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Effect of Financial Inclusion, Eco-Innovation, Globalization, and Sustainable Economic Growth on Ecological Footprint

Trong Lam Vu[1], Ch Paramaiah[2], Bushra Tufail[3], Muhammad Atif Nawaz[4], Nguyen Thi My Xuyen[5*], Pham Quang Huy[6]

[1]*Communist Review*
Tran Binh Trong st., 28, Hai Ba Trung Dist., Hanoi, Vietnam
E-mail. taitranduc715@gmail.com

[2]*Skyline University College, UAE*
E-mail. chparamaiah@gmail.com

[3]*Department of Public Administration, University of Karachi, Pakistan*
E-mail. bushtufail@yahoo.com

[4] *Department of Economics, The Islamia University of Bahawalpur, Pakistan*
E-mail. atif.nawaz.baloch@gmail.com

[5*]*Faculty of Business Administration, Van Lang University, Vietnam*
E-mail. xuyen.ntm@vlu.edu.vn **Corresponding Author*

[6]*University of Economics Ho Chi Minh City (UEH), Vietnam*
E-mail. pquanghuy@ueh.edu.vn

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Although economic growth, globalization, and ecological footprint are extensively researched altogether, however, the literature on the role of financial inclusion, ecological innovation along with growth and globalization is still limited specifically in the context of MENA region. Thereby, The study aims to scrutinize the dynamic association between the above-stated variables while considering a range of statistical estimations and methods. Data is gathered from 1990 to 2017 for the stated panel economies entitled under the MENA region. It is observed that there exists cross-sectional dependence, having stationarity proprieties, and slope heterogeneity for the variables of interest. Furthermore, the findings through CS-ARDL indicate the significant and direct impact of financial inclusion economic growth, and globalization through GDP in creating more environmental issues like EFP. Whereas ecological innovation is significantly playing its role in reducing ED for the selected economies. Finally, robust checks through "Augmented Mean Group and Common Correlated Effect Mean Group" have also revealed consistent findings when examined through CS-ARDL. Besides, various policy implications are also presented in this research.

Keywords: *Ecological Footprint; Economic Growth; Financial Inclusion; Globalization.*

Introduction

Since decades, global warming is considered to be a major issue all over the globe as it degrades the quality environment, hence, affecting all types of economies (Ahmed *et al.,* 2021; Shibli *et al.,* 2021). This deterioration in the environmental quality is threatening for future generations as it results in severe economic crisis in the form of poverty, inequality, unemployment, etc. (Ahmed, Khan, Rahman, Khattak & Khan, 2021; Ahmed, Kousar, Pervaiz & Ramos-Requena, 2020; Hartani, Haron & Tajuddin, 2021; Zameer, Yasmeen *et al.,* 2020; Rahman, Saidi & Mbarek, 2020). Researchers, therefore, became conscious about the protection of environment and start publishing studies to find out the reasons behind the environmental deterioration (ED). Different ecological researchers have reached at the conclusion that the amplified level of GHG emissions disturbs the environment quality (EQ) by increasing the level of carbon emissions (CO_2) (Ojogiwa, 2021; Shahbaz *et al.,* 2013). Researchers, hence, start exploring the determinants of carbon emissions so that they can provide definite solutions to protect the environment. The first strand of researchers regarded that rise in economic activities and the consumption of traditional energy are the main reasons behind the ED (Ali, Yusop, Kaliappan & Chin, 2021; Kihombo, Adebayo, Khan & Ali, 2021; Jermsittiparsert, 2021; Usman, Makhdum & Kousar, 2021), as they increase the level of CO_2 in the atmosphere. Contrastingly, researchers found that there are some factors (like globalization, financial development, and technological innovation) that significantly reduce co2 emissions (Nguyen & Le, 2020; Jian *et al.,* 2019; Zhao *et al.,* 2021; Dauda *et al.,* 2021). However, another strand of researchers showed the positive contributions of economic activities to the EQ (Tong *et al.,* 2020; Wirsbinna & Grega,

2021). while negative contributions of financial development and globalization to the EQ (Bilgili *et al.,* 2019; Seddighi & Mathew, 2020). Due to these conflicting findings, the environment has become a very debatable topic among researchers (Baloch, Tan, Kamran, Nawaz, Albashar & Hameed, 2021; Tiberius, Schwarzer, H & Roig-Dobon, 2021).

However, the major drawback of the existing studies is that they concluded their findings on the basis of carbon emissions (Anwar *et al.,* 2020; Chien, Kamran *et al.,* 2021), which is only an indicator of environmental pollution (not a measure of environmental deterioration), as it measures the environmental pollution that is caused by different industrial activities or consumption of energy on a large scale (Abbas *et al.,* 2021; Paraschiv *et al.,* 2021). However, Alike GHG/carbon emissions there are many other reasons that deteriorate the quality of the environment (demand or extraction of natural resources, ecological stress, human activities and orthographies, water scarcity, waste, etc.) (Majeed & Mazhar, 2019; Sarwar, Ming & Husnain, 2020). Hence, CO_2 cannot be considered a "universal measure" of ED as it does not incorporate anthropogenic pressure on the ecosystem (Abbas *et al.,* 2021; Majeed & Mazhar, 2019; Niaz, 2021). In consequence, ecological footprints, as a comprehensive tool to measure the deterioration in environmental quality have been introduced by Wackernagel & Rees (2014), which gain importance for researchers during the second decade of the 20th century.

