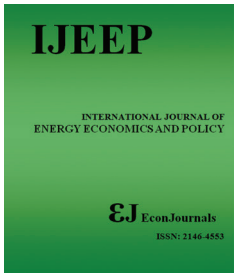

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Management Trends Towards Sustainable Environment: Nexus between CO_2 Emissions, Natural Resource Depletion and Foreign Direct Investment

Wedyan Y. Bayahya[1,2], Farrukh Nawaz Kayani[1]*, Fozi Ali Belhaj[1], Areej Y. Bayahya[3]

[1]Faculty of Business Studies, Arab Open University, Riyadh, Saudi Arabia, [2]College of Business, Effat University Saudi Arabia, [3]Department of Software Engineering, College of Engineering, University of Business and Technology, Saudi Arabia. *Email: f.kayani@arabou.edu.sa

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ABSTRACT

Nowadays, environmental sustainability has become a major concern for the policymakers and researchers, therefore, this study investigated the effects of environmental sustainability factors which are CO_2 emissions and Natural Resource Depletion on inward Foreign Direct Investment in Asian economies. The study used data Spanning from 1997 to 2022, and employed the panel data analysis, leveraging econometric models to capture both the short-run and the long-run impacts upon inward FDI. The findings revealed that CO_2 emissions have significant negative impact upon FDI in the long run. In addition, it emphasized the importance of environmental concerns in investor decision-making. In contrast, Natural Resource Depletion showed a significant positive impact, highlighting the attraction of resource-dependent industries despite sustainability concerns. The study highlighted the necessity of sustainable policies to strike a balance between economic growth with environmental preservation, offering valuable insights for future research and policymakers.

Keywords: Environmental Sustainability, Foreign Direct Investment, CO_2 Emissions and Natural Resource Depletion
JEL Classifications: F64, Q53, Q56, P28

1. INTRODUCTION

Sustainability has become a worldwide concern, influencing investment, environmental, and economic policies. Understanding the relationship between inward Foreign Direct Investment (FDI) and sustainability is essential as the international community is facing alarming climate issues. Traditionally, FDI decisions are influenced by economic factors such as access to market, reduced production costs, and technology transfer Opoku et al. (2022). However, increasing environmental degradation and climate change, considerations of sustainability have become a vital factor in shaping international investment flows Demena and Afesorgbor (2019). Due to rapid economic growth the natural resources have been adversely affected around the globe (Suleman et al., 2024; Kayani, 2024; Nawaz et al., 2024; Kayani and Alzaid, 2024; Kayani and Gan, 2022), and the developing countries are trying to achieve development by skipping the usual long process of industrialization (Aysan et al. 2020; Kayani, 2021; Kayani, 2022).

One of the main challenges that is faced by developing economies, is how to keep the alignment of economic expansion with environmental conservation, necessitating the innovative approaches. This aims to attract sustainable investment and reduce the environmental harm. Foreign Direct Investment (FDI) is broadly defined as investment by a firm or individual from one country into business or corporation in another country

(Lipsey, 2006). Furthermore, Liang et al. (2021) outlines that FDI plays a significant role in economic growth through creating jobs, technological advancements, and enhancement of infrastructure. This is a vital component of the growth strategies for many developing countries. On the other hand, environmental sustainability, defined as managing resources to meet present requirements without compromising the potential of future generations (Goodland, 1995). Sustainability is now a fundamental element in investment decision making, and investors are increasingly favoring countries that implement environmentally sustainable policies, acknowledging the value of sustainable practices in alleviating risks and enhancing long-term returns (Bodhanwala and Bodhanwala, 2018).

The study explores the way sustainability factors shape inward FDI decisions in emerging economies. Moreover, The study significantly contributes to the existing body of research by delivering a comprehensive analysis of the effect of the environmental sustainability on inward FDI across multiple countries, using diverse indicators over a long-term period, by focusing on the impact of environmental sustainability factors: CO_2 emissions (CO_2), natural resource depletion (NRD), carbon dioxide damage (CDG), and energy depletion (EDP) on inward FDI in five Asian economies which are China, India, Indonesia, Thailand, and Philippines. Additionally, the study provides a comprehensive evaluation of how environmental factors collectively affect investment flows, addressing gaps in literature and aiding policymakers in designing strategies that aligning with economic development with sustainability goals.

