INVESTIGATING THE STATIONARY PROPERTIES OF COAL, NATURAL GAS, AND OIL CONSUMPTION: THE CASE OF FRAGILE FIVE COUNTRIES

KÖMÜR, DOĞAL GAZ VE PETROL TÜKETİMİNİN DURAĞANLIK ÖZELLİKLERİNİN İNCELENMESİ: KIRILGAN BEŞLİ ÖRNEĞİ

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Abstract: We examine the stationarity properties of primary energy consumption for "Fragile Five" countries and assesses whether shocks on coal, natural gas, and oil consumption are permanent or temporary. The findings suggest that shocks on coal consumption are temporary for Brazil, South Africa, and Turkey, while are permanent for India and Indonesia. Moreover, the effect of shocks on natural gas consumption is temporary for five fragile countries except for South Africa. Finally, it is found that shocks on oil consumption are temporary for only India and Indonesia.

Keywords: Primary Energy Consumption, Fourier Unit Root Test

Jel: C12, C20, Q40

Öz: "Kırılgan Beşli" ülkeleri için birincil enerji tüketiminin birim kök özelliklerini analiz edip ve kömür, doğal gaz ve petrol tüketimi üzerindeki şokların kalıcı veya geçici olup olmadığı incelenmiştir. Bulgular, kömür tüketimi üzerindeki şokların Brezilya, Güney Afrika ve Türkiye için geçici, Hindistan ve Endonezya için kalıcı olduğunu göstermektedir. Ayrıca, şokların doğal gaz tüketimi üzerindeki etkisi Güney Afrika dışındaki beş kırılgan ülke için geçicidir. Son olarak, petrol tüketimindeki şokların sadece Hindistan ve Endonezya için geçici olduğu bulunmuştur.

Anahtar Kelimeler: Birincil Enerji Tüketimi, Fourier Birim Kök Testi

1. Introduction

Today, the most basic input in the production process is the energy factor for the realization of social and economic development. Global population growth, urbanization, and industrialization have increased economic activities and increased energy consumption and demand. Therefore, energy consumption is closely related to macroeconomic variables as well as capital productivity and labor (Hsu et al., 2008: 2318). In this context, in recent years, energy consumption has become an interesting topic by researchers and policy-makers.

It can be said that there has been an increase recently in the studies on stationarity analysis of energy consumption variables (Narayan et al., 2010: 1953). The stationarity properties of energy consumption can give very important information because of the various reasons. Firstly, if energy consumption series is not stationary, the shocks are permanent. Also, the effect of the policies to be implemented will be

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permanent (Aslan and Kum, 2011: 4256). Secondly, energy variables are directly associated with macroeconomic indicators. The non-stationary structure of any variable containing a unit root can be transferred to other variables. In this case, the stationary features of many macroeconomic variables may change. For example, economic growth, consumption, employment, and inflation rate. Finally, whether the energy consumption variables contain unit root is very important in the prediction and forecasting phase. Also, it is not possible to estimate future energy demand for variables with unit-roots (Hendry and Juselius, 2000: 5, Chen and Lee, 2007: 3526).

Nowadays, a great portion of the energy demand is met from oil, coal, and natural gas, which are called primary energy sources. But fossil fuels are finite resources, and greenhouse gas emissions from these sources are the major cause of climate change (IEA, 2016a: 23). Therefore, primary energy sources should be minimized for sustainable production, environmental protection, and carbon emission reduction. Successful policies to reduce dependence on these sources depend on whether the shocks of energy consumption are permanent or not. In this framework, this study focuses on the consumption of primary energy sources. In previous studies, unit root examination has been done by centering on total energy consumption. However, some energy variables have a unit root, while others may not. (Lean and Smyth, 2009:320). Because of this important reason, the consumption data of decomposed primary energy are used instead of the total energy consumption in the study. In the literature, some studies have analyzed total primary energy consumption (Narayan and Smyth, 2007; Hasanov and Telatar, 2011; Ozcan, 2013; Destek and Sarkodie, 2020, etc.). But some of them have examined only coal consumption (Apergis et al., 2010a, Shahbaz et al., 2014a, Congregado et al., 2012), only natural gas consumption (Apergis et al., 2010b; Aslan, 2011; Golpe et al., 2012; Shahbaz et al., 2014b among others), or only oil consumption (Narayan et al., 2008; Apergis and Payne, 2010; Maslyuk and Smyth, 2009 among others). We analyzed coal, natural gas, and oil consumption data, which are expressed as primary energy sources, separately.

