Capital Flow and Environmental Quality at Crossroads: Designing a Sustainable Policy Framework for the Newly Industrialized Countries

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Abstract: It is extremely difficult for emerging economies to achieve the Sustainable Development Goals (SDGs), and in order to close this policy gap, a comprehensive policy framework is needed. The purpose of this research is to determine the proportional impacts of domestic and foreign capital to environmental degradation in newly industrialized nations (NICs). For this reason, panel data methodology is used to evaluate, for the years 1991 to 2018, how the ecological footprint is affected by stock market capitalization, foreign direct investment, economic growth, urbanization, and energy intensity. Using the squared terms of stock market capitalization and foreign direct investment, respectively, it is also looked at whether domestic and foreign capital may have non-linear effects on the environment. According to the empirical findings, whereas local capital growth worsens the environment, increasing international capital prevents environmental degradation. There is an inverted U-shaped link between domestic capital and environmental degradation in the event of non-linearity, but foreign capital has a monotonically declining effect on environmental degradation. Additionally, it has been discovered that while using more non-renewable energy causes more environmental deterioration, using more renewable energy improves the quality of the environment. The study outcomes are utilized to design a policy framework to address the objectives of SDG 7, SDG 11, and SDG 13.

Keywords: Foreign Direct Investment, Stock Market, Ecological Footprint, Environmental Degradation

I. Introduction

The globe has begun to experience climate change difficulties due to increased economic growth, and this subject was one of the main topics of debate in the most recent Sustainable Development Goals (SDG) progress report (United Nations, 2018). The economic growth trajectory of the countries has been especially challenged in this study as being one of the main causes of the non-attainment of SDG 13, or climate action. Rapid industrialization, which again depends on ongoing reliance on fossil fuel-based energy sources and accelerated depletion of natural resources, has been used to achieve this economic expansion. This viewpoint suggests that the earth's carrying capacity is gradually declining as a result of the pursuit of economic expansion. Along with this, these countries' reliance on fossil fuel-based energy sources may prevent them from attaining SDG 7, which calls for access to affordable and clean energy. In such a scenario, the Newly Industrialized Countries (NICs) need a special mention, as the average energy intensity of these nations almost equals the global average, and above than that of the developed nations (World Bank, 2018). This high energy intensity coexists with the characteristically high economic growth potential, and because of this, they have been able to attract foreign investments, which has been able to accelerate the industrial growth in these nations (Boddin, 2016). However, according to the UNESCAP (2016) report on the regional trends of energy consumption shows that the energy consumption pattern in the NICs is ecologically unsustainable, and continuation of this particular pattern might create a predicament for these nations to achieve the objectives of SDG 7 and SDG 13.

Now, while these nations are achieving the high industrial growth, they have been able to create several job opportunities, and because of this, NICs have experienced a rural to urban migration, as these newly created jobs are majorly urban-centered. In the *Prototype Global Sustainable Development Report* by United Nations (2014), it has been mentioned that rise in the urban-centric job opportunities has given rise to the middle-class population in the urban centers, and the urban centers might encounter infrastructural difficulties due to rise in the urban population. The Transformative Urban Mobility Initiative is yet to reach its full potential for encounter this potential predicament in these nations, and therefore, sustainable city planning might prove to be an issue for these nations (United Nations Habitat, 2018). This might push the NICs away from achieving the objectives of SDG 11, i.e. sustainable cities and communities. Moreover, the rising urban population might result in rise in the energy demand, which can further add to the issues of climatic shift. Given such a scenario, it might be necessary for the NICs to realign their energy and economic policies to internalize the negative externalities exerted by their growth pattern.

In the pursuit of realignment of those policies, the role of financial development in these nations also be recognized. Growth potential of the NICs has attracted foreign direct investment, which has been responsible for technological progression and consequential industrial growth in these nations. A recent report by United Nations Industrial Development Organization has discussed this aspect (Martorano and Sanfilippo, 2017). This industrial growth has also increased the capability of creating domestic capital through the strengthening of financial market. In this context, Monge-Naranjo and Kenichi (2017) have shown that the financial development of the NICs by means of external and internal capital flow, the industrial growth is further catalyzed through a multiplier effect. For having a control over the issue of environmental degradation in these nations, the capita flow can a major role. In a joint report by International Labour Office (ILO) and the United Nations Conference on Trade and Development (UNCTAD) have discussed the potential role of financial market in combating the issues of environmental degradation (Salazar-Xirinachs et al., 2014). In light of this, one can infer that in order to ensure sustainable development in the NICs, it is important to either realign the countries' current policies or build a new policy framework. To ensure that the proposed policy framework achieves its intended goal of internalizing the negative externality through the financial channels of economic growth, it is necessary to evaluate the potential effects of these financing mechanisms on environmental quality while bringing about the redesign of the policy architecture of these countries. Herein lays the current study's main focus.