This study is organized into several sections. The literature review explores prior studies, followed by a discussion of methodology and model specification. The subsequent section presents the study's findings, and a conclusion is provided in the last section.

2. LITERATURE REVIEW

Foreign Direct Investment (FDI) plays a significant role in the global economy that is influenced by various macroeconomic, institutional, and environmental factors. Number of studies investigate the relationship between environmental sustainability and FDI. For instance, Mert and Bölük (2016) used panel integration analysis to test the Environmental Kuznets Curve (EKC) hypothesis and conducted panel causality tests to examine the long-term relationships among carbon emissions, renewable energy consumption, fossil fuel energy consumption, and Foreign Direct Investment (FDI). The findings demonstrated a significant long-term causal correlation between FDI and renewable energy consumption to carbon emissions. Moreover, the results supported that pollution haloes hypothesis that suggested the FDI enhances environmental quality by introducing cleaner technologies. Furthermore, renewable energy consumption was associated with reduced carbon emissions. However, the analysis was constrained by the availability of data for specific nations and specific time periods.

Opoku et al. (2022) conducted Lewbel's two-stage least squares (2SLS) methodology to examine the effect of environmental degradation on Foreign Direct Investment (FDI). The results indicated that CO_2 emissions significantly deter FDI inflows, while other environmental degradation, such as deforestation and water pollution tend to attract FDI. However, the influence of environmental degradation on FDI varied across different income levels and geographical regions, specifically, environmental degradation increased FDI inflows in low- and lower-middle-income countries. In addition, environmental degradation led to a decline in FDI flows in Europe, Central Asia, the Middle East, and North Africa, in contrast to stimulating FDI in South Asia, Sub-Saharan Africa, and Latin America and the Caribbean. However, the study relied on specific environmental indicators that may oversimplify the multifaceted nature of environmental degradation. Furthermore, potential for biases arising from omitted variables and inaccuracies in measurement, and the analysis failed to consider all determinants of FDI, which may leave some underlying dynamics unexamined.

Muhammad et al. (2020) used dynamic modeling techniques, including the dynamic fixed-effect model, Generalized Method of Moments (GMM), and system GMM estimators, to investigate the relationship between environmental degradation through CO_2 emissions and Foreign Direct Investment (FDI), natural resources, renewable energy consumption, and economic growth. The findings revealed that FDI contributes to environmental degradation in BRICS and developing countries. It helps mitigate environmental harm in developed nations. Further, the consumption of renewable energy and fuel resources were found to reduce environmental degradation across all geographical regions. The study outlined some limitations that may be overcome by future research for example, that relationships among all variables across different countries were not comprehensively addressed, while gaps in existing literature regarding the role of specific natural resources (fuel, ore, and metal) were not investigated in depth, and the focus on CO_2 emissions may not capture the full range of environmental degradation.

Similarly, Wall et al. (2020) employed a two-way fixed-effects model to scrutinize panel data, incorporating both country-specific and time-specific effects to examine the relationship between policy instruments and Foreign Direct Investment (FDI) in the renewable energy sector. The results showed that Feed-in Tariffs (FIT) serve as the most efficacious mechanism for attracting FDI in renewable energy ventures on a global scale. Furthermore, Fiscal Measures (FM), including tax incentives, have been evidenced to positively impact investments within renewable energy projects. Mechanisms for carbon pricing, such as carbon taxes and emissions trading systems, were determined to correlate with heightened Foreign Direct Investment (FDI), revealing notable discrepancies between OECD and non-OECD nations. Evaluations specific to sectors indicated that Feed-in Tariffs (FIT) and FM significantly bolster FDI inflows into renewable energy sectors, including wind, solar, and biomass, whereas public investments appeared to be less appealing to foreign investors. The study mentioned that the impact of carbon pricing may have been underestimated in regions where such policies are implemented.

