Are Changes in Electricity Production Perpetual or Temporary: An Evidence from Emerging Countries

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1 Introduction

The topics of detecting energy consumption stationarity properties have been underlined a massive discussion in the literature, at least for the following importance. Initially, shock will have temporary impacts on energy businesses if the energy consumption is stationary at the level; in other explanation, a transitory departure from energy consumption's long-run course resulting from any shocks or policies experienced in the energy markets will be reported. Nevertheless, when the energy consumption includes a unit root, it can be claimed that shocks will have a power deviating the energy consumption from its long-run trend path (Hasanov & Telatar, 2011). The stationarity properties of the energy consumption perform a vital position in forecasting the future energy demand and determining the energy policies. Regarding the forecasting, if the energy consumption does not follow path dependence or hysteresis, meaning no unit root in energy consumption and production, it is probable to anticipate future energy consumption movements or production by examining its past behavior. In addition to the failure of the estimation, the existence of a unit root in energy consumption or production is required to design the policies and targets to increase renewable energy and decrease nonrenewable energy (Mishra & Smyth, 2014). As for the renewable energy policies, the existence of a unit root signifies that the long-standing policy implications are recommended to implement because the positive shocks based on the perpetual policy changes,

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H. Dinçer, S. Yüksel (eds.), *Sustainability in Energy Business and Finance*,
Contributions to Finance and Accounting,
https://doi.org/10.1007/978-3-030-94051-5_4

including the renewable portfolio standard, will permanently impact renewable energy consumption and production. The implication for the nonrenewable energy sources works in the reverse direction if the nonrenewable energy sources include a unit root. Suppose the presence of the unit root in the nonrenewable energy resource is found. In that case, the policies aiming to reduce nonrenewable energy sources contrary to the policies promoting renewable energy sources will permanently impact the outcomes (Tiwari & Albulescu, 2016). Assuming the inexistence of unit root in the nonrenewable energy sources, the policies purposing to shrink nonrenewable energy consumption will be ineffective (Smyth, 2013). Briefly, it can be implied that if shocks to energy consumption are determined as temporary as a result of the investigation for the unit root process, a stabilization energy policy seem to have no permanent impacts. Hence, the government's policy should not be adopted as irrelevant points (Hsu et al., 2008).[1]

In addition to theoretical frameworks, a growing amount of empirical works have been endeavored to investigate the issue of the stationarity features of energy series. The knowledge of the stationary of the energy series provides insight information used to design and implement the energy policies along with forecasting future production and demand. ELP has been one of the most attention energy indicators since human development, economic growth, and economic development depend on sustainability access to electricity. Besides, the type of ER used for generating EL is also a significant matter for economic development. Current estimation displayed by BP statistical review of World Energy (2020) shows that NRER generate approximately 63.3%of total ELP worldwide. Usage of NRER induces environmental degradation experienced as floods, drought, diminishing biological diversities. Environmental degradation has been one of the shining out issues in both developed and developing countries because ecological degradation has significant repercussions on the planet and the sustainability of economic development. Therefore, sustainable Development Goals (SDGs) have been established within this scope to prevent environmental disasters and sustain the development and growth objectives (Işık et al., 2021). UN General Assembly in September 2015 shows the essence of Sustainable Development Goals (SDGs), and many world leaders have been in common consensus which environmental sustainability should become the center of the development plan to protect the ecosystem, sustain the adequate quality of natural resources, and prevent diminishing the variety of plant and animal species (UNEP, 2015).

[1] Later, in the study, renewable energy signifies RE, renewable energy resources signify RER; renewable energy consumption signifies REC; renewable energy production signifies REP; nonrenewable energy presents NRE; nonrenewable energy resources signifies NRER; nonrenewable energy consumption indicates NREC; nonrenewable energy production denotes NREP; electricity means EL; electricity consumption denotes ELC; electricity production ELP; energy consumption EC; energy production EP; energy resources denote ER; nuclear energy denotes NE; nuclear energy consumption NEC; natural gas consumption denote NGC; oil consumption refers OC; coal consumption signifies CC.

