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The Remittance Paradox: Balancing Economic Growth and Environmental Sustainability in Pakistan

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Abstract

This study examines the dynamic impacts of personal remittances and foreign direct investment (FDI) on CO_2 emissions in Pakistan from 1989 to 2021. Using the nonlinear asymmetric autoregressive distributed lag (ARDL) technique; we investigate the asymmetric effects of remittances and FDI on environmental degradation. Our findings suggest that an increase in personal remittances decreases CO_2 emissions, while an increase in FDI boosts CO_2 emissions. The results also indicate that GDP is a significant driver of environmental pollution. Furthermore, the study reveals that renewable energy consumption has a negative impact on CO_2 emissions, highlighting the importance of transitioning to cleaner energy sources. The study's findings have important policy implications for Pakistan's pursuit of sustainable development and environmental sustainability, emphasizing the need for policymakers to balance economic growth with environmental concerns. The results of this study can inform the development of effective environmental policies and strategies to mitigate the negative impacts of remittances and FDI on the environment.

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Introduction

Over the past two decades, the world has faced an escalating challenge of environmental deterioration. Globally, pollution and climate change have garnered significant attention. This concern arises largely due to the growing global competition for economic growth, which has led to increased consumption of various energy forms and natural resources. Most of this energy still relies on traditional sources that emit harmful chemicals into the atmosphere, accelerating global warming [Majeed and mazhar (2019), landman (2007), Dar and Asif (2017), Bouttaba (2014) and Ahmad et al. (2019)]. In 2020 alone, carbon dioxide (CO_2) emissions reached 32 billion tons globally (Climate Consulting, 2022).

In recent years, researchers have turned their focus toward understanding the link between remittances and CO_2 emissions. For example, the World Bank (2018) notes that rising remittance inflows may contribute to increasing CO_2 emissions. South Asia received USD 117 billion in remittances in 2015, placing developing economies among the top recipients. These remittances form a significant component of foreign direct investment (FDI), energy consumption, export revenues, foreign aid, and capital inflows. While remittances play a vital role in improving economic indicators and reducing poverty, their environmental impact is multifaceted. On one hand, they can enhance financial stability and boost living standards. On the other, they may lead to increased consumption of durable goods and investment-related commodities both of which often result in higher CO_2 emissions and environmental degradation. Li and Tse (2015) argue that remittances play a critical role in improving credit availability, especially for small businesses that face challenges accessing funds from traditional financial institutions.

This brings into focus the "halo hypothesis," which suggests that FDI can stimulate clean technological innovations and improve environmental quality (Energy Conversion and Management, 2016). However, the effects of remittances are not uniform. They are influenced by factors such as transaction costs, global labor mobility, political and diplomatic ties, and the economic climate of the host and recipient countries. These dynamics create both positive and negative shocks (Essandoh et al., 2020). When domestic savings fall short of investment needs, FDI becomes crucial for driving economic growth (OECD, 2022). Yet, the environmental consequences of FDI remain debated. While the "pollution-haven theory" suggests that lax environmental regulations in developing countries attract pollution-intensive industries (Yang et al., 2020), the "pollution-halo hypothesis" offers a contrasting view. It posits that FDI can facilitate global transfer of green technologies, ultimately improving environmental quality (Balsalobre et al., 2019).

Lim and Basnet (2017) provide further insight by distinguishing between temporary and permanent income. According to the permanent income hypothesis, a rise in income leads to sustained increases in consumption, whereas the transitory income hypothesis suggests that temporary income changes are smoothed over time. As remittances raise GDP per capita, energy demand also rises, contributing to climate change. Depending on income levels, institutional quality, and macroeconomic policies, remittances can lead to both positive and negative environmental shocks.