Natural resources are other factors that affect FDI have been researched. There are numerous studies that have explored the

relationship between natural resources and the inflows of Foreign Direct Investment (FDI), considering a range of economic, institutional, and political factors. For instance, Ezeoha and Cattaneo (2012) who employed a dynamic system GMM (Generalized Method of Moments) to analyze the effects of financial development and natural resource endowment on FDI. The findings suggested that countries were lacking substantial natural resources, the efficiency of governance was identified as a critical factor in attracting FDI, whereas in resource-rich nations, the functionality of formal financial systems played a critical role in managing existing investments. Moreover, the study found that the implications of natural resource and macroeconomic variables were more noticeable on the stock of FDI. It is noteworthy that the relevance of natural resource endowment as a driver of FDI has waned since the early 2000s. However, the study recognized several limitations, including the paucity of empirical data regarding optimal FDI strategies for Sub-Saharan Africa, the context-dependent nature of the findings, and restrictions pertaining to data availability, which affected the selection of countries included the analysis.

The relationship between environmental regulations and Foreign Direct Investment (FDI) has also been studied extensively for example, Gu and Hale (2023) developed a theoretical model of partial equilibrium encompassing two nations that incorporates both physical and transition climate risks to examine the impact of climate-related risks on Foreign Direct Investment (FDI). Besides that, the empirical investigation employed extensive datasets to analyze FDI responses to determinants such as extreme meteorological phenomena and climate policies, integrating various fixed effects to address heterogeneity. The results indicated limited evidence of statistically significant FDI responses to climate risks at an aggregate level. However, the analysis in the firm level indicated that entities exposed to climate risks displayed stronger negative reactions to physical risks, particularly after the Paris Accord. Furthermore, industries characterized by elevated emission productivity displayed smaller declines in FDI outflows in the aftermath of extreme weather events. However, the study highlighted that analysis may not entirely capture the degree to which firms internalize climate risks, and the dependence on historical data restricts the capacity to predict future trends in FDI behavior amid changing climate conditions.

The importance of economic factors such as market size, economic growth, and macroeconomic stability have been studied. Shah (2014) conducted fixed and random effects panel estimation models to investigate the effect of various economic factors on foreign direct investment (FDI) inflows. The analysis revealed that market size, measured by population, has a positive effect on attracting FDI. Furthermore, economic development measured by GDP per capita has positively influenced FDI inflows. However, macroeconomic stability, particularly in the presence of high inflation, negatively impacts FDI. In addition, infrastructure availability plays a crucial role in shaping investors' location preferences. The results found that geographical and linguistic characteristics, such as Anglophone country, enhance a country's attractiveness to foreign investors. However, it identified some limitations, including the potential sensitivity of the proxies chosen for infrastructure and the risk of omitted variable bias, and the rapid growth in telecommunications over time may obscure its actual effect on FDI inflows.

Dhakal et al. (2010) used panel cointegration test to evaluate long-term relationships between the factors and unit root tests to ensure stationarity. The results showed a positive and statistically significant correlation between exchange rate volatility and FDI, suggesting that foreign investors may perceive exchange rate fluctuations favorably in the context of these industries. Further, market size, measured by real GDP, demonstrated a positive and significant effect on FDI inflows, whereas other determinants such as current account balance and trade openness were not statistically significant. However, the study highlighted that potential omitted variable bias, as not all factors influencing FDI were included in the model. Moreover, the emphasis on East Asian countries limits the applicability of the results to other regions. The research fell short in addressing the role of socio-political factors and global economic conditions, and issues related to data accuracy and availability across countries and years posed further obstacles.

Institutional quality and governance efficiency have surfaced as crucial determinants of Foreign Direct Investment (FDI) within the context of the global economy. Walsh and Yu (2010) employed a Generalized Method of Moments (GMM) dynamic methodology to mitigate endogeneity issues while investigating the determinants of Foreign Direct Investment (FDI). The findings highlighted the significant influence of institutional factors. However, the study recognized that aggregation of FDI inflows may obscure sector-specific determinants, thus constraining the accuracy of the findings. Besides that, the sample predominantly included advanced economies and relatively stable emerging markets, which may not encapsulate the experiences of lower-income nations. Although the GMM methodology was utilized to tackle endogeneity, challenges remain due to the potential endogeneity between macroeconomic and institutional variables. Additionally, the measurement of certain qualitative factors proved challenging, leading to some ambiguity in the empirical results.

