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BIOMASS ENERGY CONSUMPTION AND FOREIGN DIRECT INVESTMENTS: EVIDENCE FROM DEVELOPED AND DEVELOPING COUNTRIES

BİYOKÜTLE ENERJİSİ TÜKETİMİ VE DOĞRUDAN YABANCI YATIRIMLAR: GELİŞMİŞ VE GELİŞMEKTE OLAN ÜLKELERDEN KANITLAR

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Abstract

Energy is one of the basic building blocks in the economic system of countries. Major environmental problems such as fluctuations in energy prices, insufficient energy resources, global warming and climate change have steered countries towards alternative energy sources like modern biomass energy. As a result, countries have been compelled to revise the structure of the basic macroeconomic indicators that constitute the trajectory of the economic system, such as foreign direct investments (FDI) and economic growth (EG) with regard to alternative energy sources. The causality relationship between biomass energy consumption (BEC) and FDI inflows in the country groups classified as lower-middle, upper-middle and high-income by the World Bank for the period 1970-2017 has been examined in the study. According to the findings obtained, it is understood that causality from BEC to FDI in all three countries, whereas causality from FDI to BEC disappears as the income levels of the countries increase. This findings put forward that there is a transition from growth hypothesis to feedback hypothesis as income level decreases.

Keywords: Biomass Energy Consumption, Foreign Direct Investments, Renewable Energy, Economic Growth, Panel Causality.

Öz

Enerji, ülkelerin ekonomik sistemini oluşturan temel yapı taşlarından biridir. Enerji fiyatlarındaki dalgalanmalar, enerji kaynaklarındaki yetersizlik, küresel ısınma ve iklim değişikliği gibi ciddi çevresel problemler ülkeleri modern biyokütle enerjisi gibi alternatif enerji kaynaklarına yönlendirmiştir. Bu durumun bir sonucu olarak da ülkeler, doğrudan yabancı yatırımlar ve ekonomik büyüme gibi ekonomik sistemin yörüngesini oluşturan temel göstergelerin yapısını alternatif enerji kaynaklarına göre revize etmek zorunda kalmıştır. Bu çalışmada 1970-2017 dönemi için dünya bankası tarafından alt-orta, üst-orta ve yüksek gelir olarak sınıflandırılmış ülke gruplarındaki biyokütle enerjisi tüketimi ve doğrudan yabancı yatırım girişleri arasındaki nedensellik ilişkisi incelenmiştir. Elde edilen bulgulara göre, her üç ülke grubu içinde biyokütle enerjisi tüketiminden doğrudan yabancı yatırımlara doğru nedensellik tespit edilirken, doğrudan yabancı yatırımlardan biyokütle enerjisi tüketimine doğru nedenselliğin ise ülkelerin gelir düzeyleri arttıkça ortadan kaybolduğu anlaşılmaktadır. Bu bulgular, gelir düzeyi azaldıkça büyüme hipotezinden geri bildirim hipotezine doğru bir geçişin gerçekleştiğini ortaya koymaktadır.

Anahtar Kelimeler: Biyokütle Enerjisi Tüketimi, Doğrudan Yabancı Yatırımlar, Yenilenebilir Enerji, Ekonomik Büyüme, Panel Nedensellik.

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1. INTRODUCTION

In today's world and in the future developments in national and international economies are closely related to the sustainable, safe and efficient use of energy and raw materials based on ecologically and economically relevant and cleaner production concepts and approaches for the short and long term future of society. The transition to an energy system resting on cleaner production technologies is among the most important challenges in this process. One of the most impressive features of the 20th century has been the rise of economies that were largely dependent on fossil fuel consumption. However, the limited amount of fossil fuels and the threat to energy security, instability in energy prices, global warming, climate change and the increase in greenhouse gas emissions caused by non-renewable energy as well as the oil crises in the 1970s have made it necessary for global policymakers to find an alternative energy sources. Consequently, in the 21st century, most countries have started to realize the importance of boost the spillover of RE sources in the country, such as modern biomass energy, to provide sustainable energy resources to people, to create new economic opportunities and to struggle air pollution and climate change (Ozturk and Bilgili, 2015; Ali et al., 2017; Keeley and Ikeda, 2017; Aydin, 2018).

