Renewable and eco-friendly Energy and Politics Orientations of the government of India

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Abstract

This article empirically examines the relationship between the orientation of political powers and renewable energy in 21 developed countries for the period 1960–2018 using the panel ARDL approach. The political tendencies of the governments in developed countries are tested through three models that are created for this study. According to the first result obtained from the empirical study, a positive and statistically significant long- and short-term cointegration relationship is observed between left-leaning governments and renewable energy. It appears that it is essential to have strong environmental movements in the period of left-oriented governments in achieving this result. Second, a long- and short-term cointegration relationship is found between central governments and renewable energy. Finally, there is no statistically significant relationship between right-oriented governments and renewable energy in the short and long term.

Keywords: Renewable energy, Political orientation, Energy politics, Government of India, Environmental movement

1. Introduction

Recently, there has been a discussion in the economics literature on economic growth in peace with nature. The main factor that necessitates this discussion is that economic growth cannot be sustained with traditional energy sources. A necessary but not sufficient prerequisite for economic development is sustainable economic growth. Therefore, the ability to replenishenergy resources eemergesas an essential element for sustainable economic growth.The development of renewable energy sources is significant for sustainable economic growth and the environment.

In this framework, determining factors affecting the advancement of renewable energy sources gain importance. There are many economic and non-economic factors affecting the development of renewable energy sources. As Geels (2002) and Geels etal. (2016) point out, renewable energy systems are socio-technical systems that change with the political framework. Biresselioglu and Karaibrahimoglu (2012: 32) state that governments' political orientationdirectly impacts the use and promotion of renewable energy.Such understanding of the development of renewable energy sources, as stated by Gullberg (2011), increased enviromental awareness of the media and the public, prompting political parties to include alternative energy sources such as renewable energy, without environmental side effects in their programs. In summary, the ideological orientation of the political parties holding power emerges as an essential factor affecting the development of renewable energy resources.

In this study, the effects of the orientation of political powers, which is one of the non-economic factors, on renewable energy resources will be tested with the panel ARDL approach. Althoughfew studies exist on this subject in the literature, one of the points that make this study unique is applying an estimation method that considers the cross-sectional dependency and second-generation unit root tests. In the first part of the study, the theoretical and empirical literature between the ideological orientations of the ruling political parties and the development of renewable energy sources is reviewed. In the second part, an empirical study that tested this relationship between the years 1960-2016 using the data of 21 developed countries is included. In the last section, the results obtained are evaluated.

Literature Review

Recently, when the theoretical relations between different political formations in power and the development of sustainable energy resources were reviewed in the theoretical literature, the existence of various approaches came to the fore.

Although there are many factors such as economic (Gray et al., 2018; Rentschler, 2013),environmental(Stoutenborough et al., 2015),and energy security (Manley et al., 2013; Hayes et al., 2013, Hess and Renner, 2019) for the promotion and development of renewable energyresources, such development varies between countries. Among the reasons for this aisthe important attributed renewable energy by those in power and their political orientation. Thoniget al. (2020:4) talks about three ideologically based approaches to energy politics: " the government-centered,the market-centered and the grassroots-centered."In market-oriented logic, the role of the government in renewable energy policies is limited to setting general objectives and defining the "rules of the game."According to Thoniget al. (2020:4), the central government controls and manages the transition to renewable energy within a specific master plan in the state-centered approach.Lederer et al. (2018), Altenburg and Pegels(2012), Lütkenhorstet al. (2014), and Neumayer (2003:4) emphasize that the failures of market-based policies give governments a leading role in the use and promotion of low carbon energy sources. On the other hand, a transition to renewable energy sources in the grassroots-centered approach is carried out by local governments. Finally, Thonig et al. (2020: 4) argue that the transition to renewable energy sources in the grassroots-centered method will be carried out by local governments within the framework of their available resources.

In general, it can be said that right-leaning governments adopt a market-based approach, while left-wing governments adopt a state-based approach (Schaffer and Bernauer, 2014: 18; Biresselioglu and Karaibrahimoglu, 2012: 36; Potrafke, 2010: 135; Thonig et al. 2020: 5). Within the framework of this distinction that affects the renewable energy policies of the ruling governments, it is thought that the theoretical foundations of the right and left governments for the development of renewable energy sources should be laid down.

