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Investing in Sustainability: How FDI and Trade Openness Affect the Consumption of Renewable Energy in Regional Comprehensive Economic Partnership (RCEP) Countries

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Abstract

This paper focuses on how trade openness and foreign direct investment (FDI) affect the adoption of sustainable energy among the countries of the Regional Comprehensive Economic Partnership (RCEP) based on the panel data between 1998 and 2022. The Pesaran (IPS) and Phillips-Perron tests allow to assert the stationarity of data, and the Pedroni cointegration test indicates that there is a long-term correlation between the variables, which proves the theoretical connection between economic factors and renewable energy adoption. The research employs the Pooled Ordinary Least Squares (POLS), Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) to estimate long-run effects and Canonical Cointegration Regression (CCR) to assure robustness. The findings indicate that FDI has a very positive and significant impact on the usage of renewable energy, which indicates that FDI promotes the transition to cleaner energy in RCEP countries. Conversely, trade openness affects the utilization of renewable energy negatively, so that increased trade may be linked to the increased utilization of fossil fuels or the trade-offs related to the environment. The results offer useful policies that would be recommended to the RCEP countries, affirming the need to attract green FDI and use sustainable trade policies and reinforce the financial mechanisms that motivate the use of renewable energy in investments. This study is an addition to the wider debate of sustainable development and energy policy because it provides a great insight of the economic factors related to the use of renewable energy in developing nations.

Keywords

FDI, FMOLS, RCEP, Sustainable Energy, Trade openness

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Introduction

Energy is essential to economic growth and activity (Gulfer Vural, 2021). In addition to being important to people's daily lives, it also has a big impact on the expansion of an economy (Zhongye Sun et al., 2023). However, the environmental hazards posed by fossil fuels like coal, oil, gas, and others, as well as the possibility that these natural assets would someday run out, led to a demand for alternate energy sources.

Since the Paris Agreement (2015) and the Kyoto Protocol (1997), many countries have started to take important environmental protection measures. Using as much green energy as possible instead of fossil fuels is one of these strategies. By 2050, renewable energy will provide two-thirds of the global demand for energy and make a substantial contribution to lowering greenhouse gas emissions, according to an investigation by Gielen et al. (Gulfer Vural, 2021).

Renewable energy is energy that comes from endless, naturally replenished resources like the sun, winds, and tides. In addition to geothermal, wind, solar power, tidal, and wave energy, hydropower (excluding pumped storage) is the primary energy equivalent. Non-renewable energy, on the other hand, comes from finite resources like natural gas, coal, and oil (OECD).

The usage of non-renewable energy reduces environmental standards by emitting CO2. According to a 2017 International Energy Agency study, energy-related industries accounted for about 68% of carbon emissions, with fossil fuel-based energy sources contributing 44% of these emissions. However, it increased to 89% in 2021 (Yongming Huang et al., 2022). According to research, almost 84% of the energy consumed worldwide comes from fossil fuels (Ritchie and Roser, 2020). Greenhouse gas (GHG) emissions from excessive energy use contribute to climate change and global warming (Murad et al., 2019). Governments consequently concentrated particularly on substituting renewable energy sources for polluting ones (Yongming Huang et al., 2022). Therefore, it is sense to identify the different factors impacting the utilization of renewable energy.

The use of renewable energy is influenced by social, institutional, technological (innovative), economic, and environmental factors (Gulfer Vural, 2021). Foreign Direct Investment can greatly increase a country's use of renewable energy by supplying superior technology, funds, etc. (Xueqing Kang et al., 2021). Energy consumption may benefit or suffer from trade openness, and these effects could be scale, technique, or composite (Shahbaz et al., 2014; Arrow, 1962). The beneficial impact of trade openness on energy demand suggests that trade liberalization policies intended to increase economic activity should be counterbalanced by more energy-saving measures (Koengkan, 2018).

Figure 1.1: RCEP Members (Source: Wikipedia)

The RCEP is a modern, comprehensive, and high-quality trading contract that came into force on November 15, 2020, and went into effect in January 2022. It is signed by ten members of the Association of Southeast Asian Nations (ASEAN) and five free trade partners. November 2012 marked the start of the negotiations. ASEAN's free trade partners include Australia, China, Japan, New Zealand, and Korea, and its members constitute Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam (The Financial Express).