Within this concerning sustainable objectives, in the study, we investigate the stationary properties of ELP for 1971–2015 from oil, gas, and coal (% of total) for six emerging countries where rapid urbanization and higher economic performance are observed. The first,[2] second-generation panel unit root test and newly panel unit root tests with sharp shifts and smooth breaks are employed, and all data is achieved from World Bank (2021) DataStream. Regarding our best knowledge, the study provides insight evidence for policymakers to design the energy policies in several ways. Initially, employing three types of panel unit root provides robust evidence for energy variables' stationarity properties. In the light of the evidence, the countries considered can follow common energy policies. In addition, new panel unit root tests with sharp shifts and smooth breaks also show the univariate unit root test result for each country generating panel data and structural breaks. Within this knowledge, policymakers from each country can design their energy policy.

2 Literature Review

Concerning environmental degradation, the scenarios of exhausting NRER and the energy-imported countries' efforts of the alternating ER overcome the issues generated by energy dependence; renewable energy seems to be the only solution to overcome the problems mentioned earlier. However, adequate knowledge about the RER movement is required to determine the implication to increase the number of RER. Therefore, various investigators have been endeavored to ascertain the features of RER' series. For example, Wang et al. (2016) concentrate on the stationary property of non-fossil energy in Japan for the period 1965–2011. The univariate and panel Lagrange Multiplier unit root is applied along with the Fourier-type Lagrange Multiplier test to detect the stationary situation of the variables. The empirical evidence affirms a difference between the stationary properties of NE and RE. The change in NEC exposed from any shocks is permanent; in other explanation, NEC contains unit roots. In opposition, the fluctuations in REC are concluded as permanent. Lean and Smyth (2013) try to determine the integrated order of the REP and biofuels and biomass in the US by using the LM univariate unit root test, supporting detecting two structural breaks. According to the findings, it is indicated that each series contain a unit root. Yilanci and Tunali (2014) employ a unit root test based on a Fourier function capability of detecting the unknown nature of structural breaks to analyze whether any shocks can deviate the EC per capita in 109 countries. From its trend path. The analysis results confirm that energy demand management or other surprises do not change the EC per capita for 25 countries. Demir and Gozgor (2018) analyze the stationary properties of REC in 54 countries by using the Narayan–Popp unit root test with two unknown breaks. As a result of

[2]Later, in the study, the first-generation panel unit root tests and the second-generation panel unit root test signify FirstGPUT and SecGPUT, respectively.

the analyses, it is emphasized that RE demand policies permanently impact nine countries of the considered countries. Basher et al. (2015) employ individual and panel unit root tests to determine the stationary properties of renewable ELP to ELP in 19 OECD countries for 1990–2012. The empirical evidence affirms that the effect of the shocks on the renewable share of EL output seems to be permanent in 17 of the 19 countries. Tiwari and Albulescu (2016) use the flexible Fourier stationary test improved by Becker et al. (2006) and the recent advanced Fourier ADF test to test the stationary properties of the renewable-to-total ELC ratio belonging 90 countries for 1980–2011. The finding from the first test shows that the stationary of the renewable-to-total ELC ratio for 65 countries located in different geographic areas is detected. In contrast, the second test shows that shocks permanently influence all countries' EC except for the UK. Gozgor (2016) adopts three types of unit root tests allowing for one structural break, two structural breaks, and more than two structural breaks, in turn, to analyze whether the fluctuations in REC have temporary or permanent appearances in three crucial developing countries. The result of the tests shows that REC includes a unit root in Brazil. In contrast, the fluctuations in REC in China and Brazil are found as temporary. Barros et al. (2013) prefer to disaggregate REC into hydropower, geothermal, solar, wind, wood, waste, and biofuels to examine the degree of time persistence in the US. Innovative fractional integration and autoregressive model are applied on monthly data covering the period 1994:02–2011:10. The result underlines that disaggregated REC is accepted as a better measure to forecast future trends because of persistence components. A similar data approach is also administered by Aydin and Pata (2020) in terms of disaggregated REC for the US. Wavelet-based unit root test with smooth structural breaks is applied, and it is found that the appearance of the energy policies aimed to change the REC is permanent without hydropower and biofuels energy consumption.