This study investigates the stationary properties of the primary energy consumption for "Fragile Five" by using "linear", "nonlinear", and "Fourier-based" unit root test for the period 1965-2018. These countries are (Brazil, India, Indonesia, South Africa, and Turkey). As far as we know, there is no study directly addressing these countries in the literature. Therefore, it is thought that analyzing the stationary properties of energy consumption of the fragile five countries will make a big contribution to the existing literature. The concept of "Fragile Fives" was first introduced by Morgan Stanley (2013). These countries exhibit a similar structure in terms of economic indicators. They are also more vulnerable to economic shocks. When the relationship of energy factor with many macroeconomic indicators is evaluated, fluctuations that will occur in these variables will also affect the level of energy consumption. Because of this, analyzing the stationary properties of energy consumption variables will give us very important information.

It is thought that the paper will also contribute in terms of econometric methodology. Traditional time series analyzes are based on linearity assumptions. Linear models assume that there is only one structure or regime over time. However, events such as oil crises and price collapses in the energy markets may have changed the linear structure of the series. When the nonlinearity structure of the series disregard, it is effected the unit-root test results. It causes the series to result as if it is not stationary. Failure to not consider structural break also gives similar results when the nonlinear

structure is not taken into account. In addition, nonlinear models are also very successful in achieving a smooth structural transformation. Since the aim is to make better predictions and forecast, more precise predictions can be made by accurately revealing the structure of the data.

2. Literature

To understand the dynamic behavior of energy consumption, many studies have been conducted in this field. Narayan and Smyth (2007) analyzed primary energy consumption using Dickey-Fuller (DF, 1979) test. They also used Im et al. (2003) unit root tests. In univariate unit root tests, findings have been obtained that for two-thirds of countries, the series is not stationary and according to Im et al. (2003) test results, energy consumption does not have unit root. Hasanov and Telatar (2011) examined stochastic behaviors of primary energy consumption with KSS (2003) and Sollis (2004) unit root tests to consider the nonlinear structure of the series and structural break. In the study, contradictory results per capita energy consumption of 178 countries. Ozcan (2013) applied the LM test suggested by Lee and Strazicich (2003 and 2004) and the panel LM test suggested by Im et al. (2005) for 17 Middle Eastern countries of total primary energy consumption per capita and has found that the shocks on energy consumption are transitory. Destek and Sarkodie (2020) examined unit root characteristics of the primary energy sources for 16 OECD countries using Fourier-based unit root tests. It has been found that most shocks are permanent in oil, coal and natural gas consumption. Apart from these studies, studies dealing with primary energy sources separately are also quite high in the literature. Narayan et al. (2008), Apergis and Payne (2010), Solarin and Lean (2016), Maslyuk and Smyth (2009) and Burakov (2019) investigated the stationarity of oil consumption and obtained mixed results. Regarding natural gas consumption, Aslan (2011), Golpe et al. (2012), Shahbaz et al. (2014b), Cai and Magazzino (2019) obtained contradictory findings in their studies, while Apergis et al. (2010b), Abid and Alimi (2019) found that shocks are permanent in natural gas consumption. Moreover, Apergis et al. (2010a) and Shahbaz et al. (2014a) showed that shocks are transitory when Congregado et al. (2012) revealed that the shocks on coal consumption are permanent. The literature is briefly summarized in Table 1.