The main advantage of this exclusive measure of ED is that it amalgamates the ecological data into a distinct measure that can be easily equated with the analogous industrious capability to acme the fact that *"how much of the ecosystem surface we use for sustaining life"*, as it reflects the "*human demands"* of resources.

It is a widely recognized economic proposition that human demands are unlimited, while the resources are limited (Chien, Pantamee *et al.,* 2021; Mitic *et al.,* 2020). Therefore, the higher economic or financial activities (economic growth, financial inclusion) and expansion stages (globalization) lead to the ED (Zaidi *et al.,* 2021; Mjeed & Mazhar, 2019; Yousaf *et al.,* 2021). For example, during economic activities, different resources are plucked out from the environment to fulfill the unlimited desires of mankind, which in turn, increases ED (Ahmed *et al.,* 2021). In addition to this, financial inclusion (FIN) is another crucial factor that contributes to EFP because on the one hand FIN permits individuals to access high-energy consumer goods (like cars, air-conditioners, and air-coolers, etc), which posits adverse pressure on the environment (Matuszewska-Pierzynka, 2021; Zaidi *et al.,* 2021), and on the other hand, FIN increases the economic activities (like GDP), and expansion stages (like globalization) which again enhance ED (Mikelsone *et al.,* 2020; Zaidi *et al.,* 2021). Globalization is widely recognized as an expansion stage. Due to globalization, different economies integrate with each other. Researchers recognized globalization as a phenomenon that is impacting the life of human-being by providing them access to their basic needs (Chien, Sadiq, Kamran, Nawaz, Hussain & Raza, 2021; Li, Chien, Hsu *et al.,* 2021). Globalization is promoting different industrial activities to fulfill the desires of mankind which in turn leads to ED (Bilgili *et al.,* 2020; Sell, 2020). Nonetheless, the advancement in the innovations can be a solution to improve the EQ, because these innovation permits the usage of different economic resources in a sustainable manner, which not only promotes the EG but also protects the environment (Cheng *et al.,* 2021; Streimikiene & Akberdina, 2021). In other words, advancement in innovation helps to promote sustainable economic growth (Nawaz, Hussain *et al.,* 2021; Sun *et al.,* 2020), because the use of innovative technology reduces the stress on natural resources and reduces the production cost that ultimately forces a nation to adopt eco-friendly technologies which make the production of goods and services sustainable, and hence improves the EQ. The above discussion motivates us to conduct the study in the said area (Braslauskas, 2020; Nawaz, Seshadri *et al.,* 2021).

Discussing the issue with respect to context, MENA region is facing a wide assortment of ecological stress which includes arable land exhaustion, water shortage, air pollution, loss of biodiversity, insufficient waste management, coal system deterioration, and declining nautical resources (Abumoghli & Goncalves, 2020). In addition to this, future growth scenarios are probable to worsen these challenges (Abdouli & Hammami, 20117). According to the annual report of IPCC, MENA region is most susceptible to the effects of global climate change (IPCC, 2013). Rising sea levels, intensifying temperature, discriminating rainfall variability, increased urban growth rates and enlarged population are making this situation worse. After observing the current environmental conditions of MENA region, Therefore, the study has this belief that it is crucial to work on MENA region to identify the effectiveness of financial inclusion, globalization, eco-innovation and sustainable growth so that possible solutions could be suggested in order to deal with the environmental problems.

To conclude the debate, the study intends to contribute to the prevailing discussion of the environment in the following ways. First, the study intends to use a more inclusive indicator/measurement of the environment i.e., EFP, which measures the lithospheric, atmospheric, hydrosphere, and biosphere aspects of ED. Second, the study attempts to test the long-run (LR) impact of GDP, globalization (GLO), FIN, and eco-innovation (EIN) on EFP. As per the author's knowledge, prior studies tested the LR impact of chosen variables on carbon emissions, and fewer focused on these variable outcomes on EFP. However, the collective impact of GDP, GLO, FIN, and EIN on EFP, according to the author's knowledge, has not been investigated by the researchers, especially in the MENA region context. After observing the current environmental conditions of MENA region, the present study intends to conduct research on the MENA countries.

MENA region is facing a wide assortment of ecological stress which includes arable land exhaustion, water shortage, air pollution, loss of biodiversity, insufficient waste management, coal system deterioration, and declining nautical resources (Abumoghli & Goncalves, 2020). In addition to this, future growth scenarios are probable to worsen these challenges (Abdouli & Hammami, 2017). According to the annual report of IPCC, MENA region is most susceptible to the effects of global climate change (IPCC, 2013). Rising sea levels, intensifying temperature, discriminating rainfall variability, increased urban growth rates and enlarged population are making this situation

worse. After observing the current environmental conditions of MENA region, the study has this belief that it is crucial to work on MENA region to suggest possible solutions to deal with these environmental problems.

The study is divided into multiple sections in order to provide structure to the study. As the introduction part covers the problem of study and discusses the topic in a broader way. The following section provides the theoretical grounding and proposed hypothesis in the light of prior literature. Section 3 highlights the proposed methodology and statistical techniques which are used for data analysis. The next section provides the study findings and hypotheses results. Finally, the study is concluded by offering some recommendations and implications that could be helpful for practitioners to encounter environmental issues.