Oil has been one of the leading energy sources globally, and nearly 40% of the world's energy mix is provided by oil. Oil is a NRER and one of the most known culprits regarding environmental degradation. That is why the investigation for the stationarity properties of OC becomes an important research topic for implementing efficient energy and economic policies. Solarin and Lean (2016) prefer linear and nonlinear unit root tests to detect fluctuations in OC's appearance in 57 countries for the period covering 1965–2012. They reach much evidence that the validity of nonlinearity in the series is affirmed for 21 countries, and the presence of the nonstationary is confirmed for 38 countries. Briefly, policies designed to reduce OC in the countries considered will become powerful. Although various studies have been attempted to detect the effects of natural gas consumption on several macro-economic fundamentals in the literature, the investigation for the stationary features of NGC has been received limited attention. Indeed, determining the NGC stationary level plays a vital role in the proper management of NGC because natural gas provides 22% of EL and 20% of the industry's energy demands. Shahbaz et al. (2014, 2015) effort to review the stationarity characteristics of NGC in 44 countries for 1965–2010 and 48 countries for 1971–2010, respectively. The first study finds that the null hypothesis cannot be accepted in 57% of the considered countries. In

contrast, the second study indicates that NGC in more than 60% of the selected countries is not stationary. The effects of CC on the environment have generated colossal awareness in the public, policymakers, and environmentalists, and the policies aiming to reduce CC have been accepted as consensus. On the other hand, like other disaggregating studies based on NRER, there is little investigation to determine coal consumption's stationary properties in the literature. Shahbaz et al. (2014) seek to detect whether the variations in CC per capita have temporary or permanent appear in developed and developing countries. LM unit root test with one break and Crash model with two breaks are used. As a result of the models, it is implied that energy management policies do not play an important role in CC in almost all considered countries because CC can return to its trend path. Tang et al. (2018) try to detect the decline in CC in China is temporary or permanent by using the logarithmic mean Divisia index method (LMDI), and the study confirms the validity of the permanent behavior in decline in CC.

As ELC is one of the leading EC, its management and policies aimed to increase its efficiency become a critical policy agenda for policy makers. The investigation for the stationarity properties of the ELC is vital like other investigations for other types of ER as Economic growth and development rely on sustainable access to EL. For example, Kula et al. (2012) utilize the Lagrange Multiplier (LM) unit root test to endogenously detect structural breaks to investigate the stationary properties of ELC per capita in 23 OECD countries selected in terms of high-income classifications. As a consequence of the test, it is claimed that the past behavior of the ELC per capita in almost all OECD countries will be used to forecast its future pattern because the unit root null hypothesis is rejected for 21 countries. Shahbaz et al. (2013) analyze whether the fluctuations in ELC per capita of 67 developed and developing countries are temporary or not, utilizing Lee and Strazicich's (2004) unit root test and Lagrange Multiplier (LM) test for 1971–2010. The evidence of the tests indicates that ELC per capita in 65 countries can return its trend path. Bolat et al. use the individual unit root test with structural breaks improved by Carrion et al. (2005), allowing for cross-sectional dependence and multiple structural breaks to determine the stationary properties of ELC per capita in 16 European countries for 1960–2009. The evidence of unit root test with intercept-no trend confirms that the null hypothesis of stationary can be accepted except for six countries comprising Belgium, France, Germany, Greece, Luxembourg, and Sweden. In contrast, the test result with intercept and trend affirms that the stationary of ELC seems to be not rejected except Luxembourg. All in All, it is concluded that the appearance of the shocks to ELC per capita is a temporary impact for 15 countries; in other words, ELC tends to return to its time trend. Khraief et al. (2016) apply a univariate and panel unit root test to analyze whether ELC in Sub-Saharan Africa countries contains a unit root for 1971–2013. In addition to the conventional panel unit root test involving FirstGPUT and SecGPUT, the LM panel unit root rest improved by Im et al. (2005) is also employed, and the model's result poses any events affecting ELC seem to be powerless. Dogan (2016) analyzes the appearance of the shocks on ELC utilized by sector in Turkey. The EL data is based on 12 regions of Turkey by four regions and total ELC by region involving 60 cases. The evidence indicates that 48 cases

