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Does Political (De)stabilization Drive Clean Energy Transition?

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Abstract

Exploring the political economy of clean energy development, this study appraises how political (de)stabilization influences the clean energy transition process in selected South Asian countries. Using yearly data spanning from 1998 to 2021, the results show that political stabilization facilitates the clean energy transition process by raising the share of renewables in the final energy consumption profiles of the concerned South Asian nations. Contrarily, political destabilization is found to inhibit the transition process. In addition, political stabilization is witnessed to partially offset the clean energy transition-inhibiting impact of rising carbon dioxide emissions across South Asia. Furthermore, the results endorse that financial development and receipts of international remittance contribute to the clean energy transition process while incoming foreign direct investments exert no impact in this regard. Accordingly, a couple of policies are recommended for the concerned South Asian nations.

Keywords: Political instability; political economy; clean energy transition; renewable energy

JEL Classification: Q40; Q42; P48

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1. Introduction

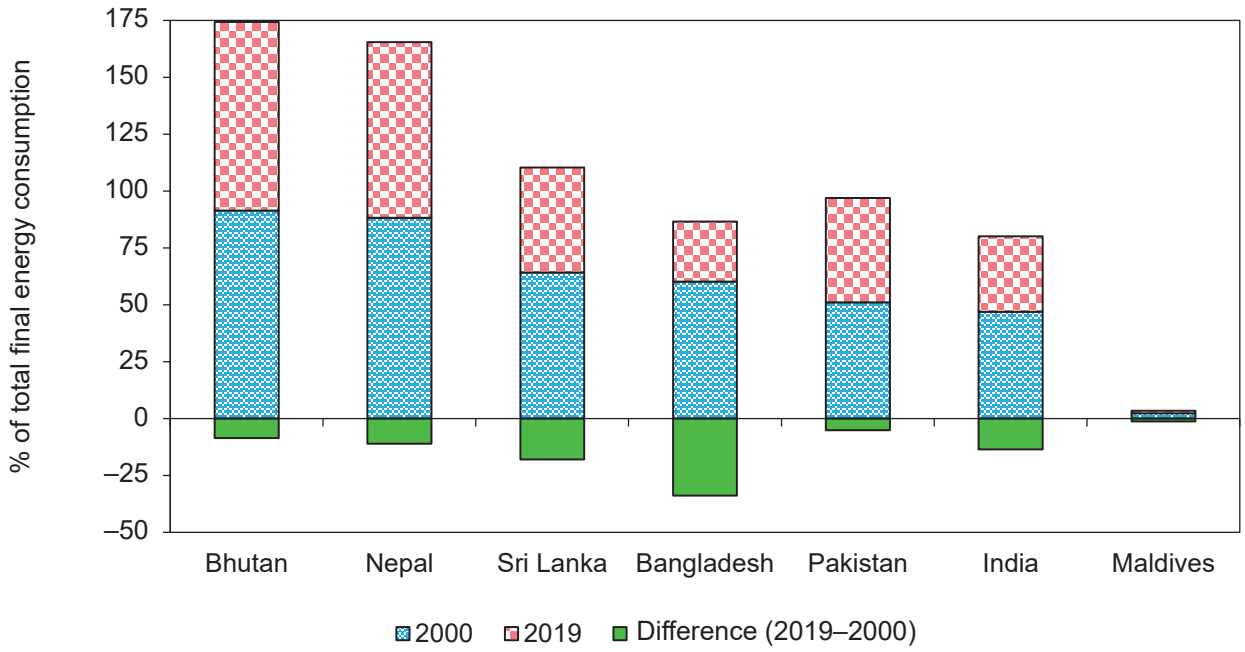
Consuming energy resources that are largely hydrocarbon free and do not account for large-scale atmospheric discharges of greenhouse gases has become essential in building resilience against environmental hazards. Accordingly, much emphasis has been put on gradually eliminating the carbon footprints associated with the energy sectors worldwide. Apart from facilitating environmental welfare motives, renewable energy penetration into the energy systems can be assumed to reduce dependency on in-grid connectivity, especially by creating scopes for enhancing off-grid connectivity in remote areas, in particular (Kumar and Channi, 2022). In line with these notions, the United Nations, via the declaration of SDG-7, has motivated the global economies in diversifying their energy consumption bundles, particularly by including cleaner energy sources while excluding the unclean ones (Alola *et al.* 2021). Besides, the significance of undergoing a Clean Energy Transition (CET) within the energy systems for realizing the environmental health-improving pledges linked made under the Paris Accord has also been highlighted at the 27th Conference of Parties (COP27).

However, having said so, although the global economies have reached a unanimity regarding the environmental havoc associated with the use of hydrocarbon-intensive fossil fuels, the global fossil fuel dependency is yet to be curtailed. Similarly, the South Asian economies have abjectly failed to reduce their monotonic fossil fuel reliance; rather, in majority of the South Asian countries the extent of fossil fuel dependency has grown over the last couple of decades. According to the World Bank, between 2000 and 2019, the mean share of clean energy in the total final energy consumption level of Bangladesh, Bhutan, Maldives, India, Pakistan, and Sri Lanka declined by more than 13 percentage points (see Figure 1). Therefore, it is quite fascinating to get accustomed to the factors that have hampered the CET process across South Asia whereby credible policies can be adopted to expedite the rate of clean energy penetration across this part of the globe.

