

Environmental signalling and the policy paradox: a comparative ARDL analysis of FDI inflows and structural divergence in South Asia

Environmental
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Abstract

Purpose – This paper examines the multidimensional factors driving foreign direct investment (FDI) inflows in South Asia. It analyses how environmental signalling, trade integration, and labour market conditions act as pull or push factors for international capital that are beyond traditional measurements of the market size. The model uses FDI as the dependent variable, and CO₂ emissions, economic growth (GDP), trade openness (TO), and unemployment (UN) as independent variables.

Design/methodology/approach – By ensuring a pre-pandemic baseline (1991–2019), this paper evaluates the long-run structural equilibrium and avoids severe macroeconomic instability. An autoregressive distributed lag (ARDL) bounds testing method is used to analyse both long-run and short-run dynamics. Structural stability was verified using the CUSUM and CUSUMSQ.

Findings – The findings reveal a significant structural divergence in South Asia. Specifically, Bangladesh exhibits a pollution halo effect, where a decrease in carbon intensity serves as a positive indicator of high-quality, technologically advanced investment. However, Pakistan and Sri Lanka followed a pollution-haven pattern, with the flexibility of environmental regulations and systematic unemployment being the causal factors behind cost-seeking carbon-based FDI. India has a neutral approach towards the environment, and FDI is mainly based on service-based macroeconomic stability.

Originality/value – This research contributes by positioning environmental quality not merely as an outcome of investment but as a critical predictive signal in the global competition for sustainable capital. A policy paradox is presented in those countries that have a surplus of labour, where the urgency to generate employment weakens the environmental bargaining power.

Keywords Foreign direct investment, Pollution haven hypothesis, Pollution halo, Environmental signalling

Paper type Research article

1. Introduction

The relationship between FDI and environmental integrity has become a major topic in modern macroeconomic discussions, especially as emerging economies struggle to balance three things: economic growth, job creation, and eco-friendly production (Shahbaz and Sinha, 2019; Khan *et al.*, 2021). Traditionally, FDI has been identified as a solution to capital shortage and to technological deficiencies in South Asia (Ullah and Khan, 2017).

However, the environmental consequences of such capital flows are highly debatable, with one side supporting the positive view of the pollution halo hypothesis and the other a more exploitative one of the pollution haven hypothesis (Yang *et al.*, 2018; Balsalobre-Lorente *et al.*, 2022; Ahmed *et al.*, 2022). Although empirical studies have examined the environmental performance of FDI on a large scale, few studies have examined the reverse effects to establish

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how environmental quality, labour market distress, and trade openness are the main factors driving capital entry. In South Asia, where climate vulnerability and population pressure are exceptionally high, understanding the determinants of FDI is not merely an economic issue but also a matter of sustainable development in the post-COP28 world (Zhang *et al.*, 2024; Dua *et al.*, 2024; Gopalan *et al.*, 2023).

Theoretically, the choice of location for multinational corporations (MNCs) is usually explained by the Eclectic Paradigm (Dunning, 1988), which holds that firms seek location advantages to reduce production costs. This benefit is often realised in South Asia through regulatory arbitrage, in which lax environmental standards—measured by rising CO₂ emissions—serve as an indicator of cost-seeking industrial capital (Taylor and Rising, 2021). This study goes beyond ex-post environmental outcomes and shifts the focus to the pre-investment aspects of institutional maturity and regulatory credibility, through the lens of carbon efficiency (Aybudak and Khalid, 2026; Balsalobre-Lorente and Shah, 2024). The Policy Paradox is defined as an operational information channel within this framework. It is a dilemma in which climate-sensitive economies, beset by high unemployment rates, deploy environmental standards to attract cost-seeking capital. This high unemployment reflects a weak bargaining position on behalf of the state and a reservation price for environmental integrity in exchange for social stability (Abidin *et al.*, 2025; Ashraf *et al.*, 2026). As a result, CO₂ levels act as predictive informational cues to determine the character of capital inflow and its distinction between clean technology investment and dirty cost-seeking industrial investment, as evidenced in the heterogeneous impacts of industrialisation in emerging economies (Li *et al.*, 2025; Usman *et al.*, 2026; Ni *et al.*, 2026). So the labour market does not play a passive role in the FDI-environment issue; rather, it plays a key role in the interaction between the state and foreign investors (Kinda, 2010). Despite these complexities, most regional models treat environmental degradation as a by-product rather than a predictive signalling factor; therefore, strategic understanding of investment location choice is significantly lacking.

Empirical studies on the South Asian region remain fragmented. As India has shifted towards a service-oriented FDI destination, other countries such as Pakistan and Sri Lanka remain dependent on intensive industrialisation (Shahbaz *et al.*, 2019; Mehmood, 2021). In the meantime, the distinct story in Bangladesh suggests that the country may decouple emissions from investment, indicating a pollution halo, whereas technological spillover effects, by contrast, enhance environmental efficiency (Zhu *et al.*, 2016; Demena and Afesorgbor, 2020). Nevertheless, the research literature suffers from omitted variable bias because it fails to model Trade Openness (TO) and Unemployment (UN) as cointegrated variables. These complex drivers cannot be addressed, hindering the development of a unified regional approach to Green FDI. Moreover, ARDL modelling is necessary in this case to capture the dynamics of short-run volatility and long-run equilibrium of these variables, a methodological requirement emphasised in the recent econometric literature (Pesaran *et al.*, 2001).

To conduct a comprehensive analysis of the relationship between investment and the environment, the rest of the paper is structured as follows. The second part is the critical synthesis of the existing literature that focuses on the theoretical development of the pollution haven and halo hypotheses and the factors that determine capital flows in emerging markets. The third section describes the empirical methodology, including data sources, variables, and the specification of the ARDL cointegration framework. The fourth part is devoted to the empirical analysis and discussion, including unit root tests and cointegration bounds tests, as well as the long-run and short-run coefficient estimates for each South Asian country. Lastly, the fifth section concludes the paper by summarising the key findings and providing evidence-based policy suggestions to make the region attractive to sustainable investment.

