i/\hat{\sigma}_i) \quad (3)$$

$$LM_{\tau}(i) = \hat{\varphi}_i/SE(\hat{\varphi}_i) \quad (4)$$

In equations (3) and (4), $\hat{\varphi}_i$, exposed the estimate beside standard error, while $\hat{\tau}^2_i$ exposed the long-run measured variance, while $\varphi i\ (L) = 1 - \Sigma\ \varphi_{ij}Lj$ exposed the scalar polynomial with L lag length, and ρ_i exposed the factor loading parameters vector.

Furthermore, this study investigates the relationships among the variables under consideration through the ARDL model. This approach is particularly suitable when the variables exhibit stationarity at either I(0) or I(1) (Zaidi & Saidi, 2018). Furthermore, the utilization of the ARDL model is justified by its capability to capture both long and short-term relationships among variables. Additionally, this model effectively controls for the impacts of heteroscedasticity and autocorrelation (Nazir et al., 2018). The equation for the model is given below:

$$ES_t = \alpha_0 + \sum\delta_1\Delta ES_{t-1} + \sum\delta_2\Delta GS_{t-1} + \sum\delta_3\Delta TIN_{t-1} + \sum\delta_4\Delta ENT_{t-1} + \sum\delta_5\Delta REC_{t-1} + \sum\delta_6\Delta INF_{t-1} + \sum\delta_7\Delta EG_{t-1} + \varphi_1 ES_{t-1} + \varphi_2 GS_{t-1} + \varphi_3 TIN + \varphi_4 ENT + \varphi_5 REC_{t-1} + \varphi_6 INF_{t-1} + \varphi_7 EG_{t-1} + \varepsilon_t \quad (5)$$

The research employed the dynamic ARDL model to examine the relationships among the variables. This method, introduced by Jordan and Philips (2018). It addresses the limitations inherent in the conventional ARDL model. The equation (6) for the DARDL model is provided below:

$$\Delta ES_t = \alpha_0 + \sum\delta_1\Delta ES_{t-1} + \sum\delta_2\Delta GS_t + \sum\delta_3\Delta GS_{t-1} + \sum\delta_4\Delta TIN_t + \sum\delta_5\Delta TIN_{t-1} + \sum\delta_6\Delta ENT_t + \sum\delta_7\Delta ENT_{t-1} + \sum\delta_8\Delta REC_t + \sum\delta_9\Delta REC_{t-1} + \sum\delta_{10}\Delta INF_t + \sum\delta_{11}\Delta INF_{t-1} + \sum\delta_{12}\Delta EG_t + \sum\delta_{13}\Delta EG_{t-1} + \varepsilon_t \quad (6)$$

Research Findings

The study meticulously examined the constructs through descriptive statistics, providing insights into the minimum and maximum values, the number of observations, mean values, and standard deviations. The results revealed that the mean value for ES was 3.693 metric tons per capita, GS had a mean value of 1.881 percent, TIN was at 34.491 percent, and ENT recorded a mean value of 3.442 percent. Additionally, the outcomes indicated that the mean value for REC was 0.890 percent, INF stood at 49.2521 percent, and EG was observed at 6.082 percent. These values are comprehensively detailed in Table 2.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ES	32	3.693	0.671	2.552	5.325
GS	32	1.881	0.020	1.841	1.900
TIN	32	34.491	1.824	31.209	37.501
ENT	32	3.442	2.352	0.001	8.250
REC	32	0.890	0.611	0.310	2.560
INF	32	49.252	108.473	-16.117	448.500
EG	32	6.082	20.066	-64.047	53.382

Moreover, the study assessed correlation through a correlation matrix. The results revealed a positive association between green spaces, technological innovation, environmental taxes, REC, inflation, and EG with environmental sustainability in Iraq. These values are presented in detail in Table 3.

