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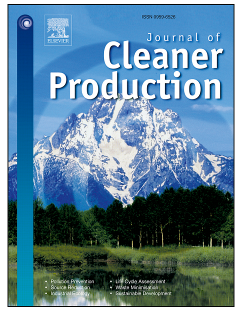

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The Role of Financial Development and Globalization in the Environment: Accounting Ecological Footprint Indicators for Selected One-Belt-One-Road Initiative Countries

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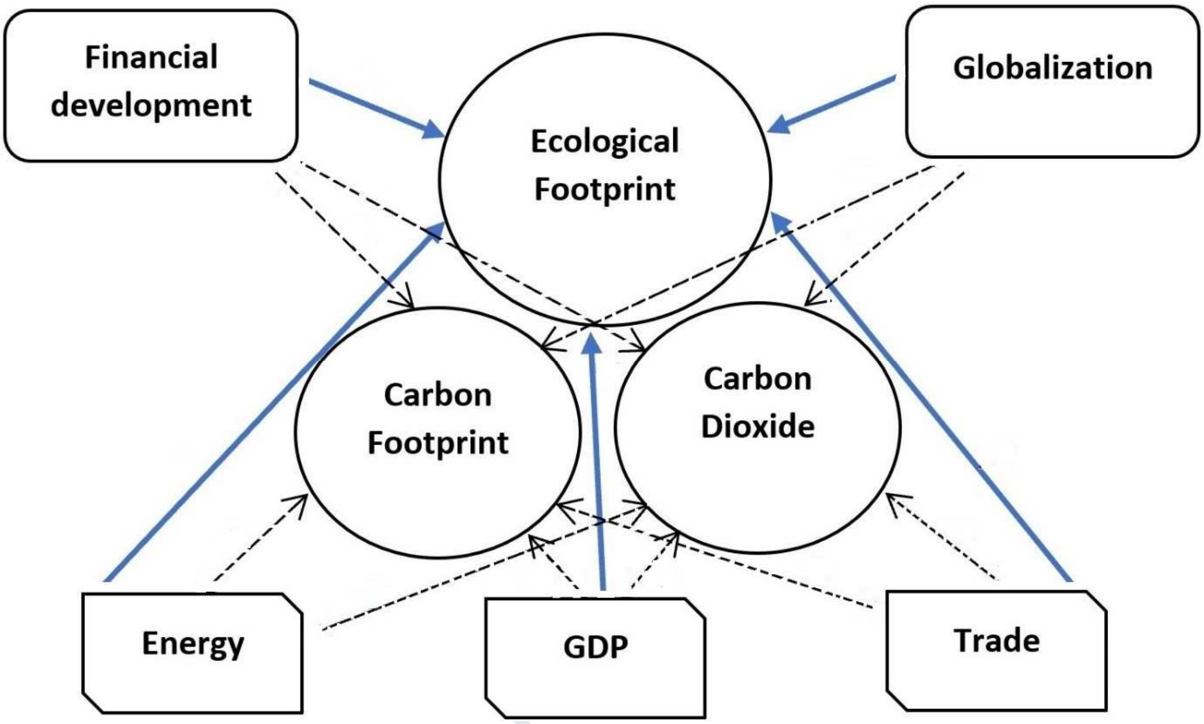
Graphical Abstract



The Role of Financial Development and Globalization in the Environment: Accounting Ecological Footprint Indicators for Selected One-Belt-One-Road Initiative Countries

Abstract

The pressure of globalization on our ecosystem is widely debated, and academics and researchers urge clear policies at all levels. In this regard, a plethora of research work use carbon dioxide (CO_2) emissions as an indicator of environmental measure to show that both globalization and financial development have diverse impacts on the environment. CO_2 emissions are only a portion of total greenhouse gas emissions, so a comprehensive measure is required to gauge total ecological deterioration. The ecological footprint (EF) indicator is a comprehensive environmental accounting tool that has streamlined input-output environmental assessments. This study investigates the role of financial development and globalization on the EF for selected one-belt-one-road initiative countries from 1990-2014. The pooled means group long-run panel estimation's results show that the EF sparks off by 0.0211 percent global hectares (gha) in selected panel countries when there is a 1 percent rise in financial development. A 1 percent growth in globalization mitigates the EF by 0.0038 percent gha in the long-run, suggesting an inverse relationship. Moreover, the country-specific findings show that the EF increases (at various percentages in gha) because of upsurges in both financial development and globalization in thirty and twenty-nine countries, respectively. However, the EF declines (at various percentages in gha) because of financial development in fourteen countries and globalization in four countries. In addition, the pairwise Granger causality finding shows the feedback effects of both financial development and globalization on EF. The EF affects environmental degradation, so efforts to reduce ecological deterioration and even immediate intervention measures should be employed in support of a sustainable environment.

Keywords: Financial Development; Globalization; Environmental Degradation; Ecological Footprint; Pooled Mean Group; One Belt One Road

1. Introduction

Human history is marked by increasing economic activities and development. These alterations have substantially increased humans' demands on nature's ability to provide food, energy, raw materials, and a healthful atmosphere (Lan et al., 2016). Humans' demands on nature alter the global ecosystem by creating ecological pressures from the extraction and depletion of natural resources, waste and pollution emissions, and movement of organisms. The impact of pressure on the environment is not limited to changes in the climate; it also results in land degradations, enhanced pollution, loss of biodiversity, and increased vulnerability of developing economies (Field et al., 2014). Currently, Earth is in the Anthropocene era, when humanity deteriorates nature and threatens all creatures' survival. Therefore, global economies are probing for more suitable ways of living to avoid social-ecological crises.

Energy plays a key role in economic progress, as it is an unalterable part of production. The conventional energy sources are the most commonly used energy sources and a major factor in industrial production. Countries try to boost their economic growth and foreign economic activity to gain competitive advantage, to increase their economic development, and to eradicate poverty. Economic development increases manufacturing production, which increases resource consumption and environmental deterioration. The extensive use of resources and generation of waste are key contributors to global greenhouse gas (GHG) and a country's carbon footprint (CF) (Kaltenegger et al., 2017) and ecological footprint (EF). The excessive consumption of fossil fuels, along with other human activities, causes climate change and ecological imbalance, which are threats to sustainable development. According to the Intergeneration Equity Theory, preserving the environment is an ethical and moral obligation for future generations (Demirel et al., 2016). To deal with such obligations, first, a comprehensive ecological measure is required to gauge total environmental degradation instead of CO_2 emissions alone, as it is only a small portion of total degradation.

The EF is a comprehensive environmental measure initially established by Wackernagel and Rees (1995). As Galli et al. (2012) explained, the EF indicator "measures human demand on nature and compares this to the availability of regenerative capacity on the planet. The method expresses human demand in terms of global hectares–i.e., biologically productive hectares with world-average productivity necessary for resource production and waste assimilation." The EF measures humans' demand on nature in terms of its five bio-capacity components: cropland, fishing grounds, built-up land, forestland, and grazing land. Human consumption has surpassed natural resources' production capacity, causing severe threat to the ecosystem. This supply-demand crisis depletes our planet's resource-production capacity, raises GHG and waste generation, and devastates our planet's ecosystem (Ewing et al., 2010).

The CF is defined as "the area of forest land required to uptake anthropogenic carbon dioxide emissions" (Lazarus et al., 2014), so this study uses a multidimensional indicator of the EF (along with the CF and carbon dioxide (CO_2) emissions). The EF, which refers to the environmental degradation triggered by human activities against the regenerative ability of the biosphere, has been investigated by numerous researchers (Rashid et al., 2018; Solarin and Bello, 2018; Ulucak and Lin, 2017), but most of the panel studies have used CO_2 emissions as an indicator of environmental degradation (e.g., Awad and Abugamos, 2017; Baek, 2015; Saud et al., 2019a, 2019b). All of these studies presented blended and inconclusive results for various regions globally.

Globalization is a contemporary topic of debate and a phenomenon that can affect the socio-economic aspects of human beings worldwide. There is no consensus on its definition, although Jones (2010) defined globalization is the expansion, inter-connectedness, and inter-relatedness of various facets of society, and Rennen and Martens (2003) defined it as a complex phenomenon that includes cross-national economic, social, cultural, technological, and environmental interactions. Globalization links economies through foreign direct investment (FDI) and trade, which increase the degree of openness and economic activities, energy demand, and financial development. Globalization also spreads cultural, social, and political values. It can abruptly affect human lives in terms of capital flows, technological transfers, and environmental consequences, so ecological processes are not distinct from globalization, as globalization's net outcome is to expand each person's EF because of the sharp rise in economic activities. All of these activities require infrastructure, energy, and natural resources for production. Global integration and differences in economies also increase the extent of ecological effects because of the rise of human demands on our ecosystem, resulting in an unsustainable environmental footprint (Hoekstra and Wiedmann, 2014). Clearly, globalization transforms our planet's health, but there are sharp disagreements about this transformation. Some empirical work has found that globalization has a positive relationship with the environment (Phong, 2019; Şenay et al., 2018; Shahbaz et al., 2015), while others have found a negative (Destek and Sarkodie, 2019; Olowu et al., 2018; Shahbaz et al., 2018b) or insignificant relationship (Haseeb et al., 2018; Xu et al., 2018). Certainly, globalization can significantly impact the environment through trade openness via channels like income effects, techniques effects, and composition effects (Grossman and Krueger, 1991). Empirical work from Lamla (2009), Paramati et al. (2017), and Shahbaz et al. (2017) has investigated the globalization-trade-environment nexus and reached diverse findings.

According to Dauvergne (2008), globalization is the universalization of financial markets, which can affect the global environment, so financial development is an additional factor with which to demonstrate the economic-environment nexus. As a measure, financial development exhibits both the wealth and scale effects on an economy. A strong financial system provides easy access to capital and wealth in an economy, which advances the standard of living and increase the purchases of big-ticket items, resulting in high energy consumption and emissions. On the other hand, the expansion of capital and financial markets leads to the establishment of new production lines and purchases of large-scale advanced equipment, which are more energy-efficient and reduce environmental waste and emissions. Financial development also has both technological and structural effects on the environment (Du et al., 2012). Financial development and the capital market stimulate financial channels and attract FDI, which brings green-environmental technology and research and development (R&D) projects. The financial sector "greases the wheels" of economic growth and development through commercialization and technological advancement (Hsueh et al., 2013). Anees et al. (2019), and Zafar et al. (2019) recently found globalization and financial development enhance environmental quality by reducing emissions, but Shahbaz et al. (2015) found that both globalization and financial development hurt the environment by producing high emissions. Hence, the present study addresses the question concerning whether globalization and financial development are an ecological solution or a crisis from the perspective of selected one-belt-one-road (OBOR) initiative countries.

======INSERT TABLE 1 ABOUT HERE.======

The 2013 OBOR initiative embraces wide-range globalization and international collaboration in the performance of mega-projects. China embarked on an economic expansion strategy called the Silk Road Economic Belt (SREB), which was accompanied by the Twenty-First Century Maritime Silk Road (TCMSR) program (See Figure 1). In 2013, China was the world's largest trading economy, with US$4.16 trillion in trade (total exports and import worth US$2.21 trillion and US$1.95 trillion, respectively) and had the second-largest economic growth (i.e., GDP of US$10 trillion) (Chang, 2014). This mega-initiative program comprised sixty-five countries—twenty-four European, twenty-six Asian, and fifteen North African and Middle Eastern—that accounted for 30 percent of global GDP, US$1.4–6.0 trillion in provision of financing, 62.3 percent of the world's human population (4.4 billion people), and 35 percent of the world's trade. The initiative sought to achieve long-range socio-economic development through globalizing the world economies and to stimulate economic and infrastructure development and financial integration (NDRC et al., 2015). In March 2015, this initiative plan was issued, describing two routes for the twenty-first CMSR, one from coastal China to the South China Sea to the South Pacific, and one from coastal China to the South China Sea to the Indian Ocean to Europe. The OBOR-initiative plan proposed three routes for the SREB: first from China to Central Asia to West Asia to the Persian Gulf to the Mediterranean Sea; from China to Central Asia to Russia to Europe's Baltic countries; and from China to Southeast Asia to South Asia to the Indian-Ocean (Chin and He, 2016; Saud et al., 2019b) (Figure1). The OBOR initiative comprised wide-range globalization, international collaboration, and mega-projects, which may have undesirable environmental consequences in the long run. In short, this initiative has absolutely no boundaries. It is composed of:

OBOR = SREB + 21st CMSR

======INSERT FIGURE 1 ABOUT HERE.======

The literature has provided insights into the nexus of financial development, globalization, and the environment. However, most of the recent empirical work (e.g., Anees et al., 2019; Haseeb et al., 2018; Şenay et al., 2018; Shahbaz et al., 2018b, 2015; Zafar et al., 2019) has used CO_2 emissions as a proxy for an environmental measure (See Table 2 for details). However, the potential impact of a more holistic indicator like the impact of the EF (and the CF) has not been well examined from the perspective of the OBOR initiative. Moreover, none of the empirical work has investigated the pros and cons of the effect of globalization and financial development on the environment in a single model from the perspective of selected countries. The finance-globalization-environment nexus is crucial, as participant countries in these mega-projects seek to attain "sustainable development goals" by 2030. The study at hand highlights and fills this gap in the academic literature.

Using panel results, this study also provides country-level results for all three selected environmental proxies: the EF, the CF, and CO_2 emissions. The selected panel countries are categorized into six sub-sections based on their geographical location and development (Table 1) to provide a deep and thorough understanding of the countries and to assist the responsible authorities in appropriate policymaking.