The findings in the literature appear to be inconsistent. This is due to the analysis of several econometric methods, several sectors and countries, as well as different periods (Akram et al. 2020: 228). In the case of structural breaks and non-linearity in the data generation process, the use of unit root tests that do not take into account these structures cause the studies to be questioned. Therefore, this paper fills the gap in the literature by focusing on these properties of the data generating process for fragile fives countries.

3. Data

We used coal, natural gas, and oil consumption data, which are expressed as primary energy sources. The data are derived from the British Petroleum Statistical Review. Data are collected for fragile five countries over the period 1965-2018. These countries are Brazil, India, Indonesia, South Africa, and Turkey. Natural gas consumption data for South Africa is starting from 1971, while the data for Turkey is starting from 1982. Oil consumption is measured in million tones (mtoes), and coal

consumption and natural gas consumption is measured in million tons of oil equivalent. The natural logarithms of the series are used in the study.

Table 1: Literature

Authors	Period and Countries	Methodology	Results
	Primary Energy Consumption		
Narayan and Smyth(2007)	1979-2000 and 182 Countries	ADF (1979), Im-Pesaran-Shin(2003)	Mixed Results
Hasanov and Telatar (2011)	1980-2006 and 178 Countries	ADF(1979), KSS(2003), Sollis(2004)	Mixed Results
Ozcan (2013)	1980-2009 and 17 Middle East Countries	Lee and Strazicich (2003; 2004)	Mixed Results
Destek and Sarkodie (2020)	1970-2018 and 16 OECD Countries	Fourier ADF(2012), Fourier KSS(2010)	Mixed Results
	Coal Consumption		
Apergis et al. 2010(a)	1982-2007 and 50 US states	Im et al.(2005),Westerlund (2005), Carion-I Silvestre et al. (2006)	Temporary
Shahbaz et al. (2014a)	1965-2010 and 47 Countries	Lee and Strazicich (2003,2004)	Mixed Results
Congregado et al. (2012)	1973Q1-2010Q3 and US	ADF(1979), Ng-Perron(2001), Zivot and Andrews(1992), Non-linear specification of an unobserved components model	Permanent
	Natural Gas Consumption		
Apergis et al. (2010b)	1980-2007 and 50 US states	Levin et al. (2002), Im et al. (2003), Maddala and Wu (1999), and Hadri (2000), Carrion-i-Silvestre et al. (2005), Im et al. (2005), and Westerlund (2005)	Permanent
Aslan (2011)	1960-2008 and 50 US States	LM (2003) and Kruse (2011)	Mixed Results
Golpe et al. (2012)	1973Q1-2013Q3 and US	ADF(1979), Ng-Perron(2001), Non-linear specification of an unobserved components model	Permanent
Shahbaz et al. (2014b)	1971-2010 and 48 Countries	Kruse (2011), LM(2003) Unit root test, Maddala and Wu (1999), Choi(2001), Levin, Lin and Chu (2013), Im et al.(2003), Im, Lee and Tieslau (2005) Moon and Perron (2004), Pesaran (2007), Choi (2002)	Mixed Results
Cai and Magazzino (2019)	1965-2016 and G7 Countries	Hadri and Rao (2008), Carrion-i-Silvestre et al. (2005), Bahmani-Oskooee et al. (2014)	Mixed Results
Abid and Alimi (2019)	1973M01-2017M02 and US	ADF (1979), Hylleberg et al. (1990), Lumsdaine and Papell test (1997)	Permanent
	Oil Consumption		
Narayan et al. (2008)	1971-2003 and 60 Countries	Levin et al. (2002), Im et al. (2003) Maddala andWu(1999), Hadri (2000), Breitung (2000), Im et al. (2005)	Temporary
Apergis and Payne (2010)	1960-2007 and US	Lee and Strazicich (2003), Narayan and Popp(2010)	Mixed Results
Burakov (2019)	1990-2017 and 15 Countries	Im et al. (2005)	Mixed Results
Maslyuk and Smyth (2009)	1973M01-2007M12 and 17 OPEC and non-OPEC Countries	Caner and Hansen (2001) Unit Root Test	Mixed Results
Solarin and Lean (2016)	1965-2012 and 57 Countries	ADF(1979), PP(1988), DF-GLS(1996) KSS(2003), Kruse(2011) and Lee and Strazicich (2003, 2004)	Mixed Results

