Greenfield Investment, Institutional Quality and Environmental Performance in Asia

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Abstract

Greenfield investment allows for better risk management of environmental and social issues, as well as the development of opportunities that provide a rate of return connected to environmental benefits and offer greater accounting. This study explores the dynamic relationship between greenfield investment, GDP per capita and its square, human capital, governance, and environmental performance across 40 Asian countries from 2003 to 2020. Using the panel ARDL modeling approach, the analysis draws on secondary data from WDI, UNCTAD, and PWT. The findings reveal that greenfield investment positively influences environmental performance in Asia-Pacific. Moreover, human capital and governance also show a positive relationship with environmental performance, while GDP per capita has a negative effect. These results carry important policy implications that promoting greenfield investment can enhance environmental sustainability in Asian countries.

Keywords: Greenfield Investment, Institutional Quality, Environmental Performance.

Introduction

One of the primary forces behind economic growth and a means of transferring cutting-edge technology to the host nations has been recognized as foreign direct investment. FDI can help create a cleaner environment, even if this negative perception of it dominates the literature, even if the foreign investment includes cleaner or greener technology. The US-owned facilities in developing nations consume less energy and cleaner energy. This demonstrates that international businesses in emerging nations are more environmentally conscious than local ones. The likelihood that overseas businesses utilize superior management techniques and cutting-edge technology than their local equivalents would lower pollution intensity and make foreign businesses more environmentally conscious (Demena & Kawaku, 2020).

The global change to greener economies has increased the need for green financing. Green finance allows for better risk management of environmental and social issues, as well as the development of opportunities that provide a rate of return connected to environmental benefits and offer greater accounting. As a result of the increased need for green finance, greenfield investments may provide

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a novel approach to green financing through improving environmental performance. Even though various studies have attempted to explain the causal connection between environmental quality and foreign direct investment, few studies have investigated the causative link between greenfield investment as well as environmental performance. Our study aims to disentangle the dynamic relationship between greenfield investment institutional quality and environmental performance in Asia. For this purpose, panel data econometrics is used. The significance of this study is that it provides policymakers and practitioners with decision-making support regarding greenfield investment environmental sustainability, developing high institutional quality, and cutting emissions in the Asian economy. In 2014, foreign direct investment into developing countries totaled $681 billion. FDI inflows into Asian developing markets, particularly East Asia and South Asia, increased by 10%, with South Asia receiving 16% more FDI than the previous year. A significant portion of this foreign capital inflow is directed into the industrial sector. Through the transfer of knowledge, organizational skills, and advanced technology, FDI promotes economic growth, builds human capital, and creates employment possibilities. Since 1990, Asian rising economies have been more successful in attracting FDI than other countries across the globe. FDI stimulates economic development and creates employment possibilities. Nonetheless, it worsens the host countries' environmental performance by shifting filthy enterprises that drive industrialization, energy consumption, urbanization, along with economic growth. Environmental degradation is the process by which the natural environment becomes contaminated by decomposing contaminants caused by human activity. According to sustainability theories, investment and trade movements degrade environmental quality via over-exploitation of natural resources. The debate over the impact of foreign capital on environmental quality is raging among academics and policymakers these days. Similarly, inadequate environmental regulations in developing countries, according to PHH, made it appealing for established economies to relocate their filthy industries to developing countries to reduce production costs. In recent years, rapid capital movements across borders have generated a variety of international and local environmental concerns because of human activities such as increased energy consumption, urbanization, and economic expansion (Nepal et al. 2020).

Review of Literature

This section is based on studies on the influence of greenfield investment and institutional quality on environmental performance. Table 1 shows the summary of the studies on greenfield investment and environmental performance.

Table 1: Summary of Studies

References	Time Period	Country	Methodology	Main Results
Sohail et al- (2021)	1991-2019	South Asian countries	ARDL, Non-linear ARDL	GDP(+) POP(+) APC(+) RPC(+)
Shabir et al – (2021)	2001-2009	24 Developed and Developing Nations	Panel Error Correction Model, Granger Causality Method	EPU(-) FDI(+) GDP(+) Trade (+) EC(+)
Bulus et al- (2021)	1970-2018	Korea	Unit root test,	FDI(+), GDP(+)