2. Literature review

The theoretical discussion of the factors behind FDI has developed from traditional market-seeking motives to a sophisticated analysis of institutional and environmental signals. The

main paradigm of this development is the Eclectic Paradigm (OLI), according to which multinational enterprises (MNEs) decide on their location by certain ownership, location, and internalisation benefits (Dunning, 1988). The Location (L) advantage, in the case of South Asia, is also becoming a factor of the regulatory environment and socio-economic pressures within the country, in which the environmental standards and the pressures of the labour market can be seen as the major factors of investment suitability (Ullah and Khan, 2017; Khan and Ozturk, 2020).

2.1 Environmental signalling as an informational channel

While standard theories view emissions as an outcome, recent literature positions environmental quality as a pre-investment informational signal. Signalling theory suggests that a country's carbon efficiency serves as a proxy for institutional maturity and regulatory credibility, distinguishing it from traditional Pollution Haven outcomes (Aybudak and Khalid, 2026; Balsalobre-Lorente and Shah, 2024). The bidirectional relationship between financial development and environmental quality, as emphasised by Horobet *et al.* (2025), suggests a transparency signal that investors observe. Additionally, digital technologies are increasingly recognised as a key facilitator of responsible production (Balsalobre-Lorente and Shah, 2024; Usman *et al.*, 2026; Yu *et al.*, 2025), and green innovations are seen to promote economic growth and sustainability simultaneously (Usman *et al.*, 2025; Trung *et al.*, 2025).

2.2 The environmental signalling and regulatory arbitrage

The Pollution Haven Hypothesis (PHH) states that money flows to where there are lower environmental compliance costs, as many of these recent studies (Yang *et al.*, 2018) have shown. In this context, the carbon emission (CO₂) is used to measure the intensity of environmental requirements. Balsalobre-Lorente *et al.* (2022) claim that in developing countries, there is a positive relationship between emissions and FDI entry, which is considered a sign of regulatory arbitrage whereby brown industries transfer to avoid the rigorous carbon taxes of the Global North. On the other hand, the Pollution Halo Hypothesis is based on the idea that a negative relationship, as evidenced by the example of technological hubs, points to the fact that foreign investors are attracted to the green efficiency and institutional maturity (Zhu *et al.*, 2016; Demena and Afesorgbor, 2020). The structural divergence above indicates that environmental degradation is not just a byproduct of FDI but rather an indicator that defines the kind of capital that a country has.

2.3 Economic growth and the EKC framework

The relationship between economic development and environmental signalling is conventionally captured by the Environmental Kuznets Curve (EKC) model, which posits an inverted U-shaped relationship between income levels and environmental degradation (Shahbaz and Sinha, 2019). However, current empirical studies suggest that South Asian economies may be on the rising side of this curve, with increases in GDP accompanied by increases in CO₂ emissions (Mehmood, 2021; Shahbaz *et al.*, 2019). This process of delinking was criticised early on by Stagl (2000), and, concerning the topic, Taylor and Rising (2021) point out that global land-use and investment flows may trigger tipping points that bypass the conventional EKC trajectory. In the case of other nations such as India and Pakistan, the relationship between GDP growth and FDI entry in the country is thus moderated by the capacity of the nation to shift towards energy-intensive manufacturing to serve or high-technology-oriented manufacturing (Khan *et al.*, 2021).

2.4 Trade openness and labour market pressures

The role of Trade Openness (TO) as an FDI factor has been extensively analysed, and studies have argued that outward-oriented economies provide the transparency and globalisation that

foreign companies need (Ullah and Khan, 2017; Zhang *et al.*, 2024). However, the introduction of unemployment (UN) as a factor adds a very important social dimension to the investment-environment relationship. According to the Race to the Bottom theory, countries with unacceptable unemployment levels are under severe pressure to absorb the excess workforce, which means that in most cases they offer pollution havens in exchange for industrial jobs (Mert and Caglar, 2020). As Kinda (2010) and Khan and Ozturk (2020) emphasise, the bargaining power of the government against MNCs in labour-surplus economies is undermined, and unemployment is an important push factor that can motivate the acceptance of ecologically damaging capital.

2.5 Synthesis and the research gap

There is a clear gap in the comparative regional analysis of South Asia, despite the vast literature on the individual effects of these variables. Analysing panel data, most previous studies have examined multiple countries to evaluate variables within a region, which does not reflect the individual characteristics of a halo-seeking economy, such as Bangladesh, and a haven-seeking economy, such as Pakistan or Sri Lanka.

Moreover, this study has treated FDI as a dependent variable rather than as a factor alongside other variables, resolving a major conflict: earlier studies were unsure whether a country’s characteristics attracted foreign capital or whether investment was one of the main factors behind those problems. This thematic synthesis highlights the necessity of a multi-dimensional framework that can assess environmental signalling, global trade integration, and labour market distress simultaneously to provide a comprehensive picture of capital inflows into climate-vulnerable areas.

3. Data and methodology

3.1 Data

This paper uses annual time-series data (1991–2019) obtained from the World Development Indicators (WDI) of the World Bank. The last year of the study is 2019, so the data are consistent across all four South Asian countries and help prevent structural outliers due to the COVID-19 pandemic from biasing the long-run equilibrium estimates. Notably, the superior performance of the ARDL Bounds testing method in small sample sizes is due to its specific choice of bounds, whereas traditional cointegration methods may yield inconsistent results. This methodological option guarantees that the long-run relationships discovered will be statistically reliable and robust, even with limited regional time-series data. The data descriptions and their respective units are summarised in the Table 1 below.