Following the discussion on the agenda 2030 to be attained by the NICs, this study aims to devise a sustainable development framework through analyzing the impact of the domestic and foreign capital flows on environmental degradation, while considering the energy intensity and urbanization as two additional policy instruments. For catalyzing environmentally sustainable economic growth, it is imperative that the financing mechanism through the flow of capital should complement the objective of attaining sustainable development. This mechanism might prove to be beneficial for internalizing the negative environmental externalities exerted by the prevailing industrial growth pattern. Along with the NICs, several other emerging economies also encountering the similar kind of issues, and therefore, the policy framework to be designed for these countries might act as a policy level benchmark for them. For example, Asia and the Pacific (Defilla, 2019) countries, and the Middle Eastern and North African (Göll et al., 2019) countries are encountering these problems. The outcome of this study might prepare a way for the other emerging economies to address the issues of sustainable development, and there lies the generalizable outlook of the policy framework suggested in this study. Through the sustainable development policy framework suggested in this study, the NICs might be able to make a progress towards achieving the objectives of SDG 7, SDG 11, and SDG 13. Considering the prevailing policy gap in the NICs, this study contributed to the literature by designing the policy framework for the NICs, which can be replicated by the other emerging economies. There lies the policy level contribution of the present study.

Now, while discussing about the policy-level contribution of the study, it should be remembered that the research problem must be complemented by the methodological adaptation. Socio-political dispersion of the NICs might negate the probability of structural diffusion of economic spillovers among the members, and this aspect should be considered while designing the policy framework. In this pursuit, fully modified ordinary least square (FMOLS) method has been adopted. As the sample size of this study is comparatively smaller than the other economic and political agglomerations, FMOLS is capable of producing robust outcome (Phillips and Hansen, 1990). Alongside the complementarity of the methodological framework, it is also necessary that the analytical framework should also complement the policy contribution. While designing a policy framework, evolutionary impact of the policy instruments on target policy parameter needs to be captured over a temporal frame. In the literature of Environmental Economics, this impact is captured by means of the Environmental Kuznets Curve (EKC) hypothesis. This methodological and analytical complementarity with the policy-level contribution of the study is the empirical contribution of this study.

The rest of the study is designed in the following manner: section II discusses the relevant academic literature, section III outlines the empirical schema, section IV discusses the results of the empirical exercise, and section V concludes the study with relevant policy implications.

II. A brief review of literature

The Environmental Kuznets curve concept, which links environmental degradation with economic production of nations, appears to be prevalent in environmental economics literature

(Grossman and Krueger 1995, Shahbaz and Sinha, 2019). The roles of local and foreign capital, which are acknowledged as the primary drivers of economic growth and as one of the most crucial means of gaining access to expensive clean energy technology, have, however, largely gone unnoticed. As a result, we divided the literary area into two categories. The literature on the connection between foreign direct investment and environmental deterioration is reviewed in the first section, and research on the relationship between stock market growth and environmental degradation are reviewed in the second.

II.I. Foreign direct investment and environmental degradation

Despite the widespread belief that numerous studies (such as Duarte et al. 2017, Tang and Tan 2018, Long et al. 2018) have demonstrated that foreign direct investment (FDI) is beneficial for economic growth, the influence of FDI on environmental quality is still undetermined. The Halo Effect approach claims that foreign investors will promote favorable environmental spillovers and cleaner technologies that will be less harmful to the environment by luring high-level research and development investment that is transferred to the host country, explaining the positive impact of FDI on environmental quality (Eskeland and Harrison 2003, Cole et al. 2008). In this regard, List and Co (2000) examined the relationship between FDI and environmental quality during the years 1986 to 1993 and came to the conclusion that FDI aids in promoting the host nations' energy efficiency and enhancing their environmental quality. For 20 developing nations, the impact of FDI on energy intensity was examined by Mielnik and Goldemberg (2002) and they discovered that using the cutting-edge technology included with FDI, increasing FDI significantly lowers energy intensity. For the BRIC economies between 1992 and 2004, Tamazian et al. (2009) evaluated the effects of economic development, FDI, and financial development on environmental quality and discovered that FDI at higher levels reduces carbon emissions. Similar findings were made by Asghari (2013), Tamazian and Rao (2010), and Linh and Lin (2012) who discovered that FDI has a detrimental impact on CO_2 emissions. Additionally, in China and countries with higher emissions, respectively, investigations by Zhang and Zhou (2016) and Zhu et al. (2016) backed up the validity of the halo effect concept.