It is argued that left-oriented governments encourage the development and consumption of renewable energy resources (Benton, 1997: 45; Neumayer,2003:27;Nicolini and Tavoni, 2017:418). The primary basis for this argument is that left-oriented governments are more receptive to environmental demands from consumers and environmental activist (Jahn, 1998; King and Borchardt, 1994; Benton, 1997;).In that sense, as stated by Hirschl (2009), Panwar et al. (2011),and Verbruggen et al. (2010),renewable energy is seen as an energy source that can cause fewer environmental problems. Besides, the interventionist nature of left-oriented governments emerges as an essential element in promoting renewable energy (Biresselioglu and Karaibrahimoglu, 2012: 32). Fankhauser et al. (2015: 60) claims that left-leaning governments with an interventionist nature can see low-carbon energy investments as a fiscal incentive.

Right-oriented political governments do not fully oppose the development of renewable energy sources. However, they seem to focus on energy policies that do not reduce dependence on fossil fuels by highlighting employment and security concerns, rather support transition to cleaner fossil fuels (Hess and Renner, 2019: 420). This perspective may be due to the fact that people do not want to pay more for renewable energy. According to Fobissiea (2019: 8), the fact that people do not want to pay extra for renewable energy stems from a political perspective rather than socio-economic conditions.

Empirical studies confirm the relationship between less pollution and the power of traditional left parties(Neumayer,2003). King and Borchardt (1994) found a relationship between left-oriented governments and less pollution in seventeen OECD countries. In the study conducted by Scruggs (1999: 25) for OECD countries, a statistically significant and positive relationship was found between good environmental performance and left governments.Historically, we can witness the efforts of the left governments to reduce environmental pollution. For example, as Gallagher (2013: 61) points out, at the end of the 1990s, the Social Democrat (SPD) and Green Party coalition in Germany implemented various policies to reduce carbon emissions and increase renewable energy sources. Lauber (2006) obtained results that empirically confirm the efforts of the Green Party and Social Democrats to support renewable energy in Germany. Another empirical study that provides substantial evidence that left-oriented powers promote renewable energy was conducted by Biresselioglu and Karaibrahimoglu (2012). The study concluded that while left-oriented and central-oriented governments in Europe support the development and consumption of renewable energy resources instead of fossil fuels, right-oriented governments have a negative impact.

When the theoretical and empirical literature is evaluated in general, it is possible to summarize the main elements that come to the fore. One of the reasons why different political parties in power have different approaches to renewable energy policies is the attitude of their voters to renewable energy. According to Karlstrøm and Ryghaug (2014), it can be said that while right-oriented governments try to win their voters through economic growth, development, etc., they do not prioritize environmental issue. However, it can be argued that right-oriented governments do not entirely disregard renewable energy for sustainable growth and their development goals that do not destroy nature and resources(yadav et al 2022b).

On the other hand, it is seen that left-oriented governments are more receptive to the demands of both voters and environmental movements than other political orientations. This distinction in attitudeleads left-leaning governments to encourage the use and development of renewable energy more often than their right leaning counterparts (yadav et al 2022c).

2. Methodology and Data

In this study, the existence of a cointegration relationship in the short and long term was tested using the pooled-mean group (PMG) and mean group (MG) estimators developed by Pesaran and Smith (1995) and Pesaran et al. (1999). The MG estimator derives its long-term parameters from the average of individual parameters. However, this estimator does not consider that certain parameters may be the same across groups.The PMG estimator allows the constant error variances and short-term parameters to

change while restricting the long-term parameters to remain the same across groups (Pesaran et al. 1999: 621). Therefore, which of the two estimators gave effective results was determined by the Hausman test.

2.1. Description of data sets

In this study, 21 countries were included in the analysis based on data availability for the years 1960-2018.The data showing the political orientation (government composition) of governments in power and reel GDP are taken from the comparative political data set. This dataset includes data from OECD and European Union countries. This data is based on calculations of Schmidt and Bayer (1992) until 1991.whereas, renewable energy data is taken from OECD.Left party data is used to represent social democrats and political parties to the left of social democratic parties. According to(Yadavv et al 2022d)The concept of a right-wing party has been used to express liberals and conservatives. Finally, center parties are used to describe the Christian democratic or Catholic parties. Renewable energy data is taken as the share of renewable energy in the primary energy supply.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
rnenergy	1,228	14.73307	17.26265	0	89.75
gov_right	1,233	41.04794	38.85865	0	100
gov_cent	1,233	25.44775	30.71808	0	100
gov_left	1,233	31.40299	36.1361	0	100
realgdpgr	1,218	2.991364	2.820945	-9.13249	25.12017

Table 1 contains descriptive statistics for the data used in the analysis.