In the present literature, researchers have pointed out that lack of technological innovation is one of the key factors holding back the CET in South Asia (Tariq *et al*., 2022). These studies argued that generating electricity by utilizing renewable sources such as solar, wind, geothermal, and hydropower pre-requisites technological innovation; therefore, since the major South Asian nations have not quite managed to develop their respective technological stocks, excessive fossil fuel dependency still exists across this region. Besides, some studies have referred to inadequate investment in renewable energy-related research and development projects as another major barrier to the CET process in South Asia (Fang *et al*., 2022). Similarly, the importance of scaling both local and foreign investment for developing South Asia's renewable energy infrastructure and expediting the CET process in this region has also been mentioned in the literature (Kang *et al*., 2021). Accordingly, underscoring the necessity of boosting investments for the CET to take place,

some studies have also recommended developing the financial sectors so that more investments can be channeled to the renewable energy sectors in South Asia (Sadiq *et al*., 2022).

Figure 1: Trends in renewable energy penetration rates across South Asia



Note: The figures show the share of renewable energy in the total final energy consumption levels of the South Asian countries for the years 2000 and 2019; difference refers to the differences in the shares between the two points in time.

Source: World Development Indicators database of the World Bank

Hence, it is apparent that the roles of financial investment in technological innovation, research and development, and infrastructural advancement for facilitating the CET in South Asia are well documented in the preceding studies. However, the discussion on the political economy of renewable energy development in this region has largely remained behind the curtains. Nevertheless, this is extremely important given that political instability is often said to promote economic policy uncertainties, especially in respect of the government's intervention in implementing climate policies on a timely basis (Farooq *et al*., 2023; Li *et al*., 2023). Accordingly, unstable political conditions may discourage renewable energy investments and thereby delay the CET process further. This is because if political instability within an economy cannot be contained, investors could find it difficult to precisely forecast the returns on investments. As a result, amidst political instability, investors in South Asia may not be tempted in financing renewable energy development projects.

Against this backdrop, this study endeavors to empirically assess whether political stabilization can be conducive to driving the CET process by considering data from seven South Asian countries. Due to the unavailability of data during the chosen period of analysis (from 1998 to 2021), Afghanistan has to be excluded from the sample of South Asian nations. The decision to focus on South Asia is driven by two factors. First, as mentioned earlier, the extent of fossil fuel reliance has persistently increased across this region (refer to Figure 1). As a result, it can be said that the South Asian countries are not on course to achieving the targets related to SDG-7 whereby the finding from this study can be expected to help the South Asian nations formulate policies that are necessary for stimulating the CET process and, therefore, partially achieving the objectives of SDG-7. Second, the state of political stability in the majority of the South Asian countries is quite poor (Pata *et al*., 2023); consequently, political instability is not only likely to hamper domestic investment in renewable energy projects but also hinder intra-regional trade of clean energy resources, in particular (Qaiser, 2022). Thus, exploring the political stabilization-CET nexus can be deemed interesting, especially for policymaking purposes.

The core novelties of this study are three-fold. First, the mainstream studies exploring the driers of clean energy adoption across South Asia have focused on the impacts of inadequate investment-led technological and infrastructural barriers (Kang *et al*., 2021; Tariq *et al*., 2022). By contrast, this study emphasizes the effects of political instability for checking whether stabilizing the economies of the South Asian countries can provide a harmonious platform for scaling renewable energy investments so that the CET can effectively take place across this region. Second, this study explores the repercussions of both stabilization and destabilization of the political economies of the selected South Asian nations on their prospects of undergoing the CET. In this regard, apart from considering the conventional index of political stability (Mahmood *et al*., 2021; Awosusi *et al*., 2023), this study considers a proxy variable for representing political destabilization and assessing its impact on the CET process in South Asia. Third, instead of only stressing the direct impacts of political conditions, this study also evaluates the indirect effects of political (de)stabilization on clean energy adoption within the selected South Asian nations. Exploring the potential indirect channels is particularly relevant for holistically formulating interactive policies that can effectively drive the CET in this region.

Following this section, the literature review is presented in Section 2. Subsequently, discussions on the empirical modeling and estimation strategies are provided in Section 3 while analytical outcomes are reported and explained in Section 4. Finally, concluding remarks along with policy insights are presented in Section 5.

2. Literature Review

Since the energy sectors of the majority of South Asian countries are predominantly fossil fuel-intensive, several studies have explored the drivers of clean energy use across this region. Among these, a particular strand of research works has assessed how technological innovation impacts the CET process. For instance, using data from Bangladesh, Murshed and Alam (2021) examined how innovations in technology influence the uses of renewable energy. Based on the findings, the authors argued that as the yearly patent counts increase, it can be assumed that the technological stock of Bangladesh is being advanced which, in turn, uplifts the barriers faced by this South Asian economy in undergoing the CET. As a result, technological innovation was claimed to be stimulating higher consumption of renewable energy n the long run. In addition, the results also affirmed the renewable electricity production-amplifying impact of technological innovation. Contrastingly, technological advancement was observed to deter the use of non-renewable energy in Bangladesh.

Similarly, Ojong (2021) highlighted the pertinence of advancing technology for promoting the adoption of solar home systems across South Asia. Murshed *et al.* (2021) also stressed the importance of developing renewable energy technologies for facilitating renewable energy penetration into the energy sectors of South Asian countries. On the other hand, Ahmad *et al.* (2022) mentioned that it is important to apply low-cost renewable energy technologies for generating electricity output using primary renewable energy sources. Likewise, for the cases of countries outside South Asia, Shang *et al*. (2022) argued that in the United States, reducing policy uncertainties can drive technological innovation to boost the nation's long-run renewable energy consumption levels. Further, using data from 29 developed economies, Bashir *et al*. (2022) remarked that innovative environmental technologies are an effective means of amplifying annual renewable energy consumption figures.