Table 3: Matrix of Correlations

Variables	ES	GS	TIN	ENT	REC	INF	EG
ES	1.000						
GS	-0.211	1.000					
TIN	-0.153	0.957	1.000				
ENT	-0.122	0.336	0.516	1.000			
REC	-0.477	0.424	0.371	-0.007	1.000		
INF	-0.407	-0.606	-0.555	-0.152	-0.248	1.000	
EG	-0.320	-0.023	-0.038	-0.120	-0.119	-0.114	1.000

Additionally, the study conducted unit root tests using the ADF and PP methods. The results demonstrated that ES, GS, TIN, INF, and EG are stationary at the level, while ENT and REC are stationary at the first difference. Comprehensive outcomes are presented in Table 4.

Table 4: Unit Root Test

ADF			PP	
Series	Level	First difference	Level	First difference
ES	-3.292***	------	-2.342***	------
GS	-2.937***	------	-3.776***	------
TIN	-3.176***	-----	-2.344***	------
ENT	------	-4.463***	------	-5.463***
REC	------	-4.373***	------	-5.745***
INF	-2.362***	------	-2.192***	------
EG	-2.887***	------	-3.271***	------

Furthermore, the study examined co-integration utilizing the approach proposed by Westerlund and Edgerton (2008). The results revealed that the t-values surpass the threshold of 1.96, and the p-values fall within the range of significance (less than 0.05), indicating the presence of co-integration. Detailed results are presented in Table 5.

Table 5: Co-integration Test

Model	No Shift		Mean Shift		Regime Shift	
	Test Stat	p-value	Test Stat	p-value	Test Stat	p-value
LM_{τ}	-4.362	0.000	-5.329	0.000	-4.281	0.000
LM_{φ}	-4.873	0.000	-5.291	0.000	-4.887	0.000

The study employed the dynamic ARDL model to examine the relationships among the variables. The results revealed a positive correlation between green spaces, technological innovation, environmental taxes, REC, inflation, and EG with environmental sustainability in Iraq. Detailed associations are presented in Table 6.

Table 6: Dynamic ARDL Model

Variable	Coefficient	t-Statistic	Prob.
ECT	-1.928***	-5.773	0.000
GS_{t-1}	-3.298***	-3.464	0.000
GS	-1.221**	-2.001	0.043
TIN_{t-1}	-2.284**	-2.133	0.032
TIN	-1.298***	-5.129	0.000
ENT_{t-1}	-3.193***	-3.982	0.000
ENT	-0.847***	-3.993	0.000
REC_{t-1}	-0.444**	-1.996	0.049
REC	-1.292**	-2.323	0.022
INF_{t-1}	-2.885***	-5.334	0.000
INF	-0.987***	-4.320	0.000
EG_{t-1}	-1.264***	-5.454	0.000
EG	-2.101***	-4.994	0.000
Cons	-3.338***	-4.933	0.000
R square = 64.887			Stimulation = 5000

Discussions

The findings demonstrated a favourable influence of green spaces on environmental sustainability, a conclusion substantiated by Kruize et al. (2019), indicating that in a nation where investments are directed towards the establishment of green spaces such as parks, forests, plantations, and vegetation, the atmospheric purification from pollutants such as CO2 can be achieved. Hence, the attainment of environmental sustainability is feasible through the incorporation of green spaces, a notion consistent with Heikinheimo et al. (2020), emphasizing that the establishment of green spaces mitigates CO2 emissions and upholds environmental quality. The study's findings indicate a favourable correlation between technological innovation and environmental sustainability. These findings find support in the research conducted by Chege and Wang (2020), which investigates the role of technological innovation in environmental sustainability. The study suggests that both profit and non-profit organizations formulate policies for the adoption of innovation, fostering technological advancements to address and mitigate CO2 emissions stemming from their activities. These results are also in line with Cheng et al. (2021), highlighting that through technological innovation, a reduction in the utilization of energy resources can be achieved, resulting in a decline in CO2 emissions and thereby contributing to environmental sustainability.