Biomass energy is the only oil substitution that is used to see a variety of energy needs, such as electricity generation, heating houses, refueling and providing processed energy resources for industrial plants. The term "biomass" can be used in a wide variety of areas, such as food, construction materials and fuel, as well as to indicate any existing plant material, such as crop mowing. Biomass energy is an option to decrease oil dependency of foreign-dependent countries in terms of energy, thanks to its advantages, such as being renewable, abundant and reproducible anywhere. Biomass energy can contribute to poverty reduction and increase rural employment, especially in less developed and developing countries. Furthermore, biomass energy can be converted into electricity, fuel and useful thermal energy by transfer. In addition to these advantages, biomass energy can decrease carbon dioxide emissions and promote energy security by replacing fuels with RE (Bildirici and Ersin, 2015; Bilgili and Ozturk, 2015).

According to the Global Bioenergy Statistics (2018) report of The World Bioenergy Association, biomass energy supply constitutes 56.5% of the total primary energy supply of renewable resources in the world as of 2016. The report is also stated that BEC constitutes a 13% share in the world's final energy consumption and this rate is estimated to increase to approximately 22% in 2030. In the World Energy Outlook (2018) report by the International Energy Agency, the demand for modern biomass energy, which was 726 million tons of oil equivalent in 2017, is expected to rise to 1 billion 427 million tons of oil equivalent by 2040. Both of these reports reveal the fact that the global world has evolved towards renewable energies, such as modern biomass energy and leaned towards technology-intensive investments to achieve this goal. However, the successful actualization of this transformation will not be possible unless technology transfers are made correctly and financial resources are appropriately allocated in the global world. Considering that natural, human and financial resources are not distributed evenly on earth and the costs of renewable energy (RE) projects are very susceptible to financing conditions, one can say that the flow of FDI between countries is very influential on resource sharing and providing appropriate financing (Keeley and Ikeda, 2017). According to the neoclassical model, FDI tends to increase the investment rate that causes a rise in per capita income by excluding technology development and labor growth. However, the new growth theory internalizes technological development and FDI as both variables have the potential to initiate long-term growth effects through technological developments and expansion in the host country. These technological developments and expansion in an open economy can facilitate trade and support EG. Nevertheless, according to

the industrial flight hypothesis, foreign entrepreneurs tend to invest in countries where production costs are minimized and as a result, the resources and environment of the host country deteriorate over time. This hypothesis reveals the fact that a stable and RE supply is a prerequisite for the economic development of countries and that controversial conflicts regarding environmental concerns need to be resolved to increase the flow of FDI between countries (Khandker et al., 2018).

There are various perspectives in the literature regarding the relationship between REC and FDI. Some researchers argue that multinational companies in developed countries where producers are subject to strict environmental regulations tend to maintain high environmental standards in host countries. In this respect, FDI can bring energy-saving technologies to the host countries and increase the demand for RE, such as biomass energy. The increase in the demand for RE can trigger the creation of investment areas with high added-value. From this perspective, according to the feedback hypothesis, BEC and FDI have a two-way causality relationship and thus, each party acts complementary to the other. This complementary relationship might reveal that the possibility of energy-saving policies reducing BEC can affect FDI and such fluctuations in FDI can be transferred back to (Bildirici and Ersin, 2015; Polat, 2018).

According to the Pollution Haven Hypothesis, the impact of FDI in developing countries on REC might not be positive. The reason for this is that, because environmental regulations are more liberal in most developing countries than in developed countries, FDI can encourage these countries to outsource industries using environmentally unfriendly energy. In developed countries, stringent energy-saving policies, such as efficiency improvement measures designed to reduce energy waste and demand management programs, ensure that FDI have a positive impact on BEC. This situation can be explained by the conservation hypothesis, which suggests that there is a one-way causality relationship from FDI to BEC. Moreover, foreign investors can have the opportunity to produce environmentally friendly products from biomass energy by establishing production facilities in countries that are rich in RE sources, such as modern biomass energy and have optimum production costs and to export their products to the world markets. This can be explained by the growth hypothesis. According to this hypothesis, the increase in BEC can boost FDI and energy-saving policies that reduce BEC can decrease FDI. Therefore, one can say that there is a one-way causality relationship from BEC to FDI (Bildirici, 2014; Bildirici and Ersin, 2015; Polat, 2018).