A second strand of research works has also analyzed the impacts of investments (both foreign and domestic) on the use of renewables in South Asia. Among these, Murshed *et al.* (2021) considered the sample of four major South Asian countries (India, Pakistan, Sri Lanka, and Bangladesh) and found evidence suggesting that Foreign Direct Investments (FDI) inflict technological spill-over to increase the use of renewable energy in the long term. However, despite amplifying the annual renewable energy consumption levels, the results in that study affirmed that such foreign investments are not capable of stimulating the CET process in the selected South Asian nations since FDI receipts were found not to increase the mean share of renewables in their total final energy consumption levels. On the other hand, using data from 69 members of China's Belt and Road Initiative (BRI), which included several of the South Asian nations, Khan *et al.* (2021) opined that financial development is key to boosting private investments necessary for

driving greater use of renewable energy. Likewise, for countries outside South Asia, Nguyen and Nguyen (2021) also highlighted the pertinence of developing the financial sector for expediting the CET process across Southeast Asia. Furthermore, Ji and Zhang (2019) asserted that financial development assists in expanding the Chinese renewable energy sector.

Therefore, the above review of the preceding studies has more or less established the potency of scaling investment for renewable energy development across South Asia. However, these studies have overlooked the issue of political instability affecting such investment decisions; thus, the influence of political stabilization on the CET process within this region is yet to be extensively explored. In this regard, there is only one previous study that has shed some light on how political stabilization affects renewable energy consumption in South Asian countries. Using data from Bangladesh, Sri Lanka, Pakistan, and India, Mahmood *et al*. (2021) recorded statistical evidence regarding a rise in the value of the World Bank's political stability indices of these countries (indicating political stabilization) resulting in higher consumption of hydroelectricity and other renewable energy resources. Nevertheless, the findings reported by Mahmood *et al*. (2021) failed to provide a clear understanding of whether political stabilization stimulates the CET process in South Asia. This is because simply increasing the volume of renewable energy use is not sufficient to capture the issue of the CET unless fossil fuel consumption is not reduced in tandem (Murshed *et al.* 2021). Besides, the findings also did not suggest whether political destabilization within South Asian economies hiders the CET process or not.

Similar studies explored the political stability-renewable energy use nexus for countries outside South Asia, as well. Considering the case of Vietnam, Awosusi *et al*. (2023) recently reported that stable political conditions are conducive to boosting renewable energy use in this Southeast Asian country, both in the short- and long-run. Accordingly, the authors recommended eliminating political risk factors in driving the CET process in Vietnam. On the other hand, using data from selected countries located in the Middle East and North Africa, Awijen *et al*. (2022) stated that it takes stabilization of the political economies of the selected nations to expedite the deployment of renewable energy. Likewise, Alsagr and van Hemmen (2021) mentioned that reducing geopolitical risks for establishing political stability is a credible mechanism for driving the CET process across emerging market economies. In the same vein, Wang *et al*. (2022) utilized data from 32 members of the Organization for Economic Cooperation and Development (OECD), Wang *et al*. (2022) highlighted the significance of political risk reduction (synonymous with political stabilization) in enhancing renewable energy consumption.

Therefore, once again, it is quite apparent that these studies have not appraised the impacts of political destabilization on the CET process. In addition, it is also evident that mostly the direct impacts of political stabilization on clean energy use were examined while the indirect mechanisms

in this regard are left unexplored. Accordingly, underscoring the necessity of bridging these major gaps in the literature, this study attempts to assess how political (de)stabilization, both directly and indirectly, influences the CET process across South Asia.

3. Research Design

3.1 Empirical models and data attributes

The baseline model considered in this study expresses the CET variable as a linear function of the political stability indicator and other key macroeconomic variables, which can be shown as follows:

$$\textbf{Model 1}: \; R_{it} = \partial_0 + \partial_1 PS_{it} + \partial_2 LnC_{it} + \partial_3 F_{it} + \partial_4 REM_{it} + \partial_5 FDI_{it} + \varepsilon_{it} \tag{1}$$

In Model 1, the outcome variable *R* stands for the annual share of renewable energy in the total final energy consumption level of the selected South Asian nations, which is used as a proxy for capturing the CET process. According to Murshed *et al*. (2021), for the CET to take place, this share needs to increase (which also indicates a decline in fossil fuel dependency) rather than simply increasing the annual volume of renewable energy consumption. Hence, if the coefficient of the parameters δ_k (k = 1,2, …, 5) are positive and statistically significant, then the CET-promoting effect of the respective covariate shall be affirmed. Contrarily, the negative sign and statistical significance of these parameters shall endorse the CET-inhibiting impact. Among the covariates, the variable PS stands for the political stability index which assigns a minimum value of −2.5 (denoting extremely unstable political conditions) and a maximum value of 2.5 (denoting extremely stable political conditions). Hence, a rise in the value of this index indicates political stabilization and vice-versa.