This study is novel in three ways in particular. First, it augments the environmental function by incorporating globalization into the model as a factor of economic growth, energy consumption, and the environment for selected OBOR countries. Adding globalization to the model avoids specification bias in the relationship between the EF and financial development. Second, the study is the first to examine the finance-globalization-environment nexus from the perspective of OBOR-initiative countries and takes a step forward by employing three environmental measures—the EF, the CF, and CO_2 emissions—in a single study. Third, the study applies the cross-sectional dependence (CD) approach and the Lagrange multiplier (LM) approach to find the cross-sectional dependence in the data. The cross-sectional augmented Dickey-Fuller (CADF) and cross-sectional Im, Pesaran and Shin (CIPS) panel unit root test, and the Westerlund (2007) cointegration test are used to take into account the issues of cross-sectional dependence and heterogeneity in the panel data. The long-run relationships are checked using the pooled mean group (PMG) approach and the fully modified ordinary least square (FMOLS) approach. Unlike other panel studies (Table 2), this study provides insights into the finance-globalization-environment nexus for both the panel and country levels. For instance, the EF increases by 0.0211 percent global hectares (gha) when there is a 1 percent increase in financial development occurs. Whereas, a 1 percent increase in globalization mitigates the EF by 0.0038 percent gha in the long run, suggesting an inverse relationship. In contrast, most of the recent literature (e.g., Anees et al., 2019; Zafar et al., 2019; and Phong, 2019) has found that globalization and financial development enhance environmental quality by reducing CO_2 emissions in APEC, OECD, and ASEAN countries, respectively. However, Haseeb et al.'s (2018) study revealed that financial development increases CO_2 emissions, although it found insignificant results for globalization in BRICS economies. Our study also notes the feedback effects of both financial development and globalization with EF.

The rest of the paper is organized as follows: Section 2 describes the methodology and data; Section 3 reports and discusses the results; and Section 4 concludes the study and presents policy recommendations.

======INSERT TABLE 2 ABOUT HERE.======

2. Methodology and data

2.1 Model specification and data

We use data on the EF, the CF, CO_2 emissions, financial development, globalization, economic growth, and energy use to examine the relationships among financial development, globalization, and the environment for selected OBOR-initiative countries.

It is a widespread belief that financing can affect the environment. Financial development is imperative for economic development, as it promotes the financial sectors (the stock market and banking sectors) and the financial efficiency of the economy (Sadorsky, 2011). A well-developed financial sector can play a crucial role in business transactions, savings, resource monitoring, and mobilization for economic growth and development (Nasreen et al., 2017). Without question, financial development boosts a country's financial structure and attracts FDI, which can affect the environment through technique, scale, and composition effects. The technique effect refers to the overall impact of the introduction and transfer of eco-friendly technology and green productions, suggesting that green technology can boost environmental quality by lowering energy consumption and CO_2 emissions. The scale effect captures the view that, through economic liberalization, FDI increases CO_2 emissions, as high levels of production in the economic-liberalization process leads to high energy consumption and CO_2 emissions (Pazienza, 2015). For its part, the composition effect refers to an economy's fluctuation from an agriculture-based to an industrial economy, which increases energy demand. The composition effect depends on the economy's production specialization and competitive advantages (Cole and Elliott, 2003).

One of the most frequently used measures of globalization is the KOF Index of Globalization, which is comprised of social, political, and economic globalization (Dreher, 2006). Globalization brings changes in economic development and comparative advantages through trade with international economies. It affects not only the domestic factors of production but also has composition effects on the environment (Ling et al., 2015). It encourages changes in trade policies related to removing cross-border restrictions and increasing the introduction of green technologies. Such changes may have an indirect effect on ecological management practices, resource allocations, and on the environment. For instance, Charfeddine and Mrabet (2017) and Uddin et al. (2017) found that financial development enlarges the EF. On the other hand, the empirical findings of Rudolpha and Figge (2017) confirmed that globalization mitigates EF, while Figge et al. (2017) found diverse results for the impact of various measures of globalization on the EF.

Based on this discussion, the specified long-run model is given in **Equation (1)**:

$$EQ = f(FD, G, GDP, EU, TR), \quad \textbf{(1)}$$

All of the modeled variables are transformed into their natural logarithms to smooth data for more reliable estimations (Shahbaz et al., 2016). Following Destek and Sarkodie (2019) and Tamazian and Rao (2010), the econometric log-linear panel function of **Equation (1)** can be rewritten as:

$$InEF_{it} = \alpha_0 + \alpha_{1i} InFD_{it} + \alpha_{2i} InG_{it} + \alpha_{3i} InGDP_{it} + \alpha_{4i} InEU_{it} + \alpha_{5i} InTR_{it} + \mu_{it}, \quad \textbf{(2)}$$

$$InCF_{it} = \beta_0 + \beta_{1i} InFD_{it} + \beta_{2i} InG_{it} + \beta_{3i} InGDP_{it} + \beta_{4i} InEU_{it} + \beta_{5i} InTR_{it} + \lambda_{it}, \quad \textbf{(3)}$$

Following Haseeb et al. (2018), Anees et al. (2019), and Zafar et al. (2019), the log-linear multivariate of **Equation (1)** is rewritten as:

$$InCO2_{it} = \delta_0 + \delta_{1i} InFD_{it} + \delta_{2i} InG_{it} + \delta_{3i} InGDP_{it} + \delta_{4i} InEU_{it} + \delta_{5i} InTR_{it} + \varpi_{it}, \quad \textbf{(4)}$$

where ***i*** is the number of countries (i.e., 1, 2, 3….49); ***t*** is the period (i.e., 1, 2, 3…., n); and InEF, InCF, and $InCO_2$ are the logarithms of the EF (dependent variable), the CF, and CO_2 emissions, respectively. The μ_{it}, λ_{it}, and ϖ_{it} are the error terms; α_0, β_0, and δ_0 are the slope intercepts; and α_1, α_2,…., α_5, β_1, β_2,…, β_5, and δ_1, δ_2,….,δ_5 are the coefficient estimates of financial development (FD_{FS}), globalization (G), economic growth (GDP), energy use (EU), and trade (T), respectively. We expect α_1, α_2, α_3, β_2, β_4, β_5, δ_1, δ_2, and δ_3 to be positive and α_4, α_5, β_1, β_3, δ_4, and δ_5 to be negative. As the logarithm of the EF refers to the number of environmental limits to humans' demands, an increase in the EF means an increase in environmental deterioration.

The goodness-of-fit of equations 2, 3, and 4 were assessed by analyzing the actual values versus the predicted values of CF, EF, and CO_2, and found it in good agreement. The actual-versus-predicted method provides useful information regarding the fitness of the linear equation(s) (Rawlings et al., 1998). Figure 2 shows the plots of actual-versus-predicted values for EF, CF, and CO_2 emissions, overlaid with the best-fit-linear regression lines. The closeness of the points to the regression lines in all three plots provides visual checks of the predicted values versus actual values and presents a significant correlation among them. Hence, all three regressions equations (i.e., Equations 2, 3, and 4) fit well and are in agreement with the actual values (data set). The data set selection is based on data availability, while model selections are based on recent literature (Anees et al., 2019; Destek and Sarkodie, 2019; Tamazian and Rao, 2010; Zafar et al., 2019), which justifies the appropriateness of our models beyond 2014 and into the future.

======INSERT FIGURE 2 ABOUT HERE.======

This study uses an annual data set for selected OBOR-initiative countries from 1990 to 2014. Following Destek and Sarkodie's (2019) data-collection method, we took data on the EF indicator and the CF indicator (in global hectares) from the National Footprint Accounts (NFA) of the Global Footprint Network (GFN, 2017). Countries whose data are inappropriate were excluded from the analysis, which reduced our sample size to forty-nine countries. Further, data for EF and the CF were available only up to 2014, constraining our choice of data-selection period to 1990-2014. Data regarding globalization was taken from the KOF Index of Globalization (Dreher, 2006; KOF, 2017), and data on CO_2 emissions (in metric tons per capita), economic growth (in constant 2010 US$), financial development (in domestic credit provided by the financial sector, scaled by GDP), and energy use (kg of oil equivalent per capita) were derived from the World Development Indicator (WDI, 2017) website. Descriptions of the data collection, variables, and measures are provided in Table 3.

The CF and CO_2 emissions are additional proxies used for robustness checks. The development of the financial sectors in the selected OBOR-initiative countries is used as a proxy for financial development (Shahbaz et al., 2018a).

======INSERT TABLE 3 ABOUT HERE.======

Figure 3 shows the summary statistics of the examined variables for the selected panel of OBOR-initiative countries from 1990-2014. The box charts show the scatterplots, and each plots percentile are 25/50/75, whisker caps represent the 1/99 percentiles. The dots signify the maximum (top) and minimum (down) values, while the square indicates their mean values.

======INSERT FIGURE 3 ABOUT HERE.======

2.2 Econometric Methodology

2.2.1 Cross-sectional dependence test

We started the econometric analysis with the CD test. CD is a common issue in panel data, as such data overlooks cross-sectional errors and offers unreliable and biased results (O'Connell, 1998). Therefore, we probed for CD among panel countries by employing the CD approach and the LM approach, as suggested by Pesaran (2004) and Breusch and Pagan (1980), respectively. The CD test uses the following equation **(5)**:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=0}^{N-1}\sum_{j=i+1}^{N}\rho ij\right), \quad \textbf{(5)}$$

where CD is the cross-sectional dependence, N is panel cross-sections, T is the period, and ρij is the cross-sectional correlation of errors between i and j.

The LM test uses equation **(6)**:

$$y_{it} = \alpha_{it} + \beta_i x_{it} + \varepsilon_{it} \quad \textbf{(6)}$$

2.2.2 *The CIPS and CADF unit root test:*

Since the CD test confirmed the presence of CD in the panel data, this study uses second-generation panel unit root tests rather than first-generation. The cross-sectional augmented Dickey-Fuller (CADF) and the cross-sectional augmented Im-Pesaran-Shin (CIPS), established by Pesaran (2007), are employed. These tests are more robust to heterogeneous CD and have more power than first-generation tests. The CIPS test uses equation **(7)**:

$$\Delta x_{it} = \alpha_{it} + \beta_i x_{it-1} + \rho_i T + \sum_{j=0}^{n} \theta_{it} \Delta x_{i,t-j} + \varepsilon_{it}\,, \quad \textbf{(7)}$$

where x_{it}, ε_{it}, i, and t are the analyzed variables, the residuals of the model, the CD in the panel, and the period, respectively.

The CIPS, recommended by Pesaran (2007), uses equation **(8)**:

$$CIPS = \frac{1}{N} \sum_{i=1}^{N} CADFi\,, \quad \textbf{(8)}$$

where CADF_i is the CD augmented Dicky Fuller statistic.

2.2.3 *Westerlund panel cointegration test*

To obtain a statistically meaningful coefficient of the variables, the variables should be stationary or cointegrated at level [I (1)]. In our case, the analyzed variables are not stationary at their level, so the Westerlund (2007) cointegration test is employed to account for the heterogeneity issue in time series panel data. The group statistics determine whether the panel is cointegrated, while the panel statistics determine that at least one cross-section in the panel should be cointegrated. The test uses equation **(9)**:

$$\Delta Y_{it} = \delta_i d_t + \alpha_i Y_{i,t-1} + \lambda_i^{'} X_{i,t-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta Y_{i,t-1} + \sum_{j=-qi}^{pi} \gamma_{ij} \Delta X_{i,t-1} + \varepsilon_{it}, \quad \textbf{(9)}$$

where i, t, ε_{it}, and, d_t are the cross-sections, the period, the residuals of the model, and the model's deterministic components, respectively.

2.2.4 Pooled Means Group (PMG)

The key inference of empirical work is the long-run relationships among the modeled variables. This study employs the PMG estimator established by Pesaran et al. (1999) to control for the heterogeneity issue in the panel data. The PMG estimator provides favorable and consistent results for the parameters in the long-run relationship and does not require the analyzed variables to be integrated at either [I(0)] or [I(1)].

The PMG model can be expressed as in equation **(10)**:

$$\Delta y_{i,t} = \phi_i Y_{i,t} + \sum\nolimits_{j=0}^{q-1} \Delta X_{i,t-j} \beta_{i,t} + \sum\nolimits_{j=1}^{p-1} \lambda_{i,y} * \Delta y_{i,t-j} + \varepsilon_{i,t}, \quad \textbf{(10)}$$

$$EC_{i,t} = y_{i,t-1} - X_{i,t} \theta, \quad \textbf{(11)}$$

where Δ, y, and X are the difference operator, the dependent variable, and the independent variables (EC, GDP, FD_{FS}, G, and TR), respectively.

2.2.5 Granger causality test

The Granger non-causality approach was employed to account for heterogeneity issues in the panel data, as suggested by Dumitrescu and Hurlin (2012). The Dumitrescu-Hurlin (DH) test is a modified version of the Granger causality test, which is more flexible for T<N and T>N in case of both unbalanced and heterogeneous data. The DH test uses equation **(12)**:

$$y_{i,t} = \phi_i + k = \sum_{k=1}^{k} \gamma i^{(k)} y_{i,t-k} + \sum_{k=1}^{k} \varphi i^{(k)} \chi_{i,t-k} + \varepsilon_{i,t}, \quad \textbf{(12)}$$

where ϕ_i is the slope-intercept; φi and γi are the slope coefficients; ε is the error term, and k is the number of leg lengths.

3. Results and discussion

3.1 Results from the CD and LM tests

The CD test results are reported in Table 4. Referring to the P values, the test provides sufficient evidence to reject the null hypothesis in favor of the alternative hypothesis for estimated panel data because the p-value is below 0.01 (p<0.01). Thus, the EF, CF, CO_2, GDP, G, FD_{FS}, EC, and TR are cross-sectionally dependent in the series.

======INSERT TABLE 4 ABOUT HERE.======

3.2 Results of the CIPS and CADF tests

The results of the CIPS and CADF tests are presented in Table 5. The CIPS and CADF results show that EF, CF, CO_2, GDP, and G are stationary at their levels (the 1% and 5% significance levels), whereas FD_{FS}, EC, and TR are not. Therefore, the tests provide enough evidence to reject the null hypothesis. All of the analyzed variables become stationary at their 1st differences for CIPS and CADF tests at the 1% significance level and are integrated at order one [I (1)]. In this case, we have to run the cointegration test.