Literature Review

Economic Growth (GDP) and Ecological Footprints (EFP)

Growth-environment nexus is discussed widely by many scholars. Many researchers have scrutinized the role of GDP on environmental deterioration (ED) in the case of different economies (Atkočiūniene & Siudikiene, 2021; Zhuang et al., 2021). Some researchers concluded the positive connection between GDP and ED (Shahbaz *et al.,* 2021; de Souza Mendonca, 2020), while others reveal a negative affiliation between GDP and ED (Mensah Sun et al., 2019; Tong, Ortiz, Xu & Li, 2020; Zameer, Yasmeen, Zafar, Waheed & Sinha, 2020; Hu, Li, You, Liu & Lee, 2020). However, some researchers indicate a non-linear relationship between these variables (Mujtaba & Jena, 2021; Udemba & Yalcıntas, 2021; Farouq *et al.,* 2020; Kassi & Francois, 2020). The outcome of all these studies is justifiable in the light of EKC theory. In the light of theory, the association between economic growth and environmental quality is divided into three stages. The first stage is known as *"Pre-industrial stage"*, where the increase in a nation's economic activities deteriorates the environmental quality (Wang *et al.,* 2020). The second stage is known as *"industrial stage"*, where the increase in economic activities does not affect the nation's environmental quality. The third stage is known as *"post-industrial stage",* where an increase in a nation's economic activity doesn't deteriorate its environmental quality, rather, it promotes a sustainable environment (Ahmed *et al.,* 2020). However, most of the researchers have used CO_2 emissions to measure the environmental deterioration/pollution/ sustainability or quality (Chaabouni *et al.,* 2016; Olesen *et al.,* 2021; Solarin, 2019), which is the only factor of environmental pollution that is caused by different industrial activities or consumption of energy on a large scale (Abbas *et al.,* 2021). However, ecological footprint as a new and most appropriate measure of environmental degradation has been developed. Many researchers have considered it more inclusive measure of the environment as compared to CO2 emissions (Aydin *et al.,* 2019; Hassan *et al.,* 2019; Abbas *et al.,* 2021; Rudolph & Figge, 2017). Hence, with the passage of time researchers start conducting their studies in the field of the environment by using EFP as a novel measure of environment. Another study conducted by Hassan et al. (2019), utilized the annual time-series data of Pakistan from 1970 to 2014 with the aim to analyze the impact of GDP on EFP. The study covering the period from 1970 to 2014, revealed the positive relationship between EFP and GDP. Similarly, Ahmed et al. (2020) also worked on GDP-EFP nexus. The study tested the dynamic role of technological innovation, natural resources, and GDP on EFP in the case of emerging economies. The findings of the study confirmed the significant association among modeled variables in long run. The study showed that GDP and natural resources positively contribute to the EFP in long run. While technological innovation is having its substantial contributions in reducing EFP. Ikram et al. (2021) also predicted the positive affiliation between GDP and EFP. Destek & Sinha (2020) also reached to the same conclusion after analyzing the data of 20 OECD economies for the period of 1980–2016.

Globalization (GLO) and Ecological Footprints (EFP)

The studies related to the association between globalization and CO_2 emissions is well researched previously. However, the results of the study revealed conflicting findings. Some researchers indicate GLO as an antagonist for a nation's environmental sustainability, while others regarded it as a friend of a nation's environmental quality. Particularly, Shahbaz et al., (2015) conducted research on India intending to analyze the role of GLO in EQ for the period of 1970–2013. The study applied ARDL and regarded GLO as a detrimental factor of India's EQ. The study indicated that GLO has the potential to maximize the level of GHG emissions which further deteriorates the EQ. Similarly, Ma & Wang (2021) also reached at the same consensus for the case of 54 emerging economies. Bilgili et al. (2019) conducted research in the context of Turkey to scrutinize the role of GLO on the emissions of GHG. Results exhibit a positive connection of GLO with GHG emissions. However, shows inconsistency with the findings of the above researchers, some studies reported a negative relationship between GLO and CO_2 emissions. These studies regarded GLO as a significant predictor of environmental sustainability (ES). For instance, Le & Ozturk (2020) did their research on 47 developing and emerging economies with the explicit aim to investigate the empirical relationship between GLO and CO_2. To achieve this objective, the study analyzed the data of selected economies covering the 1988–2017 period. Results showed the substantial contributions of GLO in the reduction of carbon emission levels. Nguyen & Le (2020) also revealed similar findings in the case of Vietnam. Shahbaz et al. (2019) also regarded GLO as a crucial factor to improve the nation's EQ. After observing the conflicting nature of results on the association among GLO-ED nexus, researchers argued that there is a need to change the indicator, through which they are measuring the EQ in order to get conspicuous impact of GLO on environmental conditions. Hence, they have started publishing their studies by using different indicators of the environment (like NOx, SOx, carbon footprints, and ecological footprints). For instance, Ahmed et al. (2019) tested the GLO impact on the environmental deterioration of Malaysia by using its novel measurement; EFP. Results of the study showed that EFP of Malaysia is significantly predicted by GLO. Saud et al. (2020) studied the dynamic role of GLO and FDt in ED by

using its three different indicators. CO_2 emissions, EFP, and carbon footprint. The study showed that GLO and CO_2 emissions are negatively connected, while GLO with EFP and carbon footprints share a positive relationship. Usman et al. (2020) tested the collective impact of globalization and REW energy on the EFP of USA. The study applies VECM and revealed the positive impact of GLO on EFP, and the negative correlation of REW energy with EFP. Ibrahiem & Hanafy (2020) also reported the significant influence of GLO on EFP.