The Pollution Haven Hypothesis, on the other hand, holds that FDI is shifting toward nations that impose less stringent environmental rules and that these nations become pollution havens as a result. This hypothesis has also been confirmed by numerous research. For instance, Baek and Koo (2009) examined the relationship between foreign direct investment and environmental deterioration and found that FDI has a favorable impact on carbon emissions. Using an autoregressive distributed lag model, Kivyiro and Arminen (2016) examined the connections between CO_2 emissions, energy use, FDI, and economic development in six Sub-Saharan African nations over the period of 1971 to 2009 and discovered that FDI appears to increase carbon emissions in Kenya and Zimbabwe while the pollution halo hypothesis holds true for the Democratic Republic of the Congo and South Africa. Using the pooled mean group estimator of dynamic panels, Baek (2016) found that FDI tends to increase CO_2 emissions for five ASEAN countries over the period of 1981–2010; this finding also supports the viability of the pollution haven theory. Additionally, other research examined the association between FDI and environmental deterioration while accounting for the causal relationship between variables. For instance, Ajide and Adeniyi (2010) used the Autoregressive Distributed Lag approach to examine the causal relationship between economic growth, FDI, and the environment in Nigeria for the years 1970–2006, and they discovered that the results showed a long-term relationship between carbon emissions and FDI inflows, supporting the pollution haven hypothesis in Nigeria. Similarly, Shahbaz et al. (2018) also confirmed the pollution increasing effect of foreign capital for BRICS countries. According to Shahbaz et al(2015a), the relationship between foreign direct investment and environmental degradation in high-, middle-, and low-income countries, there is a two-way causal relationship between CO2 emissions and FDI. Omri et al. (2014) used dynamic simultaneous-equation panel data models for 54 nations that were deployed for 3 regional sub-panels to evaluate the causal link between carbon emissions, FDI, and economic growth. With the exception of Europe and North Asia, their data suggested that FDI and CO2 emissions are causally related in both directions for all of the panels. Abdouli and Hammami (2016) used simultaneous-equation panel data VAR model estimate for the years 1990 to 2012 to explore the causal links between environmental quality, FDI, and economic growth for 17 MENA nations. According to their research, FDI and carbon emissions have a bidirectional causal relationship for the worldwide panel. Amri (2016) looked into the connections between energy use, FDI inflows, and output in 75 nations that were divided into developed and developing economies. The findings show a bidirectional relationship between FDI and renewable energy usage in affluent nations, and a unidirectional relationship between FDI and energy in emerging and developing economies. Hoffmann et al. (2005) investigated the connection between economic development, FDI, and CO2 emissions and discovered a unidirectional causality between the two, although According to Linh and Lin (2012) and He et al. (2012), there is a unidirectional Granger causality from energy consumption to FDI and from carbon emissions to FDI, respectively. In addition, some studies argued that there is a non-linear nexus between foreign direct investment and pollution. For instance, Destek and Okumus (2019) found that the inverted U-shaped relation exists between foreign capital and ecological footprint.

Some research further claimed that there doesn't appear to be a positive or negative association between FDI and environmental degradation in light of these contradicting findings. For instance, Lee (2013) examined the relationship between FDI, GDP, energy, clean energy, and carbon emissions in 19 G20 countries between 1971 and 2009. The influence of the FDI limits on an increase in CO2 emissions is shown by the results of the cointegration tests and fixed effect models, and there is no evidence between FDI and the use of clean energy. Similar to this, Shaari et al. (2014) used FMOLS in 15 developing nations to assess the impact of FDI and economic growth on carbon emissions for the annual panel data from 1992 to 2012. According to their findings, FDI has no long-term impact on CO2 emissions. Keho (2016) looked into how FDI affected CO2 emissions for 11 Economic Community of West African States members (ECOWAS). The model's findings demonstrate that FDI in Benin, Niger, Senegal, and Sierra Leone has no appreciable long-term impact on CO2 emissions. Using ARDL bound testing, Kzlkaya (2017) examined the relationships among carbon dioxide emissions, economic growth, foreign direct investment, and energy consumption in Turkey from 1970 to 2014 and discovered no significant associations between foreign direct investment and CO2 emissions. Using the ARDL model, Fauzel (2017) examined the long- and short-term effects of FDI on CO2 emissions in Mauritius from 1980 to 2012 and discovered that FDI in non-manufacturing sectors had no negative environmental effects. Using the STIRPAT model, Solarin and Al-Mulali (2018) investigated the impact of FDI on environmental degradation indicators for 20 nations. They found that the results of the panel indicated that FDI has no impact on the environmental degradation indicators.

II.II Stock market and environmental degradation

There are not many studies that concentrate on the impact of stock market development on environmental quality, despite the vast amount of research on the relationship between financial development and environmental degradation. We therefore start by reviewing earlier research on the connection between financial progress and environment. Then, we concentrate on research on the relationship between the stock market and the environment.