According to the Environmental Kuznets Curve Hypothesis, while the poorest countries are exposed to the least pollution, it is highly probable that the wealthiest countries are most likely to be exposed to pollution due to the developments in the industrialization and post-industrialization era. Therefore, the level of pollution created in an economy shows an inverse U curve and as the income levels of the countries increase, the FDI flows to the countries can create environmentally unfriendly industries and increase the demand for non-RE. This can be explained by the hypothesis of neutrality. According to this hypothesis, BEC is a relatively small component of FDI. Therefore, BEC has little or no impact on FDI. Furthermore, according to this hypothesis, even though developed countries aim to reduce BEC through energy-saving policies, these circumstances do not have any effect on FDI. In other words, there is no causal relationship between BEC and FDI (Bildirici, 2014; Bildirici and Ersin, 2015; Polat, 2018).

This study aims to detect the cointegration and causality relationships between BEC and FDI inflows. Accordingly, in the following sections of the study, the literature research, the data set and methods and finally, the findings will be discuss and interpreted.

2. LITERATURE REVIEW

Consistent with the hypothesis of study, studies testing the relationship between EC and FDI as well as the relationship between REC and FDI in the subsequent parts of literature research has also been examined.

Upon evaluating the studies investigating the relationship between BEC and EG, it has been determined that while EG has been represented the dependent variable in some of these studies; in others, both BEC and EG have been considered as dependent variables in two different models. In their studies where EG has been the dependent variable, Bilgili and Ozturk (2015), Ozturk and Bilgili (2015), Aslan (2016), Aydin (2018) and Bayrac and Ozarslan (2018) have reported that the effect of BEC on EG is positive and statistically significant. Moreover, Aslan (2016) and Aydin (2018) have found that there is a two-way causality relation from BEC to EG. In their studies in which both series have been separately modeled as dependent variables, Payne (2011), has found that there is a one-way causality relationship from BEC to EG, while Shahbaz et al. (2016) and Adewuyi and Awodumi (2017) have concluded that there is a two-way causality relationship between the series. The research by Bildirici and Ersin (2015), Bildirici (2016) and Destek (2017) have determined a two-way causality relationship between the series in respectively the USA; the USA, the UK, France; China and the USA. Furthermore, Destek (2017) have found a one-way causality relation from BEC to EG in Germany, Brazil, India and Italy; Bildirici and Ersin (2015) have revealed a two-way causality relationship from EG to BEC in Germany, Austria, Finland and Portugal and Destek (2017) have found a similar relationship in Sweden. Bildirici (2016) also has revealed a one-way causality relationship between BEC and EG in Finland and Japan and Australia and Belgium, while Destek (2017) has not detected any causal relation between the series in Finland, Japan and the UK. Finally, Bildirici and Ozaksoy (2018) have discovered a two-way causality relation between the series in all countries (Bosnia and Herzegovina, Macedonia, Hungary, Slovak Republic, Estonia, Czech Republic, Croatia, Latvia and Slovenia) except Albania (from EG to BEC), Bulgaria and Romania (from BEC to EG) in both the short and long run.

When the studies testing the relationship between EC and FDI have been examined, it has been found that in some studies, EC has been considered as the dependent variable, while in others, both series have been considered as dependent variables in different models. Abidin et al. (2015) have revealed a one-way causality relation between the series in the long-run and a two-way causality relation in the short-run from FDI to EC. Furthermore, Bekhet and Othman (2011) have identified a one-way causality relation from EC to FDI only in Mexico in the long-run and Loor and Monserrate (2015) have identified the same relationship in the short-run. Salim et al. (2017) have found that the 1% increase in FDIs reduced EC by approximately 0.21% in the long-run, while the relationship between FDI and EC has been identified as positive in the short-run. However, Lee (2013) has not detected any relationship between those series. In studies that both series have been utilized as dependent variables, Sbia et al. (2014) and Ozturk and Oz (2016) have found a two-way causality relation between the series in both the short and long run, while Khatun and Ahamad (2015) have concluded that there is a one-way causality relation from FDI to EC in both short and long run. Alam (2013) has found that only in the long run, there is a causality relation from EC to FDI in India and in Pakistan, from FDI to EC. Lastly, Leitão (2015) have determined that the relationship between EC and FDI is positive and statistically significant, while Kivyiro and Arminen (2014), Kuo et al. (2014) and Nyugen and Wongsurawat (2017) have found no causality relation between the series.