Financial Inclusion (FIN) and Ecological Footprints (EFP)

Finance-environment nexus also remained a highly debated topic among prior researchers. Studies have explored financial development in the environmental context and provided enough evidence to showcase the benefits of FD in the improvement of EQ (Jian *et al.,* 2019; Shahbaz *et al.,* 2013; Ahmed *et al.,* 2020; Ghorashi & Alavi Rad, 2018). Scholars highlighted the significance of FD and its criticality for a sustainable environment. The arguments show that a sufficient amount of capital helps the country to gain access to advanced equipment that leads to have a minimal contribution of GHG emissions. In addition to this, researchers argued that FD improves the EQ by transferring the eco-friendly projects through R & D. Moreover, FD also endorses the investment in eco-friendly projects through the expansion of foreign inflows, bank activities, and stock market activities (Majeed & Mazhar, 2019). To the best of our knowledge, the area of FIN remained less focused area among the previous researchers, as only a few researchers have explored the contributions of FIN to the quality of the environment. For instance, Le et al. (2020) did research in the Asian context and empirically tested the role of FIN in the reduction of carbon emissions. The study used so-called CO2 emissions to measure the quality of the environment. After analyzing the data covering the period 2004–2014, the study indicated the positive affiliation between FIN and CO_2 emissions. Renzhi & Baek (2020) revealed similar findings for the case of 59 developing economies for the period of 2004–2014. In contrast to the findings of the above studies, Usman & Hammar (2021) indicated the negative connection of FIN with carbon emissions. Similarly, Chaudhary et al. (2021) also highlighted the crucial role of FIN in reducing the level of GHG emissions. However, researchers do not reach to the same consensus, and hence, Kihombo et al. (2021) recognized the importance of an appropriate measure of the environment (EFP). The authors, therefore, conducted their work on the finance-environment nexus and investigated the impact of FD on EFP. The study indicated the positive relationship between said constructs. Usman et al. (2021) also recognized the importance of FIN and tested the impact of FIN on EFP by analyzing the data of the 15 highest emitting nations.

Eco-innovation (EIN) and Ecological Footprints (EFP)

In recent years, the area of innovation attracts the attention of different researchers. The literature revealed that several studies have increasingly been published in the past few years on the nexus between innovation and the environment. Researchers investigated the impact of different types of innovation including technological innovation, green innovation, and environmentally friendly innovation on the environment (Cheng *et al.,* 2021; Zhao *et al.,* 2021; Dauda *et al.,* 2021; Ahmed *et al.,* 2021; Destek & Manga, 2021). However, rare studies have been reported on the association between eco-innovation and the environment (Ji *et al.,* 2021; Puertas *et al.,* 2021; Chein *et al.,* 2021).

Cheng, Ren, Dong, Dong & Wang (2021) indicated that technological or green innovations are the best way to the provision of the finest, most proficient, and cleanest use of resources that reduces the level of GHG emissions and ultimately improves the EQ. Miskiewicz (2021) considers technological innovation as a crucial factor of having significant contributions in reducing the level of GHG emissions. The author conducted his research on G20 nations and found a negative relationship between technological innovations and CO_2 emissions. The study revealed a negative connection between technological innovation and CO2 emissions. The study found that technological innovation tends to reduce GHG emissions by stimulating the effectiveness of the factor of production. Saho & Sethi (2021) recognized the need for an appropriate indicator of the environment to re-examine the role of innovations on the environment. The author gathered data from 10 newly industrialized economies for the period of 1990–2017 and analyzed the role of different innovational domains (eco-environmental innovation and eco-economic innovation) on environmental conditions. The study used two different proxies of the environment: CO_2 emissions and EFP.

Theoretical Backgrounds

The study considered ecological modernization theory and the environmental Kuznets curve to view the theoretical linkage among the modeled variables. Ecological modernization theory stipulates that through advanced innovation processes, environmental concerns can be mitigated (Chien *et al.,* 2021). it argued that eco-economic or eco-environmental innovations have the potential to deliver a particular output level only by consuming a lesser energy level which in turn improves the environmental conditions (Destek & Manga, 2021). Environmental Kuznets curve highlights the three stages "*i.e., pre-industrial stage, industrial stage, and post-industrial stage"* of the growth-environment nexus. At the first stage, priority is given to economic progress, instead of environmental quality. At this stage, the purpose of nations is to promote economic progress at any cost. Therefore, this stage involves the increase in any sort of economic activity that deteriorates the environmental quality of the nation. At the second stage, the nation achieves the particle threshold level of economic growth, therefore, they concentrate to use such strategies which help to achieve a steady path of economic growth without damaging the environmental quality. At the third stage, priority is given to environmental sustainability over economic progress. Because, now the nation recognized that the deterioration in the environment leads to many economic losses such as poverty, inequality, and unemployment, etc. At this stage, the government uses some strategies of advancing innovation and investing in R&D projects that help to maintain a sustainable environment.