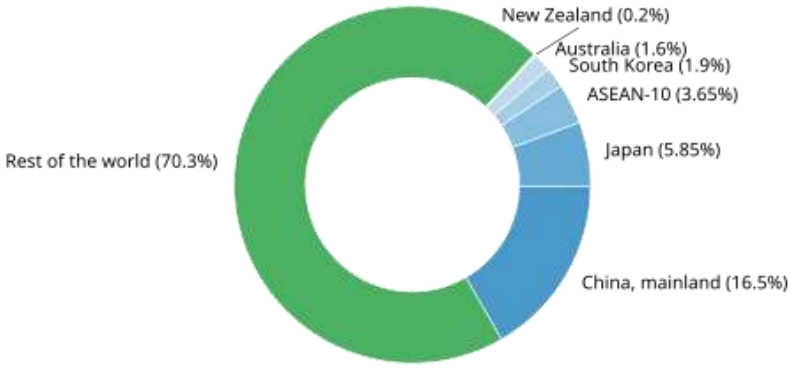

Figure 1.2: 2020 RCEP-15's share of global GDP (%) (Source: Wikipedia)

The RCEP has expanded to become the world's largest trading group, encompassing more than one-third of the global economy. With roughly one third of the worldwide population and almost 30% of the global GDP (Fig. 1.2), the RCEP is the biggest free-trade framework in the world and aims to gradually eliminate 90% of trade barriers in the region. With 2.3 billion

residents, the Asia-Pacific area has an economic partnership forum valued at US$25.8 trillion, which is or around 30% of global GDP.

The importance of employing green power in relation to natural degradation has been one of the subjects of greatest importance in the most current research. Policymakers developed several policies to protect the environment from global warming, increasing temperatures, and energy scarcity. Energy sources are used as inputs to accelerate the growth process in an industrial setting. Increased growth rates impose a pressure on the input supply because they require more inputs. The supply of non-renewable energy has been strained by the sharp increase in its use. It is hazardous and uncontrollable without the use of renewable energy sources.

However, elements determining renewable energy have been the subject of very few studies. The factors influencing the use of renewable energy must be examined in order for authorities to weigh the importance of each outcome and develop appropriate renewable energy strategies. In light of this, this study looks into how trade openness and foreign direct investment (FDI) affect a group of 15 RCEP countries from 1998 to 2022.

The particular goals of the study are as follows:

I. To analyze the impact of FDI on renewable energy consumption in RCEP countries.
II. To investigate the effect of trade openness on renewable energy consumption in the region.
III. To assess the combined influence of FDI and trade openness on renewable energy consumption.

2. Empirical Literature Review

The empirical literature review concerning the effect of trade openness and foreign direct investment on the renewable energy consumption is summarized in Table 2.1.

Table 2.1: Summary of the impact of FDI & TO on REC

Authors (Year)	Countries	Study Period	Methodology	Main Finding
Yongming Huang et al. (2022)	Indonesia, Malaysia, Singapore, Philippines and Thailand	1980-2018	POLS, FMOLS, DOLS	While there is a positive correlation between FDI and REC, the utilization of renewable energy declines as commerce increases in scale.
Xueqing Kang et al. (2021)	Pakistan, Bangladesh, India and Sri Lanka	1990-2019	FMOLS, DOLS	There is a significant and negative correlation between FDI & TO and green energy.

Gulfer Vural (2021)	Argentina, Brazil, Mexico, Colombia, Chile and Guatemala	1991-2014	FMOLS	The quantity of renewable energy generated per person is favorably and considerably impacted by trade.
Dalia M. Ibrahiem et al. (2021)	Egypt, Morocco, and Tunisia	1971-2014	Granger Causality and Panel PMG ARDL	Foreign direct investment and trade liberalization are the catalysts for renewable energy.
Md. Mahmudul Alam et al. (2019)	25 OECD nations	1970-2012	ARDL, PMG, DFE, FMOLS, DOLS	The utilization of renewable energy is significantly impacted over the long run by trade openness.