2.2. Cross-Sectional Dependency

Before looking at the relationship between the political orientation of governments and renewable energy, it is necessary to determine the degree of integration by performing unit root tests of the variables. First-generation unit root tests (Im et al. 2003; Maddala and Wu 1999; Hadri 2000 and Levin et al. 2003) do not consider cross-sectional dependency. In the words of Pesaran (2007), they are tests that assume that individual time series in the panel are distributed independently in cross-sectional terms. Therefore, second-generation unit root tests that take into account the cross-sectional dependency should be applied (yadav et al 2022e).

The cross-sectional dependency test is first based on the Breusch and Pegan (1980) LM test. Breusch and Pegan's (1980) LM test is a test that can be used when the cross-section units (N) are large and the time period (T) is small. LM statistics used in determining cross-section dependency are as follows.

$$LM = T \sum_{i=j}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \sim X_{N(N-1)/2}^2 \qquad (1)$$

In equation (1), ρ_{ij}shows the correlation coefficients obtained from the error terms of the model.Asymptotic distribution of x^2 is obtained from N for all (i, j) while$T_{(i,j)} \rightarrow \infty$.

Pesaran (2004) developed the Breusch and Pegan test and suggested the CDLM test, which can be applied in cases where both the cross-section (N) and the analysis period (T) are prominent.

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{\rho}_{ij}^2 - 1) \qquad (2)$$

In the CDLM test developed by Pesaran (2004), distortions occur when the cross-section (N) is larger than the time period (T) (Pesaran, 2021:18). For this reason, Peseran (2004) claims that a new cross-section dependency test is needed when N is significant and T is small, showing small sample properties. Peseran (2004) tests cross-sectional dependency as follows.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left\{ \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \rho_{ij} \right\} \qquad (3)$$

CD statistics,unlike LM statistics, for various panel data models (heterogeneous, homogeneous, non-stationary), N and T values are zero. Pesaran et al. (2008) developed the LMadj (Bias-Adjusted Cross-Sectional Dependency Lagrange Multiplier) test based on the Breusch and Pegan (1980) LM test.

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{\rho}_{ij}^2 \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\vartheta_{Tij}} \qquad (4)$$

While k shows the regressors number, μ_{Tij} shows the average, ϑ_{Tij} represents the variance. When the probability value obtained as a result of the test is less than 0.05, the presence of cross-section dependence is accepted.

2.3. Homogeneity Test

The homogeneity tests of the slope coefficients were tested using the delta test developed by Pesaran and Yamagata (2008). Pesaran and Yamagata's (2008) test is an improved form of Swamy's (1970) homogeneity test. Pesaran and Yamagata's (2008) homogeneity test is formulated as follows.

$$\tilde{N} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}\right) \quad (5)$$

$$\tilde{N}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-E(\tilde{Z}_{iT})}{\sqrt{Var}(\tilde{Z}_{iT})}\right) \quad (7)$$

The cross-section dependency results obtained for the variables and the three models are presented in Table 2. Table 2 also includes the delta and adjusted delta, showing the slope homogeneity test results.

Table 2: Cross-Sectional Dependency Test

Variables and Models	Breusch and Pagan (1980) LM Test	Pesaran (2004) CDLM Test	Pesaran et al. (2008) LMadj	Result Cross-Sectional Dependency
rnenergy	30000	172.7	1214	accepted
	(0.001)	(0.001)	(0.001)	
reelgdpgr	3528	14.84	73.07	accepted
	(0.001)	(0.001)	(0.001)	
gov_right1	5546	50.23	159.8	accepted
	(0.001)	(0.001)	(0.001)	
gov_cent1	8142	76.82	271.3	accepted
	(0.001)	(0.001)	(0.001)	
gov_left1	4615	43.53	119.8	accepted
	(0.001)	(0.001)	(0.001)	
Model1	23000	148.8	816.8	accepted
	(0.001)	(0.001)	(0.001)	
Model2	23000	149.1	816.1	accepted
	(0.001)	(0.001)	(0.001)	
Model3	21000	142.1	-751.2	accepted
	(0.001)	(0.001)	(0.001)	
	Model 1	**Model 2**	**Model 3**	
$\tilde{N}$	3.015	3.696	2.0150	
	(0.001)	(0.001)	(0.048)	
$\tilde{N}_{adj}$	4.099	3.995	2.022	
	(0.001)	(0.001)	(0.043)	

The values in parentheses show the probability value (*p* value).