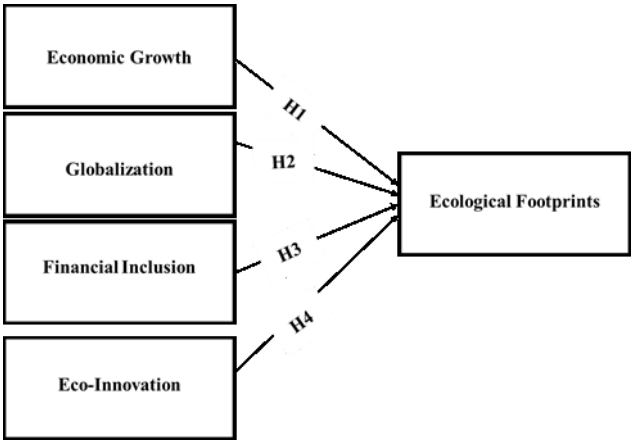

Figure 1. Theoretical Framework

H_1: "Significant relationship exists between economic growth and ecological footprints both under long run and short run estimation".

H_2: "Significant relationship exists between globalization and ecological footprints both under long run and short run estimation".

H_3: "significant relationship exists between financial inclusion and ecological footprints both under long run and short run estimation".

H_4: "significant relationship exists between ecological innovation and ecological footprints both under long run and short run estimation".

Research Methods

Under the present study, cross-sectional dependence was considered as it is believed that this method is quite beneficial while checking for the unit root properties of the study data. In this way, it is assumed that study variables like ecological innovation, financial inclusion, globalization, and economic growth are linked with the CSD. It is observed that if the issue of CSD is ignored it may cause misleading output in terms of bias stationarity and under cointegration analysis as well (Ruhul *et al.,* 2017; Westerlund, 2007b). The study for the said purpose considered Pesaran's (2015) CSD at the initial level. Various authors have suggested dealing with the Unit root test with & without a structural break (Lee & Strazicich, 2003; Narayan & Popp, 2013; Waheed, Alam, & Ghauri, 2006). In order to deal with the non-stationarity in the study variables, the present research has considered Bai and Carrion-I-Silvestre (2009) and Pesaran (2007) tests. Furthermore, after investigating the data properties and variables through CSD and unit root, heterogeneity between the slope coefficients is examined. For this purpose, Swamy's (1970) slope homogeneity test was applied, and findings are presented under a subsequent section of the study. Meanwhile, with the presence of CSD, non-stationarity, and heterogeneity between the study variables, we also have applied the Westerlund and Edgerton (2008) and Banerjee and Carrion-i-Silvestre (2017) panel cointegration analysis. Finally, the findings under the present study are based on the CS-ARDL approach for both long-run as well as short-run estimation.

In its traditional approach, the title of CSARDL is presented below:

$$EFP_{it} = \delta_{1it} + \delta_{2it}FIN_{it} + \delta_{3it}EIN_{it} + \delta_{4it}GLO_{it} + \delta_{4it}GDP_{it} + \partial i + \varphi_{it} \quad \text{Equation 1}$$

However, the expression above could be modified into Equation 2 to present the ARDL model which is as follows:

$$W_{i,t} = \sum_{I=0}^{Pw} \gamma_{I,i} W_{i,t-1} + \sum_{I=0}^{Pz} \beta_{I,i,t-1} + \varepsilon_{i,t} \quad \text{Equation 2}$$

The extended version of Equation 2 considers the cross-sectional averages for the explanatory variables as observed under the present study.

$$W_{i,t} = \sum_{I=0}^{Pw} \gamma_{I,i} W_{i,t-1} + \sum_{I=0}^{Pz} \beta_{I,i,t-1} + \varepsilon_{i,t.} + \sum_{I=0}^{Px} \partial_{i.} I\bar{X}_{t-1,} \quad \text{Equation 3}$$

For better understanding, different notations have been used in the above expression which $\bar{X}t-1 = \left(\bar{W}i,t-1, \bar{Z}i,t-1\right)$ reflects the average values for the study variables entitled as ecological footprint, financial inclusion, ecological innovation, globalization, and gross domestic product, respectively. Meanwhile, pw, pz, and px are showing the lagged values while Wit indicates the main DV; EFP. Furthermore, the titles like $\bar{X}$ is showing the cross-sectional averages to address the spillover effect in the data. Besides, the above Equation 3 can also be rearranged in the following Equation 4 to consider CS-ARDL under long-run estimation.

$$\Pi Cs - ARDL, i = \sum_{i=0}^{Pz} Bi, iPW\ /1 - \sum 1 = 0\,\gamma I, i..Equation4$$

whereas the mean group can be reflected through the following expression

$$\Pi MG = 1/N \sum_{i=1}^{N} \pi i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation5$$

However, for the short-run coefficient estimation under CSARDL, the following equations have been considered.

$$\Delta Wi,t = \vartheta i[Wi,t-1 - \pi iZi,t] \sum_{I=1}^{Pw-1} \gamma I,i\Delta I\,Wi,t-1 + \sum_{I=0}^{Pz} B1,i\Delta IZi,t + \sum_{I=0}^{Px} \partial i,IX + \varepsilon i,t \ldots\ldots Equation6$$

Furthermore, the Equations above consider the following adjustments:

$$\hat{\tau}i = -\left(1 - \sum_{I=1}^{pw} \gamma I,i\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation7$$

$$\Pi i = \sum_{1=0}^{pz} BI,i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation8$$

$$\Pi MG = I/N \sum_{i=1}^{N} \Pi i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation9$$

Finally, the paper considered the robust check with the help of an "augmented mean group" as suggested by (Eberhardt & Teal, 2010) along with the CCEMG which is finally suggested by Pesaran (2006) in order to claim that findings under the present study are consistent with no major estimation issues.