Yang (2024) implemented a two-step generalized method of moments (GMM) approach to analyze panel data and examine the impact of Foreign Direct Investment (FDI) on productivity and economic growth within both OECD and non-OECD nations. The results indicated that FDI positively influenced productivity, with economic freedom serving as a critical determinant in attracting FDI, particularly within OECD countries, and facilitating economic growth in non-OECD nations. However, the impact of FDI on output growth is substantially contingent upon the degree of economic freedom present in the host countries. The significant advantages derived from FDI are only evident in economies characterized by robust infrastructure and advanced stages of development. The study acknowledges certain limitations. Economic freedom does not guarantee considerable economic growth within OECD nations. The findings may be limited due to the study's concentration on groups of countries.

The availability of infrastructure and the advancement of technology are essential factors in the attraction of Foreign

Direct Investment (FDI), as evidenced by numerous scholarly investigations. Palit and Nawani (2007) employed an econometric model to investigate the factors influencing Foreign Direct Investment (FDI) inflows across 14 developing economies. The findings highlighted the critical role of technological competencies and the quality of communication infrastructure in attracting FDI. Countries with sophisticated technological infrastructures were observed to attract FDI, especially within technology-intensive industries. Rehman et al. (2011) used Autoregressive Distributed Lag (ARDL) methodology to examine the relationship between infrastructure and Foreign Direct Investment FDI during the period 1975-2008 in Pakistan. The findings showed a substantial positive relationship between infrastructure and FDI in short-term and long-term. Furthermore, market size positively influenced FDI inflows, while fluctuations in the exchange rate had a negative effect. However, identified that concentration on a singular low-income nation (Pakistan) may limit the generalizability of the outcomes to other developing countries.

Trade openness has been consistently recognized as a significant determinant of FDI. Omri and Kahouli (2014) employed the Generalized Method of Moments (GMM) estimator to analyze the short-run elasticities between energy consumption, Foreign Direct Investment (FDI), and economic growth. The study confirmed that both FDI and energy consumption significantly influence economic growth, and vice versa. Blas (2021) utilized a Vector Autoregression (VAR) model to examine the complex interrelations between Foreign Direct Investment (FDI) and specific economic variables, including agriculture, consumer price index (CPI), government expenditure, and unit labor cost. The findings demonstrated significant relationship between FDI and the chosen economic indicators and there is a positive impact on FDI was attributed to shocks in agriculture and government expenditure, whereas adverse impacts emerged from shocks in the CPI. It was determined that unit labor cost exerted no noteworthy effect on FDI. It clarified that the prospective fluctuations in FDI are predominantly governed by its historical values, with the indicators contributing to approximately 10% of the future variability in FDI. Notwithstanding its contributions to the field, the inquiry acknowledged several methodological constraints. However, the study recommended broader analyses, including the evaluation of investment promotion agency activities and cross-country comparisons of FDI.

3. DATA AND METHODOLOGY

3.1. Data and Variables

The purpose of this study is to investigate the effects of environmental sustainability factors like CO_2 emissions, natural resource depletion, carbon damage and energy depletion on inward Foreign Direct Investment in five Asian economies i.e. China, India, Indonesia, Thailand and Philippines (Table 1). We extracted panel data from World Development Indicators for the years spanning from 1997 to 2022.

3.2. Econometric Model

The study aimed to assess the short-term and the long-term impact of sustainability upon inward FDI of China, India, Indonesia, Thailand and Philippines. The equation comprising of dependent and independent variables is shared below:

$$FDI_t = (CO2_t, NRD_t, CDG_t, EDP_t) \quad (1)$$

The equation could be re-written with detailed specifications as below

$$FDIit = \alpha_0 + \alpha_1 CO2it + \alpha_2 NRDit + \alpha_3 CDGit + \alpha_4 EDPit + \varepsilon it \quad (2)$$

Because of the issue of Multicollinearity and stationarity at I (2), we dropped the variables of energy depletion and carbon damage respectively. Finally, we estimated an equation where FDI is dependent upon carbon emissions and natural resource depletion.

$$FDIit = \alpha_0 + \alpha_1 CO2it + \alpha_2 NRDit + \varepsilon it \quad (3)$$

where

the subscript i (i = 1., N) denotes the country i in our sample, N being equal to 5. t (t = 1., T) indicates the time. Our panel data has 5 countries and 25 years, so it has more years (T) than countries (N).