Increased household consumption encourages industrial production, further intensifying the use of traditional energy sources and reinforcing CO_2 emissions. At the same time, higher household savings driven by remittances enable investment in the financial sector. This leads to expanded industrial activities, including the establishment of new plants, which further increase CO_2 emissions (Yang et al., 2020). In many Asian nations, heavy reliance on fossil fuels and growing energy consumption has exacerbated

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environmental concerns. Pakistan, as the second-largest recipient of remittances, presents a critical case for this study. Between 2019 and 2020, remittances to Pakistan grew by 17% (World Bank, 2020). This inflow significantly raised household income, helping to alleviate poverty. It also enabled greater consumption of durable goods such as cars and appliances, which would otherwise be unaffordable. However, this shift in consumption contributes to increased fuel and energy use, thereby worsening environmental CO_2 emissions.

Previous studies have established a link between financial sector development and increased remittances, which in turn raise the deposit ratio and support both new and existing businesses (Mugableh, 2015; Farhani and Ozturk, 2015). These activities may reduce environmental quality by increasing industrial output and CO_2 emissions. Furthermore, remittances influence aggregate demand, impacting both consumption and savings. Higher consumption boosts overall demand, while increased savings contribute to domestic investment—both driving economic growth (Lartey et al., 2012; Nyeadi and Atiga, 2014; Ramirez and Sharma, 2008). According to Gupta et al. (2009), personal transfers can also enhance financial development in recipient countries.

This study investigates the impact of remittances (RE) on CO_2 emissions in Pakistan from 1989 to 2021, accounting for the roles of foreign direct investment (FDI), economic growth (GDP), and energy consumption (EC). Studies by Barajas et al. (2009) and Singh et al. (2011) suggest that remittances can offset macroeconomic volatility and support investment. However, increased investment raises energy consumption, which in turn leads to higher CO_2 emissions. In Pakistan, remittances grew from 5.4% of GDP in 1990 to approximately 7.99% in 2019 (WDI, 2020). The country remains heavily dependent on conventional energy sources such as gas, coal, and oil—all key contributors to CO_2 emissions. Recent research highlights the environmental benefits of renewable energy, showing that it can reduce CO_2 emissions in Asian countries (Anwar et al., 2021). Nonetheless, a strong financial system also encourages the purchase of energy-intensive goods such as cars, refrigerators, and air conditioners, leading to greater pollution and environmental degradation (Tamazian and Rao, 2010; Zhang, 2011).

Therefore, while remittances boost savings, investment, and economic growth, they may also contribute to environmental decline. Although the literature covers remittances and economic development extensively, fewer studies have explored the remittance–CO_2 emission nexus, particularly in the context of Pakistan. For instance, Rahman et al. (2019) studied the asymmetric effects of FDI on pollution emissions in Pakistan, concluding that FDI increases environmental output. In this study, we apply an autoregressive distributed lag (ARDL) model, decomposing remittance and FDI shocks into partial positive and negative components to capture asymmetries.

Our research aims to provide new empirical evidence that informs better policymaking. To achieve sustainable development, policymakers must implement strategies that encourage environmentally conscious use of remittances, balancing economic growth with environmental preservation. The rest of the paper is structured as follows: the next section presents a literature review; followed by a detailed discussion of the model, methodology, and data. Empirical results are presented and discussed in the following section, and the paper concludes with policy implications.

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Literature Review

Pakistan's economy has long relied on remittances from overseas workers as a vital source of foreign exchange, financial stability, and poverty alleviation. These inflows significantly fuel economic growth; however, they also contribute to a consumption-driven economy that often overlooks environmental sustainability. This literature review critically examines the complex and sometimes contradictory relationship between remittances, economic development, and environmental outcomes in Pakistan. Drawing on insights from economics, environmental studies, and development research, it highlights the dualistic nature of remittance flows—a phenomenon that this study terms the remittance paradox.

Meyer and Shera (2017) provide a foundational understanding of the economic dimension of remittances. Using multiple regression analysis, they demonstrate that remittances exert a positive and significant impact on economic growth. However, they emphasize that the productive use of these funds is crucial for sustaining and enhancing growth over the long term. Their findings suggest that when remittances are channeled into consumption and investment effectively, they can serve as a catalyst for economic prosperity and stability. Complementing this perspective, Ratha (2005) explores the role of remittances in stimulating rural economies. His study finds that remittance inflows boost household consumption, particularly on locally produced goods. This increase in consumption generates significant multiplier effects within the domestic economy, thereby fostering broader development and economic activity. These insights underline the importance of remittances as an informal yet impactful development tool.