The findings indicate a favourable correlation between renewable energy consumption and environmental sustainability, consistent with Kirikkaleli et al. (2021), who underscore that the adoption of renewable energy by economic organizations leads to a reduction in CO2 emissions, fostering environmental sustainability. These results also agree with Abbasi et al. (2022), asserting that elevated utilization of renewable energy within the nation mitigates waste emissions of CO2, thereby promoting environmental sustainability. The findings also indicated a favourable association between environmental tax and environmental sustainability. These results are supported by Ulucak and Kassouri (2020), articulating that the implementation of environmental taxes regulates all activities influencing environmental quality, leading to a consequential reduction in CO2 emissions and ensuring environmental sustainability. These outcomes align with Shahzad (2020). The study suggests that an escalation in the environmental tax burden corresponds to the sustainability of environmental quality.

The findings indicated a positive correlation between economic growth and environmental sustainability, a conclusion substantiated by Murshed et al. (2021), affirming that an upsurge in economic growth facilitates the implementation of green technologies, leading to the attainment of environmental sustainability. These results are also in line with Hysa et al. (2020), asserting that an increase in economic growth empowers the populace to mitigate environmental pollution and maintain environmental quality. The study's findings revealed a positive association between inflation and environmental sustainability. These results are also in line with Khan et al. (2022), articulating that the existence of modest inflation within the nation stimulates business expansion and increased earnings, enabling the implementation of eco-friendly initiatives conducive to environmental sustainability. These findings find support from Hang et al. (2020), which investigates the impact of inflation on environmental sustainability. The authors posit that heightened inflation within the nation correlates with increased adoption of energy-efficient technologies, thereby enhancing the likelihood of achieving environmental sustainability.

Implications

This research contributes valuable insights to the academic and research community by investigating the impacts of green spaces, technological innovation, renewable energy consumption, and environmental tax on environmental sustainability, incorporating economic growth and inflation as control factors. The study offers empirical guidance for policymakers involved in environmental regulation, emphasizing the construction of green spaces to mitigate CO2 emissions and achieve environmental sustainability. It advocates for the widespread adoption of technological innovation by individuals and institutions to sustain environmental quality. Additionally, the study underscores the importance of environmental regulators promoting renewable energy consumption as a crucial measure for ensuring environmental sustainability. The research recommends government intervention through environmental taxes to achieve environmental sustainability. It suggests aligning inflation rates to promote eco-friendly economic activities and underscores the need for strategies fostering economic growth as a pathway to environmental sustainability. Policymakers are guided to formulate policies centred on green spaces, technological innovation, and environmental taxes to attain environmental sustainability.

Conclusion

The study aimed to assess the impact of green spaces, technological innovation, renewable energy consumption, and environmental tax on environmental sustainability, considering control factors like economic growth and inflation. Quantitative data from a survey of the Iraqi economy indicated a positive correlation between green spaces, technological innovation, renewable energy consumption, environmental tax, and environmental sustainability. Increased construction of green spaces facilitated the absorption of pollutants like CO2, contributing to environmental sustainability. Additionally, the adoption of technological innovation led to the promotion of green technologies, mitigating energy use and waste emissions. Certainly, environmental sustainability is confirmed. The study found that promoting renewable energy consumption leads to a decrease in CO2 emissions, contributing to environmental sustainability. The imposition of environmental taxes by the government encourages public awareness and control of activities that may harm the environment, thereby enhancing environmental sustainability. Furthermore, the results indicated that during periods of rising inflation and economic growth, the economy can afford the utilization of green resources and effectively mitigate environmental pollution, sustaining environmental quality.