The increase in environmental deterioration caused by financial development appears to be a common finding in the environmental economics literature. For instance, Tamazian and Rao (2010) looked into how well-developed institutions, the economy, and the financial sector affected environmental degradation. Their empirical findings demonstrate that, between 1993 and 2004, environmental degradation decreased in 24 transition nations as a result of financial development. In a similar vein, Tamazian et al. (2009) investigated whether or not increased economic and financial development in BRIC economies results in environmental damage. They came to the conclusion that greater financial development results in less environmental degradation. According to Zhang (2011), financial progress results in higher CO2 emissions. Shahbaz et al. (2015b) and Boutabba (2015a) both observed that financial development causes environmental damage (2014). Javid and Sharif (2016) looked examined how per capita CO2 emissions changed between 1972 and 2013 in relation to financial development, real per capita income, real per capita income squared, per capita energy consumption, and openness. The findings demonstrate that Pakistan's financial progress resulted in higher CO2 emissions. Isik et al. (2017) examined the dynamic causal relationships between economic growth, financial development, international trade, and tourism spending on CO2 emissions from 1970 to 2014 in the instance of Greece and discovered that financial development increases CO2 emissions. By utilizing structural break and cointegration tests to analyze the association between financial development and environmental degradation over the years 1975QI–2014QIV, Shahbaz et al. (2018) found that financial development increases CO2 emissions in the United Arab Emirates. Similar to this, Destek and Manga (2021) validated the pollution increasing influence of financial development for big emerging markets.

However, several research also support the existence of the financial sector's ability to slow down environmental degradation. For instance, Jalil and Feridun (2011) used ARDL bounds testing to cointegration to evaluate the relationship between financial development and carbon emissions in China for the years 1953 to 2006. They came to the conclusion that economic growth has a detrimental impact on carbon emissions. Additionally, Shahbaz et al. (2013b) revealed that utilizing the ARDL limits testing method, financial development decreased carbon emissions in Malaysia between 1971 and 2011. In the case of the Gulf Cooperation Council (GCC) nations, Salahuddin et al. (2015) looked into the relationship between financial development and environmental nexus and found that it had a detrimental effect on environmental degradation. Charfeddine and Khediri (2015) and Al-Mulali et al. (2015) similarly discovered that financial development slows down environmental damage. In the instance of 19 emerging economies, Saidi and Mbarek (2017) evaluated the effect of financial development on CO2 emissions between 1990 and 2013. The empirical results indicate that financial development has a long-term adverse influence on CO2 emissions. Khan et al. (2018) discovered that, with the exception of India, financial development in the three Asian emerging nations they chose has a negative correlation with CO2 emissions. Shahbaz et al. (2013c, d) for Indonesia and South Africa, respectively, similarly support the positive effect of financial development on environmental quality. According to Ozturk and Acaravci (2013), financial development in Turkey between 1960 and 2007 had no appreciable impact on carbon emissions. Similarly, Destek and Sarkodie (2019) found the evidence that there is not any significant nexus between financial development and ecological footprint. Various studies have also looked into the potential non-linear relationship between financial development and environmental degradation. Charfeddine and Khediri (2016) used a sample of UAE countries for the years 1975 to 2011 and discovered an inverted U-shaped relationship between financial development and CO_2 emissions. Using a panel transition regression model during the period of 1971–2007 for 25 OECD countries, Hung et al. (2018) investigated the correlation between financial development and CO_2 emissions and discovered substantial evidence of a non-linear relationship between the variables. As a parabolic perspective, Shahbaz et al. (2021) argued that there are inverted N-shaped relation between financial progress and environmental pollution for France, Italy and the UK. There are very few research looking into how stock market growth affects environmental quality. Over instance, Paramati et al. (2016) used data from 20 developing market economies to assess the effect of stock market development on CO_2 emissions for the years 1991 to 2012. They used the ARDL panel technique and discovered that growing stock markets result in higher CO_2 emissions. Additionally, Paramati et al. (2017b) examined the relationship between stock market growth and carbon emissions for the EU, G20, and OECD countries using the CCE (common correlated effect) estimator, and they came to the conclusion that while stock market growth decreases carbon emissions in the EU and G20 countries, it worsens the environment in the OECD countries. In a similar vein, a different study by Paramati et al. (2017c) also supported the idea that rising stock markets in both developed and developing nations result in lower CO_2 emissions. De Haas and Popov (2018) looked at how financial development affected industrial pollution between 1974 and 2013 and discovered that the stock market has a negative influence on CO_2 emissions per person.

In conclusion, it is clear that there aren't many research comparing the relative impacts of FDI and stock market growth on environmental deterioration. Furthermore, since the majority of these studies use carbon emissions as a measure of environmental deterioration, it may be worthwhile to do additional research using ecological footprint measurements rather than CO_2 emissions.