Discussion

Table1 shows the output for the CSD while considering all the variables named "ecological footprint, financial inclusion, ecological innovation, globalization, and gross domestic product as economic growth" into consideration. These empirical outcomes are based on the methodological contribution as provided by Pesaran's (2015) CSD test which has claimed that it is quite significant to address such issues in the data. Otherwise, it would create a biased output for the cointegration and unit root analysis too. A similar suggestion is also observed from the research contribution of Churchill, Inekwe, Smyth, and Zhang (2019), Westerlund (2007a), and Ruhul Salim, Yao Yao, and George S Chen (2017), respectively.

Based on the study findings as shown in Table 1, it is observed that the findings are in favor of the alternative hypotheses for the study variables which state that cross-sectional dependence exists. More specifically, the test statistics are found to be statistically significant at 1 and 5 percent for all of the study variables. This shows the presence of CSD in study data

Table 1

Cross-Sectional Dependence Analysis

Construct	Test Stats (p-values)
EFP	18.018*** (0.000)
FIN	21.210*** (0.000)
EIN	19.091*** (0.000)
GLO	23.032*** (0.000)
GDP	17.107*** (0.000)

EFP; ecological footprint, FIN; financial inclusion, EIN; ecological innovation, GLO; globalization, GDP; gross domestic product, respectively

After examining the CSD under the present study, the below table presents the unit root testing outputs both with and without structural breaks based on the Pesaran (2007) test and Bai and Carrion-I-Silvestre (2009). The empirical findings gauged from Table 2 depict the rejection of the alternative hypothesis for Pesaran (2007) along with the Bai and Carrion-I-Silvestre (2009). Meanwhile, after considering the structural breaks for the study data, the empirical output still shows that H0 cannot be rejected in the case of Bai and Carrion-I-Silvestre (2009). On the other side, when considering Pesaran (2007), it is inferred that all the variables under the present study are stationarity at a level. Based on such results, our study has applied the Bai and Carrion-I-Silvestre (2009) through the first-order differencing methodology. Our study findings have provided enough evidence to reject H0 of non-stationarity and accept H1. This would justify the argument that all constructs such as EFP, FIN, EIN, GLO, and GDP are stationarity at the difference in the current study.

Table 2

Unit Root Test With & Without Structural Break

	Level I(0)			First Difference I(1)		
Constructs	CIPS	M-CIPS		CIPS	M-CIPS	
EFP	-2.119***	-4.120**		-	-	
FIN	-4.110***	-5.001**		-	-	
EIN	-6.006***	-7.012**		-	-	
GLO	-3.014***	-4.110**		-	-	
GDP	-3.510***	-5.100**		-	-	
Bai and Carrion-i-Silvestre (2009)						
	Z	P_m	P	Z	P_m	P
EFP	0.642	0.712	21.123	-6.010***	7.021***	48.101***
FIN	0.415	0.551	19.019	-3.301***	4.024***	62.060***
EIN	0.325	0.414	22.202	-5.505***	6.017***	55.010***
GLO	0.512	0.670	17.010	-4.110***	5.151***	74.012***
GDP	0.398	0.411	20.122	-3.315***	4.050***	39.030***

In addition, Table 3 considers the output for the slope heterogeneity analysis for the main dependent variable, ecological footprint. For this purpose, we proceed while applying the modified version of Swamy's (1970) slope homogeneity test as suggested in the research contribution of Pesaran and Yamagata (2008). Based on this method, it is possible to examine where there is a presence of heterogenous slope coefficients. This is due to the fact that in case of homogeneity in the slop coefficients, the findings will entirely lead to misleading output as expressed by Alam, Miah, Hammoudeh, and Tiwari (2018). More specifically, the findings under Table 3 are based on the H0 which claims that slope coefficients are homogenous whereas H1 indicates that they are not. The empirical output as shown through Delta tilde and Delta tilde adjusted are found to be significant at 1 percent, therefore, researchers have rejected Ho and accepted H1 for the heterogeneity in the slope coefficients.

Table 3

Slope Heterogeneity Analysis

DV: EFP	
	Test value (Sig.)
Delta tilde	38.073*** (.00)
Adjusted (Delta)	58.010*** (.00)

Westerlund and Edgerton (2008)

Under Table 4, the H0 is based on the idea that there is no cointegration among the study variables with the existence of CSD, structural breaks, and heterogeneity as well. On the other side, H1 specifies that there exists cointegration among the variables of interest. Our findings under Table 4 have rejected the Ho for no cointegration with no breaks, mean shift, and regime shift as well.