Limitations

The study is characterized by several limitations, necessitating modifications for enhanced rigor. Firstly, the investigation exclusively scrutinized factors such as green spaces, technological innovation, renewable energy consumption, and environmental tax, assessing their impact on environmental sustainability. In future research endeavours, it is imperative for scholars to broaden their focus by incorporating additional factors into their analysis. Secondly, the present study relied solely on data derived from Iraq, neglecting significant contributors to CO2 emissions such

as China and various other developing states. To enhance the study's applicability and generalizability, researchers ought to undertake a more comprehensive approach by incorporating data from diverse sources and regions.

References

Abbasi, K. R., Shahbaz, M., Zhang, J., Irfan, M., & Alvarado, R. (2022). Analyze the environmental sustainability factors of China: The role of fossil fuel energy and renewable energy. *Renewable Energy, 187*, 390-402. doi: https://doi.org/10.1016/j.renene.2022.01.066

Adedoyin, F. F., Alola, A. A., & Bekun, F. V. (2020). An assessment of environmental sustainability corridor: the role of economic expansion and research and development in EU countries. *Science of the total environment, 713*, 136-726. doi: https://doi.org/10.1016/j.scitotenv.2020.136726

Al-Kayiem, H. H., & Mohammad, S. T. (2019). Potential of renewable energy resources with an emphasis on solar power in Iraq: An outlook. *Resources, 8*(1), 21-42. doi: https://doi.org/10.3390/resources8010042

Al Issa, H.-E., Abdullatif, T. N., Ntayi, J., & Abdelsalam, M. K. (2023). Green intellectual capital for sustainable healthcare: evidence from Iraq. *Journal of Intellectual Capital, 24*(4), 929-947. doi: https://doi.org/10.1108/JIC-02-2022-0046

Astell-Burt, T., & Feng, X. (2019). Association of urban green space with mental health and general health among adults in Australia. *JAMA network open, 2*(7), 198-209. doi: https://doi.org/10.1001/jamanetworkopen.2019.8209

Atay Kaya, İ., & Kut Görgün, E. (2020). Land use and land cover change monitoring in Bandırma (Turkey) using remote sensing and geographic information systems. *Environmental Monitoring and Assessment, 192*(7), 4-30. doi: https://doi.org/10.1007/s10661-020-08411-1

Bhakta, I., Phadikar, S., & Majumder, K. (2019). State-of-the-art technologies in precision agriculture: a systematic review. *Journal of the Science of Food and Agriculture, 99*(11), 4878-4888. doi: https://doi.org/10.1002/jsfa.9693

Bibri, S. E., Krogstie, J., & Kärrholm, M. (2020). Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability. *Developments in the built environment, 4*, 10-21. doi: https://doi.org/10.1016/j.dibe.2020.100021

Bush, J. (2020). The role of local government greening policies in the transition towards nature-based cities. *Environmental Innovation and Societal Transitions, 35*, 35-44. doi: https://doi.org/10.1016/j.eist.2020.01.015

Cascone, S., Coma, J., Gagliano, A., & Pérez, G. (2019). The evapotranspiration process in green roofs: A review. *Building and environment, 147*, 337-355. doi: https://doi.org/10.1016/j.buildenv.2018.10.024

Chege, S. M., & Wang, D. (2020). The influence of technology innovation on SME performance through environmental sustainability practices in Kenya. *Technology in Society, 60*, 1012-1129. doi: https://doi.org/10.1016/j.techsoc.2019.101210

Cheng, Y., Awan, U., Ahmad, S., & Tan, Z. (2021). How do technological innovation and fiscal decentralization affect the environment? A story of the fourth industrial revolution and sustainable growth. *Technological Forecasting and Social Change, 162*, 120-137. doi: https://doi.org/10.1016/j.techfore.2020.120398

Enssle, F., & Kabisch, N. (2020). Urban green spaces for the social interaction, health and well-being of older people—An integrated view of urban ecosystem services and socio-environmental justice. *Environmental science & policy, 109*, 36-44. doi: https://doi.org/10.1016/j.envsci.2020.04.008