The panel ARDL model equation can be written as below

$$\Delta FDIit = \Phi_i (FDI_{i,t-1} - \beta'_i X_{i,}) + \sum^{P-1}_{J=1} \alpha ij \Delta FDI_{i,t-j} + + \sum^{q-1}_{J=0} \delta' ij \Delta X_{i,t-J} + \mu i + \varepsilon it \quad (4)$$

where

- X is the vector of explanatory variables.
- Φi is the group-specific speed of adjustment coefficient (expected that $\Phi i < 0$)
- $\beta' i$ are our vector of interest, which measures the long run impact of the explanatory.

variables on FDI.

- $[LogCO2i,-1 - \beta' iXi,t]$ is the error correction term.
- $\alpha ij, \delta' ij$ are the short run dynamic coefficients.
- p and q are optimal lag orders
- μi is the constant

Table 1: Data and variables description

Variables	Symbols	Description of variables	Measurement scale	Data source
Foreign Direct Investment	FDI	Foreign Direct Investment (FDI), Net Inflows.	% of GDP	WDI, 2024
Carbon Emissions	CO_2	CO_2 Emissions from Liquid Fuel Consumption.	Metric tons per capita	WDI, 2024
Natural Resource Depletion	NRD	Adjusted Savings: Natural Resources Depletion.	(% of GNI)	WDI, 2024
Carbon Damage	CDG	Adjusted Savings: CDG.	(% of GNI)	WDI, 2024
Energy Depletion	EDP	Adjusted Savings: Energy Depletion.	(% of GNI)	WDI, 2024

CDG: Carbon dioxide damage

Table 2: Summary statistics of the selected variables

Variables	Mean	Median	Maximum value	Minimum value	Standard deviation
FDI	2.000524	1.635034	7.451378	0.001823	1.606161
CO_2	36.50033	43.37378	75.70581	0.688355	17.73009
NRD	2.079667	1.413859	8.202803	0.024760	1.789837

The panel ARDL model is extremely beneficial as it helps in estimating the short-run and long-run impact of independent variables upon dependent variable simultaneously (Thampanya et al., 2021). The traditional Generalized Methods of Moments (GMM) model could provide the spurious results especially in the cases where 'N' is small, and 'T' is large (Ramos, 2024). We apply this Panel ARDL model when the variables have stationarity either at level i.e. I (0), or at first difference i.e. I (1) or even mixed order co-integration; but off course we do not apply this model if the variables have stationarity of 2nd difference i.e. I (2).

4. EMPIRICAL RESULTS AND INTERPRETATIONS

4.1. Descriptive Statistics

Descriptive statistics, and the results of the study are reported below in Table 2.

The mean value of FDI is 2.00 which means that, on average, the level of foreign direct investment in the dataset is around 2. The highest and the lowest values of FDI observed in the data are 7.45 and 0.001 respectively. CO2 has a mean value of 36.50 and a median value of 43.37. The highest and the lowest values are 75.70 and 0.68 respectively. NRD has a mean value of 2.07 with a minimum value of 0.02 and maximum value of 8.20. Overall, there is very little dispersion between the mean and median values of the variables, which suggest the low variability and symmetry. The CO_2 emission data appears to be more spread out with a significant range (from 0.69 to 75.71), and the average is pulled down by lower emission values, suggesting that while there are some regions with very high emissions, the majority might have moderate levels.

4.2. Panel Augmented Dicky Fuller (ADF) Unit Root Test

To check the stationarity of the variables, the study applied for Panel Augmented Dicky Fuller (ADF) unit root test which is essentially an extension of the ADF test as proposed by Dickey and Fuller (1979). It tests the null hypothesis that there is a unit root for each cross-sectional unit in the panel data (e.g., countries, firms), but it uses pooled data across all units to improve statistical power. A series of data is said to be stationary if its statistical properties, such as mean, variance and covariance, are constant or time-invariant. We found that FDI & NRD are stationary at I(1) whereas CO_2 is stationary at I(0). The results are presented below in Table 3.