======INSERT TABLE 5 ABOUT HERE.======

3.3 Results from the Westerlund cointegration test

The Westerlund cointegration test results are tabulated in Table 6. The Westerlund cointegration test uses group statistics and probability statistics. The p-values of the group statistics and probability statistics in model 1, model 2, and model 3 are all significant, so the test provides enough evidence that the analyzed variables are cointegrated in the selected panel.

======INSERT TABLE 6 ABOUT HERE.======

3.4 PMG long-run estimation

The results from the PMG estimate, depicted in Table 7, suggest that the long-run coefficient of all the analyzed indicators are significant at the 1% and 5% levels of significance. (See Equations 2, 3, and 4). The selection of the significance levels is based on Fisher's proposed grading: "If P is between 0.1 and 0.9 there is certainly no reason to suspect the hypothesis tested …"(Fisher, 1950). Fisher suggested that the reported *p*-values be P<0.01 and P< 0.05 but rarely P<0.001 (Dahiru, 2008). The use of the same proxy for the environment in multiple countries may vary our results, as the suitability of the proxies affects panel series (Charfeddine and Mrabet, 2017).

The impact of financial development on ecology is a subject of intense debate. Our results show that the coefficient of financial development concerning the EF is positive and significant at the 1% significance level (Table 7), suggesting that a one-point increase in financial development corresponds to a 0.02 percent increase in environmental deterioration, keeping all else constant. This result shows that financial development is a significant and sizable determinant of environmental degradation (Tamazian and Rao, 2010) for traditional economies. Charfeddine (2017) reported similar results for Qatar. During financial development, a strong financial sector stimulates financial markets to provide low-interest loans, which enhances investment activities and public purchasing power. The resulting rise in the purchase of energy-intensive big-ticket items increases energy demand and CO_2 emissions. Low allocation of financial resources to environmentally friendly projects and expansion of high-energy-consuming projects (Saud et al., 2019b) increases water and soil deterioration, waste of resources, and environmental degradation. The financial assistance for the long-term OBOR-initiative projects (i.e., from rail, road, and sea) may increase demands on natural resources, along with a sharp rise in industrialization and transport activities. Financial activities stimulate changes in economic expansion and development, which increase resource extraction, wastes generation, and ecological deterioration. Similarly, the relationship between financial development and CF and that between financial development and CO_2 emissions show that financial development has a strong positive impact on both the CF and CO_2 emissions at the 1% and 5% significance level, respectively (See Equations 3 and 4).

Globalization reduces the EF at the 1% significance level (Table 7), indicating that a 1 percent increase in globalization mitigates the EF by 0.0038 percent, all else kept constant. In other words, globalization enhances environmental quality via a reduction in EF. This result leads us to conclude that a high level of globalization mitigates the EF and puts less pressure on the planet's ecosystem, and it supports the view of Rudolpha and Figge (2017) for 146 countries, but not that of Charfeddine (2017) for Qatar. Today's sharp rise in the consumption needs of modern societies that are caused by both high affluence and demographic development puts pressure on the extraction and use of natural resources. Optimists perceive the globalization phenomenon as a progression that leads to increased economic growth and per-capita income, which generate funds for environmental sustainability and address environment-related problems worldwide (Dauvergne, 2004). More openness to the international markets also brings in new partners and flexibility in green investments that shield the environment from deterioration. Globalization through FDI inflows and trade bring green and low-polluting goods, fresh production methods, technology spillover, managerial skills, and so on, and may enhance economic development and environmental sustainability. The diffusion of foreign industries and the successive waves of technological innovation reduce the misuse of natural resources as inputs in their production lines and, consequently, reduce the negative ecological impact

(Borghesi and Vercelli, 2003). Hence, international liberalization with positive externalities in the form of more R&D, fresh knowledge, eco-friendly technologies induced by foreign investments can exert a significant positive impact on the environment.

Further, the literature has revealed that international agreements (i.e., political globalization) for sustainable development like the Montreal Protocol and the Kyoto Protocol are not up tackling climate change, as such global agreements are limited to GHG emissions and Ozone (O_3), while efforts to address control of other environmental issues, such as desertification, deforestation, and high waste generation, lag behind (UNEP, 2012). It seems to be appealing to rely on such agreements to enhance global environmental quality. Public awareness through electronic media (i.e., social globalization) can also play a significant role in environmental protection (Motoshita et al., 2015). Moreover, globalization also has a negative and significant impact on both the CF and CO_2 emissions at the 1% significance level (See Equations 3 and 4).

The results show that there is a positive and significant relationship between energy consumption and the EF. Table 7 shows that the EF increases by 0.5574 percent with every 1 percent increase in energy consumption, so growth in energy consumption leads to an increase of the EF in the OBOR-initiative countries. This result supports the findings of Charfeddine and Mrabet (2017) for MENA countries and those of Destek and Sarkodie (2019) for Next-11 countries. Energy is considered the largest factor in environmental deterioration. There is a strong correlation between energy consumption and pollutants like sulfur dioxide (SO_2), CO_2, suspended particle matter (SPM), and dark matter (fine smoke), as the sharp rise in industrialization, production activities, household energy consumption, and manufacturing processes requires conventional energy sources (i.e., the use of oil, electricity, gas, and heating fuels). The ecological moderation theory suggests that advancement and structural changes of institutions, technology, and policies (e.g., ecological and other development policies) can assist in controlling environmental deterioration (Charfeddine and Mrabet, 2017). The inadequate policies, high levels of conventional energy usage, lack of green-energy sources in the energy mix, weak environmental regulations, or perform untimely monitoring of industries, leading to high CO_2 emissions, wasted resources, and ecological deterioration. Mature firms invest in energy-efficient infrastructure and in the reduction of fossil fuel consumption, which helps to control environmental degradation (Sarkodie and Strezov, 2019). Similarly, an increase in energy consumption significantly increases the CF and CO_2 emissions at the 1% significance level in the selected OBOR countries.

The relationship between the EF and economic growth is positive and significant at the 5% significance level. All things kept the same, a 1 percent increase in economic growth increases the EF by 0.0566 percent in the long-run results. This positive association shows that the selected panel countries are mainly concerned with their economic expansions, by compromising on extensive polluted productions. This finding is in line with Ozturk et al. (2015) for 144 countries and with Destek and Sarkodie (2019) for Next-11 countries. The acceleration in economic growth leads to the expansion of industrialization and production activities, and in many cases, an increase in economic growth brings environmental deterioration (Borghesi and Vercelli, 2003). An increase in the scale of (inefficient) economic activity can increase environmental degradation as more inputs are required for the production of demanded output, which will increase environmental degradation. Switching agricultural land to use by manufacturing industries degrades the environment, but introducing of green industries and technological advancement can mitigate environmental stress. Thus, the sustainability theory refers to efficient resources' management, which discusses the adjudication of present and future well-being accompanied by the liquidation of primitive wealth (i.e., comprised of natural resources). In this regard, global economies should adopt a satisfactory level of savings and investment in eco-friendly policies and advanced technologies (Tiba and Frikha, 2019). Hence, the inefficient use of resources, traditional industrial structure, high production costs, lack of production efficiency, high reliance on fossil fuel energy, and high generation of industrial ecological waste are some of the most important factors in ecological degradation. The results also show that economic growth has a positive and significant impact on both the CF and CO_2 emissions (See Equations 3 and 4).

This study shows the positive association between trade and the EF. The results indicate that a 1 percent increase in trade boosts the EF by 0.0884 percent in selected OBOR countries. Trade of forestry and agricultural products from one country to another country naturally offsets the domestic ecological protection of exported country over using its natural resources by other (imported) countries (Meyfroidt et al., 2010). International trade is responsible for 30 percent of the threat to the animal species in the developing economies by causing forests and agricultural lands to be used for industry (Lenzen et al., 2012). It is the co-responsibility of the developed economies and developing economies to reduce pressure on the environment, loss of biodiversity, and ecological degradation in developing economies. Trade liberalization via the composition effect, shifts their natural resources to industries to gain competitive advantage, where economies might use more pollution-intensive resources, high levels of consumption of natural resources, and even the use of outdated technologies (Grossman and Krueger, 1995). In most cases, the competitive advantage gained from weak environmental regulations and dirty industries increases environmental damage. Chen and Han, (2015) indicated that a third of the arable land used for international trade and integration needs serious attention to mitigate its adverse impacts on the environment. However, strong environmental regulations on polluting industries and tariffs on outdated technology (through trade) will help to address environmental issues. Similarly, trade has a positive impact on CF but a negative impact on CO_2 emissions. Measures like the EF (and the CF) are more comprehensive than CO_2 emissions and capture all direct and indirect effects on the environment. The use of the same proxies for the environment in multiple countries may also provide diverse results because the aptness of the proxies affects panel series data. Thus, the PMG long-run results for the EF (Equation 2) are robust for other ecological measures, such as the CF and CO_2 emissions (See Equations 3 and 4).

Figure 4 provides a graphical summary of the long-run associations among the variables under study (obtained from Table 7).

======INSERT FIGURE 4 ABOUT HERE.======

======INSERT TABLE 7 ABOUT HERE.======

3.5 FMOLS long-run estimation results

To investigate country-level results, this study employs the FMOLS cointegration approach proposed by Pedroni (1996). The results for the selected OBOR countries are categorized for the: Southeast Asian, South Asian, West Asian and Middle Eastern, Central and Eastern European, Central Asian, and other countries, as tabulated in Table 8 and Figure 4.

The results shown in Table 8 (Equation 2) show that energy consumption has a positive and significant impact on the EF for four Southeast Asian, four South Asian, six West Asian and Middle East, thirteen Central & Eastern European, one Central Asia, and one other country, and a negative and significant effect for two Southeast Asian, three West Asian and Middle Eastern, and one Central and Eastern European country. The positive (negative) sign of the coefficient of energy consumption concerning the EF shows that in thirty (six) countries out of forty-nine energy consumption hurts (enhances) the environment. The highest positive and significant coefficient of energy consumption with respect to the EF in South Asia is in India (i.e., 5.1785% gha), followed by the Slovak Republic (3.7215%) in Central and Eastern Europe, Kazakhstan (2.3129%) in Central Asia, Azerbaijan (1.6410%) in West Asia and the Middle East, Malaysia (0.4908%) in Southeast Asia, and Russia (0.1767%) in other regions. However, the strong negative coefficient of energy consumption in West Asia and the Middle East is in Iran (i.e., -4.5119%), followed by Thailand (-3.6943%) in Southeast Asia, and Montenegro (-1.9431%) in Central and Eastern Europe. The positive association is in line with the findings of Sarkodie and Adams (2018), and the negative association could be due to the alignment of these economies with the Kyoto Protocol and other environmental policies, which can lead to significant mitigation of the EF. Their newly enacted policies for efficient energy use and green technologies helps in the reduction of environmental deterioration.

The impact of financial development on the EF is positive and significant for thirty countries: two Southeast Asian, two South Asian, five West Asian and Middle Eastern, five Central and Eastern European, and two Central Asian countries. A significant and positive coefficient of financial development is found in the Slovak Republic (i.e., 1.7336% gha) in Central and Eastern Europe, followed in Central Asia by the Kyrgyz Republic (1.1879%), in South Asia by Moldova (1.1643%), in West Asia and Middle East by the UAE (0.7329%), and in South East Asia by the Philippines (0.0760%). This result supports the findings of Charfeddine (2017) and Mrabet and Alsamara (2017). However, the results show a negative relationship between financial development and the EF for fourteen of the forty-nine countries: two Southeast Asian, two South Asian, three West Asian and Middle Eastern, six Central and Eastern

European, and one Central Asian. The negative and significant coefficient of financial development in the selected panel was found in West Asia and Middle East (Kuwait; -1.4771% gha), South Asia (Bangladesh; -0.8968%), Central and Eastern Europe (Estonia; -0.7177%), Central Asia (Kazakhstan; -0.3079%), and Southeast Asia (Singapore; -0.2068%). Our results support Uddin et al.'s (2017) findings. The results suggest that the financial sector may stimulate funding for eco-friendly industry, technologies, and green environmental projects in fourteen countries but that the increase in financial development in thirty countries hurt the environment.

Globalization increases the EF in twenty-nine out of forty-nine countries, six Southeast Asian, three South Asian, ten West Asian and Middle Eastern, eight Central and Eastern European, and one other country and decreases the EF in four countries, one Southeast Asian, two Central and Eastern European, and one other country. The positive impact of globalization on the EF is found in West Asia and Middle East (Kuwait; 18.9103% gha), South Asia (Bangladesh; 4.7116%), Central and Eastern Europe (Hungary; 4.5476%), Southeast Asia (Singapore; 3.6403%), and other countries (Russia; 1.6775%). However, the negative coefficient is found in Central and Eastern Europe (Montenegro; -11.481% gha), other countries (Mongolia; -10.6506%), Southeast Asia (Malaysia; -2.0214%), and West Asia and the Middle East (Armenia; -0.6868%). Sharif et al. (2019) found that globalization increases the EF, while Figge et al. (2017) found diverse impacts of globalization on the EF. Globalization through FDI brings industrial changes and introduces green technologies for production activities, which boosts production with low emissions (Tamazian and Rao, 2010). On the other hand, related to the pollution-haven hypothesis, economic globalization in countries with lax environmental regulation increases production in polluting industries and increases environmental deterioration (Copeland and Taylor, 2008).

The coefficient of trade has a significant and positive impact on EF, in thirteen countries, two Southeast Asian, two South Asian, two West Asian and Middle Eastern, five Central and Eastern European, one Central Asian, and one other, but it has a negative impact in fourteen countries, two Southeast Asian, two South Asian countries, four West Asian and Middle Eastern, and six Central and Eastern European. The highest positive and significant coefficient of trade is found in West Asia and the Middle East for Kuwait (6.4526% gha), followed by Belarus (1.2357%) in Central and Eastern Europe, Russia (0.4384%) in other countries, Kazakhstan (0.4382%) in Central Asia, Sri Lanka (0.3656%) in South Asia, and Malaysia (0.2916%) in Southeast Asia. A significant negative coefficient of trade is found in West Asia and the Middle East for Iran (-3.4126% gha), followed by Macedonia (-1.5753%) in Central and Eastern Europe, Bangladesh (-1.0867%) in South Asia, and Singapore (-0.5629%) in Southeast Asia. The positive impact of trade on environmental degradation, which is in line with Al-mulali et al.'s (2015b) findings, shows that international trade is not sufficient to decrease the EF in thirteen countries and that it may stimulate energy consumption through scale, composition, and technique effects. On the other hand, in fourteen OBOR countries, international trade significantly reduces the EF by combating environmental degradation.