4. Methodology: Unit Root Tests

In this paper, the unit root properties of the primary energy consumption are investigated for "Fragile Five" countries using "linear", "nonlinear", and "Fourier-based" unit root tests approaches. DF (1979) and Phillips-Perron (1988), which are traditional unit root tests, do not consider non-linearity and structural breaks in the data generation process. Due to the failure to consider non-linearity and structural breaks, these tests have a low power to reject the null hypothesis (Perron, 1989: 1362). When we consider structural unit root tests, Perron (1989), Zivot and Andrews (1992), Lee and Strazicich (2003, 2004) unit root tests come to the fore. In these tests, the structural form and the number of breaks must be known in advance. Therefore, they are criticized.

It is essential to consider that time series are generated by nonlinear properties. Kapetanios et al. (KSS, 2003) and Kruse (2011) developed tests against specific nonlinear alternatives. They examine the nonlinear stationarity against the existence of the unit root. They use ESTAR model. ESTAR assumes that the switching between regimes is smooth, and it is more suitable for economic conditions. Another test applied in the study is called the Fourier KPSS test that captures smooth and sharp breaks. It is suggested a new test that has a Fourier function by Becker et al. (2006). This test accommodates nonlinear breaks, under both the null and the alternative hypothesis. Guris (2019) propose Fourier Kruse test which considers nonlinearity and structural breaks. This test has more statistical power and size than KSS and Kruse (2011) tests. The properties of these tests are summarized in Table 2.

Table 2. The Properties of Unit Root Tests

ADF Model:	$\Delta y_t = \alpha_0 + \beta T + \delta y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + \varepsilon_t$
PP Model:	$\Delta y_t = \alpha_0 + \beta T + \delta y_{t-1} + \varepsilon_t$
KSS Model:	$\Delta y_t = \theta y_{t-1}^3 + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + \varepsilon_t$
Kruse Model:	$\Delta y_t = \theta_1 y_{t-1}^3 + \theta_2 y_{t-1}^2 + \sum_{i=1}^{k} \delta_i \Delta y_{t-i} + \varepsilon_t$
Fourier KPSS Model:	$y_t = \alpha_0 + \beta T + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + r_t + \varepsilon_t$
Fourier Kruse Model 1:	$\boldsymbol{y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + v_t}$
Fourier Kruse Model 2:	$\Delta v_t = \theta_1 y_{t-1}^3 + \theta_2 y_{t-1}^2 + \sum_{i=1}^{k} \delta_i \Delta v_{t-i} + \varepsilon_t$

5. Empirical Findings

It is obtained inconsistent results because of no use of appropriate unit root tests in the energy literature. In this respect, to determine suitable unit root tests relevant to the data generation process, linearity needs to be tested. We apply the linearity test suggested by Harvey et al. (2008) because this test is not affected by whether the series is stationary or not. In addition, this test has more statistical power than the other linearity tests. The results of the linearity test are given in Table 3.

Table 3. Linearity Test Results

Country	Coal Consumption	Natural Gas Consumption	Oil Consumption
Brazil	25.71***	6.34**	3.33
India	0.78	30.54***	12.45***
Indonesia	2.54	13.7***	7.24**
South Africa	6.01**	1.79	1.65
Turkey	4.88*	59.90***	2.23

Notes:

(i) χ_2^2 values are used for Harvey et al. (2008)

(ii) ***, ** and * the null hypothesis that the series is linear is rejected for 1%, 5%, and 10%, respectively,

According to the results for coal consumption, linearity is not accepted for Brazil, South Africa, and Turkey. The findings show that natural gas series is linear only for South Africa, while the linearity of oil consumption is rejected for India and Indonesia.