			Autoregressive distributed lag model	Sq GDP(-), Cub GDP(+) E (+), G(-), R(-)
Zhang et al – (2021)	2004-2017	China	Difference in Difference Model	Green credit policy (-) FDI(+), IIP(-) LTL(-), CR10(+)
Musibau et al- (2021)	1980-2018	9 highly industrialized Countries	Quantile on Quantile regression technique	Nonrenewable energy(+) Renewable energy(-) GDP(+), SqGDP(-)
Ren et al- (2021)	2006-2017	China	Spatial Durbin model, dynamic threshold model, spatial correlation test,	.green investment (+) R&D capital investment(-) R&D personal investment (-) Urbanization (+) Trade openness (-) GDP(+)
Khan et al- (2021)	2011-2019	Six Asian Countries	Panel unit root test, cross dependence test, OLS estimation	GF(-) GDP(+) POP(+) EC(+)
Zahoor et al (2021)	1970-2016	China	Advanced structured break unit root, fully modified ordinary least square, multiple regression robust least square	Financial development (+) Clean energy (-) Urbanization (+) Value-added manufacturing (-)
Kamal et al – (2021)	1990-2016	105 countries	Fully modified ordinary least square, Dynamic ordinary least square, ARDL	Fiscal policy (+) FDI(+) FD(+) Trade (-) Urbanization (-)
Zahan and chuanmin- (2021)	1998-2019	China	Autoregressive Distributed Lag model	Green investment(+) ET(+) FD(+) GDP(+)
Raza et al – (2021)	2002-2016	South and East Asian Countries	Panel Regression techniques	GDP(+) FDI(+) Trade(-) Urbanization (-) Clean energy (-)
Setiawan et al- (2021)	2010-2018	Indonesia	Descriptive method	Indonesia is still early stage in low carbon emission development.

Muganyi et al- (2021)	2011-2018	China	Semi-parametric Difference-in-Differences (SDID) estimation	Green fintech (-) GDP(-) TOP(+) IND(+)
Kong et al (2021)	2003-2017	China	Difference in Difference method	FDI(-), IS(+) IL (+), GDP(+)
Saeed et al (2021)	2008- 2019	Top Ten Economies Countries	Quantile on-quantile regression	Green finance (-)
Wang et al (2021)	2013-2017	China	Fixed base range entropy weight method	FDI(-) HCI(-) Urbanization (+)
Huang et al(2021)	2009-2017	China	Entropy weight method, panel threshold model	FDI(+), GDP(-) Gov (+), target (-) Gf (+)
Huang et al. (2021)	2011-2019	China	Difference in difference propensity score matching(PSM-DID), Quantile Regression	POP(+), EDI(+) EC(-), GI(-) FDI(+) IS(+), IC (+)
Ahmed et al (2022)	2003-2016	Chinese firm	negative binomial regression model.	Government effectiveness (+), Inflation (-),Patents (-),Cultural distance (-),
Kwilinski et al. (2023)	2006-2020	European Union	Tobit model	GI (+), economic openness (+), public governance (+)
Assamah & Yuan (2024)	2023-2024	Ghana	Ordinary Least Square Analysis (OLS)	Gross domestic product (+), Capital investment (+), Inflation (-), Government integrity (+)

The studies reviewed highlight that GDP, FDI, and green investment have positive effects on environmental and economic outcomes though some show non-linear or country-specific variations. Governance indicators like government effectiveness and integrity consistently support positive outcomes. Yet the impacts of trade, urbanization, and clean energy are mixed, depending on context and methodology. Overall, economic growth, investment, and good governance are key drivers, but their effects vary calling for tailored, context-specific policies.

Model Specification

The following models are suggested to explore the impact of greenfield investment on environmental performance.

Model 1: Environmental Performance Model Without Interaction Term

The functional form of the environmental performance model is:

$$EPI = f(GFI, GDPG, GDPG^2, HDI, GI) \quad \textbf{(1)}$$

The econometric form of the environmental performance model is as under:

$$EPI_{it} = \gamma_0 + \gamma_1 GFI_{it} + \gamma_2 GDPG_{it} + \gamma_3 GDPG_{it}^2 + \gamma_4 HDI_{it} + \gamma_5 GI_{it} + \varepsilon_{it} \quad \textbf{(2)}$$

Model 2: Environmental Performance Model Wit Interaction Term

The functional form of the environmental performance model is:

$$EPI = F(GFI, GDP, GDP^2, HDI, GI, GI*GFI, GI*HCI, GI*GDP) \quad \textbf{(3)}$$

The econometric form of the environmental performance model is :

$$EPI_{it} = y_0 + y_1 GFI_{it} + y_2 GDP_{it} + y_3 GDP_{it}^2 + y_4 HCI_{it} + y_5 GI_{it} + y_6 GI_{it} * GFI_{it} + y_7 GI_{it} * GDP_{it} + y_8 GI_{it} * HCI_{it} + \varepsilon_{it}) \quad \textbf{(4)}$$

Where:
EPI= Environmental performance index
GFI= Greenfield investment (Millions of dollars)
GDPG= GDP per capita growth (annual %)
GDPG²= Square of GDP per capita growth (annual %)
GI = Governance Index
HDI= Human capital index, based on years of schooling and returns to education
GI*GFI= Interaction term of GI and GFI
GI*GDP= Interaction term of GI and GDP
GI*HCI= Interaction term of GI and HCI

Data: Description, Definition, and Sources

The current study looks at the impact of greenfield investment, the governance index, the human capital index, GDP per capita growth, and the square of GDP per capita growth on the environmental performance of selected Asian countries from East Asia, South-west Asia, West Asia, and South Asia from 2003 to 2020. We have used the environmental performance index (EPI) as a proxy to evaluate the total environmental performance of countries to examine environmental degradation.