Among the other covariates that are used as controls within the baseline model, the variable *LnC* stands for the annual per capita discharges of carbon dioxide (CO_2) which are expressed in natural log levels. Since more CO_2 emissions pile up environmental concerns (Ozturk *et al*. 2023), it can be expected to motivate the stakeholders in facilitating the CET process. Conversely, low levels of per capita CO_2 emissions may not instigate concerns regarding environmental problems and therefore delay the CET process by surging fossil fuel dependencies further. The variable *F* stands for the annual share of domestic borrowing by the private sector in the GDP which provides an account of the extent of financial development in the respective South Asian countries (Ozturk *et al*. 2023). It has been argued in the literature that developing the financial sector can make private producers invest more in the renewable energy sector while making private consumers more capable of consuming renewable energy.

Similarly, the variable *REM* stands for the annual share of net remittance receipts of international remittances in the GDP. Since international remittance plays a big role in the development of South Asian nations, it is relevant to control for it within the model. Besides, receipts of the remitted funds can augment the aggregate household consumption expenditure profiles of the left-back households of the international migrants. Consequently, their renewable energy purchasing capacities can be expected to go up, as well. Lastly, the variable *FDI* stands for the annual share of net receipts of FDI in the GDP and it is used to proxy the extent of financial globalization in the respective South Asian nations. It is acknowledged in the extant literature that FDI influxes accompany technological diffusion that can help drive the CET process in the FDI-hosting economy (Murshed *et al*. 2021). On the flip side, FDI inflows can also accompany unclean energy-intensive technologies that may inhibit the CET process.

Although Model 1, via the sign and statistical significance of the coefficient parameter δ_k, can provide an understanding of the direct effect of political stabilization on the CET process, it cannot capture the indirect effects in this regard. Hence, the baseline model is augmented as follows:

$$\textbf{Model 2:}\ R_{it} = \partial_0 + \partial_1 PS_{it} + \partial_2 C_{it} + \delta_1 \left(PS * LnC\right)_{it} + \partial_3 F_{it} + \partial_4 REM_{it} + \partial_5 FDI_{it} + \varepsilon_{it} \quad (2)$$

In Model 2, though the majority of the variables are common as in the case of Model 1, the additional variable *PS***LnC* stands for an interaction term concerning the variables *PS* and *LnC*. Therefore, the coefficient parameter δ_k shall provide an account of the combined effect of political stabilization and CO_2 emissions on the CET process. Accordingly, the mode of the indirect impact of political stabilization on the CET process can be understood from the sign and statistical significance of this coefficient parameter.

Once these two models are estimated, the direct and indirect impacts of political destabilization on the CET process in South Asia are assessed using the following models:

$$\textbf{Model 3}:\ R_{it} = \partial_0 + \partial_1 PI_{it} + \partial_2 C_{it} + \partial_3 F_{it} + \partial_4 REM_{it} + \partial_5 FDI_{it} + \varepsilon_{it} \quad (3)$$

$$\textbf{Model 4}:\ R_{it} = \partial_0 + \partial_1 PI_{it} + \partial_2 C_{it} + \delta_2 \left(PI * LnC\right)_{it} + \partial_3 F_{it} + \partial_4 REM_{it} + \partial_5 FDI_{it} + \varepsilon_{it} \quad (4)$$

In Models 3 and 4, the new covariate *PI* stands for the yearly number of sources reporting incidents related to political violence which is used as a proxy for capturing the extent of political instability in the selected South Asian countries. Technically, the more the number of reporting sources, the more unstable the political economy and vice-versa. Hence, a rise in the value of this variable would indicate political destabilization. Notably, the coefficient parameters δ_2 in Model 3 and δ_2 in Model 4 shall now demonstrate the direct and indirect (combined with CO_2 emissions) impacts of political destabilization on the CET process.

In this study, yearly data spanning from 1998 through 2021 is used for analytical purposes and this period is solely determined based on data availability. However, the missing data points are filled using linear interpolation and extrapolation techniques. The variables *R*, *F*, *R*, and *FDI* are measured as percentages of GDP. The variable *PS* is measured in terms of an index while *PI* is measured as a number. Lastly, the variable *LnC* is measured in terms of metric tons (and it is naturally log-transformed). The data[1] concerning all these variables are acquired from the World Development Indicators database of the World Bank.

3.2 Estimation techniques

The estimation strategy involves several stages. Firstly, the possible existence of the cross-sectional dependency problem in the data is checked using the method of Pesaran (2021). Table 1 displays the associated results from this test (see Panel A). Since the calculated test statistics for the variables *R* and *PI* are statistically significant, the issue of cross-sectional dependency in the data is confirmed. Secondly, the issue of slope heterogeneity is checked using the method proposed by Blomquist and Westerlund (2013) and the associated outcomes are also shown in Table 1 (see Panel B). Since the delta and the adjusted delta statistics are statistically significant, the slope heterogeneity problem is confirmed for all four models.

Table 1: Results from cross-sectional dependency and slope heterogeneity tests

Panel A: Pesaran (2021) test (Null Hypothesis: cross-sectional independence)

Variable	*R*	*PS*	*PI*	*LnC*	*F*	*REM*	*FDI*
Test stat.	2.413**	0.791	6.173***	−0.059	0.279	0.373	−0.488
(*p*-value)	(0.015)	(0.429)	(0.000)	(0.953)	(0.780)	(0.709)	(0.625)

Panel B: Blomquist and Westerlund (2013) test (Null Hypothesis: slope homogeneity)

Model	Model 1		Model 2		Model 3		Model 4
Delta stat.	8.757***		6.477***		10.768***		6.458***
(*p*-value)	(0.000)		(0.000)		(0.000)		(0.000)
Adj. Delta stat.	10.188***		7.932***		12.795***		7.909***
(*p*-value)	(0.000)		(0.000)		(0.000)		(0.000)

Notes: ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.
Source: Authors´ own calculation

1 For ensuring brevity, the descriptive statistics of the concerned variables are unreported. This table can be made available upon request.