III. Data and empirical strategy

III.I. Data

The panel dataset of nine newly industrialized nations—Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand, and Turkey—uses the annual period from 1991 to 2018 based on the availability of the data. The following is how the variables are measured: Ecological footprint (EF) denotes ecological footprint per person, urbanization (URB) is measured as the proportion of the population living in urban areas, gross domestic product (GDP) per person is calculated using constant 2010 US dollars, and energy intensity (EI) denotes the amount of energy required to produce one unit of economic output at purchasing power parity. Domestic capital (DC) is the stock market capitalization of publicly traded domestic enterprises as a share of GDP, while foreign capital (FC) is calculated as the share of foreign direct investment inflows in total GDP; The generation of electricity from geothermal, wind, solar, tide and wave, biomass, and waste is referred to as renewable energy consumption per capita (REN), which is measured in billion kilowatt hours. Non-renewable energy usage per capita (NREN), which is also measured in billion kilowatt hours, refers to the production of electricity from coal, gas, and oil.

The ecological footprint data that is being used comes from the Global Footprint Network; the urbanization, GDP, energy intensity, foreign and domestic capital, and population data come from the World Development Indicators database (World Bank, 2021); and the data on the consumption of renewable and nonrenewable energy comes from the Energy Information

Administration (EIA) database. Moreover, all variables are employed in natural logarithmic form to prevent issues related to the distributional features of the data.

III.II. Model specification

The IPAT environmental model, created by Ehrlich and Holdren (1971) allows for a large-scale examination of the effects of socioeconomic factors on environmental degradation (Ehrlich and Holdren 1971). The following is a presentation of the IPAT identity's fundamental model:

$$I = P \times A \times T \quad (1)$$

Where, I is the environmental impact, which is determined by three main factors: population (P), affluence or per capita consumption (A) and technological level or efficiency (T). The IPAT's principal advantages are a privileged specification of the major factors causing environmental change and, in addition, a complete definition of the relationship between these factors and their impacts. Because changes to one element are compounded by other parameters, the specification amply indicates that the propulsive forces (P, A, and T) do not independently affect one another. This specification has a considerable impact, but it is not the only factor in environmental effects. The IPAT model, however, has come under fire based on the presumption that (I) was proportional to all of the different driving elements. Dietz and Rosa (1994) reworked the fundamental IPAT model to produce a stochastic variant known as STIRPAT in order to get around this constraint (Stochastic Impacts by Regression on Population, Affluence and Technology). The STIRPAT model can be expressed as follows in its generic form:

$$I_i = aP_i^b A_i^c T_i^d u_i \quad (2)$$

Where a denotes the constant term, b, c, and d stand for P, A, and T's respective parameters, and u_i denotes the error term. To examine the effects of foreign and domestic capital on environmental degradation, we extend this primary model by include foreign direct investment and stock market capitalization. Additionally, both sides of the equation are divided by the population in order to get each series in terms of per capita. We also include urbanization as an explanatory variable in the model because several studies, like Liddle and Lung (2010), Wang et al. (2013), Shahbaz et al. (2016b), Ji and Chen (2017), etc., have identified urbanization as one of the key variables influencing environmental deterioration. Finally, the linearized, enhanced model is as follows:

$$EF_{it} = f(GDP_{it}, EI_{it}, FC_{it}, DC_{it}, URB_{it}, v_i) \quad (3)$$

where the relationship between ecological footprint per person (EF) and economic output per person (GDP), energy intensity (EI), the share of foreign direct investment inflows in gross domestic product (FC), the share of stock market capitalization of domestic listed companies in gross domestic product (DC), and urbanization (URB). As a measure of environmental degradation in this study, Wachernagel and Rees' (1996) ecological footprint was utilized. The justification for this preferential treatment comes from the fact that environmental degradation extends beyond merely affecting ambient air quality; it also shows how the earth's carrying capacity is falling due to the deterioration of its soil, forest, and mineral reserves. Because of this, the ecological footprint, which has six subcomponents (Cropland, Grazing Land, Fishing Grounds, Forest Land, Built-up Land, and Carbon Footprint), may be able to measure the degree of environmental degradation. Therefore, from a policymaking viewpoint, considering ecological footprint could result in a more comprehensive and comprehensive picture of the state of environmental deterioration in NICs.