Data for different variables were obtained from a variety of sources. Greenfield investment data (millions of dollars) from UNCTAD, governance index data from the World Governance Index, human capital index data (based on years of schooling and returns to education) from Pen World Table 9, and gross domestic per capita growth (annual percent) and square of gross domestic per capita growth (annual percent) from World Development Indicators.

Table 2: Variables: Description and Sources

Variable	Description	Source
Dependent Variable		
EPI	Environmental Performance Index	Yale University,2020
Explanatory Variables		
GFI	Greenfield Investment (Millions of dollars)	UNCTAD
GI	Governance Index	WGI
HCI	Human capital index, based on years of schooling and returns to education	PWT9
GDP	GDP per capita growth (annual %)	WDI
GDPG²	Square of GDP per capita growth (annual %)	

Environmental Performance Index

The environmental performance index is a method for assessing and quantifying the environmental performance of states." The environmental performance index provides a data-driven view of global sustainability. The EPI ranks 180 countries based on their performance in climate change, environmental health, and ecosystem vitality using 32 performance indicators spread over 11 issue categories. These indicators indicate how close countries are to meeting specified environmental policy goals on a national scale. The EPI publishes a scorecard that recognizes environmental leaders and laggards, as well as practical advice for countries seeking to progress toward a more sustainable future (Yale university,2020).

Greenfield Investment

A greenfield investment is a form of foreign direct investment in which a parent corporation builds a subsidiary in another country from the ground up." Greenfield investments occur when multinational corporations raise the bulk of their investment or create new production capacity in the host country. Greenfield investments are a popular kind of foreign investment in host nations. Particularly when the main objective is to minimize excessive unemployment. Greenfield investments are the major focus of a host country's promotional operations as they produce new manufacturing capacity employment, transfer technology, and know-how, and may lead to linkages to the global marketplace (Chen, 2020).

Governance Index

"Governance refers to the conventional arrangements through which a nation's authority is exercised." This includes the mechanism by which governments are elected, monitored, and changed, as well as the government's ability to effectively create and implement appropriate policies, as well as people's and the state's respect for the institutions that regulate economic and social ties among them. The global governance indicators are a research dataset that summarizes citizens' and expert survey respondents' perceptions of the quality of governance in industrial and developing countries. The global governance indicators provide aggregates and territories for six governance aspects from 1996 through 2020. The indicators are 1) rule of law 2) control of corruption 3) regulatory law 4) voice and accountability 5) government effectiveness.

Human capital index, based on years of Schooling and returns to education

The human capital index represents growth in the average years of schooling and returns to education thus, in human capital, the choice turns out to be much more consequential. To illustrate this, we compute a human capital index based on both series:

$$\Phi(s)=\begin{cases}0.134.s & if\ s\le 4\\ 0.134.4+0.101(s-4) & if\ 4\le s\le 8\\ 0.134.4+0.134.4+0.068(s-8) & if\ s\ge 8\end{cases} \quad \textbf{(5)}$$

GDP per capita growth (annual %)

GDP purchasing power parity (PPP) per capita (PPP) (PPP). This is GDP divided by midyear population, where GDP is the total value of goods and services produced by resident producers in an economy, regardless of the allocation to domestic and international claims. It excludes deductions for physical capital depreciation or natural resource depletion and deterioration. PPP refers to the exchange rate that adjusts for pricing differences across nations, allowing for international comparisons of real production and income. PPP rates enable standard comparisons

of real prices between nations, just as traditional price indices provide comparisons of actual values across time. The annual growth rate of GDP per capita is defined as the least-square annual growth rate estimated from the constant price of GDP per capita in local currency units (WDI,2022).
Formula of GDP

$$GDP = \left[\frac{G_{t+1} - G_t}{G_t} \times 100\right] \quad \textbf{(6)}$$

Square of GDP per capita growth (annual %)
Per capita gross domestic product (GDP) is a financial measure that reflects a country's economic output per person and is calculated by dividing a country's GDP by its population. Simply multiply the GDP per capita by the square of the GDP per capita.
We are explaining the different Asian countries in the table. The data was collected from different Asian countries such as East Asia, South-East Asia, South Asia, and West Asia according to greenfield investment.
The formula of GDP square

$$GDP^2 = \left[\frac{G_{t+1} - G_t}{G_t} \times 100\right]^2 \quad \textbf{(7)}$$

Methodology: Panel ARDL

The unrestricted Error Correction Model (ECM) for the impact of greenfield investment, human capital index, governance index, gross domestic product per capita growth, and square of gross domestic product on environmental performance for Asian countries is given below.