After determining whether the series is linear or not, we applied ADF, PP, Kapetanios et al. (KSS, 2003) and Kruse (2011) tests. The findings of linear and nonlinear unit root tests for coal consumption, natural gas consumption, and oil consumption are given in Table 4. Moreover, the suggestion of Schwert (1989) for the maximum lag length is followed in the study.

According to the findings of the ADF and PP tests, the null hypothesis of the unit root for coal consumption and natural gas consumption is not rejected for all countries. The oil consumption of Turkey is stationary for the ADF and the PP test. The oil consumption of Brazil is stationary at the 10% level of significance. And, the null hypothesis for oil consumption is not rejected for India, Indonesia, South Africa. The KSS test results of coal consumption show that the null hypothesis is not rejected for Indonesia. Moreover, the KSS unit root test results null hypothesis is not rejected for natural gas consumption at the 10% level of significance for South Africa in raw data. According to KSS unit root test results, the oil consumption of only Turkey is stationary in detrend data. In the Kruse test, the results obtained from raw data and detrend data are different.

As in coal consumption findings, the Kruse test results obtained from raw data and detrend data are different for the natural gas consumption. The results of the Kruse test display that oil consumption series has a unit root for India, Indonesia, and South Africa in raw data, and the null hypothesis is not rejected for Turkey in detrend data.

Table 4. ADF, PP, KSS and Kruse Test Results

Coal Consumption	ADF		PP		KSS		Kruse	
Country	Level	First Dif.	Level	First Dif.	Raw Data	Detrend	Raw Data	Detrend
Brazil	-0.931(0)	-6.722(0)***	-0.909(1)	-6.765(3)***	1.295(0)	-1.489(0)	26.073(0)***	14.589(9)**
India	-3.028(0)	-6.960(0)***	-3.030(1)	-6.966(2)***	0.984(10)	-2.932(5)	103.47(0)***	12.177(7)*
Indonesia	-1.893(0)	-5.840(0)***	-2.073(2)	-5.843(1)***	0.227(2)	-4.308(10)***	2.841(2)	22.866(10)***
South Africa	-0.478(0)	-6.411(0)***	-0.428(3)	-6.410(1)***	2.685(0)	-0.569(0)	24.119(0)***	0.949(0)
Turkey	-2.091(0)	-8.408(0)***	-2.016(1)	-8.375(1)***	1.589(2)	-1.797(2)	12.431(2)**	5.133(2)

Natural Gas Consumption	ADF		PP		KSS		Kruse	
Country	Level	First Dif.	Level	First Dif.	Raw Data	Detrend	Raw Data	Detrend
Brazil	-0.704(0)	-3.465(1)***	-0.810(3)	-6.568(4)***	-0.507(9)	-0.826(9)	3.296(9)	2.997(9)
India	-0.742(0)	-7.621(0)***	-0.575(1)	-7.609(3)***	0.409(3)	-0.645(0)	17.583(0)***	0.505(0)
Indonesia	-0.240(5)	-1.008(7)	-0.941(2)	-6.888(3)***	-0.593(10)	-0.589(10)	0.719(10)	6.893(10)
South Africa	-2.868(0)	-6.782(0)***	-3.046(2)	-7.578(9)***	-1.929(0)*	-2.103(0)	4.200(0)	22.576(1)***
Turkey	-1.695(0)	-4.843(0)***	-1.678(2)	-5.040(4)***	-0.456(10)	-0.294(10)	25.649(9)***	7.856(7)