The link between economic growth and the EF is positive and significant for seven Southeast Asian, two South Asian, six West Asian and Middle Eastern, four Central and Eastern European, two Central Asian, and one other country. The positive and significant coefficient of economic growth with respect to the EF is found in West Asia and the Middle East for Iran (5.4901% gha), followed by Mongolia (4.6138%) in other countries, Thailand (4.2712%), in Southeast Asia, the Kyrgyz Republic (2.3491%) in Central Asia, Montenegro (1.5295%) in Central and Eastern Europe, and Sri Lanka (0.8160%) in South Asia. The positive relationship can be attributed to the use of old, obsolete energy technologies, conventional methods of production, inefficient use of resources, and high wastage. Our results support Kaltenegger et al.'s (2017) findings, as they offered that economic growth positively affects the EF. The negative impact of economic growth on environmental degradation is found for two South Asian, two West Asian and Middle Eastern, five Central and Eastern European, and one other country. The strong negative and significant impact of economic growth on the EF is found in South Asia for India (i.e., -2.9674% gha), followed by Georgia (-1.2579%) in West Asia and the Middle East, Slovenia (-1.0016%) in Central and Eastern Europe, and Russia (-0.6537%) in other countries. A decrease in environmental degradation in these economies can be accredited in part to technological advances and changes in the economic growth structure, as Sarkodie and Adams (2018) noted the adverse effect of economic growth on EF.

Figure 5 displays a country-level graphical summary of the EF and other analyzed variables (obtained from Table 8). The robustness of the EF results was tested using two additional proxies, the CF and CO_2 emissions (Equations 3 and 4), the results and graphical summaries of which are presented in the appendix (See Tables A1 and A2 and Figures 7 and 8, respectively).

======INSERT FIGURE 5 ABOUT HERE.======

======INSERT TABLE 8 ABOUT HERE.======

3.6 Dumitrescu-Hurlin (DH) panel causality test

The pairwise DH, an advanced version of the Granger non-causality test suggested by Dumitrescu and Hurlin (2012), accounts for the presence of heterogeneity in the panel data. This technique is comprised of Wbar- and Zbar statistics. The DH causality test results are tabulated in Table 9. The results reveal the Granger causality from financial development and globalization to the EF, the CF, and CO_2 emissions. Olowu et al. (2018) found a similar causal relationship for financial development and the EF, while Charfeddine and Mrabet (2017) reached the conclusion that globalization stimulates the EF. Economic growth's relationships with the CF and CO_2 emissions are bidirectional. Destek and Sarkodie (2019) found similar relationships. A significant feedback relationship between financial development and economic growth shows that financial channels facilitate high economic growth, which is connected to industrial manufacturing activities. Therefore, financial development could be used in the production function as a sustainable economic opportunity, as Li et al. (2015) found similar outcomes. A significant bidirectional causality between trade and financial development indicates that financial development stimulates trade openness, resulting in the introduction of advanced technology. This causal relationship is in contrast with Saud et al.'s (2019b) findings. Economic growth has a bidirectional causal relationship with both globalization and CO_2 emissions. There is evidence of bidirectional Granger causalities between globalization and financial development, trade and the EF, energy consumption and the CF, and the CF and economic growth. The world's economies depend heavily on the extraction and use of natural resources, which increases environmental degradation, so the integration of sustainable policies from natural resources extraction to depletion can lead to more generation and less waste of resources (United Nations, 2015). Moreover, the newly industrialized economies are heavily dependent on conventional energy sources rather than environmentally sustainable, renewable energy sources, which leads to environment deterioration (Owusu and Samuel, 2016). A significant unidirectional causality link also comes from financial development to economic growth, and one-way causal associations are found that come from energy consumption to both trade and financial development. Figure 6 shows a graphical summary of the causal relationships among the modeled variables.

=====INSERT FIGURE 6 ABOUT HERE.======

======INSERT TABLE 9 ABOUT HERE.======

4. Conclusion and policy recommendations

Globalization's confrontation with the global environmental is a subject of debate among academics, researchers, and policymakers. Earth is in the Anthropocene era, where humanity deteriorates nature and create threats to survival. As Einstein wrote, "Humanity is going to require a substantially new way of thinking if it is to survive."

This study was undertaken to determine the relationships among financial development, globalization, and the environment for a panel of forty-nine selected OBOR-initiative countries, from 1990 to 2014. The empirical findings in the panel sample show that the EF increases because of growth in financial development, energy consumption, economic growth, and trade. However, globalization mitigates the EF and does not hurt the environment. Instead, it seems that financial development, energy consumption, economic growth, and trade are the main culprits behind environmental deterioration in the selected sample, as the diverse environmental measures deliver parallel outcomes (except the trade-CO_2 nexus in Equation 4). Financial development in some countries stimulates investments in eco-friendly policies and green industries, while in other countries it leads to polluting industries, outdated technology use, and high fossil fuel consumption, which increases environmental degradation, so our findings are heterogeneous. Globalization plays a key role in economic development by bringing foreign investment, innovative methods of production, and technology and operational efficiencies into some countries, but it increases demand for natural resources and harms the environment in other economies. Thus, the rise in overall globalization can bestow up to the desired level of sustainable development in the OBOR initiative countries. Moreover, the findings of the presence of Granger causality in both financial development and globalization with the EF, the CF, and CO_2 emissions confirm the feedback effects. A unidirectional causal relationship runs from financial development to economic growth.

This study's empirical findings suggest several policy implications that can help government officials, responsible authorities, and policymakers of selected countries to control the adverse impact of environmental deterioration. The financial sector hurts the environment by providing loans for polluting projects in some countries, so governments and policymakers should formulate pollution-eradication policies in these countries by discouraging the financial sector from lending to high-polluting industries and high-energy-consuming. The financial sectors can be used as a tool to achieve sustainable development by allocating more of their lending budgets to socially responsible industries, green environmental projects, and firms that pursue green production. Strong and prudent environmental regulations, along with supervision of the financial sector, can be a step toward sustainable development. The establishment of green financial institutions (i.e., depository and green investments) can stimulate financial activities and can assist in the availability of financial resources for eco-friendly projects. The overall encouragement of globalization will attract foreign investments that will bring with them innovative methods of production, advanced industrial technology, and fresh knowledge and skills to the home soil. As energy is a crucial source of economic development and the second-largest source of environmental degradation, energy conservation tends not to be viable in these economies. The introduction of a renewable energy mix in their production lines, fresh technology, R&D investments, strict environmental policies, tariffs on outdated technology (via trade), control of deforestation and waste, and implementation of carbon pricing for polluting industries can contribute to a sustainable environment. Government(s) can also boost eco-friendly corporate practices through public awareness campaigns and educating youth regarding environmental protection can ensure sustainable development in these regions.

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Compliance with ethical standards

Conflict of interest declaration

None.

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Appendices Tables A1 and A2 and Figures 7 and 8: Supplementary Materials

=====INSERT FIGURE 7 ABOUT HERE.======

======INSERT TABLE A1 ABOUT HERE.======

=====INSERT FIGURE 8 ABOUT HERE.======

======INSERT TABLE A2 ABOUT HERE.======

Tables

Table 1
One-Belt-One-Road program-initiated countries

Section	Countries	Total
Southeast Asia	Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Myanmar	8
South Asia	Bangladesh, India, Moldova, Nepal, Pakistan, Sri Lanka	6
West Asia & Middle East	Armenia, Azerbaijan, Bahrain, Iran, Georgia, Turkey, Israel, Jordan, Qatar, Yemen Republic, Oman, UAE, Kuwait, Lebanon	14
Central & Eastern Europe	Albania, Bosnia & Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Estonia, Hungary, Macedonia, Montenegro, Poland, Romania, Slovak Republic, Serbia, Slovenia, Ukraine	16
Central Asia	Tajikistan, Kyrgyz Republic, Kazakhstan	3
Others	Mongolia, Russia	2

Table 2:
Summary of selected studies on financial development and or globalization- environmental Nexus.

No	Authors	Country	Time Period	Variables	Methodology	Hypothesis	Causality
1	Al-mulali et al. (2015a)	129 economies	1990-2011	FD, TO, URB, GDP, CO_2	DOLS, GC	FD decreases CO_2	---
2	Shahbaz et al. (2015)	India	1970-2012	GL, FD, GDP, EC, CO_2	ARDL	GL increases CO_2 FD increases CO_2	---
3	Nasreen et al. (2017)	SAC	1980-2010	FD, EC, EG, CO_2	TYCT	FD decreases CO_2	---
4	Haseeb et al. (2018)	BRICS	1995 -2014	GL, FD, GDP, EC, UR, CO_2	DSUR, DH	GL insignificant CO_2 FD increases CO_2	GL→CO_2 FD↔CO_2
5	Hafeez et al. (2018)	OBORI	1980-2016	FD, Pop, GDP, CO_2	DOLS, FMOLS, DH	FD increases CO_2	---
6	Rizwan Nazir et al. (2018)	21KAC	1970-2016	FD, TR, GDP, URB, CO_2	GMM	FD decreases CO_2	---
7	Şenay et al. (2018)	Turkey	1970-2013	GL, FD, TEC, UR, POP, CO_2	JCT, ECM	GL increases CO_2 FD decreases CO_2	---
8	Shahbaz et al. (2018b)	UAE	1975QI-2014QIV	GL, FD, GDP, EC, CO_2	VECM, TYCT	GL decreases CO_2 FD increases CO_2	FD↔CO_2
9	Shahbaz et al. (2018c)	25 DC	1970-2014	GL, CO_2	DH	GL increases CO_2	---
10	Xu et al. (2018)	Saudi Arabia	1971-2016	GL, FD, EC, GDP, UR, CO_2	ARDL, VECM	GL insignificant CO_2 FD increases CO_2	GL↔CO_2 FD↔CO_2
11	Phong (2019)	ASEAN	1971-2014	GL, GDP, UR, EC, FD, CO_2	DHWS	GL increases CO_2 FD increases CO_2	---
12	Zafar et al. (2019)	OECD	1990-2014	GL, FD, GDP, EC, CO_2	CUP-FM, CUP-BC, DH	GL decreases CO_2 FD decreases CO_2	CO2→FD GL‡CO_2
13	Anees et al. (2019)	APEC	1990-2016	GL, FD, GDP, EI, CO_2	CUP-FM, CUP-BC, DH	GL decreases CO_2 FD decreases CO_2	GL↔CO_2 FD↔CO_2
14	Olowu et al. (2018)	SADC	2000-2016	FD In, EF, SEOI	BPGC	FD decrease EF	FD → EF
15	Destek and Sarkodie (2019)	N-11	1977-2013	FD, EF, GDP, EC	AMG, HPC	GDP increases EF FD decreases EF	GDP↔EF EF↔FD
16	Sharif et al. (2019)	15-TGC	1970-2016	GL, EF, EC, GDP	QQ, GCQ	GL increases EF (8C) GL decreases EF (4C)	---
17	Saud et al. (2019b)	59-BRI	1980-2016	FD, FDI, GDP, EC, TR, CO_2	DSUR, DH	FD decrease CO_2 FDI decrease CO_2	FD↔CO_2 FDI↔ CO_2
18	Saud et al. (2019a)	18-CEECs	1980-2016	FD, EC, TR, UR, GDP, CO_2	DSUR, DH	FD decrease CO_2	FD ↔ EC

Note: FD (financial development), GL (globalization), GDP (economic growth), EC (energy consumption), CO2 (carbon dioxide emissions), UR (urbanization), TEC(technology), POP (population), EI (energy intensity), FD In (financial development index), EF (ecological footprint), SEOI (sustainable economic opportunity

Index), ARDL (autoregressive distributed lag model), DSUR (dynamic seemingly unrelated regression), VECM (vector error correction model), TYCS (Toda-Yamamoto causality test), DHWS (Durbin–Hausman–Wu statistic), CUP-FM(Continuously Updated Fully Modified), CUP-BC(Continuously Updated Bias-Corrected), DH(Dumitresu-Hurlin causality), BPGC (bootstrap panel Granger causality test), AMG (Augmented Mean Group), HPC (heterogeneous panel causality test), QQ (Quantile-on-Quantile regression), GCQ (Granger causality in quantiles), UAE (United Arab Emirates), BRICS (Brazil, Russian Federation, India, China, and South Africa), OECD (Organization for Economic Co-operation and Development), APEC (Asia Pacific Economic Cooperation countries), TGC (top 15 globalized countries), SADC (Southern African Development Community) and N-11 (Next 11 countries).

Table 3
Variables, measures and definition.

Variables	Symbols	Measure	Source	Time Span
Ecological Footprint	EF	In global hectares	NFAs	1990-2014
Carbon Footprint	CF	In global hectares	NFAs	1990-2014
Carbon Dioxide	CO_2	In metric tons/capita	WDI	1990-2014
Financial development	FD_{FS}	In % of GDP	WDI	1990-2014
Economic Growth	GDP	In constant 2010 US$	WDI	1990-2014
Globalization	G	KOF Index	KOF Index	1990-2014
Energy Consumption	EC	In kg of oil equivalent /capita	WDI	1990-2014
Trade	TR	Total imports & exports	WDI	1990-2014

Source: NFAs, WDI, and KOF (Author's compilation)

Table 4

Results from Pesaran's LM and CD tests.