Model 1: Environmental Performance Model Without Interaction Term

$$\Delta(EPI)_{it} = \partial + \phi_1(EPI)_{it-1} + \phi_2(GFI)_{it-1} + \phi_3(GI)_{it-1} + \phi_4(HCI)_{it-1} + \phi_4(GDPG)_{it-1} + \phi_5(GDPG^2)_{it-1}$$
$$+\sum_{i=1}^{B}\theta_{1i}\Delta(EPI)_{it-1} + \sum_{i=0}^{B_2}\theta_{2i}\Delta(GFI)_{it-1} + \sum_{i=o}^{B_3}\theta_{3i}\Delta(GI)_{it-1} + \sum_{i=0}^{B_4}\theta_{4i}\Delta(HCI)_{it-1} + \sum_{i=0}^{B_5}\theta_{5i}\Delta(GDPG)_{it-1}$$
$$+\sum_{i=0}^{B_6}\theta_{6i}\Delta(GDPG^2)_{it-1} + \varepsilon_{it} \quad \textbf{(8)}$$

Model 2: Environmental Performance Model with Interaction Term

$$\Delta(EPI)_{it} = \partial + \phi_1(EPI)_{it-1} + \phi_2(GFI)_{it-1} + \phi_3(GI)_{it-1} + \phi_4(HCI)_{it-1} + \phi_4(GDPG)_{it-1} + \phi_5(GDPG^2)_{it-1}$$
$$+\phi_6(GI*GFI)_{it-1} + \phi_7(GI*HCI)_{it-1} + \phi_8(GI*GDPG)_{it-1} + \sum_{i=1}^{B}\theta_{1i}\Delta(EPI)_{it-1} + \sum_{i=0}^{B_2}\theta_{2i}\Delta(GFI)_{it-1}$$
$$+\sum_{i=o}^{B_3}\theta_{3i}\Delta(GI)_{it-1} + \sum_{i=0}^{B_4}\theta_{4i}\Delta(HCI)_{it-1} + \sum_{i=0}^{B_5}\theta_{5i}\Delta(GDPG)_{it-1} + \sum_{i=0}^{B_6}\theta_{6i}\Delta(GDPG^2)_{it-1} + \sum_{i=o}^{B_7}\theta_{7i}(GI*GFI)_{it-1}$$
$$+\sum_{i=0}^{B_8}\theta_{8i}(GI*HCI)_{it-1} + \sum_{i=0}^{B_9}\theta_{9i}(GI*GDPG)_{it-1} + \varepsilon_{it} \quad \textbf{(9)}$$

The parameters Ø are the corresponding long-run multiplier whereas the θ (for i=0) is the short-run dynamic coefficient and others θ (i= 1,2……, B1, B2…., B6) are the VAR coefficient of the ARDL models. ε is the white noise error and Δ is the first difference operator.

If the long-run relationship exists, the long-run parameters can be estimated by using the following equation for Asian countries.

Model 1: Environmental Performance Model Without Interaction Term

$$\Delta(EPI)_{it-1} = \alpha + \sum_{i=1}^{B_1} \phi_{1t}(EPI)_{it-1} + \sum_{i=0}^{B_2} \phi_{2t}(GFI)_{it-1} + \sum_{i=0}^{B_3} \phi(GI)_{it-1} + \sum_{i=o}^{B_4} \phi(HCI)_{it-1} + \sum_{i=0}^{B_5} \phi(GDP)_{it-1}$$
$$+ \sum_{i=0}^{B_6} \phi(GDP)^2_{it-1} + \varepsilon_{it} \quad \textbf{(10)}$$

Model 1: Environmental Performance Model with Interaction Term

$$+ \sum_{i=0}^{B_6} \phi(GDP)^2_{it-1} + \sum_{i=0}^{B_7} \phi(GI * GFI)_{it-1} + \sum_{i=0}^{B_8} \phi(GI * HCI)_{it-1} + \sum_{i=0}^{B_9} \phi(GI * GDP)_{it-1}\varepsilon_{it}$$
$$\Delta(EPI)_{it-1} = \alpha + \sum_{i=1}^{B_1} \phi_{1t}(EPI)_{it-1} + \sum_{i=0}^{B_2} \phi_{2t}(GFI)_{it-1} + \sum_{i=0}^{B_3} \phi(GI)_{it-1} + \sum_{i=o}^{B_4} \phi(HCI)_{it-1} + \sum_{i=0}^{B_5} \phi(GDP)_{it-1} \quad \textbf{(11)}$$