Falih Chichan, H., & Alabdullah, T. T. Y. (2021). Does environmental management accounting matter in promoting sustainable development? A study in Iraq. *Journal of Accounting Science, 5*(2), 110-122. doi: https://doi.org/10.21070/jas.v5i2.1543

Hang, T. T. B., Nhung, D. T. H., Huy, D. T. N., Hung, N. M., & Pham, M. D. (2020). Where Beta is going-case of Viet Nam hotel, airlines and tourism company groups after the low inflation period. *Entrepreneurship and Sustainability Issues, 7*(3), 2282-2296. doi: https://doi.org/10.9770/jesi.2020.7.3(55)

Hassan, M. K. R. (2023). Factors Affecting Urbanisation in Iraq: A Historical Analysis from 1921 to the Present. *Urbanisation*, 24-86. doi: https://doi.org/10.1177/24557471231169386

Heikinheimo, V., Tenkanen, H., Bergroth, C., Järv, O., Hiippala, T., & Toivonen, T. (2020). Understanding the use of urban green spaces from user-generated geographic information. *Landscape and Urban Planning, 201*, 1038-1053. doi: https://doi.org/10.1016/j.landurbplan.2020.103845

Hsu, C.-C., Quang-Thanh, N., Chien, F., Li, L., & Mohsin, M. (2021). Evaluating green innovation and performance of financial development: mediating concerns of environmental regulation. *Environmental Science and Pollution Research, 28*(40), 57386-57397. doi: https://doi.org/10.1007/s11356-021-14499-w

Hunter, R. F., Cleland, C., Cleary, A., Droomers, M., Wheeler, B. W., Sinnett, D., et al. (2019). Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environment international, 130*, 104-923. doi: https://doi.org/10.1016/j.envint.2019.104923

Hysa, E., Kruja, A., Rehman, N. U., & Laurenti, R. (2020). Circular economy innovation and environmental sustainability impact on economic growth: An integrated model for sustainable development. *Sustainability, 12*(12), 4831-4849. doi: https://doi.org/10.3390/su12124831

Jordan, S., & Philips, A. Q. (2018). Cointegration testing and dynamic simulations of autoregressive distributed lag models. *The Stata Journal: Promoting communications on statistics and Stata, 18*(4), 902-923. doi: https://doi.org/10.1177/1536867X1801800409

Khan, I., Tan, D., Azam, W., & Hassan, S. T. (2022). Alternate energy sources and environmental quality: The impact of inflation dynamics. *Gondwana Research, 106*, 51-63. doi: https://doi.org/10.1016/j.gr.2021.12.011

Khan, K., Su, C. W., Khurshid, A., & Qin, M. (2023). Does energy security improve renewable energy? A geopolitical perspective. *Energy, 282*, 128-824. doi: https://doi.org/10.1016/j.energy.2023.128824

Kirikkaleli, D., Adebayo, T. S., Khan, Z., & Ali, S. (2021). Does globalization matter for ecological footprint in Turkey? Evidence from dual adjustment approach. *Environmental Science and Pollution Research, 28*(11), 14009-14017. doi: https://doi.org/10.1007/s11356-020-11654-7

Klymenko, M. (2019). Environmental taxation as a policy instrument for green growth. *Problems of World Agriculture/Problemy Rolnictwa Światowego, 19*(34, Part 3), 35-45. doi: https://doi.org/10.22004/ag.econ.296746

Kruize, H., van der Vliet, N., Staatsen, B., Bell, R., Chiabai, A., Muiños, G., et al. (2019). Urban green space: creating a triple win for environmental sustainability, health, and health equity through behavior change. *International journal of environmental research and public health, 16*(22), 4403-4418. doi: https://doi.org/10.3390/ijerph16224403

Lafta, R. K., & Al-Nuaimi, M. A. (2019). War or health: a four-decade armed conflict in Iraq. *Medicine, Conflict and Survival, 35*(3), 209-226. doi: https://doi.org/10.1080/13623699.2019.1670431