Expanding on the financial sector's role, Barajas et al. (2009) argue that remittances can enhance financial development by increasing the volume of deposits in the banking system. This, in turn, promotes economic growth through two channels: improved financial intermediation efficiency and political economy effects, where a larger depositor base creates pressure for financial reforms. Their work reinforces the view that remittances, if effectively leveraged, can contribute to systemic financial improvements. However, not all scholars agree on the strength of this contribution. Sheikh et al. (2016), for instance, find that while foreign direct investment (FDI), gross capital formation (GCF), and foreign aid significantly influence Pakistan's GDP, personal remittances exhibit an insignificant impact on economic growth. This discrepancy highlights the varying effectiveness of different external financial sources and suggests that remittances may not always be optimally utilized within Pakistan's broader economic framework.

The environmental implications of remittances introduce a more complex layer to the discourse. Ahmad et al. (2022) explore this dimension and find that positive remittance shocks correlate with increased pollution emissions, whereas negative shocks lead to a reduction in pollution, both in the short and long term. Their findings underscore the unintended environmental consequences of remittance-driven consumption and highlight the challenge of aligning economic benefits with environmental sustainability. Similarly, Khan et al. (2023) present evidence suggesting that remittances may, in some contexts, undermine sustainable development goals. This view is partially contradicted by Chand and Singh (2024), who, in a broader cross-country analysis of 52 developing and emerging economies, conclude that remittances positively contribute to sustainable economic development. They argue that, alongside real GDP per capita and globalization, remittances play a constructive role in advancing economic sustainability.

The nuanced nature of remittances' impact is further explored by Islam et al. (2024), who adopt the Environmental Kuznets Curve (EKC) framework. Their findings indicate that

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while positive remittance shocks enhance economic growth, they simultaneously degrade environmental quality. Conversely, negative shocks reduce pollution levels. This asymmetric relationship reveals the dual-edged nature of remittance inflows in influencing both economic and environmental indicators. Das et al. (2024) offer additional empirical support for this asymmetry. Their study finds that positive remittance shocks exacerbate environmental degradation, whereas negative shocks mitigate it. Importantly, they establish a one-way causality from both positive and negative remittance shocks to environmental quality. This reinforces the idea that the environmental consequences of remittance flows are not merely incidental but structurally embedded in how these funds interact with local economies and consumption patterns.

In summary, the existing literature paints a multifaceted picture of remittances in Pakistan. On one hand, they are a vital source of economic support, enhancing household welfare, boosting consumption, and stimulating financial development. On the other, their environmental costs—particularly through increased consumption and urbanization—pose significant challenges for sustainable development. The remittance paradox lies in this tension: how can Pakistan continue to benefit economically from remittances while also mitigating their environmental downsides? Understanding and managing this paradox is essential for policymakers aiming to craft a development model that is both economically vibrant and environmentally sustainable.

Model, Methodology, and Data

This Study demonstrates the symmetric and asymmetric impacts of remittances and foreign direct investment on emissions of CO2. Literature has shown that remittances and foreign direct investment are key contributors to CO2 emissions. (Mikayla et al. 2018; Rahman et al. 2019; rown et al. 2020; et al.). However, although some studies show a negative correlation between remittances, FDI, and environmental quality, other researchers discover a beneficial correlation (Brown et al. 2020). Therefore, it stands to reason that, through economic variables, remittances and FDI have a substantial balance between the two with CO2. We construct the model as follows;

$$LCO_{2_t} = \alpha_0 + \alpha_1 LGDP_t + \alpha_2 LFDI_t + \alpha_3 LREC_t + \alpha_4 LPREM_t + \varepsilon_t ----- (1)$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ & α_4 are the long-run parameters estimates. All variables are in logarithmic form. The logarithmic form of Carbon dioxide is represented by LCO2, LGDP represents the logarithmic form of Gross Domestic Product, foreign direct investment is shown by LFDI in logarithmic form, and renewable energy consumption in logarithmic form is shown by LREC and Personal remittances logarithmic form is shown by LPREM. The long-term CO2 emission estimates are provided by equation (1).