The parameters associated with the summation signs represent the long-run parameters.
The short-run dynamics can be found estimated in the following equation for Asian countries

Model 1 without an interaction term

$$\square(EPI)_{it-1} = \alpha + \sum_{i=1}^{B_1} \nu_{1i}(EPI)_{it-1} + \sum_{i=0}^{B_2} \nu_{2i}(GFI)_{it-1} + \sum_{i=o}^{B_3} \nu_{3i}(GI)_{it-1} + \sum_{i=0}^{B_4} \nu_{4i}(HCI)_{it-1}$$
$$+ \sum_{i=0}^{B_5} \nu_{5i}(GDPG)_{it-1} + \sum_{i=0}^{B_6} \nu_{6i}(GDPG^2)_{it-1} + \omega ECM_{it-1} + \varepsilon \quad \textbf{(12)}$$

Model 2 with an interaction term

$$\square(EPI)_{it-1} = \alpha + \sum_{i=1}^{B_1} \nu_{1i}(EPI)_{it-1} + \sum_{i=0}^{B_2} \nu_{2i}(GFI)_{it-1} + \sum_{i=o}^{B_3} \nu_{3i}(GI)_{it-1} + \sum_{i=0}^{B_4} \nu_{4i}(HCI)_{it-1}$$
$$+ \sum_{i=0}^{B_5} \nu_{5i}(GDPG)_{it-1} + \sum_{i=0}^{B_6} \nu_{6i}(GDPG^2)_{it-1} + \sum_{i=0}^{B_7} \nu_{7i}(GI * GFI)_{it-1} + \sum_{i=o}^{B_8} \nu_{8i}(GI * GDP)_{it-1} + \sum_{i=0}^{B_9} \nu(GI * HCI)_{it-1}$$
$$\omega ECM_{it-1} + \varepsilon \quad \textbf{(13)}$$

In equation 13, the parameters associated with the summation signs represent the short-run parameters and the coefficients of ECM in both equations represent (w) showing the speed of adjustments toward the long-run equilibrium. The coefficient should be negative and statistically significant for convergence.

Results and Discussion

Unit Root Analysis

The unit root test is used to determine if statistics are stationary or non-stationary. The stationary means that the data must have constant mean-variance and covariance. In non-stationary, the first array variation is used to make it stationary. Several tests have been developed to determine the order of integration of the variables included in the research, including panel unit root tests: (1) “LLC” Levin, Lin, and Chu (2) “IPS” stands for I'm, Persian, and Shin. (3) Augmented Dickey-

fuller (ADF) Fisher chi-square and (4) Phillips-Perron (PP) Fisher chi-square The ADF test outlines the reconciliation arrangements that are being explored. The primary difference between the Augmented Dickey broader unit root test and the Phillips Perron unit root test is their strategy for treating blunder terms with serial relationships. The findings are shown in Table 3.

Table 3: Results of Panel Unit Root Tests

Variable	Intercept				Intercept and Trend				None			Conclusion
	LLC Test	IPS Test	ADF-Fisher Chi-Square	PP-Fisher Chi-Square	LLC Test	IPS Test	ADF-Fisher Chi-Square	PP-Fisher Chi-Square	LLC Test	ADF-Fisher Chi-Square	PP-Fisher Chi-Square	
EPI	-2.05 (0.02)	-0.37 (0.35)	18.23 (0.31)	28.63 (0.03)	-0.23 (0.41)	0.06 (0.52)	14.44 (0.57)	12.56 (0.70)	-2.99 (0.00)	28.04 (0.03)	27.82 (0.03)	**I(1)**
GFI	-0.26 (0.39)	-2.23 (0.01)	30.13 (0.02)	79.07 (0)	-0.49 (0.31)	-2.23 (0.01)	30.51 (0.02)	84.52 (0.00)	-3.7 (0.00)	33.7 (0.01)	73.05 (0.00)	**I(0)**
GDPG	3.077 (0.99)	-0.85 (0.2)	24.65 (0.08)	29.2 (0.02)	3.29 (1)	-0.34 (0.37)	18.54 (0.29)	19.08 (0.26)	-2.74 (0.00)	28.02 (0.03)	37.18 (0.00)	**I(1)**
HDI	-4.40 (0.05)	5.38 (0.09)	23.54 (0.1)	63.01 (0.00)	-268.17 (0.00)	-253.81 (0.00)	57.22 (0.00)	65.04 (0.00)	-1.47 (0.07)	10.2 (0.86)	4.95 (0.99)	**I(0)**
GI	0.98 (0.83)	1.03 (0.85)	8.42 (0.94)	13.28 (0.65)	-0.64 (0.26)	1.21 (0.89)	8.34 (0.94)	18.74 (0.28)	-0.45 (0.33)	17.01 (0.38)	12.55 (0.70)	**I(1)**

Three distinct test results demonstrate that variables are stationary at stage 1(0) and initial difference 1. The outcome demonstrates a varied tendency in the sequence of integration. Table 3 shows mixed trends such as HDI and GFI are integrated at level 1(0). While other variables such as EPI, GDPG, and GI are stationary at first order1(1).