Thirdly, the unit root analysis is conducted to detect the stationarity characteristics of the concerned variables. In this regard, the method put forward by Herwartz and Siedenburg (2008) is employed. This method is claimed to nullify concerns linked with cross-sectionally-dependent heterogeneous panel data. Fourthly, the cointegration analysis is performed to check whether there are long-run associations among the variables in the respective models. This is important because, in the absence of such cointegrating relationships, it is inappropriate to conduct the long-run regression analysis. Accordingly, the method suggested by Westerlund (2007) is employed as it can efficiently handle cross-sectionally-dependent data.

Lastly, the regression analysis is performed for predicting the long-run effects of political stabilization and destabilization on the CET process in the selected South Asian countries, controlling for environmental hazards, financial development, and receipts of international remittances and FDI. In this regard, the Dynamic Common Correlated Effects (Dyn-CCE) mean group panel regression method introduced by Ditzen (2021) is used. This technique follows an instrumental variable setting within the conventional Dyn-CCE estimator proposed by Chudik and Pesaran (2015). Hence, the regression technique of Ditzen (2021) not only counters the issues related to cross-sectionally-dependent heterogeneous panel data but also neutralizes endogeneity concerns, particularly by including lagged levels of the covariates as instruments.

4. Empirical Findings

In this section, firstly the outcomes generated from the unit root analysis are reported. Accordingly, the findings derived using the panel unit root estimator of Herwartz and Siedenburg (2008) are reported in Table 2. Since the calculated test statistics of all variables are statistically significant only at the first difference, it can be said that these variables have a common order of stationarity. Moreover, the stationarity confirmation eliminates the possibility of predicting spurious coefficient parameters from the regression analysis. Next, the findings derived from the cointegration analysis suggested by Westerlund (2007) are reported in Table 3.

Table 2: Results from unit root analysis

Herwartz and Siedenburg (2008) test (Null Hypothesis: series in non-stationary)			
Variable at Level	**Test Stat. (*p*-value)**	**Variable at 1st Diff.**	**Test Stat. (*p*-value)**
R	0.758 (0.775)	***D.R***	–1.328* (0.093)
PS	–1.128 (0.130)	***D.PS***	–1.491* (0.068)
PI	–1.206 (0.102)	***D.PI***	–1.308* (0.097)
LnC	–1.201 (0.141)	***D.LnC***	–1.515* (0.054)
F	0.464 (0.678)	***D.F***	–1.940** (0.026)
REM	0.389 (0.610)	***D.REM***	–2.112** (0.014)
FDI	–0.145 (0.442)	***D.FDI***	–2.316*** (0.010)

Notes: The prefix *D* indicates first differencing of the respective variable; see notes of Table 1.
Source: Authors´own calculation

Table 3: Results from cointegration analysis

Westerlund (2007) test (Null Hypothesis: no cointegration)				
Test stat (*p*-value)	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Gt	–2.777 (0.231)	–15.667*** (0.000)	–2.562* (0.077)	–2.704 (0.231)
Ga	–8.578*** (0.000)	–0.675 (0.385)	–0.789*** (0.000)	–9.987* (0.066)
Pt	–5.181 (0.692)	–3.328 (0.632)	–4.800 (0.385)	–5.476 (0.462)
Pa	–5.110 (0.923)	–0.487 (0.462)	–5.206 (0.308)	–5.716 (0.460)

Notes: 5000 Bootstrapped replications; see notes of Table 1.
Source: Authors´own calculation

Next, the results derived from the Dyn-CCE regression analysis for all four models are reported in Tables 4 and 5. Firstly, concerning Models 1 and 2, the regression results shown in Table 4 show that the previous year's renewable energy share in the total final energy consumption level negatively influences the current year's share. Thus, this finding corroborates the statistics illustrated in Figure 1 and justifies the persistent rise in the extent of fossil fuel dependency in the selected South Asian countries. Besides, it also signals that unless policies aimed at restricting fossil

fuel consumption and adopting renewable energy are put into effect, the CET process is not likely to be initiated across South Asia.

Moreover, the results show that the estimated coefficient parameters associated with the variable *PS* are positive and statistically significant, as well. Hence, these findings endorse the CET-stimulating impacts of political stabilization. Hence, it can be assumed that if the existing political conflicts across South Asia can be contained, a favorable platform for scaling renewable energy investment can be created. Consequently, more investment in projects aimed at innovating renewable energy technologies and advancing relevant energy infrastructure may prove to be effective in driving the CET process in this part of the globe. For instance, limiting political instability can raise the expected financial returns on investments in the renewable energy sectors across South Asia which, in turn, shall motivate private investors, in particular, to inject funds into these sectors. More importantly, since energy investments in South Asia are predominantly undertaken by the respective governments, political stabilization can be assumed to attract private investors into these state-dominated sectors. Likewise, Mahmood *et al*. (2021) argued that political stabilization promotes more use of renewable energy in Bangladesh, Sri Lanka, Pakistan, and India. Besides, Awosusi *et al*. (2023) concluded that containing political risks is pertinent in expediting renewable energy penetration rates in the Vietnamese energy sector.