Estimating the following econometric formulation is a modeling strategy that enables us to estimate the long-run and short-run impacts in a single step:

$$\Delta LCO2_t = \gamma_0 + \sum_{k=1}^{p} \delta_k \Delta LCO2_{t-k} + \sum_{k=0}^{p} \theta_k \Delta LREM_{t-k} + \sum_{k=0}^{p} \theta_k \Delta LFDI_{t-k}$$

$$+ \sum_{k=0}^{p} \tau_k \Delta LREC_{t-k} + \sum_{k=0}^{p} \lambda_k \Delta LGDP_{t-k} + \varphi_1 LCO2_{t-1} + \varphi_2 LGDP_{t-1} + \varphi_3 LFDI_{t-1}$$

$$+ \varphi_4 LREC_{t-1} + \varphi_5 LPREM_{t-1}$$

Pesaran et al.(2001) is the reason for error-correction model. where "Δ" variables are described as having short-run implications. The Long-run effects are represented with the estimates of ϕ2 to ϕ5 normalized for ϕ1 in (2). The stationarity of variables is tested by using Augmented Dickey Fuller unit root test. The Error Correction Model (ECM) is

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proposed to determine the significance of the predicted negative coefficient. Hence, the variables are integrated at order one.

The F-test is recommended to measure the joint degree of significance of variables as an indication of co-integration measure. The ECM is introduced as a method for determining if the estimated coefficient is negative and significant. Model 2 can only be employed to examine the linear effects of remittances and (foreign direct investment) FDI on CO_2 emissions. We modify equation (2) to determine the likelihood of asymmetric effects of FDI and personal remittances on CO_2 emissions. To that purpose, using the partial sum approach proposed by Shin et al. (2014), FDI and personal remittances are splited into two distinct time-series variables (negative and positive changes) as follows:

$$LPREM_t^+ = \sum_{n=1}^{t} \Delta LPREM_t^+ = \sum_{n=1}^{t} \max(\Delta LPREM_t, 0) \quad (3)$$

$$LPREM_t^- = \sum_{n=1}^{t} \Delta LPREM_t^- = \sum_{n=1}^{t} \min(\Delta LPREM_t, 0) \quad (4)$$

$$LFDI_t^+ = \sum_{n=1}^{t} \Delta FDI_t^+ = \sum_{n=1}^{t} \max(\Delta LFDI_t, 0) \quad (5)$$

$$LFDI_t^- = \sum_{n=1}^{t} \Delta LFDI_t^- = \sum_{n=1}^{t} \min(\Delta LFDI_t, 0) \quad (6)$$

Substituting Eqs. (3), (4), (5), and (6) in Eq. (2), the resulting model will be as follows:

$$\Delta LCO2_t = \gamma_0 + \sum_{k=1}^{p} \delta_k \Delta LCO2_{t-k} + \sum_{k=0}^{p} \theta_k \Delta LREM_{t-k}^+ + \sum_{k=0}^{p} \phi_k \Delta LREM_{t-k}^-$$
$$+ \sum_{k=0}^{p} \vartheta_k \Delta LFDI_{t-k}^+ + \sum_{k=0}^{p} \rho_k \Delta LFDI_{t-k}^- + \sum_{k=0}^{p} \tau_k \Delta LREC_{t-k} + \sum_{k=0}^{p} \lambda_k \Delta LGDP_{t-k} \quad (7)$$
$$+ \varphi_1 LCO2_{t-1} + \varphi_2 LPREM_{t-1}^+ + \varphi_3 LPREM_{t-1}^- + \varphi_4 LFDI_{t-1}^+ + \varphi_5 LFDI_{t-1}^- + \varphi_6 LREC_{t-1}^+ + \varphi_7 LGDP_{t-1}^- + \varepsilon$$

Equation 7 represents asymmetric time series ARDL models (Error-correction model), whereas equation 2 represents symmetric time series ARDL models. Additional diagnostics for short- and long-run asymmetries are provided by the asymmetric model. We used annual data from Pakistan collected by World Bank's World Development Indicators (WDI). The research spans the data years 1989 through 2021. CO_2 emissions are measured in kilotons as the dependent variable. While personal remittances current and FDI inflows are treated as independent variables are both measured in current US$. FDI, GDP and Renewable Energy Consumption are employed in model as control variables. We transformed data set into natural logarithmic form. We have used the moving average method for missing values.