Long Run Analysis

Now we demonstrate a comprehensive examination of the long-run connection and identify the long-run coefficients of Panel ARDL estimates of greenfield investment. The long-run results are described in Table 4.

Table 4: Long-Run Panel ARDL Estimates of Greenfield Investment, Institutional Quality, and Environmental Performance Model (Without Interaction terms)

Dependent Variable: D(EPI)				
Model selection method: Akaike info criterion (AIC)				
Selected Model: ARDL (1, 1, 1, 1, 1, 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
GFI	0.8185	0.3125	2.6193	0.0094
GDPG	-0.2556	0.0313	-8.1591	0.0000
$GDPG^2$	0.0178	0.0018	9.7842	0.0000
HDI	0.7669	0.1805	4.2475	0.0000
GI	0.1333	0.0188	7.0997	0.0000
C	4.2908	2.8208	1.5211	0.1295

Greenfield investment has a significant impact on the host country's economic growth by providing job opportunities and increasing competitiveness. Greenfield investment with a powerful institution improves environmental performance. The coefficient of GFI has a positive value indicating a positive relationship between EPI and GFI for Asian countries. However, for

Asian countries, this link is statistically significant at the 1% level. The explanation for this is the idea of the pollution halo. According to the pollution halo idea, foreign direct investment reduces emissions. According to the pollution halo hypothesis, multinational businesses transfer greener technology to host nations through FDI. Other studies have shown a link between EPI and Ayamba et al (2019), Waqiy et al (2019), Ahmad et al (2019), and Nepal et al (2020).

GDP growth is essential because it provides information about the size and performance of an economy. GDPG has a negative sign, indicating an inverse link between GDPG and EPI. As a result, an inverted U-shaped Kuznets curve exists between EPI. This means that early-stage economic growth results in increasing influences, which causes environmental degradation, and that later-stage economic growth contributes to alleviating the indicator of environmental degradation due to the use of low-carbon, non-polluting green energy, which reduces environmental pollution. Other research, including those by Wang and Zu (2021), Hao et al (2020), Rehman et al (2021), and Atif Jahangir (2021), verified the negative connection between GDPG and EPI.

GDPG square coefficient has a positive sign, indicating a favorable relationship between GDPG and EPI. This finding confirms the inverted U-shape link between $GDPG^2$ and EPI in the Asian nations studied. Following investigations verify our findings, Mehmood et al (2019), Atif Jahanger (2021), Rehman et al (2021), and Hao et al (2021). (2020).

Advances in human capital in sectors such as research, education, and management lead to increases in creativity, social well-being, equality, enhanced productivity, and higher rates of participation, all of which contribute to economic development. The HDI coefficient has a positive sign, indicating a favorable association between HDI and EPI. The panel suggested reasons for increasing environmental efficiency in four regions: East Asia, South Asia, Southwest Asia, and West Asia. Because educated individuals are more receptive to environmental legislation, human capital plays an important role in climate change. As a result, in nations where individuals have acquired a particular degree of knowledge, their activities will probably have an indirect or direct impact on environmental efficiency. As a result, there is a positive relationship between human capital and environmental efficiency. The second idea is that increased political globalization encourages human capital to enhance technological advantages, knowledge, and health, hence reducing environmental damage. Other studies, such as Quang et al (2020), Mehmood et al (2019), and Rehman et al (2021), have shown that human capital has a favorable influence on the environment.

Good collaborative governance makes better use of resources and provides easier access to financing. The GI coefficient has a positive sign, indicating a positive relationship between the variables GI and EPI. The reason for this is that improving government through various channels such as macroeconomic policies consistent with environmental protection and the deviation of relative prices to conserve natural resources and prevent environmental damage have been effective in improving environmental performance. It may be claimed that an increase in political rights and information freedom can boost environmental organizations' awareness and actions and that this problem eventually leads to increased public knowledge and social pressure to implement environmental protection legislation. Other investigations have shown a link between GI and EPI. Handoyo and Fitriyah (2019), Adinehzadeh et al. (2018), Hosseini and Kaneko (2013), and Shahabadi et al. (2013) are some of the authors (2016).

Table 5 describes the results with interaction terms and examines whether the results same or not without interaction terms. We have the same sign with interaction terms in the first variable as we did without interaction terms in Table 4, but the magnitude is much less. However, we discovered

that the association is statistically negligible when interaction terms are used. In the second variable, we obtained the same sign as without interaction terms in Table 4., but the magnitude is greater in Table 5, and the link between the variables is statistically insignificant. The sign of the third variable is the same as that of the interaction terms in Table 5.