Data and Methodology

This study uses annual panel data to investigate the relationship between trade openness, renewable energy use, and foreign direct investment (FDI) in 15 RCEP nations between 1998 and 2022. Panel data is used in this analysis because it has a number of benefits over cross-sectional or time-series data, such as the ability to account for the impact of nations and time-invariant factors. Using seven variables—Renewable Energy Consumption, Foreign Direct Investment Net Inflows (FDI), Trade Openness, CO_2 Emissions, GDP, Domestic Credit to Private Sector (as a percentage of GDP), and Total Population—this method adheres to the corpus of recent research. The following variables are included in this study as both instrumental and control variables: CO_2 Emissions, GDP, Domestic Credit to Private Sector (as a percentage of GDP), and Total Population. All of these characteristics were gathered for this study from the World Bank and UNCTAD-run World Development Indicators (WDI) portal.

3.1 Empirical Model

The degree of stationarity is tested using panel unit root tests. The POLS, FMOLS, DOLS, and CCR models are examined after the stationarity has been verified. According to stationarity tests, every variable is first-order stationary. The panel cointegration model's findings show that there is a long-term relationship between the variables in the context of 15 RCEP countries. We used the DOLS model for robustification.

3.2 Pooled OLS (Econometric Model)

By combining (or "pooling") data collected from multiple entities (such as individuals, companies, and countries) and time periods, a statistical technique known as pooled OLS produces a regression model. It is often employed in the evaluation of panel data, which consists of observations for various groups over a series of time periods.
In this study, we examine the short- and long-term effects of GDP, trade openness, foreign direct investment, and CO2 on the usage of renewable energy in RCEP nations. One approach to express the relationship is as follows:

$$\mathbf{REC = f\ (FDI,\ TO,\ lnCO_2,\ GDP,\ FD,\ lnPOP)} \quad \textbf{.....(3.1)}$$

RE, or renewable energy consumption, is the proportion of renewable energy in the total quantity of final energy utilized. Conversely, FDI is for foreign direct investment net inflows (as a percentage of GDP), CO2 stands for carbon dioxide emissions in metric tons per capita, and TO stands for trade openness, which is the total of imports and exports as a proportion of GDP. GDP, the private sector's domestic credit as a percentage of GDP, and the population as a whole.

In regression form,

$$\mathbf{REC_{it} = \alpha + \delta_1 FDI_{it} + \delta_2 TO_{it} + \delta_3 lnCO_{2_{it}} + \delta_4 GDP_{it} + \delta_5 FD_{it} + \delta_6 lnPOP_{it} + \mu_{it}} \quad \textbf{(3.2)}$$

On the other hand, the δ_i (i = 1, 2, 3, 4, 5, 6) represents the anticipated coefficients for the future impact of trade openness, foreign direct investment, CO2 emissions, GDP, domestic credit to the private sector, and total population on the usage of renewable energy.

3.3 Panel Cointegration Test

After the approach is presented, cointegration determines if the study will move forward with the analysis. In this case, figuring out the presence and order of zero stationary properties (unit root) is important in two respects. First, for panel integration testing, it is essential to comprehend the unit root order of the sequence. Cointegration panel testing is limited to sequences of the same integration order. Second, if panel cointegration is not demonstrated, the series' unit-based order is necessary to eliminate misleading regression risks. In this case, the unit root test results facilitate sequence modification through taking the first or second alternatives in stationary form. However, estimating of spurious coefficients would be aided by the use of nonstationary, non-cointegrated data. In this study, the long-term relationship is examined using the Padroni test.

H_0: There is no cointegration;
H_1: There is cointegration

If the aforementioned tests confirm that the variables are cointegrated, the panel FMOLS and DOLS models will be employed in this investigation.

3.4 Panel Fully Modified OLS (Econometric Model)

Once long-term associations within the panel set have been identified, it is crucial to assess their relevance and amplitude. The OLS method is not parametric for a fully modified (FM) model. There is disagreement among scholars on which study approach is more effective and which produces smaller biological and robust coefficients when it comes to the panel root and cointegration tests. For instance, Kao and Chaing (2000) looked into the idea that FMOLS would be biased than DOLS for more than 60 observations, while Benerjee (1999) concluded that FMOLS and DOLS are basically equivalent. To overcome this limitation, the FMOLS and DOLS approaches were developed by Pedroni (2000) and are applied in this analysis. Since the least squares method produces inconsistent results when used to follow a series with a long history of correlation, the FMOLS and DOLS approaches are created. To deal with endogeneity and autocorrelation, the FMOLS procedure employs a nonparametric approach. The following is the framework of FMOLS Pedroni's method:

$$\widehat{\boldsymbol{\delta}}\mathbf{FM}\boldsymbol{\delta} = \sum_{\mathbf{i=1}}^{\mathbf{N}} \widehat{\boldsymbol{\varphi}}_{\mathbf{22}}{}^{\mathbf{2}}\, \mathbf{i} \sum_{\mathbf{t=1}}^{\mathbf{T}} (\mathbf{y_{it}}\hat{\mathbf{y}}_{\mathbf{t}})^{\mathbf{2}} \sum_{\mathbf{i=1}}^{\mathbf{N}} \widehat{\boldsymbol{\varphi}}_{\mathbf{11i}}{}^{\mathbf{1}} \widehat{\boldsymbol{\varphi}}_{\mathbf{22i}}{}^{\mathbf{1}} \sum_{\mathbf{t=1}}^{\mathbf{T}} (\mathbf{y_{it}}\bar{\mathbf{y}}\mathbf{t})\, \mathbf{e_{it}} \mathbf{T}\widehat{\boldsymbol{\omega}}_{\mathbf{i}} \text{.....(3.3)}$$

$$\hat{\mathbf{e}}_{\mathbf{it}} = \mathbf{e_{it}}\widehat{\boldsymbol{\varphi}}_{\mathbf{22}}{}^{\mathbf{1}}\widehat{\boldsymbol{\varphi}}_{\mathbf{21i}},\ \widehat{\boldsymbol{\omega}}_{\mathbf{i}} = \hat{\mathbf{I}}_{\mathbf{22i}} + \widehat{\boldsymbol{\varphi}}_{\mathbf{22i}}{}^{\mathbf{0}}\widehat{\boldsymbol{\varphi}}_{\mathbf{21i}}{}^{\mathbf{0}}\widehat{\boldsymbol{\varphi}}_{\mathbf{21i}}(\hat{\mathbf{I}}_{\mathbf{22i}} + \widehat{\boldsymbol{\varphi}}_{\mathbf{22i}}{}^{\mathbf{0}} \text{.....(3.4)}$$

The matrix of covariance can be broken down into the following parts: $\widehat{\varphi}_1 = \widehat{\varphi}_1 + \hat{I}_i + \hat{I}_i$, where $\hat{I}_i$ is the concurrent covariance matrix and $\widehat{\varphi}^0$ is the weighted amount of autocovariance. The appropriate estimator of $\widehat{\varphi}_i{}^0$ is shown by the $\widehat{\varphi}_i{}^0$.

3.5 Panel Dynamic OLS (Econometric Model)

The dynamic co-integrated panels show that DOLS responds to short-term disturbances in long-term equilibrium and manages the heterogeneity components of the cross-sections by examining individual mean differences. According to Kao and Chiang, DOLS can be transformed into a co-integration analysis using the following equation:

$$\mathbf{y_{i,t}} = \boldsymbol{\alpha}_{\mathbf{i}}\mathbf{x_{i,t}} + \sum_{\mathbf{g=-q}}^{\mathbf{q}} \boldsymbol{\sigma}_{\mathbf{ij}}\Delta\mathbf{x_{i,t+j}} + \boldsymbol{\delta}_{\mathbf{1i}}\mathbf{D_{1i}} + \boldsymbol{\mu}_{\mathbf{i}} \text{.....(3.5)}$$

In this case, "q" is a special econometric construct that determines the lags of the model. The endogeneity element of the model is likewise addressed by this approach. The ability of the technique to yield trustworthy results is one of the most important and desired aspects of any econometric investigation. Autocorrelation is eliminated by the DOLS method.

In the framework of RCEP countries, the FMOLS and DOLS results agree fairly well. That is, when it comes to coefficient signs and significance in the context of certain countries, FMOLS and DOLS yield identical results.

3.6 Canonical Cointegration Regression (CCR)

Long-term relationships between cointegrated time series variables are estimated using a statistical method known as canonical cointegration regression (CCR). Park's (1992) Canonical Cointegration Regression is used to assess cointegrating vectors in a structure with an integrated procedure of I (1). By providing accurate and efficient parameter estimations in the event of cointegration, it aims to address the common issues of serial correlations and endogenous factors in such situations.