Further, since the estimated coefficient parameters associated with the variable *LnC* are negative and statistically significant, it can be said that despite environmental concerns across South Asia have been persistently mounting over time, the urgency of implementing credible CET-stimulating policies is yet to be realized. Thus, higher annual per capita atmospheric releases of CO_2 are accompanied by lower "shares of renewable energy in the national energy consumption portfolios" of the concerned South Asian nations. Probably, these findings signal that CO_2 emission-led environmental apprehensions are yet to reach a substantial level beyond which the South Asian nations shall be triggered to forgo their fossil fuel dependency and undergo the CET. In addition, these findings also point out that environmental regulations imposed across this region are likely to be weak whereby the environmental wrongdoers are not compelled to comply with such laws. This can also be linked to a lack of investment in renewable energy development in South Asia. In the same vein, Uzar (2020) concluded that CO_2 emissions motivate greater consumption of renewable energy both in developed and developing countries.

More importantly, referring to the results related to Model 2, the predicted coefficient parameter associated with the interaction term $PS * LnC$ is positive and statistically significant. This finding signals that political stabilization and CO_2 emission-led environmental complications jointly drive the CET process across South Asia. Hence, considering the previous findings, it can be said that political stabilization partially offsets the CET-hindering impact of higher CO_2 emissions. This is likely to happen because under a stable political setting implementing climate

policies becomes easier whereby more compliance with environmental regulations can be expected. For instance, if there is political stability, the overall quality of institutions is likely to be strong and effective in penalizing environmental misconduct. As a result, energy consumers can be assumed to replace fossil fuels with clean energy resources; thus, renewable energy investments are expected to be scaled as well. As a consequence, there shall be greater possibilities of initiating the CET process in the concerned South Asian economies. This is an important result that highlights the relevance of pursuing political stabilization and environmental protection policies, in tandem.

Table 4: Results from the Dyn-CCE regression analysis concerning Models 1 and 2

	Model 1		Model 2	
Covariates	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
L.R	−0.756***	0.000	−0.789***	0.000
PS	5.648***	0.436	7.561***	0.445
LnC	−21.70***	0.930	−20.38***	0.881
PS * LnC	–	–	5.584***	0.367
F	0.184***	0.038	0.232***	0.033
REM	0.429***	0.078	0.446***	0.066
FDI	1.177	1.040	1.237	1.054
Constant	74.15***	1.217	70.48***	1.193
Observations	161		161	

Notes: The prefix *L* denotes the one-period lagged level of the dependent variable *R*; see notes of Table 1.
Source: Authors´own calculation

Among the other key findings shown in Table 4, it can be seen that the predicted coefficient parameters associated with the variable *F* are positive and statistically significant. Hence, these findings endorse the CET-driving effect of financial development. Consequently, the hypothesis regarding financial development-led investment in private renewable energy development projects in South Asia can be deemed valid. Likewise, Ji and Zhang (2019) asserted that renewable energy penetration into the Chinese energy sector is driven by financial development. On the other hand, the results show that incoming international remittances can also drive the CET process in the selected South Asian countries. This statement is rationalized by the positive signs of the statistically significant coefficient parameters associated with the variable *REM*. Since

international remittances are prime sources of foreign exchange for South Asian countries, receipts of international remittances can be expected to scale investments in renewable energy development projects while uplifting household expenditure on renewable energy, as well. In the same vein, Subramaniam *et al*. (2023) concluded that international remittance is conducive to boosting renewable energy consumption in developing countries. Lastly, the results affirm that net receipts of FDI cannot drive the CET process across South Asia since the predicted coefficient parameters associated with the variable FDI are statistically insignificant.

Furthermore, for checking the robustness of the findings regarding the political economy of CET in South Asia, the direct and indirect effects of political destabilization on clean energy use are assessed. Accordingly, the Dyn-CCE regression results in the context of Models 3 and 4 are shown in Table 5. Overall, almost all findings are common for all four models, especially in respect of the predicted signs and statistical significance of the predicted coefficient parameters. However, the estimated coefficient parameters associated with the variable *PI* are negative and statistically significant which indicates that political destabilization hiders the CET process in the concerned South Asian countries. In addition, the negative sign of the predicted coefficient parameter associated with the interaction variable *PI* * *LnC* is evidenced to be negative and statistically significant. This finding implies that political destabilization cannot offset the CET-hindering impact of CO_2 emission-related environmental complications. Therefore, the findings endorsing the CET-driving effects of political stabilization and the CET-inhibiting effects of political destabilization can be considered robust.

Table 5: Results from the Dyn-CCE regression analysis concerning Models 3 and 4

	Model 3		Model 4	
Covariates	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
L.R	–0.559***	(0.000)	0.616***	(0.000)
PI	–3.402***	(0.316)	–2.444***	(0.382)
LnC	–20.88***	(1.396)	–14.30***	(2.151)
PI * LnC			–1.094***	(0.284)
F	0.413***	(0.0398)	0.399***	(0.0414)
REM	0.332***	(0.0842)	0.468***	(0.0946)
FDI	2.040	(1.910)	1.980	(1.789)
Constant	81.86***	(2.027)	70.09***	(3.488)
Observations	161		161	

Notes: The prefix *L* denotes the one-period lagged level of the dependent variable *R*; see notes of Table 1.
Source: Authors´own calculation

5. Conclusion and Policies

Excessive reliance on fossil fuels is a major threat to establishing sustainable environmental conditions within South Asia. Hence, this study explored the political economy of clean energy development across this region by appraising whether political (de)stabilization can reduce the traditional dependency on fossil fuels and promote renewable energy adoption in selected South Asian countries. Since the outcomes derived from the empirical analysis affirmed that political stabilization is a potent driver of the CET process across South Asia while political destabilization hinders the transition mechanism, the concerned nations need to design policies through which the prevailing conditions of the political economies can be improved. Moreover, confirming the finding that the CET-stimulating impact of political stabilization takes both direct and indirect channels, it is equally important to formulate policies that can simultaneously stabilize the political economies of the South Asian countries while limiting the CO_2 emission-triggered environmental havoc. Accordingly, some policy recommendations are made.