	Pesaran scaled LM		Pesaran CD	
Variables	statistic	Probability	Statistic	Probability
$LOGCO_2$	105.29[a]	0.0000	15.211[a]	0.0000
LOGEF	67.798[a]	0.0000	2.9664[a]	0.0030
LOGCF	71.547[a]	0.0000	3.1251[a]	0.0018
$LOGFD_{FS}$	135.38[a]	0.0000	23.242[a]	0.0000
LOGEC	95.844[a]	0.0000	8.1702[a]	0.0000
LOGGDP	66.194[a]	0.0000	6.5709[a]	0.0000
LOGGLOB	337.29[a]	0.0000	117.81[a]	0.0000
LOGTRADE	81.877[a]	0.0000	6.6946[a]	0.0000

Note: [a], indicate significance level at 1%.

Table 5

Results of CIPS and CADF

	CIPS		CADF	
	Level	1st difference	Level	1st difference
$LOGCO_2$	-2.675[b]	-4.226[a]	-2.70[b]	-3.569[a]
LOGEF	-2.844[a]	-4.611[a]	-2.99[a]	-3.653[a]
LOGCF	-2.900[a]	-4.386[a]	-3.07[a]	-3.763[a]
$LOGFD_{FS}$	-2.470	-4.261[a]	-2.47	-3.307[a]
LOGEC	-2.289	-3.939[a]	-2.03	-2.593[a]
LOGGDP	-2.667[b]	-3.844[a]	-2.67[b]	-3.104[a]
LOGGLOB	-3.263[a]	-4.942[a]	-2.71[b]	-3.710[a]
LOGTRADE	-2.506	-4.860[a]	-2.395	-3.842[a]

Note: [a] & [b], Indicate the level of significance at 1% and 10%.

Table 6
Results of Westerlund cointegration test

Statistic	Model-1 (EF)			Model-2 (CF)			Model-3 (CO_2)		
	Value	Z-value	P-value	Value	Z-value	P-value	Value	Z-value	P-value
G_t	-2.470[a]	-1.868	0.031	-2.119	0.548	0.708	-2.489[a]	-2.00	0.023
G_a	-3.046	7.912	1.000	-2.802	8.133	1.000	-3.390	7.597	1.000
P_t	-10.04	2.558	0.995	-15.20[a]	-1.66	0.048	-14.431	-1.031	0.151
P_a	-2.469	4.897	1.000	-2.547	4.828	1.000	-2.217	5.118	1.000

Note: [a], shows the level of significance at 1%.

Table 7

Results of PMG (ARDL) Panel estimation

	Model-1 (EF)			Model-2 (CF)			Model-3 (CO_2)		
	Co-efficient	t-value	Prob.	Co-efficient	t-value	Prob.	Co-efficient	t-value	Prob.
$LOGFD_{FS}$	0.0211[a]	02.6045	0.0094	0.2541[a]	13.5625	0.0000	0.0063[b]	02.0861	0.0374
LOGEC	0.5574[a]	16.5812	0.0000	0.3313[a]	03.6971	0.0002	0.9563[a]	55.9829	0.0000
LOGGDP	0.0566[b]	02.4817	0.0134	1.5008[a]	27.2433	0.0000	0.0933[a]	10.4768	0.0000
LOGGLOB	-0.0038[a]	-11.8111	0.0000	-0.0902[a]	-07.8440	0.0000	-0.3563[a]	-12.5811	0.0000
LOGTRAE	0.0884[a]	04.0687	0.0001	0.1939[a]	05.0903	0.0000	-0.0185[b]	-02.0339	0.0424
S.E. of regression	0.0829	----	----	0.0817	----	----	0.0362	----	----
Log likelihood	2875.9	----	----	2622.8	----	----	3215.8	----	----

Note: [a], &[b], specify the level of rejection at 1%, and 5% levels.

Table 8
Results of country-wise long-run estimations (Model-1) EF

		EC		FD_{FS}		GDP		GLOB		TRADE	
Section	Country Name	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.
Southeast Asia	Brunei Da-	0.1920	0.5011	0.1142	1.5461	0.6769	0.4013	1.9310[a]	3.2546	0.1254	0.2155
	Indonesia	0.2825[b]	2.1949	-0.0077	-0.2155	0.4925[a]	10.2385	0.2782[c]	1.8563	-0.0159	-0.3251
	Malaysia	0.4908[b]	2.7527	-0.0623	-1.3650	1.3132[a]	8.4292	-2.0214[a]	-3.9314	0.2916[a]	4.3412
	Philippines	-0.7823[a]	-4.4153	0.0760[c]	2.0874	0.4368[a]	3.5152	0.3494[c]	1.9079	0.3020[a]	3.7782
	Singapore	0.0427	0.4067	-0.2068[c]	-1.8382	0.7269[a]	5.4376	3.6403[a]	4.9241	-0.5629[b]	-2.2359
	Thailand	-3.6943[a]	-8.7126	0.0168	0.0901	4.2712[a]	10.781	2.2796[b]	2.5452	0.0885	0.1600
	Vietnam	0.1860[a]	3.0686	0.0536[a]	3.4063	0.4159[c]	1.9954	0.7203[b]	2.1343	-0.0360	-0.4419
	Myanmar	0.3864[a]	4.5344	-0.0702[b]	-2.2411	0.1972[a]	3.1721	-0.0662	-0.8334	-0.0232[a]	-9.0467
South Asia	Bangladesh	0.7482	0.5509	-0.8968[a]	-6.4640	0.6671	0.6740	4.7116[a]	7.4277	-1.0867[a]	-4.3812
	India	5.1785[a]	10.073	0.2687	0.8048	-2.9674[a]	-6.4535	2.0812[a]	5.9612	-0.0001	-0.0006
	Moldova	2.5786[a]	6.9810	1.1643[b]	2.1727	-1.0526[b]	-2.4889	0.2935	1.1535	0.0976	0.1767
	Nepal	2.6220[a]	8.8871	-0.3549[a]	-2.9432	0.3187	0.7770	0.1147	0.3114	0.1369[b]	2.1089
	Pakistan	0.9868[a]	4.4262	0.2499[a]	3.3597	0.2892[b]	2.5649	0.8456[a]	3.0043	-0.3919[a]	-5.5785
	Sri Lanka	-0.0846	-0.5568	-0.1375[c]	-1.8158	0.8160[a]	6.0173	0.1026	1.0387	0.3656[a]	3.7104
West Asia & Middle East	Armenia	0.0589	1.0394	0.1520[a]	6.3374	0.5015[a]	6.5111	-0.6868[a]	-4.6105	-0.1795	-1.3470
	Azerbaijan	1.3063[a]	9.9431	0.2669[c]	2.0717	-0.6598[a]	-3.9273	3.2701[a]	8.4983	-0.2234	-1.3168
	Bahrain	0.7295	1.0813	0.0041	0.0475	-1.1877	-1.5475	5.4345[a]	9.4730	-0.2903[c]	-1.7518
	Iran	-4.5119[b]	-2.6035	0.5594	0.4863	5.4901[c]	1.9835	3.7252	1.2450	-3.4126[b]	-2.7380
	Georgia	1.9847[a]	8.2633	-0.3395	-1.6500	-1.2579[b]	-2.3447	3.0852[a]	3.3651	0.1828	0.5036
	Turkey	0.2008	1.5398	-0.5568[a]	-9.1357	1.0134	5.5119	2.7620[a]	5.9221	-0.2620	-1.6823
	Israel	-0.1594[a]	-3.1926	-0.0143	-0.0773	1.6715[a]	15.1144	0.0702	0.2868	0.3152[c]	2.0177
	Jordan	0.1583[c]	1.7514	0.5890[b]	2.5703	1.0635[b]	2.3832	0.5304	0.8289	-0.4656	-2.5603
	Qatar	-1.0679[b]	-2.7966	0.2704[c]	2.0443	-0.0783	-0.3643	6.3651[a]	7.8790	0.6905	1.4620
	Yemen Rep.	0.1765[a]	3.2401	0.0216	1.0369	1.4540[a]	12.0590	1.45257[a]	6.8713	-0.0599	-0.5919
	Oman	0.7261[c]	1.7459	0.2502	0.9887	-1.6297	-1.6777	4.7061[b]	2.2242	-1.2021[c]	-2.0618
	UAE	-0.0933	-0.2872	0.7329[a]	4.2570	0.4231	1.2950	3.1204[a]	5.3588	-0.3882[c]	-1.9908
	Kuwait	0.8165	0.7797	-1.4771[c]	-1.8882	-1.6734	-1.2983	18.9103[c]	1.9701	6.4526[b]	2.2878
	Lebanon	0.5702[a]	3.4777	-0.2841[a]	-4.0951	0.4514[c]	1.9432	2.3118[a]	5.5335	0.0428	0.3650
Central & Eastern Europe	Albania	0.5260[a]	5.0974	0.2096[a]	5.0204	0.7517[a]	3.1555	-0.0968	-0.4475	0.2617[a]	4.3257
	Bosnia	0.1410	0.5751	-0.1243	-1.2664	0.1994	1.1814	0.8272[a]	3.3775	0.7371[a]	3.6342
	Bulgaria	1.5663[a]	16.5021	-0.0906[c]	-1.7924	-0.4639[c]	-2.0500	2.3484[a]	4.4640	-0.1919	-1.0014
	Belarus	1.6410[a]	9.5149	0.0257[c]	1.7301	-0.9237[a]	-2.9703	1.5669[b]	2.6301	1.2357[a]	5.0734

	Croatia	2.1874[a]	7.4400	0.0123	0.2347	-0.0530	-0.1319	-0.1625	-0.5015	0.2560	0.9659
	Czech Rep.	2.5166[a]	5.2752	-0.3539[b]	-2.5653	1.2750[b]	2.1161	-3.8937[a]	-3.9055	0.6175	1.4554
	Estonia	1.5054[a]	5.2841	-0.7177[a]	-2.9371	-0.8010[a]	-3.1519	4.1172[a]	5.0969	-1.4383[a]	-6.2022
	Hungary	0.7592[a]	3.3986	-0.2426[b]	-2.2412	-0.2420	-0.8408	4.5476[a]	6.5448	-1.0651[a]	-7.6542
	Macedonia	1.8808[a]	3.5841	0.1936[c]	1.8056	0.9993	1.4409	0.0686	0.1131	-1.5753[a]	-5.9572
	Montenegro	-1.9431[b]	-2.7504	-0.2839[a]	-3.2204	1.5295[a]	4.4370	-11.481[a]	18.381	-0.6092[c]	1.9344
	Poland	1.8680[a]	14.450	-0.1186	-0.9624	-0.0409	-0.1194	1.6258[a]	3.5558	-0.4129[c]	-1.8663
	Romania	0.8261[a]	5.9914	-0.0547	-0.9838	-0.0877	0.5914	0.4265[c]	2.0538	-0.1792[c]	-1.8200
	Slovak Rep.	3.7215[b]	2.4082	1.7336[a]	3.3555	0.5057[c]	1.7819	2.6192[c]	2.0367	0.6392	0.9409
	Serbia	3.1557[a]	10.435	0.2776[a]	3.0245	-0.2137[b]	-1.7543	-1.3745	-0.9745	-0.07432	-0.4679
	Slovenia	3.0857[a]	6.5169	-0.0716	-0.6993	-1.0016[a]	-2.9295	0.1863	0.3516	0.7342[b]	2.7652
	Ukraine	-0.2623	-0.6976	-0.2138[b]	-2.5421	0.3269	1.3163	0.1868	0.4591	0.4070[c]	1.9139
Central Asia	Tajikistan	-0.2467	-0.9376	0.2818[a]	6.2730	0.4192[b]	2.5557	0.0907	0.2409	-0.0479	-0.8289
	Kyrgyz Rep.	-0.2606	-0.3854	1.1879[a]	4.8447	2.3491[b]	2.7581	0.0164	0.0216	-0.2517	-0.4783
	Kazakhstan	2.3129[a]	12.990	-0.3079[a]	-5.9403	-0.0760	-0.2524	-0.2556	-0.7867	0.4382[a]	4.3508
Others	Mongolia	-1.7363	-0.8287	-0.2903	-0.6321	4.6138[c]	1.9406	-10.6506[a]	-3.8534	-0.5729	-0.5487
	Russia	0.1767[a]	15.4633	-0.0289	-0.2650	-0.6537[a]	-4.4228	1.6775[a]	7.3912	0.4384[a]	4.9034

Note: [a,b] & [c,] indicates the level of significance at 1%, 5% & 10% respectively.