Empirical Results

Descriptive Statistics

Table 4.1: Descriptive Statistics

Variables	Mean	St. Deviation	Maximum	Minimum
REC	27.14587	26.15569	0	86.62
FDI	4.223189	5.434268	-3.811793	32.69116
TO	99.92762	83.13767	.17468	437.3267
lnCO_2	1.121978	1.416727	-1.894576	3.07758
GDP	4.489393	3.937016	-13.12673	14.51975
FD	90.53524	55.55518	3.121103	217.7609
lnPOP	17.25614	1.891955	12.67655	21.06853

Source: Author's estimation

The descriptive statistics for each variable used in the analysis of this study are shown in Table 4.1. First, it shows that the average amount of Foreign Direct Investment (FDI) was 4.223189 and the average amount of Renewable Energy Consumption (REC) was 27.14587 between 1998 and 2022. Its greatest value is 32.69116, and its lowest is -3.811793. Trade Openness (TO) has a range of values from 0.17468 at the lowest to 437.3267 at the most. The lnCO2 emissions in this case vary from a minimum of -1.894576 to a maximum of 3.07758. The GDP (annual percentage) is 4.489393, with the lowest and highest figures being -13.12673 and 14.51975, respectively. FD stands for Domestic Credit to Private Sector as Financial Development. FD swings from its lowest value of 3.121103 and its maximum value of 217.7609. The average for lnPOP is 17.25614, with a minimum of 12.67655 and a maximum of 21.06853.

4.2 Partial and Semi-partial Correlation Matrix

Table 4.2: Partial and Semi-partial Correlation Matrix

Variables	Partial corr.	Semi-partial Corr.	Partial corr.^{2}	Semi-partial Corr.^{2}	Significance level
FDI	0.2942	0.0620	0.0866	0.0038	***
TO	-0.6321	-0.1642	0.3995	0.0269	***
lnCO_2	-0.9464	-0.5899	0.8958	0.3480	***

GDP	0.3019	0.0637	0.0912	0.0041	***
FD	0.3710	0.0804	0.1376	0.0065	***
lnPOP	-0.6067	-0.1536	0.3681	0.0236	***

Source: Author's estimation, ***p < 0.01

Table 4.2 displays the Partial and Semi-partial Correlation Matrix for each variable, as well as a statistical significance and relationship analysis. With a clear contribution of 0.38% (0.0038), FDI explains 8.66% (0.0866) of the variance after controlling for other variables. Trade Openness explains 39.95% (0.3995) of the variation and has a unique contribution of 2.69% (0.0269). CO_2 emissions account for 89.58% (0.8958), the largest partial variance, with a unique contribution of 34.8% (0.3480). 9.12% (0.0912) of the fluctuation may be attributed to GDP, whereas 0.41% (0.0041) is the result of a unique contribution. Financial Development explains 13.76% (0.1376) of the variation and has a unique contribution of 0.65% (0.0065). The population accounts for 36.81% (0.3681) of the variance, with a unique contribution of 2.36% (0.0236). Every variable has a substantial effect on the dependent variable ($p < 0.01$). $LnCO_2$ is the highest partial influence that accounts for the greatest amount of volatility. Even though their contributions are small, elements like foreign direct investment and gross domestic product are significant.

4.3 Unit Root Test

Im-Pesaran-Shin (IPS) and Fisher-Phillips Perron (PP) tests have been applied.

Table 4.3: Unit Root (IPS & PP)

Variables	**IPS**		**PP**	
	At Level	**At First Difference**	**At Level**	**At First Difference**
REC	5.1859	-8.1705***	3.6384	-12.8965***
FDI	-5.2168	-11.5568***	-7.3575	-21.1277***
TO	-0.4230	-8.7926***	-0.8902	-13.4172***
$lnCO_2$	4.0367	-7.3513***	3.1603	-10.8803***
GDP	-7.9796	-11.8200***	-12.5446	-22.0325***
FD	3.2683	-5.4190*	1.1803	-7.1334***
lnPOP	-7.0937***	2.0310	-15.0215***	1.2062