Table 5: Long-Run Panel ARDL Estimates of Greenfield Investment, Institutional Quality, and Environmental Performance Model (With Interaction terms)

Dependent Variable: D(EPI)				
Model selection method: Akaike info criterion (AIC)				
Selected Model: ARDL (1, 1, 1, 1, 1, 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
GFI	0.1524	0.0787	1.9381	0.0533
GDPG	-0.0405	0.0249	-1.6279	0.1054
GDPG^2	0.0177	0.0030	5.9148	0.0000
HDI	0.5776	0.2235	2.5847	0.0106
GI	0.2565	0.0183	14.0306	0.0000
GI*GFI	0.0391	0.0081	4.7976	0.0000
GI*GDPG	0.0076	0.0017	4.4318	0.0000
GI*HDI	0.0757	0.0204	3.7202	0.0003
C	0.0388	0.0337	1.1527	0.2497

The magnitude is not as large in Table 5 as it was in Table 4 without interaction variables, but it is still statistically significant. The HDI coefficient is the same as in the table without interaction terms. Associated Table 5, the magnitude is no longer in with interaction terms and is determined to be statistically significant at the 5% level. In Table 5, we now infer the same sign of GI as in the absence of interaction variables. Table 5 shows that the magnitude is no more than it is without interaction factors. And, as in Table 4, a statistically significant connection between variables was discovered in Table 5. At the 1% level, the interaction term GI*GFI sign was determined to be positive and statistically highly significant. Excellent governance indirectly increases the efficiency of greenfield investment in environmental performance; in other words, when money is spent judiciously on greenfield investment with good governance, it improves a nation's environmental attributes. By interacting the governance index with GDP per capita, the interaction term GI*GDPG coefficient is positive, indicating that good governance matters and considerably moderates per capita and environmental performance in Asian nations. Similarly, the coefficient of interaction between the human capital index and the governance index is positive and statistically highly significant at the 1% level, indicating that the region’s environmental quality has increased. On the average value of GI, the influence of human capital on environmental performance by 0.0388. Earlier research by Katrakilidis, Kyritsis, and Patsika (2016) and Nepal et al. (2016) similarly found that the governance index matters in an economy's environmental performance (2020).

Error Correction Analysis

After investigating the long-run relationship among the variables used in our models the next step is to examine the short-run fluctuation of these variables. The short-run dynamics can be measured by the error correction model (ECM) without interaction terms. In this model without interaction term, the dependent variable is EPI, and the independent variables greenfield investment, gross

domestic per capita growth square, human development index, gross domestic product per capita growth, and governance index.

Table 6: Error Correction Estimates of Greenfield Investment, Institutional Quality, and Environmental Performance Model (Without Interaction terms)

Dependent Variable: D(EPI)				
Model selection method: Akaike info criterion (AIC)				
Selected Model: ARDL (1, 1, 1, 1, 1, 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
COINTEQ01	-0.1354	0.0329	-4.1119	0.0001
D(GFI)	1.5478	1.1815	1.3101	0.1914
D(GDPG)	-0.0671	0.0390	-1.7192	0.0863
D(GDPG^2)	0.2511	0.0149	16.8336	0.0000
D(HDI)	-0.0085	0.0032	-2.6496	0.0084
D(GI)	0.0224	0.0238	0.9432	0.3465
C	-0.0160	0.0823	-0.1949	0.8456

The error correction term (ECM) in Table 6 represents the speed of adjustment required to restore equilibrium in the strong model. The (ECM) coefficient value reflects how quickly or gradually the variables move toward equilibrium. It defines the phrase statistically significant negative mark. The ECM parameter for the model is -0.1354. The findings reveal that the rate of adjustment is fast, and it will return to its equilibrium position.

The Error Correction Estimates of Greenfield Investment, Institutional Quality, and Environmental Performance Index Model are shown in Table 7. (With interaction terms).

Table 7: Error Correction Estimates of Greenfield Investment, Institutional Quality, and Environmental Performance Model (With Interaction terms)

Dependent Variable: D(EPI)				
Model selection method: Akaike info criterion (AIC)				
Selected Model: ARDL (1, 1, 1, 1, 1, 1)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
COINTEQ01	-0.1784	0.0433	-4.1167	0.0001
D(GFI)	0.2507	0.0149	16.7884	0.0000
D(GDPG)	-0.0092	0.0034	-2.7391	0.0064
D(GDPG^2)	-0.0010	0.0038	-0.2599	0.7952
D(HDI)	-3.8744	4.6798	-0.8279	0.4089
D(GI)	1.6108	2.0562	0.7834	0.4345
D(GFI*GI)	0.0027	0.0060	0.4548	0.6495
D(GDPG*GI)	-0.0042	0.0191	-0.2194	0.8266
D(GI*HDI)	-0.9347	1.1083	-0.8433	0.4002
C	0.1450	0.1097	1.3219	0.1880

The interaction term represents the rate of adjustment required to reestablish equilibrium. The error correction model parameter is -0.178. The findings reveal that at a high rate of adjustment, it will return to its equilibrium position.