Oil Consumption	ADF		PP		KSS		Kruse	
Country	Level	First Dif.	Level	First Dif.	Raw Data	Detrend	Raw Data	Detrend
Brazil	-3.272(3)*	-4.247(0)***	-2.844(3)	-4.267(3)***	1.783(8)	-1.406(8)	6.732(8)	1.995(8)
India	-2.839(0)	-6.801(0)***	-2.891(1)	-6.806(3)***	0.312(10)	-0.702(6)	19.90(6)***	0.509(6)
Indonesia	-0.120(0)	-5.758(0)***	-0.319(2)	-5.808(3)***	0.218(8)	-1.893(2)	19.38(2)***	4.405(2)
South Africa	-2.313(0)	-5.199(0)***	-2.311(4)	-5.284(4)***	0.321(3)	-0.415(3)	46.58(0)***	7.796(3)
Turkey	-4.170(0)***	-5.718(0)***	-4.186(2)***	-5.703(2)***	1.216(10)	-3.933(10)***	2.147(10)	15.039(10)**

Notes:

(i) Table critical values are obtained from MacKinnon (1991) for ADF and PP tests. Table critical values are obtained from KSS (2003) and Kruse (2011).

(ii) ***, ** and * imply rejection of the unit root at the 1%, 5%, 10% level, respectively

These four tests used do not consider the structural breaks in the series. Since shocks such as oil crises, price collapses in energy markets may have caused structural breaks in the series, we applied the Fourier KPSS test, which is successful in capturing sharp breaks and smooth breaks. The results of the Fourier KPSS test are given in Table 5. The null hypothesis of the unit root for the series of primary energy consumption is rejected for all countries. These findings are not surprising, because the effects of the energy crises experienced as of the period under consideration may have caused breaks in the structure of the series.

According to linearity findings in Table 3, some series are linear while others are not. Also, it is required to consider the structural breaks in the series. Therefore, we also apply the Fourier Kruse test which captures the structural breaks and nonlinearity. The results of the Fourier Kruse (2019) test are shown in Table 5.

Table 5. Fourier KPSS and Fourier Kruse Test Results

	Coal Consumption		Natural Gas Consumption		Oil Consumption	
Country	FKPSS		FKPSS		FKPSS	
Brazil	0.1315***		0.1306***		0.1247***	
India	0.1319***		0.1332***		0.1343***	
Indonesia	0.1290***		0.1314***		0.1305***	
South Africa	0.1301***		0.1091***		0.4269***	
Turkey	0.1316***		0.1081***		0.1280***	
	Coal Consumption		Natural Gas Consumption		Oil Consumption	
Country	FKruse	F-Ist	FKruse	F-Ist	FKruse	F-Ist
Brazil	16.703(9)*	226.13	8.054(9)	57.397***	10.019	35.915***
India	9.115(0)	32.682***	12.801(0)	146.73***	5.524(6)	19.162***
Indonesia	24.040(8)**	47.528	3.297(10)	159.52***	3.922(2)	139.30***
South Africa	6.454(0)	109.09***	52.634(1)***	16.850	9.383(3)	25.185***
Turkey	6.223(2)	23.689***	9.763(5)	45.745***	15.620(5)	85.998***

Notes:

(i) k indicates the optimal frequency. The optimal frequency value for the Fourier KPSS test is 1 for all variables. Moreover, the optimal frequency value for the Fourier Kruse test is 2 for coal consumption of India, and is 3 for natural gas consumption of South Africa.

(ii) For the Fourier KPSS test ***, **, * present the null hypothesis that the series is stationary is rejected for 1%, 5%, and 10%, respectively,

(iii) For the Fourier Kruse test ***, **, * present the unit root null hypothesis is rejected for 1%, 5% and 10% respectively.

According to the consequences of Fourier Kruse that coal consumption of Brazil and Indonesia and natural gas consumption of South Africa are found stationary.