Table 9

Results of Dumitrescu-Hurlin (DH) panel causality

Variables	LOGCO2	LOGCF	LOGEC	LOGEF	LOGFD$_{FS}$	LOGGDP	LOGGLO	LOGTR
		4.26276[a]	6.64418[a]	3.88455[a]	4.17521[a]	7.09404[a]	7.69033[a]	4.86076[a]
LOGCO2	---	[5.52250]	[12.0565]	[4.48480]	[5.28228]	[13.2908]	[14.9269]	[7.16325]
		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	8.47937[a]		12.1563[a]	6.76215[a]	4.00413[a]	6.65738[a]	10.8528[a]	3.99204[a]
LOGCF	[17.0918]	---	[27.1804]	[12.3802]	[4.81288]	[12.0927]	[23.6040]	[4.77970]
	0.000		0.000	0.000	0.000	0.000	0.000	0.000
	2.79929[a]	4.20766[a]		4.65401[a]	2.79738	4.87479[a]	6.22319[a]	2.41906
LOGEC	[1.50710]	[5.37130]	---	[6.59598]	[1.50186]	[7.20174]	[10.9014]	[0.46385]
	0.000	0.000		0.000	0.1331	0.000	0.000	0.6428
	7.55447[a]	4.36610[a]	10.0622[a]		3.72309[a]	8.49002[a]	8.01099[a]	4.63887[a]
LOGEF	[14.5541]	[5.80603]	[21.4346]	---	[4.04178]	[17.1210]	[15.8067]	[6.55445]
	0.001	0.000	0.000		0.000	0.000	0.000	0.000
	6.50242[a]	5.70867[a]	6.89197[a]	5.75498[a]		7.21288	7.30015[a]	5.75019[a]
LOGFD$_{FS}$	[11.6675]	[9.48969]	[12.7364]	[9.61676]	---	[13.6169]	[13.8563]	[9.60361]
	0.000	0.000	0.000	0.000		0.130	0.000	0.000
	5.26277[a]	4.52537[a]	7.47074[a]	4.44276[a]	6.66848[a]		12.3847[a]	5.16477[a]
LOGGDP	[8.26626]	[6.24303]	[14.3244]	[6.01636]	[12.1232]	---	[27.8069]	[7.99739]
	0.000	0.000	0.000	0.000	0.000		0.0000	0.000
	3.91622[a]	4.44092[a]	3.03003[b]	4.72815[a]	3.11953[a]	6.44077[a]		2.80825[a]
LOGGLO	[4.57168]	[6.01131]	[2.14021]	[6.79941]	[2.38576]	[11.4984]	---	[1.53169]
	0.000	0.000	0.0323	0.000	0.0170	0.0000		0.1256
	8.39812[a]	7.25827[a]	6.00308[a]	11.7943[a]	3.56613[a]	6.62421[a]	5.58277[a]	
LOGTR	[16.8689]	[13.7414]	[10.2975]	[26.1871]	[3.61112]	[12.0017]	[9.14426]	---
	0.000	0.000	0.000	0.008	0.0003	0.000	0.000	

Note: Null hypothesis: No causality

top values represent W-stat,

[] represents Z-stats,

[a,] represents 1% level of significance,

Appendices Table A1 and A2. Supplementary Materials

Table A1

Results of country-wise long-run estimations (Model-2) CF

		EC		FD_{FS}		GDP		GLOB		TRADE	
Section	Country Name	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.
Southeast Asia	Brunei Daru-	0.5099	0.7769	0.2435[c]	1.9248	0.9909	0.3429	2.2166	2.1811	0.0816	0.0819
	Indonesia	2.7414[a]	6.1797	0.0973	0.6630	0.5815[b]	2.6998	-1.6527[a]	-3.0168	0.5147[b]	2.6203
	Malaysia	0.4319	1.4761	-0.0163	-0.2185	2.0013[a]	7.8275	-1.8212[b]	-2.1584	0.4008	3.6360[a]
	Philippines	-0.8621[a]	-3.2505	0.2951[a]	5.4151	0.2238	1.2033	0.5037[c]	1.8371	0.2422[c]	2.0246
	Singapore	0.1514	1.0715	-0.2111	-1.3930	0.6214[a]	3.4519	4.7830[a]	4.8042	-0.6992[c]	-2.0622
	Thailand	-2.5166[a]	-6.8963	0.0710	0.4425	3.6372[a]	10.667	1.2462	1.6168	0.1123	0.2361
	Vietnam	0.5485[a]	4.3214	0.0837[b]	2.5415	-0.0461	-0.1056	1.9288[a]	2.7302	0.0416	0.2435
	Myanmar	2.7118[a]	12.296	0.2295[b]	2.8320	-1.8750[a]	-11.650	-0.2123	-1.0327	-0.0316[a]	-4.7648
South Asia	Bangladesh	1.3891[c]	1.9070	0.2637[c]	1.8105	-0.3957	-0.7544	1.5669[b]	2.6828	0.4055[b]	2.5398
	India	3.9493[a]	13.7065	0.0754	0.4033	-1.5954[a]	-6.1908	1.5263[a]	7.8003	0.0570	0.3664
	Moldova	3.1552[a]	6.2205	1.1168[b]	2.2517	-1.1116[b]	-2.8045	0.7337[c]	2.0500	0.6704	1.0920
	Nepal	1.1071	1.2818	-0.1729	-0.7372	2.2162[a]	2.9366	-0.0841	-0.1269	0.4136[a]	3.3268
	Pakistan	0.3713	1.4194	0.1901[b]	2.1777	0.9514[a]	7.1901	1.8129[a]	5.4884	-0.1798[b]	-2.1807
	Sri Lanka	0.5578[b]	2.5774	-0.2696[b]	-2.4998	1.3714[a]	7.1023	0.4144[a]	2.9454	0.7100[a]	5.0602
West Asia & Middle East	Armenia	0.2097	1.5274	0.1929[a]	3.3180	0.6233[a]	3.3406	-1.4410[a]	-3.9930	-0.5427	-1.6806
	Azerbaijan	1.2687[a]	7.7818	0.3249[c]	2.0320	-0.8738[a]	-4.1914	3.5776[a]	7.4920	-0.2056	-0.9770
	Bahrain	0.9915	1.2840	-0.0444	-0.4447	-1.5432[c]	-1.7567	5.9061[a]	8.9946	-0.4493[b]	-2.3681
	Iran	-2.9360[c]	-2.0616	0.4378	0.5135	3.5385[a]	3.7127	4.2269[b]	2.2091	-2.6014[b]	-2.6064
	Georgia	2.6874[a]	7.4615	-0.1373	-0.4449	-2.2023[b]	-2.7374	3.8509[b]	2.8010	-0.2447	-0.4496
	Turkey	0.2344[b]	2.7585	-0.2177[a]	-5.4817	1.1790[a]	9.8420	1.7568[a]	-5.7814	-0.1345	-1.3259
	Israel	-0.2051[a]	-3.2348	-0.0360	-0.1528	1.5453[a]	11.0092	0.6146[c]	1.9767	0.0890	0.4489
	Jordan	0.2216[c]	1.7601	0.4893	0.4893	1.8875[a]	3.0385	0.0045	0.0049	-0.7180[a]	-3.3406
	Qatar	-1.0055[b]	-2.4011	0.3209[b]	2.2125	-0.1215	-0.5154	6.6519[a]	7.5090	0.6207	1.1985
	Yemen Rep.	0.2993[a]	5.5218	-0.0738[a]	-3.5525	0.1008	0.8404	3.4123[a]	16.2257	0.0636	0.6310
	Oman	0.9128[b]	2.7544	0.0712	0.4996	-0.7210[c]	-1.8421	5.2585[b]	2.6478	-1.3696[b]	-2.5219
	UAE	-0.0649	-0.1888	0.7875[a]	4.3227	0.4307	1.2459	3.0023[a]	4.8723	-0.4416[b]	-2.1402
	Kuwait	0.7219	0.5708	-1.6847[c]	-1.7832	-1.6219	-1.0420	19.720	1.7013	6.9066[b]	2.3888
	Lebanon	0.7684[a]	4.0561	-0.1641[c]	-2.0475	0.5822[b]	2.1693	1.2186[b]	2.5245	0.2415[c]	1.7825
Central &	Albania	0.9912[a]	5.0733	0.1881[b]	2.3793	1.5001[a]	1.5001	1.2080[a]	2.9474	-0.0444	-0.3880

Eastern Europe	Bosnia & He-	0.0429	0.1127	0.3112[b]	2.3697	0.5813[b]	2.2373	0.9856[b]	2.7954	1.1466[a]	6.8970
	Bulgaria	1.3604[a]	15.050	-0.0905[c]	-1.8800	-0.4060[c]	-1.8837	2.3900[a]	4.7704	-0.1002	-0.5492
	Belarus	-0.6737[b]	-2.3851	0.0119[c]	2.0357	0.6781[a]	3.2563	-1.3059[a]	-3.3039	0.2131[c]	1.9543
	Croatia	2.5175[a]	7.9406	-0.0125	-0.2200	-0.7183	-1.6575	0.8208[b]	2.3487	0.0513	0.1795
	Czech Rep.	2.6743[a]	4.9705	-0.3546[b]	-2.2787	1.3979[c]	2.0572	-4.5971[a]	-4.0885	0.6443	1.3464
	Estonia	1.5361[a]	3.6538	-0.3085	-0.8558	-0.8696[b]	-2.3187	2.4071[c]	2.0194	-0.9636[b]	-2.8158
	Hungary	0.6236[a]	3.0033	-0.1021	-1.0146	-0.2386	-0.8918	4.4881[a]	6.9488	-1.0271[a]	-7.9407
	Macedonia	2.0265[a]	4.6986	0.3281[a]	3.7223	0.4301	0.7546	0.6865	1.3770	-1.5432[a]	-7.1003
	Montenegro	-1.3794[b]	-2.1615	-0.3103[a]	-3.8962	1.5525[a]	4.9856	-11.4056[a]	-20.214	-0.6880[b]	-2.4184
	Poland	2.0244[a]	18.164	-0.0664	-0.6249	-0.2165	-0.7332	1.4919[a]	3.7848	-0.3464[c]	-1.8165
	Romania	2.02443	18.164	-0.0664	-0.6249	-0.2165	-0.7332	1.4919[a]	3.7848	-0.3464[c]	-1.8165
	Slovak Rep.	-0.6831	-0.3202	-0.6839	-0.9590	-0.4039	-1.0310	3.3180[c]	1.8690	-1.1086	-1.1821
	Serbia	3.0657[a]	11.415	0.3076[a]	4.1340	-0.2604[b]	-2.2558	-0.3391	-0.8716	-0.0543	-0.3643
	Slovenia	3.6676[a]	9.2049	-0.0113	-0.1317	-0.9476[a]	-3.2938	-0.1494	-0.3353	0.6304[b]	2.8214
	Ukraine	1.3428[a]	5.7859	-0.1318	-1.1191	0.0211	0.0655	0.5848	1.3785	1.2253[a]	4.1150
Central Asia	Tajikistan	1.8459[a]	5.3518	0.0889	0.6198	-0.3921	-0.9239	1.1591[b]	2.1752	0.3602[c]	2.0210
	Kyrgyz Rep.	-0.2008	-0.2379	1.4188[a]	4.6356	2.1558[c]	2.0277	-0.8627	-0.9108	0.3936	0.5993
	Kazakhstan	2.5842[a]	13.5138	-0.2974[a]	-5.3416	-0.2426	-0.7504	-0.2372	-0.6799	0.1767	1.6340
Others	Mongolia	4.7587[b]	2.3472	-1.7659[a]	-3.7750	1.5236	0.4647	-7.0627[c]	-1.8786	0.9937	0.7223
	Russia	2.0929[a]	13.8484	-0.0278	-0.2304	-0.7465[a]	-4.5571	1.8346[a]	7.2942	0.4220[a]	4.2587

Note: [a, b] & [c,] indicates the level of significance at 1%, 5% & 10% respectively.

Table A2

Results of country-wise long-run estimations (MODEL-3) CO_2

		EC		FD_{FS}		GDP		GLOB		TRADE	
Section	Country Name	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.
Southeast Asia	Brunei Daru-	0.9026[a]	3.6167	-0.2208[a]	-4.8164	-0.6528[b]	-2.8393	0.5974[c]	1.9593	-0.0253	-0.0676
	Indonesia	-1.1383[c]	-1.8216	-0.4648[b]	-2.2475	0.2738	0.9025	2.5083[a]	3.2504	-0.6544[b]	-2.3652
	Malaysia	1.4247[a]	3.9851	0.2130	1.5744	0.8348	1.7170	-4.2411[a]	-3.7054	0.1095	0.5146
	Philippines	1.0977[a]	7.2720	0.1332[a]	4.2969	0.2751[a]	2.5983	0.2848[c]	1.8254	-0.1493[a]	-2.1930
	Singapore	0.3459	0.9807	-0.1749	-0.4496	-0.7565	-1.6887	6.1688[a]	4.5120	-3.2164[a]	-3.6970
	Thailand	1.0535[a]	4.1298	0.0173	0.3533	0.5114[c]	1.9954	1.4967[a]	3.9895	-0.2169	-1.4233
	Vietnam	-2.6471[a]	-3.4461	0.8252[a]	5.1598	3.5521	1.1889	-5.1454	-1.0755	1.6400	0.1437
	Myanmar	-0.5390[b]	-2.2644	-0.6527[a]	-3.9618	0.2463[b]	2.8569	0.6114	1.4516	0.0178	1.2685
South Asia	Bangladesh	-0.0207	-0.0157	0.9514[a]	7.0734	0.5349	0.5575	-3.1275[a]	-5.0860	0.9573[a]	3.9815
	India	1.6225[a]	8.5835	-0.1248[b]	-2.6743	-0.1653	-1.1903	0.2742[a]	3.1903	0.0036	0.0954
	Moldova	1.3596[a]	3.7940	-0.6412[c]	-1.8298	0.5424[c]	1.9371	-0.1873	-0.7410	-0.8134[c]	-1.8753
	Nepal	-5.1752[a]	-9.2784	0.6206[b]	2.7220	4.7814[a]	6.1653	-2.1835[a]	-3.1353	1.0595[a]	8.6332
	Pakistan	1.0313[a]	5.0689	-0.0229	-0.3378	0.2813[b]	2.7342[b]	0.3862	1.5036	0.1151[c]	1.7949
	Sri Lanka	1.1784[a]	3.9710	0.0314	0.2126	0.6841[b]	2.5840	-0.2732	-1.4164	0.4444[b]	2.3102
West Asia & Middle East	Armenia	0.5001[a]	6.3292	-0.0141	-0.4225	0.3340[a]	3.1106	0.1692	0.8150	0.3490[c]	1.8785
	Azerbaijan	0.2007[a]	3.4494	-0.0343	-0.6021	0.1979[b]	2.6600	-0.8136[a]	-4.7729	0.3453[a]	4.5943
	Bahrain	0.6959	0.8519	0.2441[b]	2.3099	0.2687	0.2892	-1.8599[b]	-2.6776	0.1542	0.7683
	Iran	0.7820[a]	10.0596	0.2051[a]	3.9764	-0.4870[a]	-3.9222	0.7017[a]	5.2277	-0.1197[b]	-2.1414
	Georgia	-0.4564[b]	-2.4159	0.0830	0.5131	1.7852[a]	4.2299	-2.3870[a]	-3.3097	-0.2227	0.4450
	Turkey	0.8128[a]	8.8083	0.3427[a]	7.9490	0.0090	0.0694	-1.5933[a]	-4.8296	0.1896	1.7217
	Jordan	0.8931[a]	12.0871	0.4154[b]	2.4531	-0.5000	-1.3716	-0.0924	-0.1692	-0.5175[a]	-4.1036
	Israel	0.8276[a]	38.3981	-0.3474[a]	-4.2917	-0.1957[c]	-1.8503	0.0723	0.4667	-0.0204	-0.2917
	Qatar	0.3079	1.0789	0.2898[a]	2.9309	0.7025[a]	4.3707	-3.2290[a]	-5.3473	-0.3123	-0.8846
	Yemen Rep.	0.0057	0.0951	-0.1093[a]	-4.7570	-0.5092[a]	-3.8373	1.1078[a]	4.7619	-0.1432	-1.2839
	Oman	1.0828[a]	6.5918	0.3617[a]	5.1144	-0.5470[b]	-2.8196	0.4195	0.4261	-0.9395[a]	-3.4898
	UAE	-0.6957	-1.0076	-0.2546	-0.6962	0.7684	1.1071	0.3565	0.2882	0.1464	0.3534
	Kuwait	1.2134[a]	7.8125	0.0857	0.9804	-0.3050	-1.6262	-1.9926[a]	-3.6879	0.7515[b]	2.1353
	Lebanon	0.4956[a]	3.8766	0.1880[a]	3.4757	0.2277	1.2571	-1.2301[a]	-3.7761	0.0138	0.1512
Central & Eastern Europe	Albania	1.7972[a]	9.1192	0.1626[c]	2.0398	-0.2223	-0.4886	-0.1642	-0.3972	0.0837	0.7250
	Bosnia & He-	1.2965[a]	3.5212	-0.4411[a]	-3.4727	-0.1825	-0.7265	-0.3084	-0.9044	-0.7703[a]	-4.7914
	Bulgaria	1.1090[a]	6.6914	0.0576	2.6799[b]	-0.0718	-0.7477	0.0762	0.3383	-0.0682	-0.8115
	Belarus	0.3299[b]	2.1151	0.0124[a]	3.8402	0.2329[c]	2.0259	-0.4491[c]	-2.0578	0.1169[c]	1.9410