Table 4

A Panel Cointegration

Test	No break	Mean shift	Regime shift
DDV: EFP			
$Z_{\varphi}(N)$	-5.010***	-4.242***	-6.040***
P_{value}	.00	.00	.00
$Z_{\tau}(N)$	-4.101***	-3.357***	-5.072***
P_{value}	0.000	0.000	0.000

Banerjee and Carrion-i-Silvestre (2017)

The findings from the above table confirm the cointegration association between the study variables. Furthermore, the cointegration association for Banerjee and Carrion-i-Silvestre (2017) and Westerlund and Edgerton (2008) are found to be significant evidences.

Table 5

A Cointegration Aanalysis

Nations	No deterministic specification	With constant	With trend
DV: EFP emission			
Full Sample	-4.024***	-3.010***	-4.112***
Algeria	-6.011***	-5.100***	-7.017***
Bahrain	-3.013***	-3.000***	-4.014***
Egypt	-4.104***	-3.123***	-5.101***
Iran	-4.010***	-3.101***	-5.105***
Iraq	-3.023***	-3.005***	-4.010***
Jordan	-5.025***	-4.023***	-6.410***
Kuwait	-7.070***	-6.016***	-8.100***
Lebanon	-4.120***	-3.010***	-5.108***
Libya	-5.144***	-4.134***	-6.011***
Oman	-6.010***	-5.005***	-7.024***
Qatar	-7.020***	-6.051***	-8.010***
Saudi Arabia	-5.014***	-4.212***	-6.101***
Tunisia	-3.012***	-3.001***	-4.000***
United Arab Emirates	-7.987***	-6.456***	-8.753***
Yemen	-5.124***	-4.101***	-6.016***

In addition, the output under Table 6 shows the CS-ARDL results. The findings indicate that financial inclusion and ecological footprint share positive relations. This may provide justification for the argument that with a higher level of FIN, it impacts EFP directly in the targeted region. More specifically, this notes that a 1 percent rise in the value of FIN causes to increase EFP by 0.18 percent. In the existing body of literature, the connection of FIN with the ecological footprint is also investigated by various other researchers. For example, Yang, Jahanger, and Ali (2021) have examined the trends in ecological footprint in BICS countries while considering financial development and technological innovation as the main explanatory variables covering the period from 1990 to 2016. The study findings confirm that financial development in the selected economies significantly deteriorates the quality of the

natural environment, hence creating more environmental degradation. Similarly, the research work as contributed by M. Usman and Makhdum (2021) has also examined the dynamic linkage between financial inclusion through financial development and the ecological footprint of the BRICS economies. The study findings confirm that an increase in financial development is leading towards a higher level of environmental degradation among the BRICS countries. However, some researchers have also found that factors like financial inclusion through development have a significant contribution while improving environmental quality. For instance, M. Usman and Hammar (2021) focus on Asia Pacific Economic Cooperation economies and state that FD accelerates the quality of the natural environment in a significant manner. Besides, M. Usman, Makhdum, and Kousar (2021) have also provided their empirical findings while claiming that FD contributes towards overcoming environmental degradation in the 15 highest emitting countries.

Furthermore, Table 6 reports the association between ecological innovation and ecological footprint where the coefficient is -0.357 with a t-score of -3.072. This would indicate that EIN and EFP in a given sample shares positive relation. More specifically, one unit increase in the value of EIN is causing a downward shift of -0.357 in the value of ecological footprint and vice versa. It means that for lowering the environmental degradation in the MENA region, ecological innovation is playing a constructive role. Considering it, the study of Yang et al. (2021) has provided significant evidence for the reduction in ecological footprint through innovation in the BICS countries during the period of 1990–2016. Kihombo, Ahmed, Chen, Adebayo, and Kirikkaleli (2021) have also provided a similar justification and claim that technological innovation is helpful in reducing the EFP in the West Asia and the Middle East economies. Ke, Yang, Liu, and Fan (2020) have also justified the association between innovation efficiency and ecological footprint. It is explained the inverted U-shaped link of innovation efficiency with EFP where the former firstly promotes and then surprises the environmental issues like EFP.

Meanwhile, the findings under Table 6 also report the role of globalization in determining the ecological footprint. It is observed that GLO is significantly and positively associated with EFP with a coefficient of 0.247. This relationship is also justified in the existing literature where a series of studies have confirmed that globalization is among the core determinants of environmental pollution in the world economy. For instance, Sabir and Gorus (2019) have collected data for globalization and EFT for Asian countries during 1975–2017. The study findings show that various measures of globalization like foreign investment, trade openness, and KOF globalization index are showing their significant positive linkage with the EFP. O. Usman, Akadiri, and Adeshola (2020) have also provided similar evidence for the positive pressure of globalization on the ecological footprint in the economy of the USA. Furthermore, some other studies also have explored the dynamic association between ecological footprint and globalization (Figge, Oebels & Offermans, 2017; Kirikkaleli, Adebayo, Khan & Ali, 2021; Pata, 2021; Rudolph & Figge, 2017; Saud, Chen, & Haseeb, 2020).