In addition, we have included squared terms of foreign and domestic capital to observe the evolutionary impact of capital flows on environmental degradation. Given this policy-level objective, ecological footprint can be modeled as follows:

$$EF_{it} = f(GDP_{it}, EI_{it}, FC_{it}, FC_{it}^2, DC_{it}, URB_{it}, v_i) \quad (4)$$

$$EF_{it} = f(GDP_{it}, EI_{it}, FC_{it}, DC_{it}, DC_{it}^2, URB_{it}, v_i) \quad (5)$$

where FC^2 and DC^2 indicates squared terms of foreign and domestic capital, respectively. In case of equation-4, the positive (negative) sign of the coefficient of FC (FC^2), it is concluded that there is inverted U-shaped relationship between foreign capital and environmental degradation. However, the negative coefficient of FC and the positive coefficient of FC^2 show the existence of U-shaped relationship between them. Similarly, in case of equation-5, the positive (negative) sign of the DC (DC^2) means that there is inverted U-shaped relationship between domestic capital and ecological footprint, and vice versa.

III.III. Methodology

This study examines the link between the aforementioned variables using panel unit root, panel cointegration, and panel causality approaches. Because panel data encompasses information in both cross-sectional and time dimensions, utilizing panel data as opposed to time series boosts the power of the unit root and cointegration test (Nazlioglu and Soytas, 2012). Our empirical approach consists of four steps. First, panel unit root tests are used to look at the stationary qualities of the variables. Second, a panel cointegration test is used to determine whether the long-run relationship is legitimate. Third, using a panel cointegration parameter estimator, the long-term effects of each explanatory variable are examined. Finally, a panel causality test is used to look into the causal relationship between the variables.

Examining the stationary qualities of variables is a key stage in econometric analysis. To establish the order of integration of the variables, we employ widely used two panel unit root tests like the LLC unit root test of Levin et al. (2002) and IPS unit root test of Im et al. (2003). The LLC test's primary model is built as follows:

$$\Delta y_{it} = \mu_i + \rho y_{it-1} + \sum_{j=1}^{k} a_j \Delta y_{it-j} + \delta_i t + \theta_t + \varepsilon_{it} \quad (7)$$

where Δ indicates the first difference operator, k implies the lag length, μ_i and θ_t are unit-specific fixed and time effects, respectively. In testing procedure of LLC, the null of $\rho = 0$ for all cross-sections is tested against the alternative of $\rho < 0$ for all cross-sections.

Im et al. (2003) developed the IPS unit root test to take into account the possible different speed of adjustment process of cross-sectional units which is ignored by LLC test. When the main model of LLC test is re-written as follows:

$$\Delta y_{it} = \mu_i + \rho y_{it-1} + \sum_{j=1}^{k} a_j \Delta y_{it-j} + \delta_i t + \theta_t + \varepsilon_{it} \quad (8)$$

In testing procedure of IPS test, similar to the LLC test, the null hypothesis of $\rho = 0$ implies that all series have a unit root. However, alternative hypothesis of $\rho < 0$ implies that some of the series are stationary in the panel.

We use the panel cointegration test of Pedroni (1999) to investigate the existence of the long-run link between variables after determining the stationary features of the variables. The primary empirical models are initially computed for each cross-section throughout the testing method. Then, the regression model of $\varepsilon_{it} = \delta_i \varepsilon_{it-1} + \sum_{k=1}^{K_i} \delta_{ik} \Delta\varepsilon_{it-k} + v_{it}$ is estimated. Pedroni (1999) developed seven statistics to test the null of there is no cointegration against the alternative of cointegration existence.

The next step of the analysis is to examine the long-run coefficients of cointegrated variables. In this study, the long-run coefficients of variables are estimated with fully modified ordinary least squares (FMOLS) developed by Pedroni (2001). The estimation of FMOLS can be constructed as $\hat{\beta}_{GFMOLS} = N^{-1} \sum_{i=1}^{N} \beta_{FMOLS}$ where β_{FMOLS} is acquired from individual FMOLS estimation of the main models.

In order to determine the causal connection between the variables, we then do the panel heterogeneous causality test proposed by Dumitrescu and Hurlin (2012). One benefit of employing this test is that it yields consistent results regardless of the sample size or cross-sectional dependence. ii) If all of the variables are stationary at the same level, this test is appropriate. iii) The test is suitable for imbalanced panels and panels with various lag orders for each person. The following is how the panel heterogeneous causality approach is put together:

$$W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} W_{i,t} \qquad (9)$$

where $W_{i,t}$ is the Wald statistic for the country i, therefore the first statistic computed with the simple means of individual Wald statistics. In addition, Dumitrescu and Hurlin (2012) suggested another statistic with standardizing $W_{N,T}^{HNC}$ statistic by using estimated values of mean and variance of each Wald statistic with a small sample for T. The computation of this statistic is as following:

$$Z_{N,T}^{HNC} = \frac{\sqrt{N}\,[W_{N,T}^{Hnc} - \sum_{i=1}^{N} E(W_{i,t}]}{\sqrt{\sum_{i=1}^{N} Var(W_{i,t})}} \qquad (10)$$

IV. Empirical results and discussion

In first step, we examine the stationary properties of the variables using with panel unit root tests. The empirical results are illustrated in Table-1. We find that the null hypothesis of unit root process is not rejected by both tests for all variables in the level form. However, in first differenced form, the null hypothesis is rejected at 1 percent significance level and all variables have become stationary. This shows that all the variables are integrated at I(1).