Ma, B., Zhou, T., Lei, S., Wen, Y., & Htun, T. T. (2019). Effects of urban green spaces on residents' well-being. *Environment, Development and Sustainability, 21*, 2793-2809. doi: https://doi.org/10.1007/s10668-018-0161-8

Murshed, M., Rahman, M. A., Alam, M. S., Ahmad, P., & Dagar, V. (2021). The nexus between environmental regulations, economic growth, and environmental sustainability: linking environmental patents to ecological footprint reduction in South Asia. *Environmental Science and Pollution Research, 28*(36), 49967-49988. doi: https://doi.org/10.1007/s11356-021-13381-z

Nazir, M. I., Nazir, M. R., Hashmi, S. H., & Ali, Z. (2018). Environmental Kuznets Curve hypothesis for Pakistan: Empirical evidence form ARDL bound testing and causality approach. *International journal of green energy, 15*(14-15), 947-957. doi: https://doi.org/10.1080/15435075.2018.1529590

Nguyen, H. A. T., Sophea, T., Gheewala, S. H., Rattanakom, R., Areerob, T., & Prueksakorn, K. (2021). Integrating remote sensing and machine learning into environmental monitoring and assessment of land use change. *Sustainable Production and Consumption, 27*, 1239-1254. doi: https://doi.org/10.1016/j.spc.2021.02.025

Schillinger, J., Özerol, G., Güven-Griemert, Ş., & Heldeweg, M. (2020). Water in war: Understanding the impacts of armed conflict on water resources and their management. *Wiley Interdisciplinary Reviews: Water, 7*(6), 14-80. doi: https://doi.org/10.1002/wat2.1480

Shahzad, U. (2020). Environmental taxes, energy consumption, and environmental quality: Theoretical survey with policy implications. *Environmental Science and Pollution Research, 27*(20), 24848-24862. doi: https://doi.org/10.1007/s11356-020-08349-4

Shao, S., Hu, Z., Cao, J., Yang, L., & Guan, D. (2020). Environmental regulation and enterprise innovation: a review. *Business strategy and the environment, 29*(3), 1465-1478. doi: https://doi.org/10.1002/bse.2446

Ulucak, R., & Kassouri, Y. (2020). An assessment of the environmental sustainability corridor: Investigating the non-linear effects of environmental taxation on CO2 emissions. *Sustainable Development, 28*(4), 1010-1018. doi: https://doi.org/10.1002/sd.2057

Wang, Y., & Yu, L. (2021). Can the current environmental tax rate promote green technology innovation?-Evidence from China's resource-based industries. *Journal of Cleaner Production, 278*, 123-443. doi: https://doi.org/10.1016/j.jclepro.2020.123443

Westerlund, J., & Edgerton, D. L. (2008). A simple test for cointegration in dependent panels with structural breaks. *Oxford Bulletin of Economics and Statistics, 70*(5), 665-704. doi: https://doi.org/10.1111/j.1468-0084.2008.00513.x

Wolde-Rufael, Y., & Mulat-Weldemeskel, E. (2023). Effectiveness of environmental taxes and environmental stringent policies on CO2 emissions: the European experience. *Environment, Development and Sustainability, 25*(6), 5211-5239. doi: https://doi.org/10.1007/s10668-022-02262-1

Zaidi, S., & Saidi, K. (2018). Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. *Sustainable cities and society, 41*, 833-840. doi: https://doi.org/10.1016/j.scs.2018.04.034

Zhu, X., Xu, Y., Zhen, G., Lu, X., Xu, S., Zhang, J., et al. (2023). Effective multipurpose sewage sludge and food waste reduction strategies: A focus on recent advances and future perspectives. *Chemosphere, 311*, 136-670. doi: https://doi.org/10.1016/j.chemosphere.2022.136670