Firstly, for establishing political stability, the competence of the respective governments of the South Asian countries has to be enhanced so that socially sound policies can be implemented. In this regard, such policy implementation can lead to better investment environment which can also be expected to scale investment in clean energy development so that the CET process can be successfully initiated. Besides, the law and order systems in the South Asian countries have to made corruption free so that rule of law can be set with effect. Accordingly, environmental misconducts can be prevented and those responsible can be trialed. As a result, it can be expected that producers would be tempted in investing in clean projects which can be expected to boost finances for renewable energy development projects, as well. More importantly, the respective governments should strive to get more close with the people; especially, they should try to earn goodwill from the investors and encourage them to inject funds into the clean energy sector rather than financing projects that are fossil fuel intensive.

Secondly, apart from political stabilization, it is important for the South Asian governments to raise awareness regarding environmental degradation and its adverse socioeconomic consequences. This is of great relevance since unless the consequences are known, the urgency to take environmental actions cannot be ensured. As a result, environmental awareness building can be expected to green economic activities across this region whereby fossil fuel dependency may decline to stimulate the CET process further. Thirdly, the traditionally pursued unclean financial development policies should be replaced with carbon-neutral financial policies. In this regard, it is essential to liberalize interest rates charged on loans extended for investment in green projects; notably, it is important to charge concessional interest rates against loans to be granted for investment in the clean energy sectors across South Asia. Lastly, since international remittance receipts were

found to positively influence the CET process, effective policies should be taken for making receipts of international remittances hassle-free for the let behind households of the expatriates. In this, the respective governments can provide monetary incentives against remittances remitted through formal channels so that the national foreign exchange reserves of the South Asian countries can be boosted. This in turn can make sure that the governments scale investment in projects associated with the development of clean energy technologies and infrastructure.

5.1 Limitations and future research directions

Regarding the limitations, since this study is focused on South Asian nation, it is unclear whether the policies would be appropriate for non-South Asian nation as well. Hence, future studies can look to conduct counterfactual analyses by performing similar studies on countries outside the South Asian region.

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References

Ahmad, U. S., Usman, M., Hussain, S., et al. (2022). Determinants of renewable energy sources in Pakistan: An overview. Environmental Science and Pollution Research, 29(19), 29183–29201. https://doi.org/10.1007/s11356-022-18502-w

Alola, A. A., Ozturk, I., & Bekun, F. V. (2021). Is clean energy prosperity and technological innovation rapidly mitigating sustainable energy-development deficit in selected sub-Saharan Africa? A myth or reality. *Energy Policy*, 158, 112520. https://doi.org/10.1016/j.enpol.2021.112520

Alsagr, N., van Hemmen, S. (2021). The impact of financial development and geopolitical risk on renewable energy consumption: evidence from emerging markets. Environmental Science and Pollution Research, 28, 25906–25919. https://doi.org/10.1007/s11356-021-12447-2

Awijen, H., Belaïd, F., Zaied, Y. B., et al. (2022). Renewable energy deployment in the MENA region: Does innovation matter?. Technological Forecasting and Social Change, 179(C), 121633. https://doi.org/10.1016/j.techfore.2022.121633

Awosusi, A. A., Rjoub, H., Dördüncü, H., & Kirikkaleli, D. (2023). Does the potency of economic globalization and political instability reshape renewable energy usage in the face of environmental degradation? *Environmental Science and Pollution Research*, 30(9), 22686–22701. https://doi.org/10.1007/s11356-022-23665-7

Bashir, M. F., Ma, B., Bashir, M. A., Radulescu, M., & Shahzad, U. (2022). Investigating the role of environmental taxes and regulations for renewable energy consumption: evidence from developed economies. *Economic Research-Ekonomska Istraživanja*, 35(1), 1262–1284. https://doi.org/10.1080/1331677X.2021.1962383

Blomquist, J., & Westerlund, J. (2013). Testing slope homogeneity in large panels with serial correlation. *Economics Letters*, 121(3), 374–378. https://doi.org/10.1016/j.econlet.2013.09.012

Chudik, A., Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics*, 188(2), 393–420. https://doi.org/10.1016/j.jeconom.2015.03.007

Ditzen, J. (2021). Estimating long-run effects and the exponent of cross-sectional dependence: An update to xtdcce2. *The Stata Journal*, 21(3), 687–707. https://doi.org/10.1177/1536867X211045560

Fang, W., Liu, Z., Putra, A. R. S. (2022). Role of research and development in green economic growth through renewable energy development: empirical evidence from South Asia. *Renewable Energy*, 194(C), 1142–1152. https://doi.org/10.1016/j.renene.2022.04.125

Farooq, U., Gillani, S., Subhani, B. H., et al. (2023). Economic policy uncertainty and environmental degradation: the moderating role of political stability. *Environmental Science and Pollution Research*, 30(7), 18785–18797. https://doi.org/10.1007/s11356-022-23479-7