<Insert Table I here>

The unique order of integration leads us to apply panel cointegration approach for testing the presence of cointegration between the variables. The panel cointegration results are reported in Table-2. It can be seen that the null of there is no cointegration is rejected by four statistics for the first model. Therefore, the existence of the long-run relationship between variables is confirmed in case of newly industrialized economies.

<Insert Table II here>

After determining the long-run relationship between variables, we first examine the long-run effects of urbanization, real income, energy efficiency, foreign capital and domestic capital on ecological footprint with FMOLS estimation. The empirical results are reported in Table-3. We find that urbanization has positive and significant effect on ecological footprint i.e. environmental degradation. This empirical finding implies that the rural-urban migration is causing a pressure on the existing urban infrastructure, and consequentially, environmental degradation is being accelerated. This particular finding is consistent with finding of Dogan and Turkekul (2016), Destek (2021), Destek et al (2021). This association gives an indication regarding the unsustainable industrial growth pattern on the environmental quality, and this issue might be a concern for the policymakers regarding urban planning. This piece of evidence shows the rationale behind the NICs taking a departure from attaining the objectives of SDG 13. The impact of urbanization on environmental quality is complemented by the environmental impact of economic growth pattern. The impact of real income on environmental degradation is positive and significant, and a similar kind of impact is also exerted by energy intensity. This empirical evidence that both economic growth and its driver are responsible for environmental degradation, and this piece of evidence is in the similar lines with Sadorsky (2014) and Destek and Aydın (2022). This evidence suggests that the policymakers of these countries are giving more importance to achieving economic growth, even at any cost of environmental quality. As the economic growth pattern of these nations is largely dependent on fossil fuel-based solutions, this driver of economic growth is causing the worsening of environmental quality. This is causing the NICs to take a drift away from attaining the objectives of SDG 7.

In continuation to this discussion, it might prove to be necessary for the policymakers to discover the possible financing mechanisms for ascertaining the sustainable development in these nations, and in this pursuit, the impact of domestic and foreign capital flow on the environmental degradation has been analyzed. The results show that the effect of foreign capital on ecological footprint is negative and significant, while domestic capital affects ecological footprint positively and significantly. The prevailing industrial growth pattern in these nations is encouraging the firms to become cost-effective, and in that pursuit, firms are relying more on the fossil fuel-based solutions. Therefore, the capital generated domestically is gradually exerting a negative environmental externality. In such a situation, it might be difficult for the policymakers to rely on domestic financial market as a viable channel to ascertain sustainable development, and they might start looking into international financing mechanism. A potential reason for relying less on the domestic capital can be the growth in domestic capital might be a result of disproportionate industrial growth, and that's why the policymakers might resort to import of environment-friendly technologies. This might help them in ascertaining the objectives of SDG 13. This empirical finding is similar to Paramati et al. (2017c) for developing countries.

While saying this, it is also necessary to look at the evolutionary impact of the domestic and foreign capital on the environmental quality, and it is divulged by means of their non-linear impact analyzed through EKC hypothesis. The empirical results are illustrated in Table-3. The results demonstrate the evolutionary impact of domestic capital on the environmental quality to be gradually turning out to be positive, as the turnaround point of the inverted U-shaped association is within the sample range. This empirical evidence is similar to the finding of the Charfeddine and Khediri (2016). On the other hand, evolutionary impact of foreign capital on the environmental degradation to be gradually turning out to be monotonically decreasing. This can be explained by the gradually decreasing environmental risk potential of domestic investors in the NICs relative to foreign investors. In fact, for relatively large-scale international investors, green projects are seen as a bearable risk. For this reason, domestic capital owners have observed the profitability of such projects for a certain period and have increased their investments in such projects through long-term government incentives. From this perspective, both domestic and foreign capital flows can be considered as viable mechanisms for handling the issues of environmental degradation in the NICs.

<Insert Table III here>

In order to design a robust policy framework, it is necessary to understand the inherent bidirectionality among the policy instruments. For looking into this issue, we examined the possible causal linkages between ecological footprint and its determinants using with the panel causality test and results are reported in Table-4. We find the presence of bidirectional causality between urbanization and ecological footprint. This piece of evidence gives an indication that the rising problem of the environmental degradation might force the policymakers to rethink about the urban planning, so that the urbanization can be sustained. Existence of this causal association might create a hinderance in achieving the objective of SDG 11. Along with this, unidirectional causality is found running from real income and domestic capital to ecological footprint, whereas ecological footprint is found to be causing foreign capital. These casual association give an indication regarding the environmentally unsustainable growth pattern achieved by the NICs, and these causal association might be a concern of the policymakers. At the same time, the causal impact of ecological footprint on foreign capital might provide the policymakers with a potential solution to address this issue.