Source: Author's estimation; *p < 0.1, **p < 0.05, ***p< 0.01

Table 4.3 compiles the results of the IPS & PP unit root test performed on several variables (including REC, FDI, TO, $lnCO_2$, GDP, FD, and lnPOP) at both their levels and first differences. For IPS unit root test, differentiating is not required to achieve stationarity because factors such as lnPOP are stationary at levels (with a significance level of -7.0937 at 1%). Variables like REC, $lnCO_2$, FDI, TO, GDP, and FD are non-stationary at levels, but they become stationary at initial differences (REC, for instance, is stationary at -8.1705***). Again for PP unit root test, variables like REC, $lnCO_2$, FDI, TO, GDP, and FD are non-stationary at levels, but they become stationary at initial differences (REC, for instance, is stationary at -12.8965***).

4.4 Cointegration Tests

The study implies the Pedroni (1999) approach.

Table 4.4: Results of the Pedroni Cointegration Model

	Statistic	p-value
Modified Phillips-Perron t	3.6951	0.0001
Phillips-Perron t	-2.1440	0.0160
Augmented Dickey-Fuller t	-2.6846	0.0036

Source: Author's estimation, *p < 0.1, **p < 0.05, ***p< 0.01

Phillips-Perron modified t: The statistic is 3.6951 and the p-value is 0.0001. The null hypothesis that there is no cointegration is probably going to be rejected because of the incredibly low p-value. Phillips-Perron t: the statistic is -2.1440 and the p-value is 0.0160. Since its p-value is also modest, the null hypothesis—that there is no cointegration—is rejected. Augmented Dickey-Fuller t: The statistic is -2.6846, and the p-value is 0.0036. Again, the modest p-value leads to the rejection of the null hypothesis that there is no cointegration. All three tests yield statistically significant results against the null hypothesis of no cointegration at conventional significance levels (e.g., 1% or 5%). This implies that the elements in the panel data have a long-term equilibrium connection, which means that they are most likely cointegrated.

4.5 Results of the Study

Table 4.5: POLS, FMOLS & DOLS

Regressand: Renewable Energy Consumption						
Variables	**POLS**		**FMOLS**		**DOLS**	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
FDI	.51807***	.0998513	.5713869**	.2793567	.7712199***	.321456
TO	-.0857508***	.0062381	-.089728 ***	.0174747	-.1018228***	.0188203
lnCO_2	-18.40918***	.3726647	-17.92204***	1.050004	-18.20959***	1.096213
GDP	.5490596***	.1028782	.5540886**	.2878944	1.118937***	.4139734
FD	.0727366***	.0108048	.0637087**	.030308	.0949851***	.0334033
lnPOP	-3.265199***	.2538752	-3.21931***	.7101322	-3.804221***	.7697286
Constant	100.944***	4.176255	100.2623***	11.68296	105.9108***	12.0079
R^2	**0.95**		**0.50**		**0.96**	
Adjusted R^2	**0.95**		**0.49**		**0.96**	

Source: Author's estimation, *p < 0.1, **p < 0.05, ***p< 0.01

For POLS, every additional unit in foreign direct investment results in a 0.51807 unit increase in the use of renewable energy. Trade openness has a negative influence on the use of renewable energy; however, the effect is small (-0.0857508). The coefficient -18.40918 for lnCO_2 shows that the utilization of renewable energy is significantly harmed by CO_2 emissions. The GDP coefficient of 0.5490596 indicates a positive correlation between GDP and the utilization of renewable energy. While population size has a negative effect on lnPOP (coefficient: -3.265199), financial growth and the use of renewable energy have a weak but positive link with FD (coefficient: 0.0727366).

For FMOLS, the usage of renewable energy rises by 0.5713869 units for every unit increase in foreign direct investment. Trade openness has a negligible negative influence on the use of renewable energy (-.089728). The $lnCO_2$ coefficient of -17.92204 indicates that CO_2 emissions significantly reduce the usage of renewable energy. A positive correlation between GDP and the utilization of renewable energy is indicated by the GDP coefficient of.5540886. The population size has an adverse impact on the use of renewable energy, as indicated by the coefficient -3.21931 for lnPOP, whereas the coefficient.0637087 for FD indicates a somewhat positive relationship between financial growth and the use of renewable energy.