Empirical Results and Discussion

Table 1 shows the results of Augmented Dickey Fuller test. Augmented Dickey-Fuller is ideal for situations where data set is large. Further, unit-root test is required to examine the order of integration. The null hypothesis for ADF reflects the presence of unit root, whereas the alternative indicates stationary of data series. The results advocated that LCO2, LGDP, LFDI, LPREM and LREC all are stationary after taking first difference.

Table 1: Results of A.D.F Unit Root Test

Variable	P-Value	Result
LCO_2	0.0001	Stationary at first difference
LGDP	0.0002	Stationary at first difference
LFDI	0.0008	Stationary at first difference
LPREM	0.0013	Stationary at first difference

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LREC	0.0004	Stationary at first difference

Table 2: ARDL Bound Test and LR Estimates

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP	0.542774	0.047523	11.42136	0.0001
LFDI	0.065606	0.014576	4.500950	0.0064
LREC	-1.094466	0.256798	-4.261971	0.0080
LPREM	-0.164383	0.018424	-8.922360	0.0003
C	4.386543	1.911292	2.295068	0.0702

REC = LCO_2 - (0.5428*LGDP + 0.0656*LFDI -1.0945*LREC
-0.1644*LPREM + 4.3865)

F-Bounds Test present of co-integration in long run — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I_0	I_1
			Asymptotic: n=1000	
F-statistic	2.201349	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Table 2 indicates the results of ARDL BOUND TEST estimates. The values of F-statistics indicate that there is no co-integration among variables in the long run at 1%, 2.5% and 5% level of significance and at 10% level of significance there is indecisive situation. Turnout for the ARDL Bound test estimate in long run shows positive impact of LGDP and LFDI on CO_2 emission while the negative impact for LPREM and LREC on CO_2 emissions. The results indicate that a 1% increase in LGDP will increase the CO_2 emissions by 54.27%. A 1% increase in LFDI will raise the CO_2 emission by 6.5% remaining other variables constant. However, A 1% increases in LREC will decrease the CO_2 emission by 109.44%. A 1% increase in LPREM will decrease the CO_2 emission by 16.4%. The turnout also elaborates that LPREM and use of LREC has a statistically significant and has negative impact on carbon emissions keeping other variables constant.

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Table 3: ARDL SR Estimates And ECM (error correction model) TERM

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCO2(-1))	1.323067	0.349052	3.790456	0.0128
D(LCO2(-2))	0.414516	0.176593	2.347289	0.0658
D(LCO2(-3))	-0.136015	0.051842	-2.623646	0.0469
D(LGDP)	-0.046547	0.054820	-0.849093	0.4346
D(LGDP(-1))	-0.863901	0.184709	-4.677094	0.0054
D(LGDP(-2))	-0.549994	0.146076	-3.765132	0.0131
D(LGDP(-3))	-0.227071	0.070851	-3.204909	0.0239
D(LFDI)	0.101465	0.017804	5.699087	0.0023
D(LFDI(-1))	-0.099905	0.020392	-4.899267	0.0045
D(LFDI(-2))	-0.039792	0.010952	-3.633198	0.0150
D(LFDI(-3))	-0.080492	0.016840	-4.779796	0.0050
D(LRENEWABLE_ENERGY)	-2.586114	0.223381	-11.57715	0.0001
D(LRENEWABLE_ENERGY(-1))	0.644531	0.359839	1.791164	0.1333
D(LRENEWABLE_ENERGY(-2))	-0.553040	0.373984	-1.478779	0.1993
D(LPERSONAL_REMIT)	-0.029151	0.018058	-1.614331	0.1674
D(LPERSONAL_REMIT(-1))	0.270770	0.058570	4.622999	0.0057
D(LPERSONAL_REMIT(-2))	0.122800	0.029397	4.177349	0.0087
D(LPERSONAL_REMIT(-3))	0.172259	0.037555	4.586807	0.0059
CointEq(-1)*	-2.115884	0.411677	-5.139669	0.0036