<Insert Table IV here>

V. Conclusion and policy implications

This study is to compare the effect of domestic and foreign capital on environmental degradation in newly industrialized countries for the period of 1991-2018. In doing so, the urbanization, economic growth and energy intensity are included in the EKC hypothesis framework. The results provide several insights for designing a policy framework for attaining the objectives of SDGs, so that the framework can be replicated to other emerging economies around the world.

V.I. Central policy framework

As the industrial growth pattern is causing the environmental degradation in these nations, the suggested policy framework needs to internalize the negative externalities exerted by industrial growth pattern. While energy intensity is having a detrimental impact on the environmental quality, it is necessary for the policymakers to push the industrial sector towards bringing forth energy reforms. In this pursuit, the industrial sector needs to introduce as transformation in their energy usage pattern, which is highly characterized by fossil fuel-based energy solutions. Now, this transformation needs to be carried out in phases, as any overnight transformation of energy resources might cause harm to the economic growth pattern. In order to ensure a smooth transformation, the policymakers need to initiate the process at the household level, followed by the industrial sector. During the first phase, the urban households can be provided with renewable energy solutions at a pro-rata rate, with certain interest rate holiday. In this way, the household sector will be able to move towards adopting the renewable energy solutions in a cost-effective manner. In order to cover the fiscal loss incurred during this process, the policy makers need to offer the renewable energy solutions to the industrial sector at a pro-rata rate, which will be differentiated by the ecological footprint of the firms. This will discourage the firms to use traditional fossil fuel-based solution, as this policy move will have a direct impact on the competitive position in the international market. However, it might not be possible for all the firms to replace the fossil fuel-based energy solutions during the first phase, and hence, those firms need to look into improving their production process for bringing forth energy efficiency. Moving onto the second phase, these firms might look into importing environment-friendly technological solutions, till these solutions are prepared indigenously. The foreign capital flow channel might thus be utilized for ensuring the environmental-friendly operation of the firms. This will help these nations to make a progress towards achieving the objectives of SDG 7.

For ensuring the indigenous technological development, the policymakers need to depend on the domestic capital flow. As for the first two phases firms are already on the path of making their production processes environmentally sustainable, it will be easier for the policymakers to incentivize the industrial sector in channelizing the fund for technological development. This particular phase can be considered as the third phase of the policy implementation. By the time this phase is initiated, the household sector already started taking the benefits of renewable energy solutions, and the environmental degradation issue arising out of the urban region might be controlled. Further expansion of the urban centers might consider development of energy efficient buildings in order to reduce the environmental degradation arising out of space heating. This particular move might help these nations to make their urban centers sustainable, and help these nations to make a progress towards achieving the objectives of SDG 11. While all these three phases are operational, these nations make a substantial progress attaining the objectives of SDG 13.

V.II. Tangential policy framework

While the central policy framework is derived directly out of the study outcomes, the tangential policy framework might extrapolate the results for assuring the sustenance of the central policy framework. While the household sector is accustomed with the renewable energy solutions, it is necessary to imbibe the environmental awareness at the grassroots level. For ensuring this, the policy makers might consider modifying the educational curriculum, so as to have more emphasis on the environmental awareness, the environmental protection, and the environmental benefits of renewable and alternate energy solutions. This might create a sustained demand of the renewable energy solutions for the households. Moreover, the indigenous technological development might create several job opportunities, which can have positive impact on the economic growth pattern.

V.III. Policy caveats

Any policy framework needs to have certain assumptions and caveats, without which the framework might not operate effectively. First, the policy makers need to ensure import substitution and removal of subsidies for the fossil fuel-based solutions. Second, regulations and laws for environmental protection need to be more stringent. Third, the common property rights need to be defined more clearly, so that the unauthorized depletion of natural resources can be restricted and reduced. Fourth, in order to promote new job opportunities, policy makers need to have a control over the rent-seeking mechanism of the governmental agencies, as without this control in place, the industrial growth might be negatively impacted.

V.IV. Limitations and future directions

While the policy framework is being discussed, it is also necessary to talk about the limitations of the study. First, due to unavailability of the data, span of the study is restricted till 2018. Second, the policy implications could have been enriched by using the spatial parametric methods. However, these limitations can be addressed in future by considering the spatial dispersion of the environmental degradation among the emerging economies and by introducing the gravity model framework for encompassing the international trade relations.

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