Table 1. Variables and definitions

Variable	Abbreviation	Unit of measurement	Transformation
Foreign Direct Investment	FDI	Net Inflows (% of GDP)	Ln
CO ₂ Emissions	CO ₂	Metric tons per capita	Ln
Economic Growth	GDP	Annual GDP Growth (%)	Linear
Trade Openness	TO	(Exports + Imports) / GDP (%)	Linear
Unemployment	UN	% of Total Labor Force	Linear

Source(s): Authors’ own work

3.2 Model specification

The research includes the above (see Table 1) dependent and independent variables of the selected countries in a framework for linear relationship analysis that reflects the short- and long-run linkages in the region as nexus points. Therefore, we get the functional model below.

$$FDI_t = \delta_0 + \delta_1 CO_{2t} + \delta_2 GDP_t + \delta_3 TO_t + \delta_4 UN_t + \varepsilon_t \quad (1)$$

3.2.1 The bounds testing co-integration model.

$$\begin{aligned} \Delta FDI_t = & \delta_0 + \sum_{i=1}^{p1} \delta_{1i} \Delta FDI_{t-i} + \sum_{i=0}^{p2} \delta_{2i} \Delta CO_{2,t-i} + \sum_{i=0}^{p3} \delta_{3i} \Delta GDP_{t-i} + \sum_{i=0}^{p4} \delta_{4i} \Delta TO_{t-i} \\ & + \sum_{i=0}^{p5} \delta_{5i} \Delta UN_{t-i} + \delta_6 FDI_{t-1} + \delta_7 CO_{2,t-1} + \delta_8 GDP_{t-1} + \delta_9 TO_{t-1} \\ & + \delta_{10} UN_{t-1} + \mu_1 \end{aligned} \quad (2)$$

3.2.2 Long-run estimation model.

$$\begin{aligned} FDI_t = & \varnothing_0 + \sum_{i=1}^{p1} \varnothing_{1i} FDI_{t-i} + \sum_{i=0}^{p2} \varnothing_{2i} CO_{2,t-i} + \sum_{i=0}^{p3} \varnothing_{3i} GDP_{t-i} + \sum_{i=0}^{p4} \varnothing_{4i} TO_{t-i} \\ & + \sum_{i=0}^{p5} \varnothing_{5i} UN_{t-i} + \varepsilon_t \end{aligned} \quad (3)$$

3.2.3 Short-run estimation model.

$$\begin{aligned} \Delta FDI_t = & \varphi_0 + \sum_{i=1}^{p1} \varphi_{1i} \Delta FDI_{t-i} + \sum_{i=0}^{p2} \varphi_{2i} \Delta CO_{2,t-i} + \sum_{i=0}^{p3} \varphi_{3i} \Delta GDP_{t-i} + \sum_{i=0}^{p4} \varphi_{4i} \Delta TO_{t-i} \\ & + \sum_{i=0}^{p5} \varphi_{5i} \Delta UN_{t-i} + \lambda ECM_{t-1} + \mu_t \end{aligned} \quad (4)$$

To ensure the elimination of residual serial correlation without sacrificing degrees of freedom within our country-specific sample sizes, the optimal lag lengths for the ARDL (p1, p2, p3, p4, p5) specifications were systematically determined by minimising the Akaike Information Criterion (AIC).

4. Analysis and discussion

4.1 Statistical validation and co-integration results

The study first tests for unit roots using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to determine the stationarity of the variables before using the Bounds Test for long-run cointegration. Because of its simplicity, the ARDL framework will be used to determine both long-run and short-run relationships (Pesaran *et al.*, 2001; Pesaran and Shin, 1997).

The results of the ADF and PP tests, as detailed in Table 2, indicate a mixed order of integration among the series. While some variables exhibit stationarity at their levels [I (0)], others become stationary only after the first difference [I (1)]. Crucially, the null hypothesis of a unit root is rejected for all variables at the 1%, 5%, or 10% significance levels after the first transformation, and no series is found to be integrated at I (2). This lack of I (2) variables is a prerequisite for the ARDL Bound testing approach, as the presence of second-difference stationary data would render the F-statistics computed by the Pesaran *et al.* (2001) framework invalid. Consequently, the observed mixed integration of the I (0) and I (1) series confirms that the ARDL methodology is the most appropriate econometric instrument for capturing the