Causality Analysis

To find the direction of causality between the variables, we have used causality analysis. Because the optimal lag length model needs to be used to indicate. The table shows the different criteria to choose the optimal lag length.

Table 8: VAR Lag Order Selection Criteria (Endogenous variables: GFI GI EPI)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-759.3161	NA	0.026596	4.886642	4.922632	4.901026
1	262.4939	2017.420	4.03e-05	-1.605730	-1.461769	-1.548193
2	294.8972	63.35252	3.47e-05	-1.755751	-1.503818	-1.655061
3	321.065	50.65929*	3.11e-05*	-1.86580*	-1.50590*	-1.72196*
4	329.5920	16.34241	3.12e-05	-1.862770	-1.394894	-1.675774
5	332.3443	5.222142	3.24e-05	-1.822720	-1.246873	-1.592571

The table shows the different criteria HQ, AIC, SC, FPC, and LR in which the specified model 3 Displays that lag optimal selection. Now causality results explain which applies the Dumitrescu Hurlin Panel causality test.

Table 9: Pairwise Dumitrescu- Hurlin Panel Causality Tests

Null Hypothesis	W-Stat.	Zbar-Stat.	Prob.
GI ↛ GFI	3.69224	1.99490	0.0461
GFI ↛ GI	2.57791	0.21338	0.8310
EPI ↛ GFI	4.77460	3.72532	0.0002
GFI ↛EPI	10.0773	12.2030	0.0000
GI ↛ EPI	6.90246	7.12721	1.0013
GI ↛EPI	3.81107	2.18488	0.0289

Table 9 shows the result of the Dumitrescu-Hurlin panel causality test. GI is not causing GFI is causing GI which means that one-way causality between GI and GFI. There is uni-variate causality between GI and GFI. EPI is not causing GI and GFI also not causing the EPI. It means there is no causality between the GFI and EPI. EPI is causing the GI and GI is not causing the EPI. It means that one-way causality between EPI and GI.

Conclusions and Policy Implications

The study discovers the lively causal connection between greenfield investment, gross domestic per capita growth, square of gross domestic per capita growth, human capital index, governance index, and environmental performance for 40 Asian countries over the period 2003- 2020. A panel autoregressive distributed lag (ARDL) modeling approach was secondhand to observe the connotation between greenfield investment, GDP per capita growth, the square of GDP per capita growth, human capital index, governance index, and environmental performance. This study depends on secondary data accumulated from various WDI, UNCTAD, and PWT. The empirical estimates have shown that greenfield investment positive association with environmental performance in Asia Pacific countries. Human capital positive relation with environmental

performance, Gross domestic product negative connotation with environmental performance, and governance index positive relation with environmental performance.

The deduction of our study leads to key policy implications for Asian countries.

- The empirical results suggested that policymakers and governments are focused on increasing greenfield investment and through foreign capital and procedure of production can ensure a healthy and clean environment in Asian countries.
- The result suggested that human capital has a positive influence on environmental performance and educated people are more likely to follow environmental regulation than those who are not and recommended that more invest in the human capital of Asian countries thus education and skills for long-term positive influence on the environment.
- These countries accomplish high economic growth at the rate of ecological degradation. The government in these countries may lead up-to-date resourceful technology in industries and boost the use of renewable energy so that environmental value may be better. In other arguments, governments in Asian countries may emphasize on technological effect and not on scale effect of economic development.
- Economic growth and environmental performance have a positive association it could be a blessing to economic freedom. This study suggested that policymakers in Asian countries not only establish pollution control measures relatively it also necessary for the eco-efficiency of environmental sustainability with a position to increase the speed of the process of economic improvement.

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Appendix

Table 10: List of Asian countries according to Greenfield Investment Data (2003-2020)

East Asia
China, Korea, Democratic People's Republic of Korea, Republic of Hong Kong China Mongolia, Taiwan Province of China, Macao, China
South-East Asia
Brunei Darussalam, Cambodia, Indonesia, Lao People’s Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam
South Asia
Afghanistan, Bangladesh, Bhutan, India, Iran, the Islamic Republic of, Maldives Nepal, Pakistan, Sri Lanka
West Asia
Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, State of Palestine, The Syrian Arab Republic, Turkey, United Arab Emirates, Yemen