contain a unit root, which means that energy management can play a vital role in changing ELC.

Regarding the literature, great studies are trying to reach useful knowledge for the stationarity properties of the energy sources. In this study, we concentrate on the ELP from oil, gas, and coal (% of total) in six emerging countries considering data techniques like Basher et al. (2015), Tiwari and Albulescu (2016) by using newly panel unit root tests with sharp shifts and smooth breaks along with FirstGPUT and SecGPUT. The importance of EL for urban and industrialization needs for emerging countries and the more useful knowledge resulting from the econometric techniques may execute an essential role in expanding the existing literature.

3 Results

The result section covers the findings of the three types of the panel unit root tests: FirstGPUT and SecGPUT, and a panel root test that allows for considering both sharp and smooth breaks introduced Bahmani-Oskooee et al. (2014). All three types of panel unit root tests are employed to investigate whether the impacts of the shocks on ELP from NRER are temporary or permanent. Before conducting the panel stationarity tests, Cross-sectional dependence (CD) tests involving Breusch-Pagan LM, Pesaran Scaled LM, Bias-Corrected Scaled LM, and Pesaran CD (2004) are carried out. The result of the tests is reported in Table 1 Panel A. According to the finding, the existence of CD is found.

FirstGPUT involve Levin et al. (2002), Breitung (2001), Im et al. (2003), ADF-Fisher, and PP-fisher. The result of FirstGPUT tests is reported in Table 1 Panel B. According to Table 1 Panel B, it is concluded that the electricity production from oil, gas, and coal is not stationary; in other words, it contains a unit root. However, FirstGPUT tests are exposed to significant drawbacks without regarding the effects of CD. SecGPUT are an improved model of FirstGPUT because they consider the cross-sectional dependence. SecGPUT test improved by Pesaran (2004) is carried out in this study. The result poses that the effects of the shocks on ELP in emerging countries are permanent. FirstGPUT and SecGPUT imply that ELP from oil, gas, and coal in the emerging countries has unit roots; in other words, it is not stationary. The energy management policies aimed to reduce ELP from NRER will be effective.

Nevertheless, there is also some drawback related to SecGPUT. They do not consider structural breaks. Various studies focus on sharp structural breaks to investigate the properties of the fluctuations in the energy, but smooth breaks are received less attention by just limited studies. A newly proposed panel unit root test for sharp and smooth structural breaks introduced by Bahmani-Oskooee et al. (2014) is employed. The cross-sectional independent among the variables is required to conduct panel unit root tests considering structural breaks. Still, Table 1 for the result of the CD tests poses that there is a CD. Bahmani-Oskooee et al. (2014) offer that the method introduced by Maddala and Wu (1999)‘s producer is used to overcome this

Table 1 The finding of cross-sectional dependence and first-second generation panel unit root tests

Panel A: Cross-sectional dependence tests				
Variables	**Breusch-Pagan LM**	**Pesaran scaled LM**	**Bias-corrected scaled LM**	**Pesaran CD**
Electricity production from oil, gas, and coal sources (% of total)	142.2798 (0.000)	22.14257 (0.000)	22.07439 (0.000)	8.826020 (0.000)