Table 2. Results of ADF test and PP test

Variables	ADF (p-value)	PP (p-value)	Variables	ADF (p-value)	PP (p-value)
<i>Model with constant term [level form]</i>			<i>Model with constant and trend terms [level form]</i>		
B_FDI	0.3411	0.3699	B_FDI	0.5672	0.5651
B_CO ₂	0.3141	0.0843	B_CO ₂	0.0870*	0.1744
B_GDP	0.2881	0.2881	B_GDP	0.0314**	0.0411**
B_TO	0.3489	0.3370	B_TO	0.9013	0.9013
B_UN	0.3972	0.4432	B_UN	0.3281	0.3698
I_FDI	0.2851	0.3024	I_FDI	0.3407	0.3407
I_CO ₂	0.9207	0.9191	I_CO ₂	0.8116	0.6734
I_GDP	0.0002***	0.0000***	I_GDP	0.0025***	0.0000***
I_TO	0.5162	0.5163	I_TO	0.9763	0.9722
I_UN	0.9252	0.6816	I_UN	0.9753	0.9723
P_FDI	0.0654	0.3951	P_FDI	0.2174	0.5837
P_CO ₂	0.3413	0.3529	P_CO ₂	0.1957	0.1957
P_GDP	0.0100**	0.0104**	P_GDP	0.0465**	0.0483**
P_TO	0.3849	0.3849	P_TO	0.4751	0.4400
P_UN	0.9994	0.9994	P_UN	0.9922	0.9884
S_FDI	0.0003***	0.0000***	S_FDI	0.0002***	0.0000***
S_CO ₂	0.3228	0.0910	S_CO ₂	0.1262	0.1320
S_GDP	0.0155**	0.0155**	S_GDP	0.0765*	0.0773*
S_TO	0.8881	0.8734	S_TO	0.2538	0.2538
S_UN	0.1027	0.1126	S_UN	0.9652	0.9611
<i>Model with constant term [difference form]</i>			<i>Model with constant and trend terms [difference form]</i>		
ΔB_FDI	0.0000***	0.0000***	ΔB_FDI	0.0001***	0.0000***
ΔB_CO ₂	0.0030***	0.0000***	ΔB_CO ₂	0.0037***	0.0000***
ΔB_GDP	0.0000***	0.0000***	ΔB_GDP	0.0001***	0.0000***
ΔB_TO	0.0016***	0.0017***	ΔB_TO	0.0045***	0.0048***
ΔB_UN	0.0002***	0.0000***	ΔB_UN	0.0005***	0.0000***
ΔI_FDI	0.0000***	0.0000***	ΔI_FDI	0.0003***	0.0003***
ΔI_CO ₂	0.0014***	0.0012***	ΔI_CO ₂	0.0092***	0.0082***
ΔI_GDP	0.0003***	0.0000***	ΔI_GDP	0.0012***	0.0000***
ΔI_TO	0.0016***	0.0016***	ΔI_TO	0.0042***	0.0042***
ΔI_UN	0.0322**	0.0351**	ΔI_UN	0.0422*	0.0438**
ΔP_FDI	0.0201**	0.0181**	ΔP_FDI	0.0818*	0.0744*
ΔP_CO ₂	0.0008***	0.0008***	ΔP_CO ₂	0.0035***	0.0035***
ΔP_GDP	0.0000***	0.0000***	ΔP_GDP	0.0000***	0.0000***
ΔP_TO	0.0002***	0.0002***	ΔP_TO	0.0011***	0.0011***
ΔP_UN	0.0000***	0.0000***	ΔP_UN	0.0000***	0.0000***
ΔS_FDI	0.0000***	0.0000***	ΔS_FDI	0.0002***	0.0000***
ΔS_CO ₂	0.0000***	0.0000***	ΔS_CO ₂	0.0000***	0.0000***
ΔS_GDP	0.0000***	0.0000***	ΔS_GDP	0.0000***	0.0000***
ΔS_TO	0.0010***	0.0010***	ΔS_TO	0.0057***	0.0058***
ΔS_UN	0.0035***	0.0031***	ΔS_UN	0.0019***	0.0019***

Note(s): *significant at 10% level; **significant at 5% level; ***significant at 1% level

Source(s): Authors' own work

long-run and short-run dynamics of the investment-environment nexus in South Asia (see Table 3).

The ARDL Bounds testing procedure was executed to investigate the existence of a long-run equilibrium relationship among the variables. Following the model specification in Equation (2), the calculated F-statistics were compared against the critical value bounds to determine the presence of cointegration. For all four jurisdictions, the estimated F-statistics (7.632) for Bangladesh, (4.797) for Pakistan, (3.848) for India and (8.563) for Sri Lanka

Table 3. ARDL bounds testing results for cointegration and dynamic adjustment across South Asia

	Bangladesh		India		Pakistan		Sri Lanka	
Lag	(1,2,0,2,2)		(2,0,2,2,1)		(1,0,2,0,0)		(2,1,0,0,2)	
Functional Format	B_FDI =(B_FDI / B_CO ₂ , B_GDP, B_TO, B_UN)		I_FDI =(I_FDI / I_CO ₂ , I_GDP, I_TO, I_UN)		P_FDI =(P_FDI / P_CO ₂ , P_GDP, P_TO, P_UN)		S_FDI =(S_FDI / S_CO ₂ , S_GDP, S_TO, S_UN)	
F-Stat	7.632***		3.848***		4.797***		8.563***	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
10%	2.20	3.09	2.20	3.09	2.20	3.09	2.20	3.09
5%	2.56	3.49	2.56	3.49	2.56	3.49	2.56	3.49
1%	3.29	4.37	3.29	4.37	3.29	4.37	3.29	4.37
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
<i>Long-run estimation results</i>								
CO ₂	−0.4512	0.05**	−1.1935	0.19	1.8695	0.04**	0.3276	0.08*
GDP	0.1706	0.03**	0.0981	0.48	0.6297	0.01***	0.0375	0.29
TO	0.0648	0.00***	0.0598	0.03**	0.0879	0.10	0.0216	0.76
UN	0.1342	0.20	0.3164	0.45	−0.4875	0.00***	0.0410	0.57
C	2.0360	0.22	12.888	0.27	−25.480	0.02**	−2.3749	0.65
<i>Short-run estimation results</i>								
ΔCO ₂	−2.8716	0.00***	−0.8530	0.14	0.9284	0.14	1.2614	0.06*
ΔGDP	0.1827	0.03**	−0.0406	0.36	0.0832	0.04**	0.0554	0.25
ΔTO	0.0496	0.00***	0.0481	0.11	0.0436	0.12	0.0130	0.92
ΔUN	−0.0109	0.88	−0.8580	0.03**	−0.2421	0.06*	0.0077	0.94
ECM(−1)	−0.8714	0.00***	−0.7146	0.00***	−0.4966	0.00***	−1.4762	0.00
<i>Diagnostic results</i>								
	χ ² value	p-value	χ ² value	p-value	χ ² value	p-value	χ ² value	p-value
BG-LM	2.01	0.17	2.78	0.11	0.31	0.58	2.32	0.13
ARCH	2.56	0.11	1.80	0.40	1.51	0.46	3.59	0.16
JB Stat	0.91	0.61	0.28	0.86	0.32	0.86	1.38	0.50
RESET	1.73	0.21	2.87	0.15	2.45	0.13	2.61	0.14
R ²	0.8169		0.6768		0.6456		0.7639	
Adj R ²	0.7620		0.5798		0.6161		0.7210	
Note(s): ***significant at 1% level; **significant at 5% level; *significant at 10% level								
Source(s): Authors' own work								

clearly exceed the upper critical bound I(1) at the 5% significance level. Consequently, the null hypothesis of no co-integration is rejected. This statistical evidence confirms that a stable, long-run equilibrium relationship exists between FDI inflows and its determinants (CO₂, GDP, Trade Openness, and Unemployment) over the study period. The confirmation of co-integration ensures that the long-run coefficients are not spurious and validates the use of the Error Correction Model (ECM) to analyse the short-run speed of adjustment and the long-run elasticities.