Herwartz, H., Siedenburg, F. (2008). Homogenous panel unit root tests under cross sectional dependence: Finite sample modifications and the wild bootstrap. *Computational Statistics & Data Analysis*, 53(1), 137–150. https://doi.org/10.1016/j.csda.2008.07.008

Ji, Q., Zhang, D. (2019). How much does financial development contribute to renewable energy growth and upgrading of energy structure in China?. *Energy Policy*, 128, 114–124. https://doi.org/10.1016/j.enpol.2018.12.047

Kang, X., Khan, F. U., Ullah, R., et al. (2021). Does foreign direct investment influence renewable energy consumption? empirical evidence from South Asian countries. *Energies*, 14(12), 3470. https://doi.org/ https://doi.org/10.3390/en14123470

Khan, A., Chenggang, Y., Hussain, J., et al. (2021). Impact of technological innovation, financial development and foreign direct investment on renewable energy, non-renewable energy and the environment in Belt & Road Initiative countries. *Renewable Energy*, 171, 479–491. https://doi.org/10.1016/j.renene.2021.02.075

Kumar, R., Channi, H. K. (2022). A PV-Biomass off-grid hybrid renewable energy system (HRES) for rural electrification: Design, optimization and techno-economic-environmental analysis. Journal of Cleaner Production, 349, 131347. https://doi.org/10.1016/j.jclepro.2022.131347

Li, Z. Z., Su, C. W., Moldovan, N. C., Umar, M. (2023). Energy consumption within policy uncertainty: Considering the climate and economic factors. *Renewable Energy*, 208(C), 567–576. https://doi.org/10.1016/j.renene.2023.03.098

Mahmood, H., Tanveer, M., Furqan, M. (2021). Rule of law, corruption control, governance, and economic growth in managing renewable and nonrenewable energy consumption in South Asia. *International Journal of Environmental Research and Public Health*, 18(20), 10637. https://doi.org/10.3390/ijerph182010637

Murshed, M., & Alam, M. S. (2021). Estimating the macroeconomic determinants of total, renewable, and non-renewable energy demands in Bangladesh: the role of technological innovations. *Environmental Science and Pollution Research*, 28(23), 30176–30196. https://doi.org/10.1007/s11356-021-12516-6.

Murshed, M., Abbass, K., Rashid, S. (2021). Modelling renewable energy adoption across south Asian economies: Empirical evidence from Bangladesh, India, Pakistan and Sri Lanka. *International Journal of Finance & Economics*, 26(4), 5425–5450. https://doi.org/ 10.1002/ijfe.2073

Nguyen, T. T., Nguyen, V. C. (2021). Financial development and renewables in Southeast Asian Countries – The role of organic waste materials. *Sustainability*, 13(16), 8748. https://doi.org/ 8748; https://doi.org/10.3390/su13168748

Ojong, N. (2021). Solar home systems in South Asia: Examining adoption, energy consumption, and social practices. *Sustainability*, 13(14), 7754. https://doi.org/10.3390/su13147754

Ozturk, I., Farooq, S., Majeed, M. T., Skare, M. (2023). An empirical investigation of financial development and ecological footprint in South Asia: Bridging the EKC and pollution haven hypotheses. *Geoscience Frontiers*, 101588. In press. https://doi.org/10.1016/j.gsf.2023.101588

Pata, U. K., Yilanci, V., Hussain, B., Naqvi, S. A. A. (2022). Analyzing the role of income inequality and political stability in environmental degradation: evidence from South Asia. *Gondwana Research*, 107, 13–29. https://doi.org/10.1016/j.gr.2022.02.009

Pesaran, M. H. (2021). General diagnostic tests for cross-sectional dependence in panels. *Empirical Economics*, 60(1), 13–50. https://doi.org/10.1007/s00181-020-01875-7

Qaiser, I. (2022). A comparison of renewable and sustainable energy sector of the South Asian countries: An application of SWOT methodology. *Renewable Energy*, 181, 417–425. https://doi.org/10.1016/j.renene.2021.09.066

Sadiq, M., Amayri, M. A., Paramaiah, C., et al. (2022). How green finance and financial development promote green economic growth: deployment of clean energy sources in South Asia. *Environmental Science and Pollution Research*, 29(43), 65521–65534. https://doi.org/10.1007/s11356-022-19947-9

Shang, Y., Han, D., Gozgor, G., et al. (2022). The impact of climate policy uncertainty on renewable and non-renewable energy demand in the United States. *Renewable Energy*, 197, 654–667. 10.1016/j.renene.2022.07.159

Subramaniam, Y., Masron, T. A., Loganathan, N. (2022). Remittances and renewable energy: an empirical analysis. *International Journal of Energy Sector Management*, 17(5), 1034–1049.

Tariq, G., Sun, H., Ali, I., et al. (2022). Influence of green technology, green energy consumption, energy efficiency, trade, economic development and FDI on climate change in South Asia. *Scientific Reports*, 12(1), 16376. https://doi.org/10.1038/s41598-022-20432-z

Uzar, U. (2020). Is income inequality a driver for renewable energy consumption?. *Journal of Cleaner Production*, 255, 120287. https://doi.org/10.1016/j.jclepro.2020.120287

Wang, E., Gozgor, G., Mahalik, et al. (2022). Effects of institutional quality and political risk on the renewable energy consumption in the OECD countries. *Resources Policy*, 79, 103041. https://doi.org/10.1016/j.resourpol.2022.103041

Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69(6), 709–748. https://doi.org/10.1111/j.1468-0084.2007.00477.x