Panel B: First and second-generation panel unit root test						
Variables	**First-generation panel unit root test**					**Second-generation panel unit root test**
	Common unit root process		**Individual unit root process**			**Pesaran CADF**
	Levin, Lin &Chu	**Breitung**	**Lm, Pesaran and Shin**	**ADF-Fisher**	**PP-Fisher**	
Electricity production from oil, gas, and coal sources (% of total)	1.89843 (0.9712)	2.66504 (0.9962)	1.56552 (0.9413)	8.75434 (0.7238)	15.1551 (0.2331)	0.836 (0.798)
D(Electricity production from oil, gas, and coal sources (% of total))	−7.78035 (0.000)	−5.16783 (0.000)	−8.94619 (0.000)	90.0122 (0.000)	257.175 (0.000)	−7.121 (0.000)

drawback. The bootstrap procedure of Maddala and Wu (1999) with 1000 replication is carried out to achieve the critical values. Therefore, the conclusion of the panel stationary test introduced by Bahmani-Oskooee et al. (2014) is reported in Table 2 Panel A. The KPSS statistics for the homogenous and heterogeneous tests are lower than the critical values at the 10% significance level, implying that the stationary null hypothesis for six emerging countries is accepted. In other words, ELP from oil, gas, and coal sources is stationary. Panel B in Table 2 presents the results of a univariate version of the stationary test. The critical values for the univariate version are measured using a Monte Carlo simulation with 1000 replication. Thus, the null hypothesis of stationarity is rejected at the 10% significance level for three countries: China, Indonesia, and India. In contrast, the null hypothesis of the stationarity test cannot be rejected for Brazil, Mexico, and Turkey. These results emphasize that the fluctuations in ELP or the effects of the shocks on ELP from NRER are temporary for Brazil, Mexico, and Turkey; whereas, the effects of the shocks on ELP from NRER are permanent for China, Indonesia, and India. According to the achieved results from all panel unit root tests, it can be argued that ELP from NRER contains unit roots as a result of FirstGPUT and SecGPUT. This result implies that energy management policies purposed to reduce NRER share seem to be effective. Nevertheless, the result of the panel stationarity tests with sharp shifts and smooth breaks indicates that ELP from NRER cannot respond to the energy policies aimed to diminish the share of the NRER in ELP because the result

Table 2 Panel unit root tests with multiple sharp breaks

Panel A: Panel unit root test
Number of cross: 6.0000
Time period: 1971–2015
Number of replication: 1000
Maximum number of breaks: 2.0000
Maximum number of frequencies: 5.0000

	Stat.	**90%**	**95%**	**97.5%**	**99%**
Homogeneous Panel KPSS Test	−2.1445 (0.9840)	0.8993	1.2984	1.7724	2.2049
Heterogeneous Panel KPSS Test	−2.0295 (0.9788)	−0.5500	−0.3030	−0.0497	0.3340

Panel B: Univariate unit root test and multiple breaking dates

	KPSS Test	**90%**	**95%**	**97.5%**	**99%**	**Multiple breaking dates**	
Brazil	0.0369	0.1128	0.1476	0.1889	0.2442	2011.0000	0.0000
China	0.1616	0.1499	0.1822	0.2204	0.2624	1990.0000	2011.0000
Indonesia	0.1021	0.1009	0.1333	0.1709	0.2065	1977.0000	1995.0000
India	0.1105	0.0813	0.0989	0.1309	0.1585	1984.0000	1994.0000
Mexico	0.1325	0.1432	0.1864	0.2278	0.2598	1977.0000	2000.0000
Turkey	0.0982	0.1609	0.2062	0.2658	0.3325	1974.0000	1998.0000

Panel C: The results for optimum frequency and f-statistic and its critical values