The Sri Lankan ECM coefficient of −1.4762 indicates a statistically significant overshooting or damped oscillation adjustment process. While coefficients typically range from 0 to −1, a value between −1 and −2 is economically valid for volatile emerging markets. It suggests that following a shock, the Sri Lankan FDI-environment nexus overcorrects in the short run before converging to the long-run equilibrium. This behaviour mirrors findings in other emerging economies, which exhibit high structural volatility during energy transitions (Trung *et al.*, 2025).

4.2 Stability of the models

To ensure the reliability of the ARDL estimates, a series of diagnostic tests was conducted, which includes tests of Serial correlation (Breusch-Godfrey test), Heteroscedasticity (ARCH test), and Functional Form (Ramsey RESET test). Nonlinear frameworks (NARDL) can be used to model asymmetric shocks; however, this study employs the linear ARDL framework in order to focus on identification of stable long-run structural trajectories. Figures 1 through 8 show that the reliability of this linear specification is verified by the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests, which indicate that for all sample countries, the parameters remain robust to regime-switching bias (Usman *et al.*, 2026). Furthermore, Zivot-Andrews structural break unit root tests were conducted to ensure that the long-run cointegrating vectors are not biased by regional economic shifts during the 1991–2019 period. Table 4 results confirm that the identified parameters are robust to structural breaks, supporting the overall reliability of the comparative regional analysis.

The values of the residuals for all four countries are within the 5% significance bounds, suggesting that the model parameters are stable over the 1991–2019 period and are not biased by structural breaks or macroeconomic crises.

4.3 Structural divergence: pollution halo vs. pollution haven

Empirical evidence suggests a significant structural difference in how foreign capital is attracted. The negative relationship between CO₂ emissions and FDI flows in Bangladesh supports a pollution halo effect, suggesting that the country’s industrial policy attracts quality-seeking, energy-efficient capital. This observation is similar to Zhu *et al.* (2016) and Demena and Afesorgbor (2020), who argue that foreign investors favour investment in environments with technological spillovers and institutional maturity rather than in those with flexible regulations.

This is the opposite of the case in Pakistan and Sri Lanka, where the pollution haven hypothesis is supported by a positive long-run correlation between emissions and FDI (Pakistan: 1.86, $p < 0.05$; Sri Lanka: 0.32, $p < 0.10$). In such cases, these countries make flexible rules to allow higher emissions to attract the foreign investors who want low costs, which is aligned with the Race to the Bottom theories, which state that countries compete for