As a result, we applied Harvey et al. (2008) test to specify whether the series is linear or not first. The series of coal consumption of Brazil, South Africa, and Turkey are nonlinear and for natural gas, the series is nonlinear for Brazil, India, Indonesia, and Turkey. Also, the linearity of oil consumption is rejected for only India and Indonesia. Secondly, ADF and PP are applied. The results of coal consumption and natural gas consumption show that series are non-stationary in level for all countries. The oil consumptions of India, Indonesia, South Africa are non-stationary, but the oil consumption of Brazil is stationary at the 10% level of significance. At this stage, KSS (2003) and Kruse (2011) non-linear unit root tests are also applied. According to the KSS test results, the null of the unit root for natural gas consumption is not rejected at the 10% level of significance for only South Africa in raw data. Indonesia for coal consumption and Turkey for oil consumption is stationary in detrend data. In the Kruse test, the results obtained from raw data and detrend data are different. As in coal consumption results, the Kruse test results obtained from raw data and detrend data are different for natural gas consumption. The results of the Kruse test reveal that the null hypothesis of the unit root for oil consumption is not rejected for India,

Indonesia, and South Africa in raw data, and the null hypothesis is not rejected for Turkey in detrend data. Thirdly, the Fourier KPSS test is applied. These findings show that series are not stationary for all countries. Finally, we applied the Fourier Kruse (2019) test. According to the consequences that coal consumption of Brazil and Indonesia and natural gas consumption of South Africa is found stationary.

Overall, the findings support that the shocks on coal consumption are temporary for Brazil, South Africa, and Turkey, while are permanent for India and Indonesia. The findings imply that coal consumption reverts to its own balance within the short-term for Brazil, South Africa, and Turkey. Moreover, the effect of the shocks on natural gas consumption is temporary for five fragile countries except for South Africa. From an energy policy point of view, South African policymakers will not achieve their goals in the long-term. Finally, it is shown that the shocks in oil consumption are temporary for India and Indonesia, while they are permanent for Brazil, South Africa, and Turkey. Thus, Brazil, South Africa, and Turkey can define new energy policies on oil consumption.

6. Conclusion

The study focuses on the stationarity properties of primary energy consumption. These properties are investigated using several unit root tests for fragile five countries for the period of 1965–2018.These countries are Brazil, India, Indonesia, South Africa, and Turkey.

Although the fragile five countries display a similar structure economically, the unit root characteristics of their primary energy consumption series differ. Primary energy sources are a finite resource, and greenhouse gas emissions from these sources are the major cause of climate change. The success of the policies to be applied to decrease the dependence on these sources depends on whether the consumption series is stationary or not. If the energy consumption series is stationary, shocks to energy consumption are temporary.

The findings of the study show that the effect of the shocks will occur in coal consumption is temporary for Brazil, South Africa, and Turkey, while it is permanent for India and Indonesia. And, the shocks on the natural gas consumption is found permanent for only South Africa. Moreover, the effect of the shocks that will occur in oil consumption is temporary for India and Indonesia, while it is permanent for other countries. The findings of the study are mixed and it is similar to the results of Narayan and Smyth (2007), Hasanov and Telatar (2011), Ozcan (2013), Destek and Sarkodie (2020).

According to the consequences of the paper, in the case of implementation of sustainable development goals for fragile five countries, show that the policies to be implemented may have different impacts on each country. Therefore, it can be stated that short-term policies in some countries and long-term policies in some countries will be effective. The policies to be applied may not always have the same effect. Therefore, policies should be implemented very carefully. In addition, in countries where shocks are temporary, future values of primary energy sources can be forecast by using past values.

Unit root tests used in this paper are determined in accordance with the structure of the series. As can be seen, considering different structures of the series caused different results. The findings of these tests lead to more often the null hypothesis rejection. Because they do not consider structural breaks and/or nonlinearity. This shows that both economists and policymakers should be careful and consider the nonlinearity and structural breaks that would be possible in the analysis of properties of stationarity.

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