	F-Stat	**90%**	**95%**	**97.5%**	**99%**		
Brazil (1)	24.7728	2.4486	3.2177	4.2783	5.5166		
China (4)	8.3743	2.4532	3.2528	4.0672	5.3204		
Indonesia (4)	6.1633	2.5167	3.3886	4.0680	5.3259		
India (1)	5.9975	2.4505	3.2250	4.2643	0.1585		
Mexico (4)	7.8619	2.4873	3.4247	4.1903	0.2598		
Turkey (4)	3.1885	2.5270	3.3166	4.2247	0.3325		

of the panel statistic for the homogenous and heterogeneous show that ELP from NRER is stationary. As for the univariate version of the stationary test, the temporary effects of the shocks on ELP holds for Brazil, Mexico, and Turkey; while, the permanent effect is valid for China, Indonesia, and India. The difference leads to unique energy management policies among the countries. The energy implementation used to diminish the share of the NRER in ELP is recommended for China, Indonesia, and India.

Besides, Panel C in Table 2 confirms that all F statistics belonging to countries are higher than the critical values, leading to the null hypothesis's rejection. Therefore, the trigonometric variables are significant, which implies that both the sharp and smooth breaks model can be used for all variables. The global energy crisis that occurred in the 1970s and the 1980s is experienced in Indonesia, India, Mexico, and Turkey due to the multiple breaking dates. However, China has experienced multiple Breaking Dates occurring in the 1990s and the 2000s, named the massive industrialization and the increase in the urban development in China. In these periods, energy demand for urban needs and industrialization in China seem to induce multiple breaks.

4 Conclusion

ELC has been one of the most crucial development indicators. Economic growth and development objectives place reliance on an adequate and stable supply of EL; all in all, EL is a requisite figure in every side of human life. Although sustainable access to EL becomes irreplaceable steps for economic development, types of energy sources providing EL have been another essential point. In the world, generating EL from NRER accounts for approximately 63.3% worldwide. NRER are the main culprit for environmental degradation experienced around the world. CO2 emissions, marine pollution, and habitat destruction are the detrimental effects of NRER, harming sustainable development goals. In addition, NRER are ultimately subordinate to run out of fatefulness. Regarding the damaging effects of NRER, EL generation from RER has become irreplaceable to achieve development objectives. Within this aim, the investigation for the stationary properties of ELP provides insight information for policymakers to design and implement energy policies. For example, if ELP generation from NRER contains unit roots, any shocks from energy policies will permanently impact ELP. However, if ELP does not involve unit root; in other explanation, the variable restores to its trend route in the aftereffect of shocks, the energy policies will have a transitory impact on ELP. In contrast, the presence of the stationary can be used in formulating forecasting. Within these objectives, the study investigates ELP from oil, gas, and coal (%of total) in six emerging countries to reach a piece of knowledge concerning stationarity characteristics of the considered variable.

Employing FirstGPUT and SecGPUT and a newly improved panel unit root test allowing for considering sharp shifts and smooth breaks introduced by

Bahmani-Oskooee et al. (2014) investigate the unit root characteristic of ELC from NRER (% of total) for six emerging countries over the period 1971–2015. The results of FirstGPUT and SecGPUT found that the ELP from NRER involves unit roots, which implies that shocks will have a power deviating the ELP from its long-run trend way. The policymakers can adopt defined target levels regarding the share of ELP from NRER. The energy management policies aimed to decrease the percentage of NRER in ELP will be effective. Nevertheless, the result of the panel unit root test introduced by Bahmani-Oskooee et al. (2014) indicates that homogeneous and heterogeneous tests are not higher than the critical values, which presents the stationary hypothesis for six emerging countries. According to these implications, any shock-generating energy policies will temporarily impact ELP, which follows its long-run trend. Moreover, the univariate version of the stationary result for each country shows that the rejection of the null hypothesis holds for China, Indonesia, and India. In contrast, the acceptance of the null hypothesis is found for Brazil, Mexico, and Turkey. According to this finding, it is not recommended for six emerging countries to follow standard energy policies. Therefore, China, Indonesia, and India have a policy tool to diminish the share of NRER in ELP because the energy policies will have a long-lasting impression on electricity production.

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