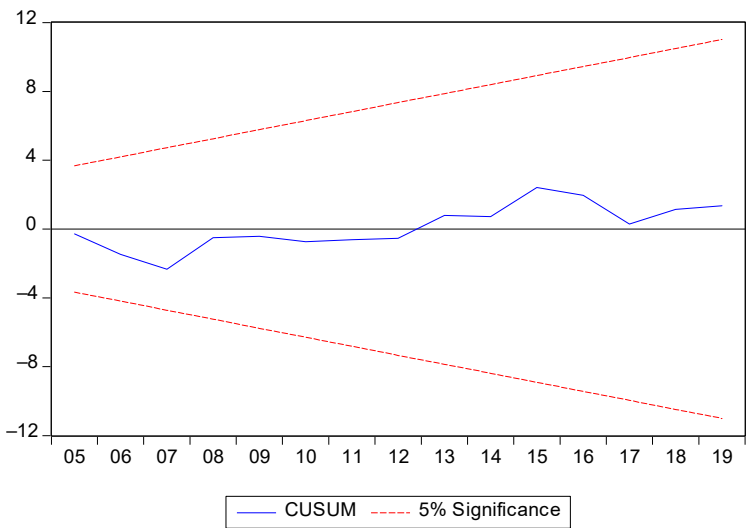


Figure 1. CUSUM Bangladesh. Source(s): Authors’ findings

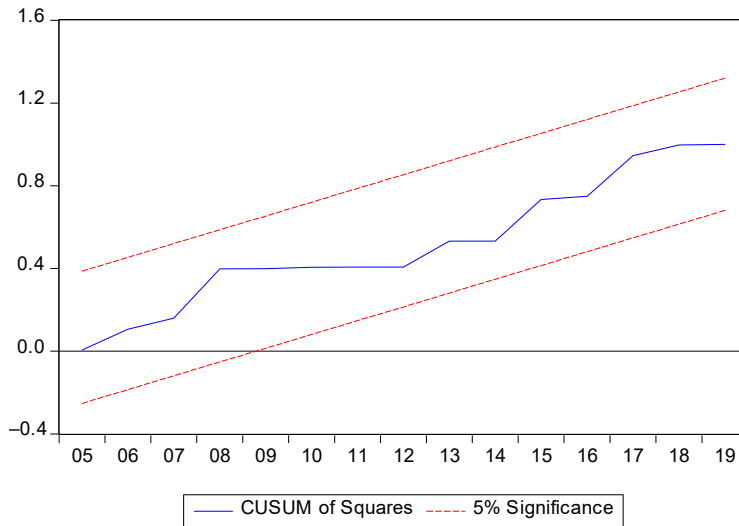


Figure 2. CUSUMQ Bangladesh. **Source(s):** Authors' findings

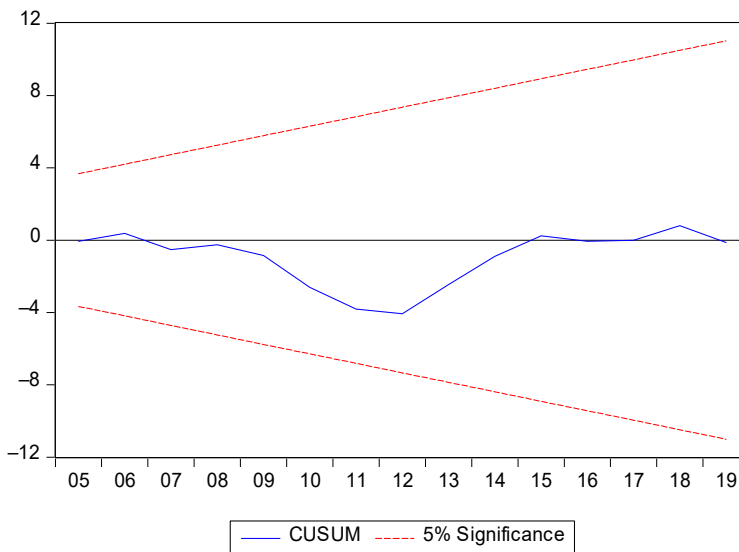


Figure 3. CUSUM India. **Source(s):** Authors' findings

investment without considering the qualities of the environment (Balsalobre-Lorente *et al.*, 2022; Yang *et al.*, 2018). Such findings indicate that Pakistan and Sri Lanka might still be enjoying a comparative location advantage, as they are attracting companies by appealing to environmental considerations. In contrast, Bangladesh appears to attract investment while maintaining relatively better control over carbon emissions.

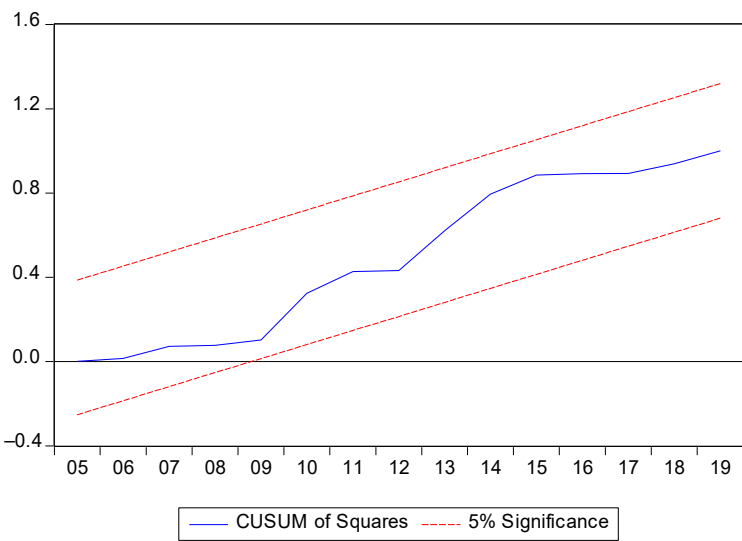


Figure 4. CUSUMQ India. Source(s): Authors' findings

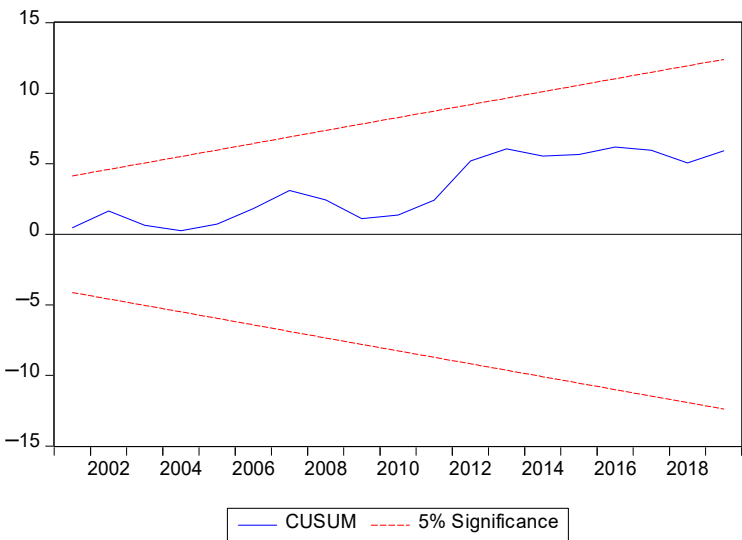


Figure 5. CUSUM Pakistan. Source(s): Authors' findings

4.4 The unemployment-environment paradox

One of the main contributions of this research is that it has examined the policy paradox, which is further fueled by the pressure in the labour market. According to Table 3, in Pakistan, there is a significant negative relationship between unemployment (UN) and FDI ($-0.4875, p < 0.01$) in the long run.

Mathematically, that negative sign represents that high unemployment is a strong negative push factor or pull-back factor to foreign capital, presumably because it suggests social