Cross-section dependency results are presented in Table 2. As a result of the tests, cross-section dependency was determined in variables and models. For this reason, the second generation unit root test, which takes into account the cross-sectional dependence, was used.

2.4. Panel and sustaibbilty Test

As mentioned before, cross-section dependency in variables and predicted models necessitates the application of second-generation unit root tests.One of the second generation unit root tests is the Cross-sectional augmented Dickey-Fuller (CADF) test developed by Pesaran (2007). Pesaran (2007) CADF test is a test that can be applied when the time dimension (T) is larger or smaller than the cross-section dimension (N). Pesaran's (2007: 269) CADF test used in the study is as follows.

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \quad (8)$$

CADF test statistics are calculated as follows.

$$t_i(N,T) = \frac{\Delta Y_i' M_W Y_{i,-1}}{\hat{\sigma}_i (Y_{i,-1}' M_W Y_{i,-1})^{\frac{1}{2}}} \quad (9)$$

On the other hand, it is calculated by taking the average of t statistics values for the cross-section;the panel CIPS test statistic equation is given below.

$$CIPS(N,T) = N^{-1} \sum_{i=1}^{N} t_i(N,T) \quad (10)$$

A stability test was performed by comparing the CIPS statistics calculated for 21 developed countries in the study with Pesaran's (2007) critical table values. The results obtained are presented in Table 3.

Table 3: CADF Panel Unit Root Test Results

Variables	**CIPS STATISTICS**		
	Test Statistics	***P*-value**	**Result**
Rnenergy	-1.780	0.501	I(1)
d.rnenergy	-4.380***	0.001	
gov_right1	-2.445***	0.001	I(0)
gov_cent1	-2.982***	0.001	I(0)
gov_left1	-2,907***	0.001	I(0)
Reelgdpgr	-3.052***	0.001	I(0)

*** indicate significance at the 1% level

The CIPS statistics obtained from the CADF unit root test is a statistic calculated for the entire panel.Pesaran's (2007) CADF unit root test results show that all variables except renewable energy (rnenergy) are stationary at level. When the difference in the renewable energy (rnenergy) variable is taken, it becomes stationary.

2.5. MG and PMG Estimations

The relationship between government policy orientations and renewable energy has been tested using PMG (pooled-mean group) and MG (mean group) estimators. MG and PMG are non-stationary dynamic panel estimators where intergroup parameters are heterogeneous. In this framework, three models created to investigate the long-term relationship are as follows.

Model I : $$rnenergy_{it} = \alpha_0 + \alpha_{1i} gov\_right_{it} + \alpha_{2i} reelgdp_{it} + \epsilon_{it} \quad (11)$$

Model II : $$rnenergy_{it} = \alpha_0 + \alpha_{1i} \text{gov\_cent}_{it} + \alpha_{2i} reelgdp_{it} + \epsilon_{it} \quad (12)$$

Model III : $$rnenergy_{it} = \alpha_0 + \alpha_{1i} \text{gov\_left}_{it} + \alpha_{2i} reelgdp_{it} + \epsilon_{it} \quad (13)$$

Among the variables included in the models, gov_right indicates right-handed governments, gov_center central governments, realgdp equals real GDP and ϵ_{it}denotes the error term.In the first model, the cointegration relationship between right-oriented governments and renewable energy is examined. This model includes renewable energy (rnenergy), right-oriented governments (gov_right), and real GDP (realgdp) variables. In the second model, the cointegration relationship between central governments and renewable energy is investigated. The variable gov_cent in this model represents central governments. In the last model, the relationship between left-oriented governments and renewable energy is tested. The gov_left variable in the model represents left-oriented governments. For each model, PMG and mg were estimated, and the effective predictor was determined by the Hausman test.The long and short-term coefficients obtained from the estimation of the models are presented in table 4.