4.3 Panel ARDL Long-run and Short-run Results

The panel ARDL long-run and short-run results have helped us to gauge the impact of CO_2 and NRD upon FDI both in the long-run and short-run. In the long-run CO_2 and NRD both have a significant positive impact upon FDI as we can see in Table 4 below. For each unit increase in CO_2 emissions or NRD, FDI increases by 0.047 and 0.813 units, respectively.

Table 3: Panel ADF unit root test for stationarity

Variables	Symbol	ADF (Level)	ADF (1st Difference)
Foreign Direct Investment	FDI	Non-Stationary	Stationary (P=−0.0000)
Carbon emissions	CO_2	Stationary (P=−0.0242)	
Natural resource depletion	NRD	Non-Stationary	Stationary (P=−0.0000)

Table 4: Panel ARDL long-run results

ARDL (1, 1, 1, 1) Dependent variable: FDI				
Variables	**Coefficient**	**Std Error**	**t-statistics**	**P-value**
CO_2	0.047244	0.013175	3.585934	0.0005
NRD	0.812609	0.022957	35.39688	0.0000

Table 5: Panel ARDL short-run results

ARDL (1, 1, 1, 1) Dependent Variable: FDI				
Variables	**Coefficient**	**Std Error**	**t-statistics**	**P-value**
D (CO_2)	−0.019962	0.034039	−0.586451	0.5589
D (NRD)	−0.073610	0.221048	−0.333007	0.7398

The coefficient of CO_2 (0.047244) is displaying that for each 1-unit increase in CO_2 emissions, FDI increases by 0.047244 units in the long run. This suggests a positive relationship between CO_2 emissions and FDI, meaning higher emissions are associated with higher FDI over the long term. Since the P-value (0.0005) is much smaller than 0.05, the coefficient for CO_2 is statistically significant, meaning there is strong evidence that CO_2 emissions influence FDI. Whereas the coefficient of NRD (0.812609) shows that for each 1-unit increase in NRD, FDI increases by 0.812609 units in the long run. This is a strong positive relationship. A P = 0.0000 strongly indicates that NRD has a significant effect on FDI, and the effect is very unlikely to be due to random chance.

Both CO_2 emissions and Natural Resources Dependency (NRD) are negatively related to FDI in the short run, but neither of these relationships is statistically significant (P-values are high). This implies that in the short run, changes in CO_2 and NRD are unlikely to have a significant effect on Foreign Direct Investment we can see in Table 5. CO_2 coefficient (−0.019962) means that a one-unit increase in CO_2 emissions is associated with a decrease in FDI by approximately 0.02 units in the short run. Whereas P-value (0.5589) suggests that the relationship between CO_2 emissions and FDI is not statistically significant.

5. CONCLUSION

The study aimed to investigate the effect of environmental sustainability factors by focusing on CO_2 emissions and natural resource depletion on FDI in five Asian economies. The study employed the panel data analytical approach to integrating data from the countries of China, India, Indonesia, Thailand, and the Philippines, spanning from 1997 to 2022. The analytical framework used econometric models to evaluate both short-term and long-term impacts on FDI. The main findings indicated that environmental sustainability plays a significant role in Foreign Direct Investment (FDI). In addition, it found that over the long term, carbon dioxide emissions have a significant negative impact upon FDI. Conversely, the natural resources depletion showed a positive correlation with FDI. The findings contribute to enhancing the existing knowledge by focusing on the important environmental factors that affect FDI collectively.

The study had some limitations such as the availability of data restricted the analysis to 2022, leaving more recent trends unexplored, and it focused on just five countries; future studies can include more Asian countries for a further detailed and comprehensive analysis that encourage the future research to conduct further studies in different contexts and regions. The study recommended the important policy implications to emphasize the need for environmental policies that can attract foreign direct investment (FDI) by making sustainable resource management as a priority to ensure that short-term economic gains do not jeopardize long-term environmental sustainability and investment potential, and decision-makers should examine how environmental policies intersect with broader economic strategies. Moreover, countries should focus on transitioning to renewable energy, improving energy efficiency, and adopting carbon management strategies. Finally, the study suggested that governments and stakeholders should develop comprehensive frameworks that encourage sustainable investments.

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