	Croatia	2.0562[a]	12.852	0.0337	1.3333	-0.6871[a]	-3.0413	0.0644	0.2729	0.2248[c]	1.7512
	Czech Rep.	1.3530[a]	4.8373	-0.3240[a]	-4.0049	-0.0942	-0.2668	-1.9449[a]	-3.3272	0.3888	1.5629
	Estonia	0.2354[b]	2.3682	-0.0386	-0.4530	0.5280[a]	5.9551	-1.5948[a]	-5.6587	0.4254[a]	5.2579
	Hungary	1.5980[a]	13.9730	-0.1429[a]	-3.7741	-0.2335[b]	-2.3296	0.1887	0.7505	-0.1791[a]	-3.4816
	Macedonia	0.8109[a]	4.8572	-0.1286[a]	-3.7709	-0.1432	-0.6489	-0.5140[b]	-2.6635	-0.1214	-1.4429
	Montenegro	0.6631[a]	3.7716	-0.0458[c]	-2.0902	0.1885[b]	2.1978	-0.2025	-1.3029	-0.1735[b]	-2.2144
	Poland	0.9882[a]	22.8803	-0.0183	-1.0552	-0.2610[a]	-5.6211	0.1108	1.7033	0.0857[b]	2.7801
	Romania	0.9882[a]	22.880	-0.0183	-1.0552	-0.2610[a]	-5.6211	0.1108	1.7033	0.0857[b]	2.7801
	Serbia	0.3749[a]	3.2975	0.0139	0.4426	0.0228	0.4675	-0.3822[b]	-2.3203	-0.0008	-0.0129
	Slovak Rep.	1.3683[a]	7.6184	-0.0175	-0.2916	-0.1477[a]	-4.4808	-0.3225[b]	-2.1581	0.1052	1.3331
	Slovenia	1.1225[a]	6.6399	0.0242	0.6631	0.1959	1.6051	-0.5309[b]	-2.8067	-0.2480[b]	-2.6160
	Ukraine	0.3028[b]	2.8538	-0.1356[b]	-2.5180	0.2708[c]	1.8349	-0.3031	-1.5627	-0.1852	-1.3606
Central Asia	Tajikistan	1.3092[a]	4.1054	0.1084[c]	1.9920	-0.1752	-0.8812	0.7183	1.5739	-0.2486[a]	-3.5449
	Kyrgyz Rep.	0.7174	1.3530	-0.2316	-1.2047	0.3865	0.5786	-2.4756[a]	-4.1600	0.7598[c]	1.8413
	Kazakhstan	0.0418	0.2571	0.1233[b]	2.6000	0.5227[c]	1.8972	-0.4469	-1.5032	-0.2615[b]	-2.8370
Others	Mongolia	-0.7886	-1.5341	0.2474[c]	2.0861	2.0646[b]	2.4834	-1.8846[c]	-1.9769	-0.4236	-1.2145
	Russia	-0.3906[a]	-2.8929	0.1397	1.2924	0.3311[b]	2.2623	0.1399	0.6226	0.4217[a]	4.7636

Note: [a, b] & [c,] indicates the level of significance at 1%, 5% & 10% respectively.

Nomenclature	
CF	Carbon footprint
EF	Ecological footprint
SREB	Silk road economic belt
NFAs	National footprint accounts
OBOR	One belt and one road initiative
TCMSR	21st Century maritime silk road
ICT	Information and communication technology

FIGURES

Fig. 1: Geographic Coverage of the OBOR regions.

Figure 1: Geographic coverage of the study regions of One-Belt-One-Road initiative: *(source: the Fung Business Intelligence Centre)*.

FIG. 2 Actual vs Predicted Plots

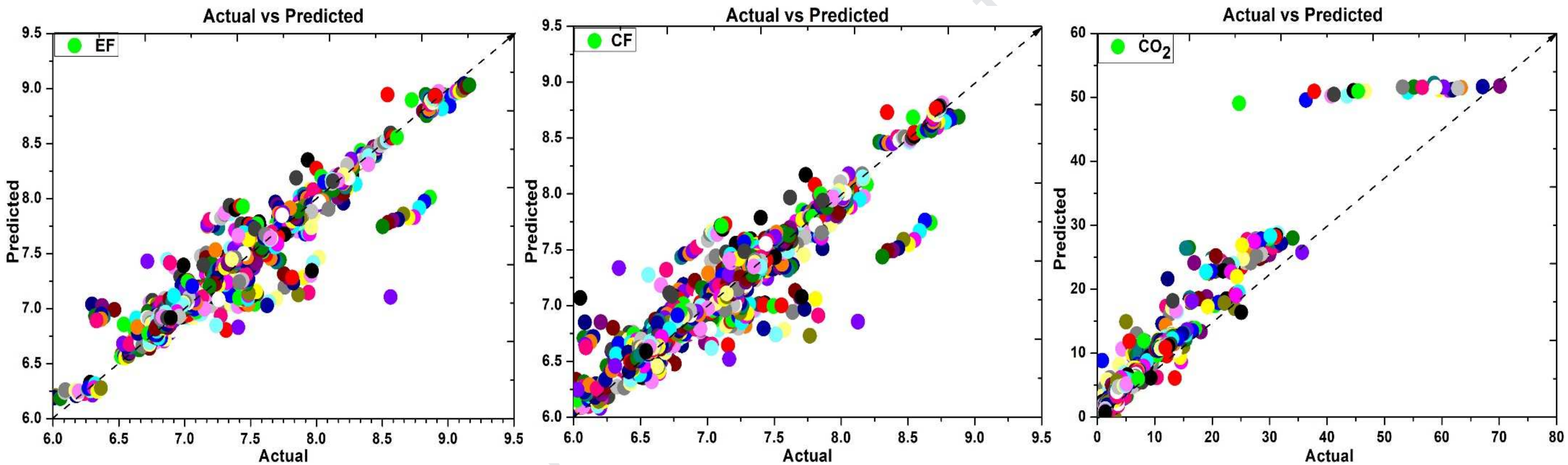

Figure 2: Scatter plots of actual values versus predicted values (for ecological footprint (EF), carbon footprint (CF), and carbon dioxides (CO_2)) overlapped with the best-fit linear regressions lines.

Fig. 3: Plots-box

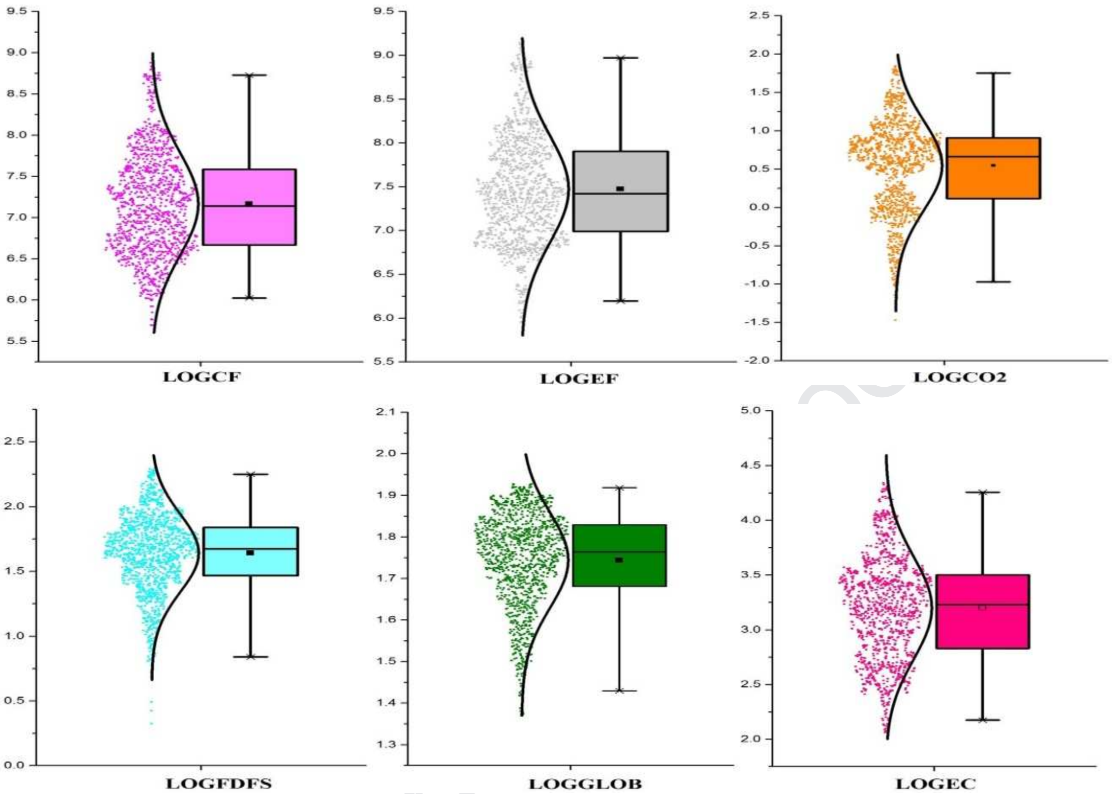

Figure 3: Plots-Box for the investigated variables (carbon footprint, ecological footprint, CO_2 emissions, financial development, globalization, and energy consumption) in selected panel of One-Belt-One-Road initiative countries from 1990-2014.

Fig. 4: Long-run results

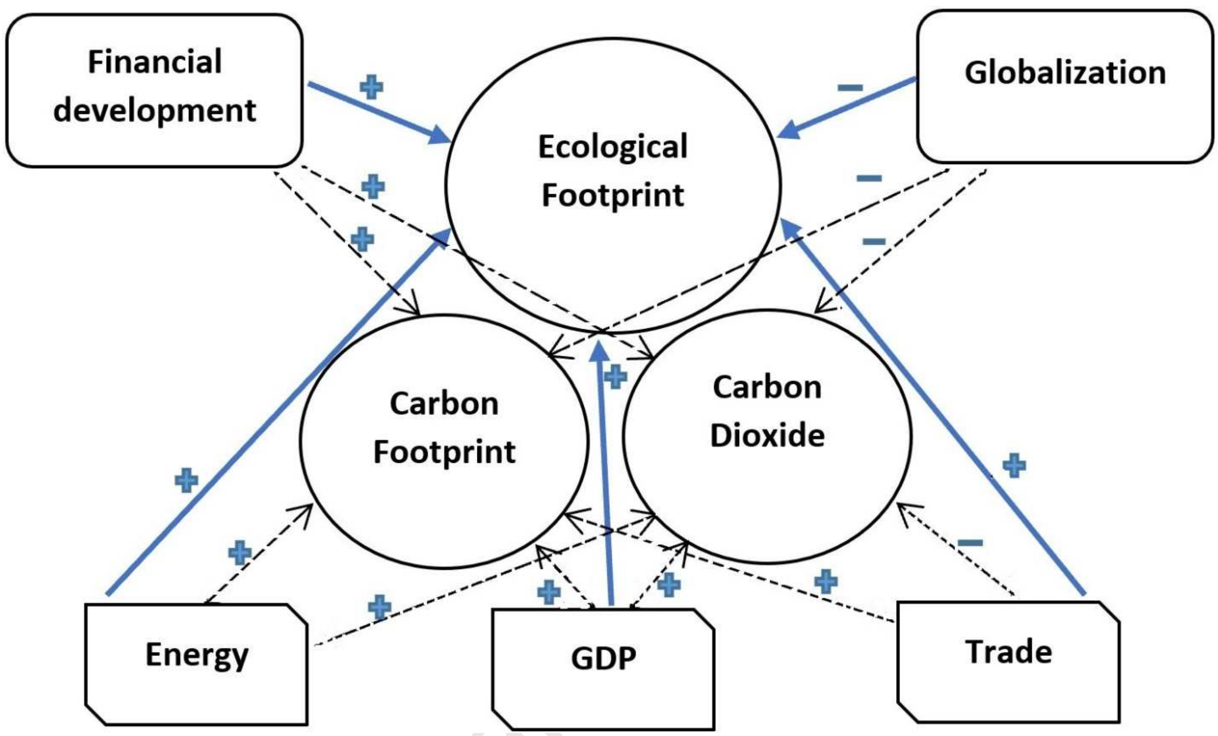

Figure 4: Shows the long-run panel estimation relationships among the analyzed variables. Where, (-) & (+) shows the negative and positive relationships; (→) shows relationship with EF, while (-->) shows associations with CF and CO_2 emissions.