Finally, the long-run estimation from Table 6 has shown that economic growth via GDP connects positively with EFP. This means that for every single unit increase in GDP, there is a .147 percent increase in the value of environmental issues like EFP for the MENA region. A common notion is that a higher level of economic growth in any economy is based on the production and transportation of goods and services which creates more environmental issues. Meanwhile, a similar argument is also justified by a range of researchers who have found a positive nexus between economic growth and EFP in different economies. For instance, Danish, Hassan, Baloch, Mahmood, and Zhang (2019) have examined the role of economic growth in determining the EFP. It is found that economic growth is positively associated with the EFP. Additionally, Hassan, Xia, Khan, and Shah (2019) have also confirmed the direct association between economic growth and ecological footprint for the economy of Pakistan. Furthermore, Alola, Bekun, and Sarkodie (2019), and Baz et al. (2020) have also confirmed the significant nexus between economic growth and EFP.

Table 6

CS-ARDL Analysis (Long Run)

Constructs	Coeff	t-stat	Sig.
DV: EFP			
FIN	.187***	7.010	0.000
EIN	-.357***	-3.072	0.000
GLO	.247**	2.049	0.045
GDP	.147***	5.174	0.000
CSD-Statistics	-	0.046	0.537

The analysis for the CS-ARDL short-run estimation is presented under Table 7. The findings under the short run show that financial inclusion and EFP share a positive connection, whereas ecological innovation plays an effective role in the reduction of environmental degradation in the MENA region. Likewise, higher ecological innovation is not only beneficial under the long run but also under short-run estimation too. Meanwhile, our results show that globalization and economic growth through GDP are among those indicators which are causing higher environmental pollution like EFP as shown in Table 7. Finally, the ECT-1 shows the pace of adjustment, which is -0.313, significant at 1 percent for CS-ARDL. More specifically, the coefficient under short-run estimation through CS-ARDL is found to be lower than the long-run estimation as shown in Table 6.

Table 7

CS-ARDL Analysis (Short Run)

Constructs	Coeff	t-stat	Sig.
DV: EFP			
FIN	.075***	4.045	0.00
EIN	-.056***	-5.102	0.00
GLO	.141***	5.010	0.00
GDP	.085***	3.741	0.00
ECT(-1)	-.313***	-4.010	0.00

Finally, the results under Table 8 show the output for the robustness check through AMRG and CCEMG. The results for AMG indicate that ecological innovation and EFP are negatively correlated. On the other side, the coefficients for FIN, GLO, and GDP are found to be positively significant (i.e. beta=0.043, 0.132, 0.210). This means that the findings through AMG are supporting the long-run and short-run estimation as generated through the CS-ARDL approach. Similarly, the findings under CCEMG testing method also provide evidence for the fact that financial inclusion, gross domestic product, and globalization are playing their significant role while more environmental issues like EFP. The same output is found under CS-ARDL long-run as well as short-run estimation. However, ecological innovation is showing its significant and negative role in reducing environmental degradation. Based on the above findings, it is inferred that both long-run and short-run estimations are quite consistent with the AMG and CCEMG robustness check. Based on the study findings, all of the study hypotheses have been accepted.

Table 8

= AMG & CCEMG for Robustness Check

DV= CO2	(AMG)			(CCEMG)		
	Coeff	t-stat	Sig.	Coeff	t-stat	Sig.
FIN	0.043***	3.010	0.000	0.181***	4.023	0.00
EIN	-0.072***	-3.023	0.000	-0.060***	-4.101	0.00
GLO	0.132***	4.110	0.000	0.281***	3.147	0.00
GDP	0.210***	5.011	0.000	0.137***	5.000	0.00
Wald test	-	63.47	0.000	-	39.021	0.00

Conclusion

The agenda of the paper is to scrutinize the connection of financial inclusion, globalization, economic growth, and ecological innovation with ecological footprints in the sample of the MENA region. The study employed different statistical techniques to evaluate the trends in the chosen sample. Furthermore, the present research has applied cointegration analysis techniques to evaluate the relationship between chosen constructs. The estimated outcomes through the CSARDL technique provide evidence regarding the positive relation of study constructs. However, factor like ecological innovation is observed with a negative and significant coefficient which claims that such innovation is beneficial in reducing environmental degradation for the MENA region. However, the coefficients under long-run estimation are found to be higher as compared to short-run estimation. Meanwhile, the findings through robust checking also confirm the consistency in the output as generated through CSARDL estimation.

Based on the study findings, this research recommends that to reduce the effect of economic growth on the ecological footprint, governments in MENA region should seriously redefine the growth pattern in a way that it has lower environmental consequences. For this purpose, economic activities like the production and transportation of goods and services should be more linked with those energy sources which are renewable in nature. In this way, there will be positive outcomes in the form of low carbon emissions in the natural environment as generated through economic growth in the selected countries. Meanwhile, another suggestion for the MENA region is based on the fact that financial inclusion in this area should be upgraded with clean energy projects, green bonds, green financing, and various similar other projects so that the environmental impact of financial inclusion may reduce to a reasonable level. Finally, to control the direct relationship of globalization and the ecological footprint, it is suggested that policymakers should analyze the environmental viability of key indicators or globalization like foreign investment, trade openness, and various others. In this regard, investors should be encouraged to do their investments more in those projects which are directly playing their role towards environmental improvements. Furthermore, social awareness should be enhanced while using different media sources at the global platform so that the adverse impact of globalization and its key indicators towards the natural environment would be controlled to an optimal level. Along with recommendation, the study has some limitations too. The study evaluated the role of said constructs in MENA region, means the finding may vary in other regions. Similarly, the study the used CS-ARDL technique to explore the association among variable. The are other techniques and methods too which could be used by future researchers.

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