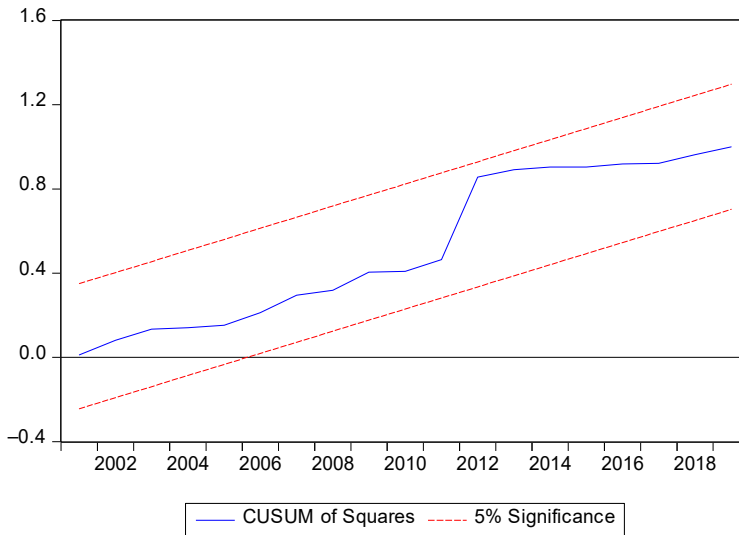


Figure 6. CUSUMQ Pakistan. **Source(s):** Authors' findings

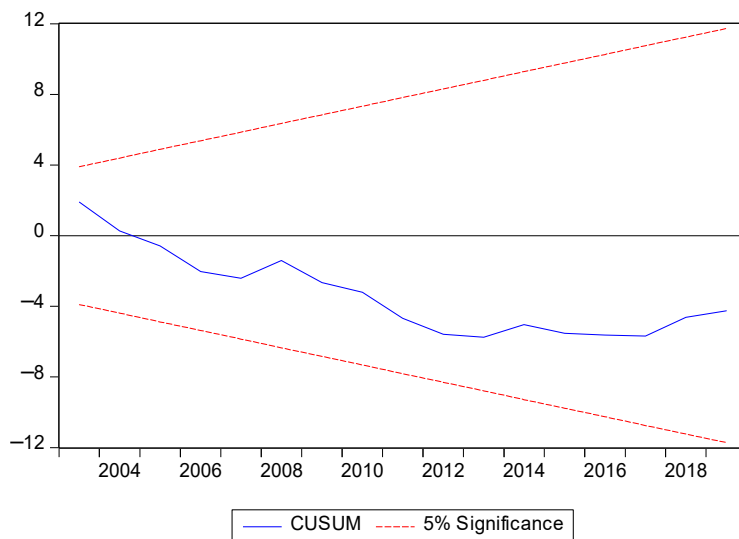


Figure 7. CUSUM Sri Lanka. **Source(s):** Authors' findings

instability and low domestic buying power in the face of labour market distress. This result generates a strategic dilemma: because an increase in unemployment is discouraging high-quality investment, the government has been forced into a policy paradox where it must provide regulatory arbitrage and reduced environmental protection (the pollution haven effect) in order to offset this labour market failure and be able to bring forward cost-seeking industrial capital. This confirmation supports the theoretical assumptions of [Khan and Ozturk \(2020\)](#) and [Mert and Caglar \(2020\)](#), who believe that countries with labour surplus tend to undermine the

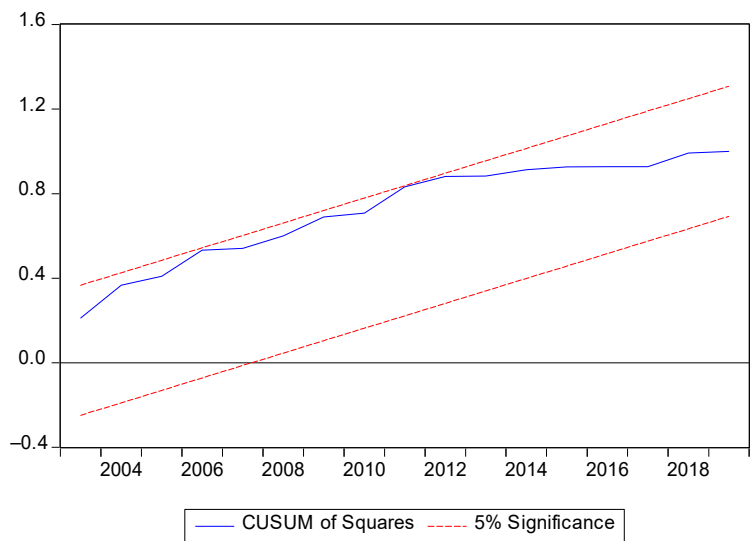


Figure 8. CUSUMQ Sri Lanka. Source(s): Authors’ findings

Table 4. Zivot-Andrews structural break unit root test results

Country	Variable	Lag	T-statistic	Break year	Decision
Bangladesh	FDI	0	−5.321**	2013	Stationary at I(0)
	CO ₂	0	−4.508	1995	Non-stationary
	GDP	1	−4.437	2005	Non-stationary
	TO	0	−4.421	2011	Non-stationary
	UN	0	−5.341**	2010	Stationary at I(0)
India	FDI	0	−4.880*	2006	Stationary at I(0)
	CO ₂	0	−1.972	2007	Non-stationary
	GDP	1	−4.177	2004	Non-stationary
	TO	0	−3.109	2011	Non-stationary
	UN	0	−1.058	2007	Non-stationary
Pakistan	FDI	1	−4.510	2004	Non-stationary
	CO ₂	0	−3.782	2010	Non-stationary
	GDP	0	−4.284	2008	Non-stationary
	TO	0	−4.195	2005	Non-stationary
	UN	2	−5.841***	2011	Stationary at I(0)
Sri Lanka	FDI	1	−6.594***	2006	Stationary at I(0)
	CO ₂	0	−4.510	2006	Non-stationary
	GDP	0	−4.704	2010	Non-stationary
	TO	0	−3.619	2009	Non-stationary
	UN	0	−2.215	2011	Non-stationary

Note(s): 1. FDI = Net inflows (% of GDP), CO₂ = Emissions (metric tons per capita), GDP = Annual growth (%), TO = Trade Openness (% of GDP), UN = Total Unemployment (%)
2. ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively
3. Critical values: 1%: −5.57; 5%: −5.08; 10%: −4.82
4. Lag selection is based on the Akaike Information Criterion (AIC)
5. The test allows for breaks in both the intercept and trend
Source(s): Authors’ own work

bargaining power of environmental issues to ensure that social stability in the country is maintained by job creation. This Policy Paradox operates as a strategic informational signal where investors interpret systemic labour distress as an implicit guarantee of regulatory flexibility. Consequently, high unemployment signals a ‘weak bargaining position’ for the state, attracting cost-seeking industrial capital (Abidin *et al.*, 2025; Ashraf *et al.*, 2026).

However, the insignificant relationship between unemployment and FDI attraction in Bangladesh ($p = 0.20$) indicates a critical sectoral decoupling. Although the same can be said of Bangladesh, FDI in this country is extremely concentrated in the Ready-Made Garment (RMG) industry. In contrast to the extractive or heavy industrial production, the RMG sector is a labour-intensive industry that is, however, increasingly regulated by the international green supply chain requirements of the international purchasers. This means Bangladesh is no longer degrading its ecology to reduce unemployment, offering technological advancement to attract foreign capital, which is called the Halo effect (Zhu *et al.*, 2016). In the meantime, the neutral performance of India is indicative of an apparently less environment-sensitive service-based investment regime, as defined by Shahbaz *et al.* (2019).