For DOLS, the usage of renewable energy rises by.7712199 units for every unit increase in foreign direct investment. Trade openness has a negative effect on the use of renewable energy; however, the effect is small (-.1018228). The value of -18.20959 for $lnCO_2$ indicates that the utilization of renewable energy is significantly harmed by CO_2 emissions. The GDP coefficient of 1.118937 indicates a positive correlation between GDP and the utilization of renewable energy. While there is a tiny but favorable link between financial development and the utilization of renewable energy (coefficient.0949851 for FD), there is a negative association between population size and the usage of renewable energy (coefficient -3.804221 for lnPOP).

4.6 Robust Analysis Estimation

Table 4.6: Canonical Cointegration Regression (CCR)

Regressand: Renewable Energy Consumption		
Variables	**Coefficient**	**Std. Error**
FDI	.5822184**	.3136129
TO	-.0903202***	.0188641
$lnCO_2$	-17.91344***	1.061703
GDP	.5633295	.3579518
FD	.0637977**	.0317685
lnPOP	-3.21817***	.7531978
Constant	100.1906***	12.09856
R^2	**0.49**	
Adjusted R^2	**0.48**	

Source: Author's estimation, *p < 0.1, **p < 0.05, ***p< 0.01

The usage of renewable energy rises by.5822184 units for every unit increase in foreign direct investment. Although the effect size is small (-.0903202), trade openness has a negative influence on the consumption of renewable energy. The $lnCO_2$ coefficient of -17.91344 indicates that CO_2 emissions significantly reduce the usage of renewable energy. There is a positive correlation between GDP and the utilization of renewable energy, as indicated by the GDP coefficient of .5633295. Population size has a detrimental impact on the use of renewable energy, as indicated by the coefficient -3.21817 for lnPOP, whereas the coefficient.0637977 for FD indicates a somewhat positive relationship between financial growth and the use of renewable energy.

Conclusion

Taking into consideration CO2 emissions and economic growth, this study examined the effects of trade openness and foreign direct investment on the usage of renewable energy in 15 RCEP countries. Panel data approaches are used to frame data from 1998 to 2022 in order to

achieve the required objective. Panel unit root tests are used to test the order of stationarity. Once the stationarity is confirmed, the POLS, FMOLS, DOLS, and CCR models are analysed. Stationarity tests demonstrated that all of the variables, except for lnPOP, were first-order stationary.

In the context of 15 RCEP countries, the results of the panel cointegration model demonstrate a long-term link between the variables. The results of estimation approaches are as follows: The utilization of renewable energy is negatively impacted by trade openness in a statistically meaningful way. The variable FDI had a beneficial effect on the use of renewable energy. The logarithmic degradation of the environment (CO2) and population coefficients are both negative and significant in all models. The utilization of renewable energy is positively impacted by financial development and GDP.

Based on the findings of the current study, policymakers are advised to replace non-renewable energy sources with renewable ones using state-of-the-art technology, knowledge, and concepts. Additionally, by utilizing renewable energy, MNCs and FDI will ensure effective manufacturing in domestic economies. In actuality, the renewable energy industry usually relies on initial government fiscal subsidies, which are finite and eventually unsustainable. Our research suggests that financial institutions may effectively assist the renewable energy industry, fostering its long-term expansion. In light of this, governments can also provide specific policy support, such as preferential interest rates and special loans, to reduce the financial obstacles that renewable energy enterprises must overcome. Governments should also encourage R&D investment by providing tax incentives and low-interest financing options. Patent applications and innovative work related to renewable energy technologies should be supported and acknowledged. Universities and research centers should encourage research and development projects that use renewable energy technology efficiently. Investing in human capital is another important stage. Therefore, more scientists and engineers are required to develop and implement renewable energy technology. RCEP nations should educate the people about the importance of renewable energy and clean ecosystems.

Since it is anticipated that our results might vary from observations from other countries, future research may examine additional groupings of countries with various moderating characteristics. Using advanced techniques like pooled mean group procedures, cross-sectional dependency, and Westerlund co-integration may make the results more palatable. Since this can provide us with a clearer picture of the financial sectors' impact over the consumption of renewable energy, researchers should focus on looking at how financial development affects certain types of renewable energy usage, such as wind and solar energy consumption.

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