Fig. 5: Dependent variable, ecological footprint (EF):

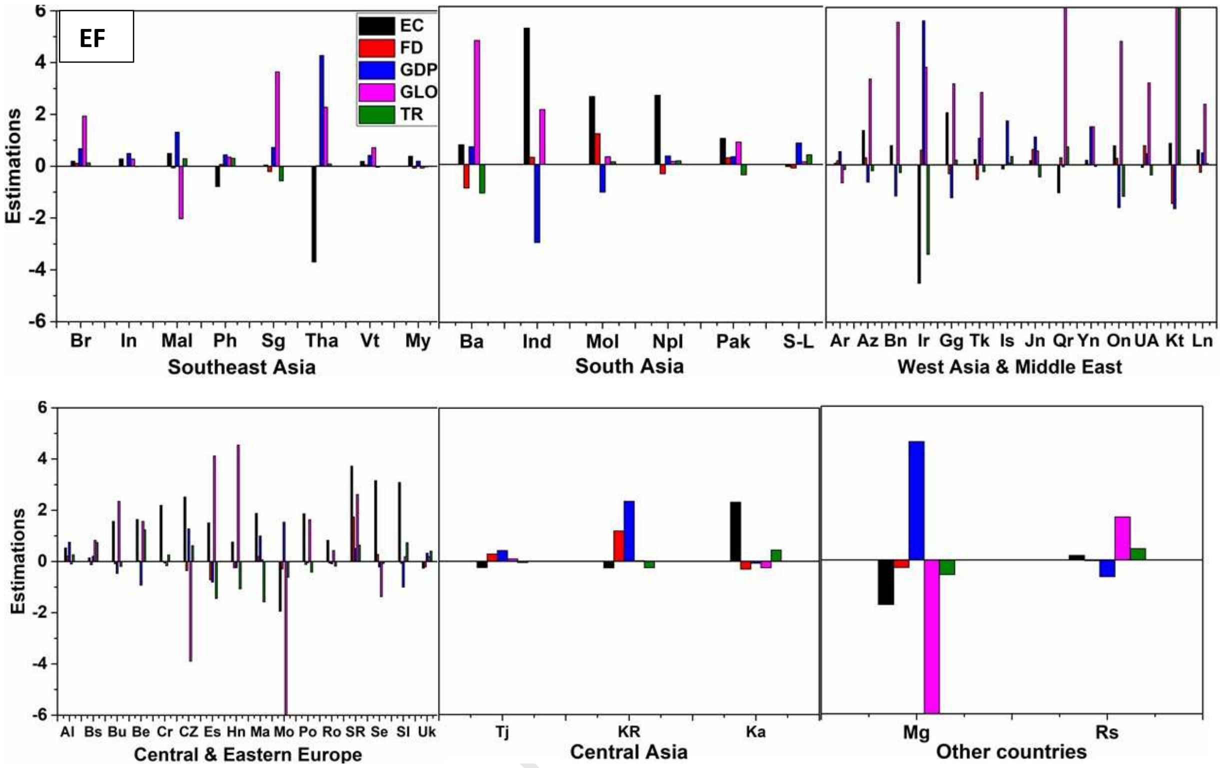

Figure 5: Shows the country-wise estimations of long-run indicators (i.e., EF (DV), EC, FD, GDP, GLO, TR) for selected OBOR sub-sectioned countries.

Fig. 6: DH causality

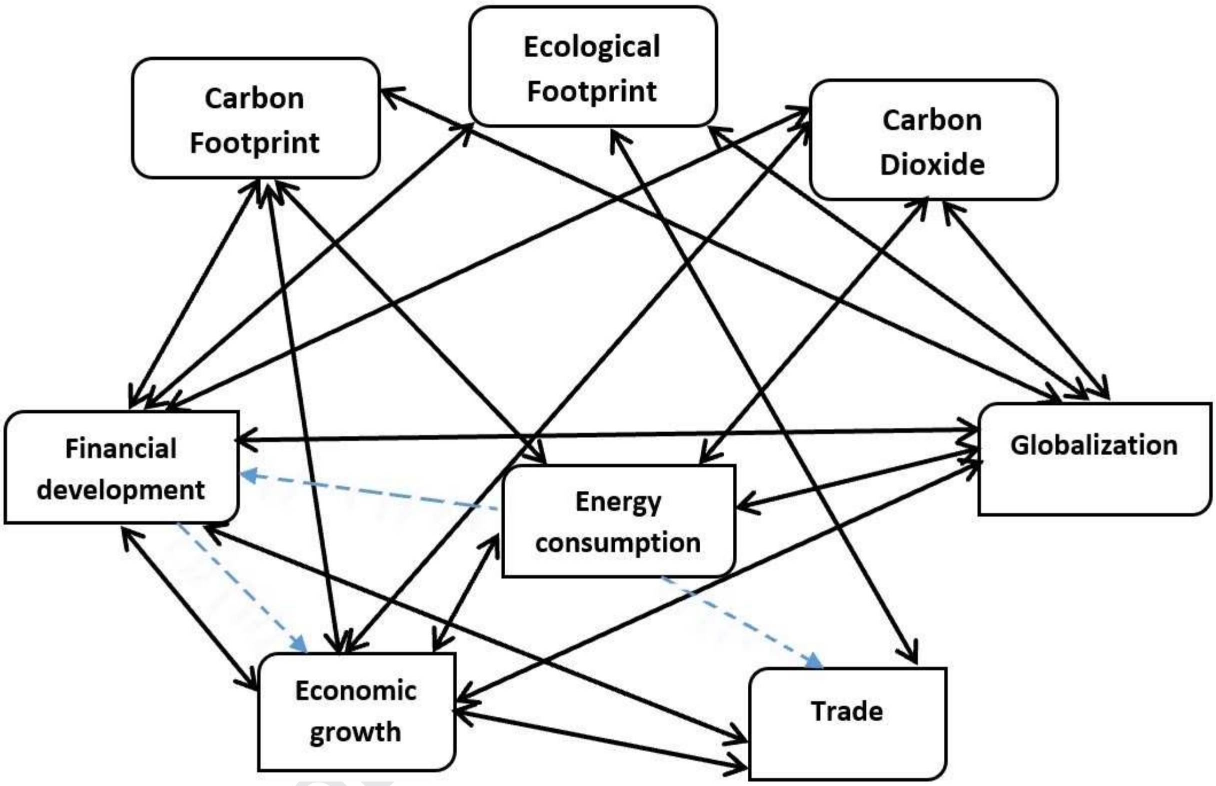

Figure 6: Shows the causality relationships among the analyzed variables, where, (-->) and (↔) shows the unidirectional and bidirectional causality relationships, respectively.

Appendices Figures 7 and 8. Supplementary Materials

Fig. 7: Dependent variable, carbon footprint (CF):

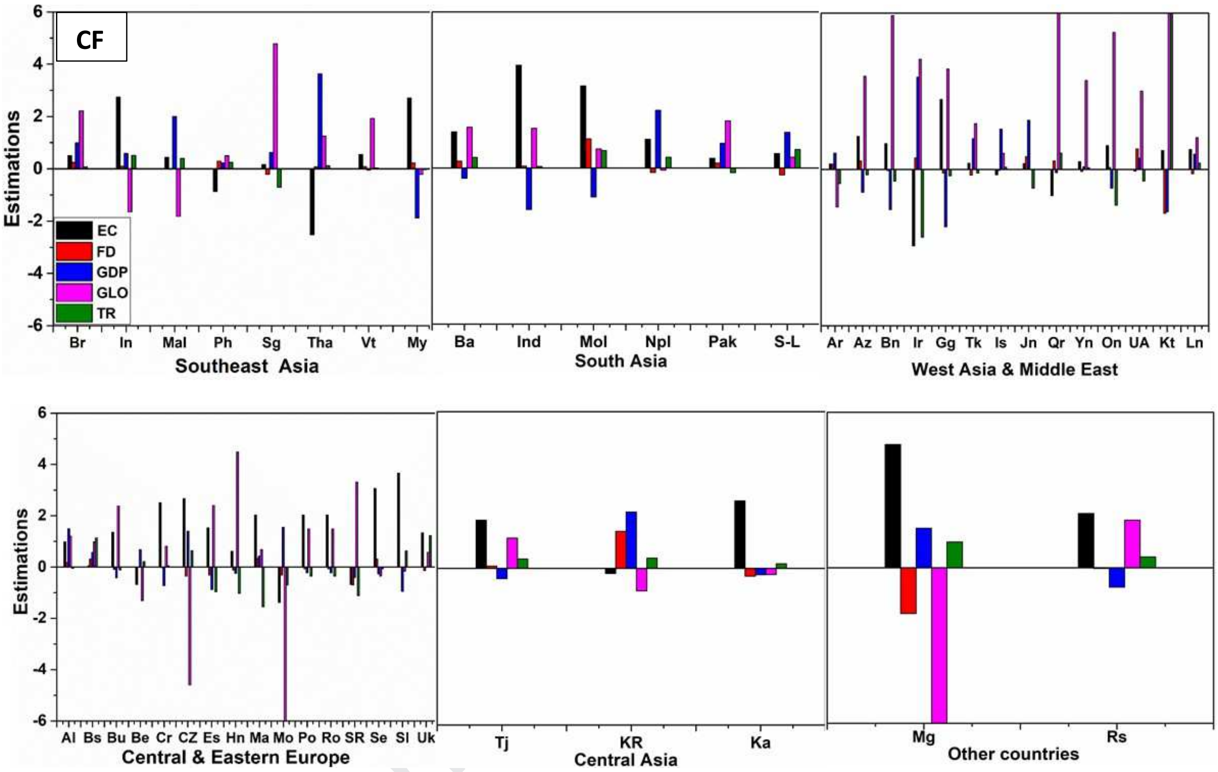

Figure 7: Shows the country-wise estimations of long-run indicators (i.e., CF (DV), EC, FD, GDP, GLO, TR) for selected OBOR sub-sectioned countries.

Fig. 8:

Dependent variable, carbon dioxide (CO_2):

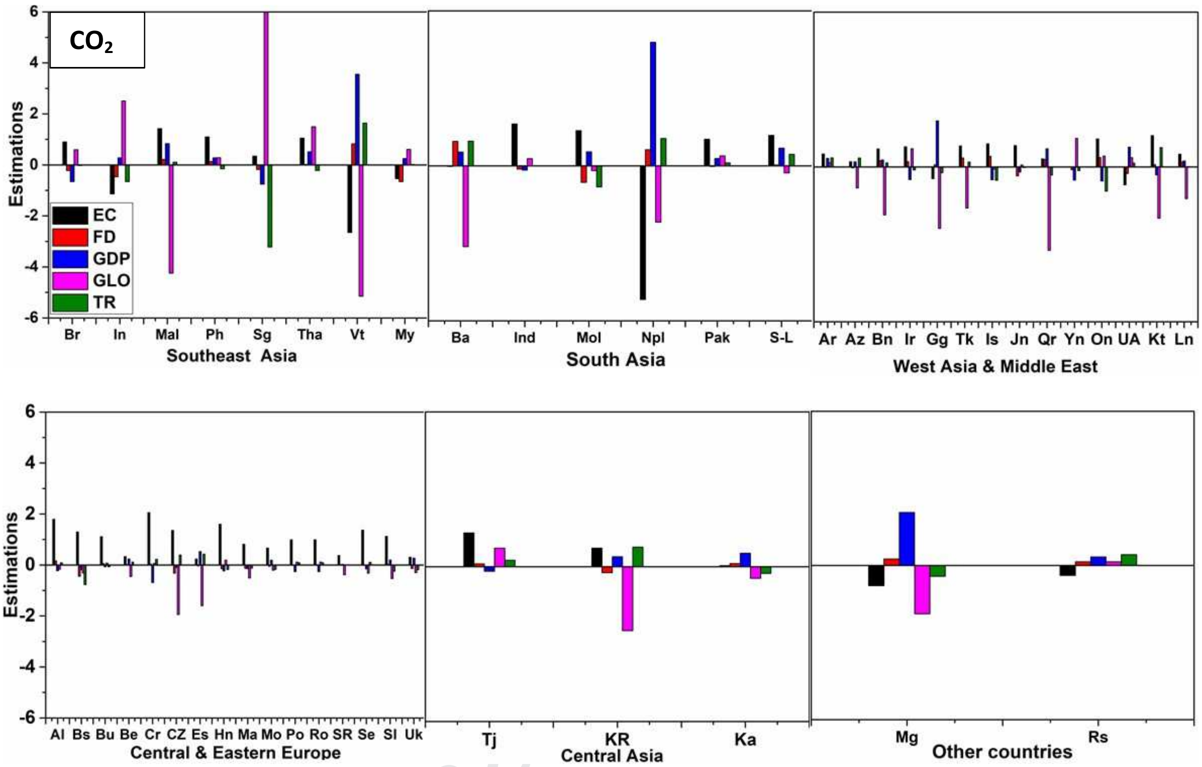

Figure 8: Shows the country-wise estimations of long-run indicators (i.e., CO_2 (DV), EC, FD, GDP, GLO, TR) for selected OBOR sub-sectioned countries.

Highlights

- Investigate the effect of financial development and globalization in the environment for selected one-belt-one-road (OBOR) initiative countries,
- Concerns among ecological footprint (EF), carbon footprint (CF), and carbon dioxide (CO_2) emissions indicators have been highlighted,
- Financial development is positively related to ecological footprints, carbon footprint and carbon dioxide emissions,
- Globalization is negatively impact on ecological footprint, carbon footprint and carbon dioxide emissions.