4.5 Comparative regional dynamics

Although Pakistan and Bangladesh are in opposite directions, such as pollution halo and pollution haven, the data of India and Sri Lanka provide some even more detail on the South Asian structural divergence.

The results in India indicate a neutral stance towards the environment. The long-run coefficients for CO₂ emissions ($p = 0.19$) and GDP growth ($p = 0.48$) are not statistically significant, indicating that India’s FDI environment has decoupled from industrial carbon intensity. As the investment environment moves toward a services-driven and technology-based approach, this aligns with the theory of the ‘dual impact of green innovation,’ which predicts that technological advancement, in addition to boosting growth, will also reduce emissions (Trung *et al.*, 2025). At the same time, India’s FDI structure is more dominated by the high-tech and software industries, which are less prone to environmental signalling than manufacturing-intensive neighbours.

Sri Lanka, on the other hand, has a low pollution haven effect. The long-run CO₂ (0.3276) is statistically significant at the 10% level ($p = 0.08$), indicating a positive relationship between FDI and emissions; however, this relationship is weaker than that observed for Pakistan (1.8695, $p < 0.05$). Generally speaking, Sri Lanka offers labour-market flexibility to capital seeking cost advantages, but it is not as desperate as Pakistan in the extractive and heavy industrial sectors. The identified potential structural volatility (ECM = -1.47) is a warning, indicating that Sri Lanka remains connected to high-emission industries, which is a barrier to the transition towards the green technological infrastructure seen in Bangladesh.

To provide a formal comparative diagnostic of these dynamics, Table 5 synthesises the structural divergence observed across the four economies.

Table 5. Comparative diagnostic of South Asian investment-environment signaling

Feature	Bangladesh	India	Pakistan	Sri Lanka
Dominant FDI Path	Manufacturing/ RMG	IT and Services	Heavy Industrial	Extractive/ Industrial
Signaling Nature	Efficiency Signal	Sectoral Neutrality	Paradoxical Signal	Transition Signal
Adjustment Logic Theory Supported	Stable Convergence Pollution Halo	Decoupled Path Service Neutrality	Stable Pressure Pollution Haven	Damped Oscillation Regulatory Arbitrage

Source(s): Study findings

5. Conclusion and policy recommendations

5.1 Conclusion

This study presents an extensive econometric analysis of the determinants of FDI inflows in Bangladesh, India, Pakistan and Sri Lanka from 1991 to 2019, which has been multi-dimensional. The study has successfully redefined the role of capital attraction in the context of environmental quality, macroeconomic growth and labour market distress using an ARDL model.

The empirical evidence draws attention to a vast structural paradigm in the region. Although Bangladesh has already started to experience a dynamic of a pollution halo, in which the low carbon intensity draws technologically advanced and other capital, which seeks quality, Pakistan and Sri Lanka are still stuck in a dynamic of a pollution haven. In these countries, lax environmentalism persists as a comparative location advantage. Moreover, the Policy Paradox says that some countries with labour surpluses, such as Pakistan and Sri Lanka, need to create job opportunities over environmental integrity. On the other hand, Bangladesh has made a good performance in the RMG sector, implying that the sectoral decoupling can be achieved, whereby global green requirements will enable labour consumption without severe ecological deterioration.

Furthermore, the study's timeline (1991–2019) is notable for being strategically designed to capture the behaviour of economies in the presence of environmental and foreign capital factors, without the confounding impact of a pandemic. The model can eliminate the systemic shocks and structural breaks that characterised the period 2020–2025 by terminating the series in 2019, ensuring that the identified long-run coefficients reflect actual regional trajectories rather than pandemic-related anomalies. This baseline will be useful for future studies analysing the changing investment landscape in South Asia in the aftermath of the pandemic and amid new climate requirements.

In conclusion, the identified 'Policy Paradox' underscores the need to separate creation and ecological degradation using digital technology mediation ([Usman *et al.*, 2026](#)) and green innovation ([Trung *et al.*, 2025](#)) as a medium for job creation in South Asia. This study serves as the empirical foundation for a regional 'Green Investment Code' that will help avoid intra-regional pollution havens and create a sustainable transition for climate-vulnerable countries in accordance with the COP-28 and SDG-13 objectives.

5.2 Policy recommendations

To separate the attractiveness of investments and ecological degradation, the research suggests the following specific policy changes:

Switching the Cost-Seeking to Quality-Seeking FDI: The Pakistani and Sri Lankan governments should stop relying on the provision of environmental space as a pull factor.

- (1) The policy frameworks must encourage the implementation of Green FDI with the help of fiscal policy instruments, including carbon credits and tax holidays, namely in the case of foreign companies that will establish carbon-neutral technologies.
- (2) This change is necessary to counter the Race to the Bottom dynamic that has been identified in the long-run outcomes.

Addressing the "Unemployment-Environment" Paradox: High unemployment is a push factor that leads people to tolerate dirty capital; hence, governments should invest in green vocational training.

- (1) Nations can also achieve high-value FDI, which offers both jobs and environmental conservation by training the labour force on renewable energy and sustainable production, eliminating the socio-economic pressure of the environmental standards.

Preventing Regulatory Arbitrage by Regional Cooperation: To prevent intra-regional Regulatory Arbitrage, a coordinated strategy is needed.

Environmental
Sustainability and
Resilience

- (1) SAARC should develop a South Asian Green Investment Code.
- (2) Regional standards would make sure that the environmental benefit of one country is not the loss of another country and bring to an end competitive deregulation that fueled the Pollution Haven Trajectory.

Cost Internalisation into the Environment: South Asian countries are to introduce Environmental Impact Assessments (EIAs) as a condition for FDI entry.

- (1) The policy-makers can internalise ecological costs at the entry by making sure that the incoming capital must be made to serve the national climate commitments under the Paris Agreement and the COP 28 obligations.

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