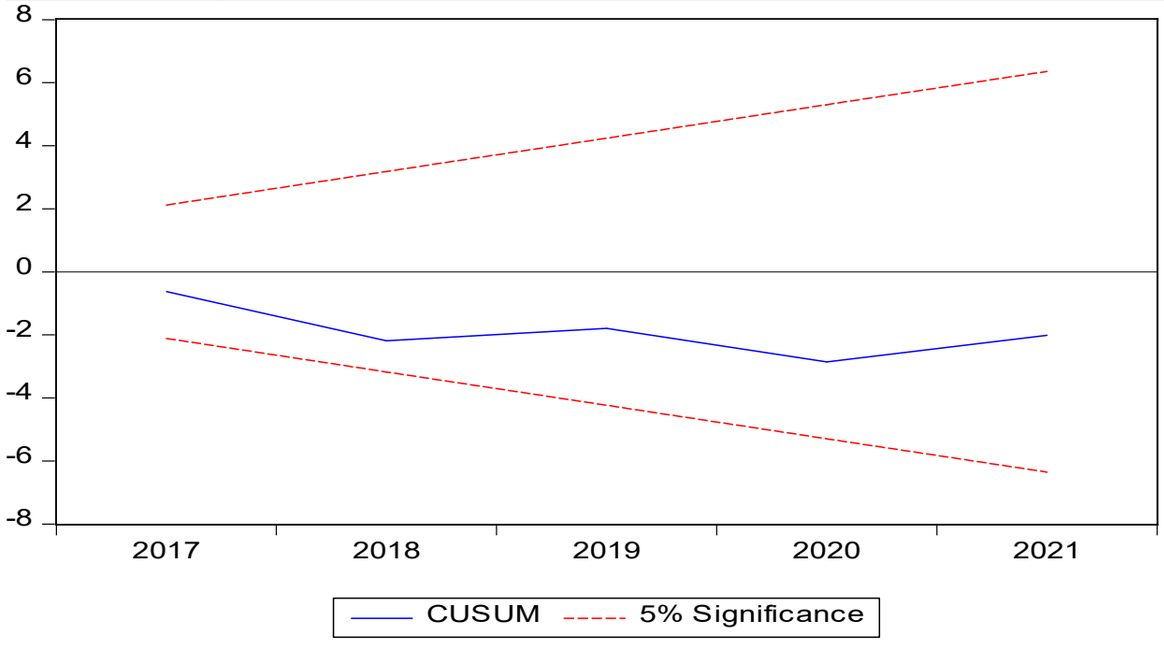

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Table 3 represents the result of error-correction model. According to short run estimates our ECM term that is negative and significant. ECM term reflects that (by multiplying with 100) due to changes in independent variables our dependent variable is converging towards equilibrium at the rate of 211.5884% per year. CUSUM is used in this study to test the model's adequacy. The findings showed that the model did not suffer from variance instability.

Conclusion and Policy Implications

Previous empirical studies examined how remittances and FDI may affect the environment in either direction. A new approach in the most recent empirical research demonstrates that once personal remittances and renewable energy consumption increase causing the CO2 emissions to decrease. While increase in FDI and GDP is causing a rise in CO2 emissions. Using yearly time series data from 1989 to 2021, this study explores the dynamic impacts of personal remittances and FDI on CO2 emissions in Pakistan. In this study, we examined one critical question: are personal remittances and FDI boosting CO2 emissions in Pakistan? We employed the nonlinear asymmetric ARDL technique for analysis. This is a novel research for Pakistan that adds to the current body of literature. The findings suggest that a decrease in personal remittances increases CO2 emissions in the short and long term. On the other hand, increases in FDI, both positive and negative, have not helped to reduce CO2 emissions since it boosts CO2 emissions in Pakistan. Nonlinear results indicate that GDP is the biggest polluting driver in the environment.

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