Table 4: MG and PMG Estimations Results

Dependent Variable:	**MODEL I**		**MODELII**		**MODELIII**	
Renewable energy	**MG**	PMG	MG	**PMG**	**MG**	PMG
Long-run coefficients						
ReelGDP	0.4373661	-0.8022411	0.3518326	-0.593601	0.8184486	-0.377046
	(0.590212)	(0.3559688)	(0.6045131)	(0.3310278)	(0.516966)	(0.3109586)
Gov_right	0.0023398	-0.0138342				
	(0.227902)	(0.208983)				
Gov_centre			-0.2214891	-0.2454312		
			(0.0278836)***	(0.251996)***		
Gov_left					0.1478609	0.2158078
					(0.0245373)***	(0.0185453)***
Short-run coefficients						
ReelGDP	0.4600155	1.149434	0.6554005	1.056189	0.4067935	1.025539
	(0.4600155)	(0.2466744)***	(0.3815235)	(0.2537236)***	(0.381438)	(0.2515729)***
Gov_right	-0.0200759	-0.0135523				
	(0.141478)	(0.0076461)				
Gov_centre			0.1736071	-0.1659659		
			(0.0144135)***	(0.0086049)***		
Gov_left					0.0786743	0.1022176
					(0.0156172)***	(0.100543)***
Statistics						
Hausman test (p-value)	8.34		5.27		19.87	
	(0.0155)		(0.0718)		(0.0001)	
Number of observations	1128		1128		1128	

The values in parentheses show the probability value (*p* value). *** indicate significance at the 1% level.

As seen in Table 4, according to Hausman test results, MG in the first model, PMG in the second model, and MG in the final model give effective results. Within the framework of the Hausman test, it was determined that the MG estimator gave more effective results for the first model (Yadav et al 2022). The Hausman *p*-value obtained in the first model is lower than 0.05, indicating that the MG estimator gives more effective results. In the results obtained from the first model in which the cointegration relationship between right-oriented governments and renewable energy was tested, a positive but not statistically significant coefficient was found in the long run. In other words, it can be said that there is no long-term cointegration relationship between right-oriented governments and renewable energy. On the other hand, the error correction term estimated for the first model is negative and statistically significant, which means that the error correction mechanism is working. Besides, when a deviation from the long-term balance occurs, it will come to balance again (Yadav et al 2021).

When the findings obtained from the estimation of the second model are evaluated, it is determined that there is a long-term and statistically significant relationship between central governments and renewable energy. The probability value of the Hausman test is more important than 0.05, indicating that the PMG estimator is effective. According to PMG estimation results, there is a

long and short-term cointegration relationship between renewable energy and central governments. The long and short-term coefficients obtained in the model are -0.2454312 and -0.1659659, respectively.

In the last model in which the relationship between left-oriented governments and renewable energy is tested, there is a cointegration relationship in the long and short term. Hausman test shows that the MG estimator is valid. It is seen in the model that the long-term cointegration coefficient is 0.1478609, and it is statistically significant at a one percent significance level. In addition, the short-term coefficient is also positive and statistically significant(Yadav et al 2022).

3. Results

In the study, the long and short-term cointegration relationship between the ruling parties' political orientations and renewable energy was investigated using the data of 21 developed countries between1960-2018.

The first of the findings is that there is no cointegration relationship between right-oriented governments and renewable energy in the short and long term. There may be two reasons for these results. First of all, it may arise from the fact that the business world, which is the financier of right-oriented political powers, sees renewable energy as a factor that increases costs. Renewable energy is a sector that requires long-term investments. In addition, while profit maximizationis the main goal for corporations, the goal of governments is to increase social welfare.This can lead to a conflict between corporations' goals and government policies. For this reason, right-oriented governments may take a hesitant stance in implementing long-term renewable energy policies that prioritize social welfare(Yadav et al 2020).

The second finding shows the long and short-term cointegration relationship between centrist governments and renewable energy. However, the long-term and short-term cointegration coefficient is negative. The term error-correction is negative and statistically significant (Yadav et al 2022).

The main finding obtained from the last model is that there is a positive and statistically significant cointegration relationship between left-oriented governments and renewable energy in the long and short run. This result is parallel with empirical studies that apply different statistical methods (Biresselioglu and Karaibrahimoglu 2012; Neumayer 2003). This study is unique because it considers the cross-sectional dependency, and the second generation unit root tests are applied (Yadav et al 2022). One reason for the long- and short-term relationship between left-oriented governments and renewable energy is thought to be the strengthening of environmental movements under left-oriented governments. Second, left-leaning governments are open to demands from the electoral base for economic growth and development that is environmentally friendly(yadav et al 2021).

In summary, although there are many factors affecting the consumption and development of renewable energy, the political orientations in power have different perspectives on the subject for various reasons, which is an element that affects renewable energy.

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