When the studies on the relationship between REC and FDI have been reviewed, it has been found that REC is used as the dependent variable in most of them, while in some studies, both series have represented the dependent variable in separate models. In one of the works that use REC as the dependent variable, Doytch and Narayan (2016), basing their research on the low, lower-middle, upper-middle and high-income group country rankings made by the World Bank, have investigated the relationship between REC and FDIs on a sectoral basis using the data on 74 countries for the period 1985-2012 and adopting the Blundell-Bond dynamic panel estimator. The authors have concluded that FDI on a sectoral basis have a reducing effect on REC. In a study on Bangladesh, Khandker et al. (2018) have investigated the relationship between REC and FDI by employing the Granger causality tests based on Johansen cointegration and error correction model, using the data of the relevant country for the period 1980-2015. The authors have concluded that there is a two-way causality relation between REC and FDI in the long-run, whereas there is no causality relation between the series in the short-run. In a study on 85 developed and developing countries, Polat (2018) has investigated the relationship between REC and FDI by dynamic panel data analysis using the data of the relevant countries for the 2002-2014 period. The author has concluded that FDI has a reducing effect on REC in developed countries, whereas FDI has no effect on REC in developing countries.

One of the studies that utilize both series as representative of the dependent variable, the work by Amri (2016) has investigated the relationship between REC and FDI applying dynamic panel data analysis by using the data from 25 developed and 50 developing countries for the period 1990-2010. The author has concluded that a 1% rise in REC leads to a 0.158% increase in FDI and a 1% rise in FDI increases REC by approximately 0.292%. In a study on 22 Central and South African countries, which are determined based on the lower-middle, upper-middle and high-income groups of the World Bank's country rankings, Jebli et al. (2019) have investigated the relationship between REC and FDI by employing Granger causality tests based on panel cointegration and error correction model, using the data of the relevant countries for the period 1995-2010. The authors have concluded that there is a lon-run relation between the series. They also have found that there is a two-way causality relation between REC and FDI in the long-run, whereas there is no causality relation between the series in the short-run.

A general review of the literature demonstrates that the relationship between EC and FDI has been intensively investigated in different countries through the utilization of different methods and models. However, in the literature research, it has found that there are relatively few studies testing the relationship between REC and FDI and no research testing the relationship between BEC and FDIs. It has expected that this aspect of the study will contribute to the scientific world by filling the gap in the literature.

3. DATA AND ECONOMETRIC METHODOLOGY

For this study, it has been used annual data for the period 1970-2017. These data have been classified based on country groupings of the World Bank in terms of national income per capita in 2018. In this respect, the countries classified as lower-middle, upper-middle and high-income constitute the data set of our study. All of the data available from these countries have been included in the paper. The BEC data of the countries have been collected from the material flows analysis portal, FDI inflow data have been collected from the World Bank's database and GDP data have been collected from the IMF and World Bank's database. Gauss 10.0 and Eviews 10.0 programs have been used during the analyzes. Information about the data set of the paper has been comprised based on the papers in the literature is presented in Table 1.

Table 1. Information on the Data Set of the Study

Abbreviation of Variables	Variables Used in the Study	Unit of the Variables	Researches Using the Variables
BIO	BEC	used extraction of biomass (ktoe: kt oil equivalent)	Bilgili and Ozturk (2015), Ozturk and Bilgili (2015), Shahbaz et al. (2016), Bildirici and Ozaksoy (2016), Ali et al. (2017), Destek (2017), Aydin (2018).
FDI	FDI Net Inflows	FDI, net inflows (BoP, current US $)	Bekhet and Othman (2011), Lee (2013), Leitão (2015), Khatun and Ahamad (2015), Amri (2016), Ozturk and Oz (2016), Nguyen and Wongsurawat (2017).
GDP	EG	GDP (current US $)	Ozturk and Bilgili (2015), Aslan (2016), Shahbaz et al. (2016), Ali et al. (2017).

In light of these data, the models of the study have been established as follows:

$$BIO = \propto + \beta_1 FDI + \beta_2 GDP + u \quad (1)$$

$$FDI = \propto + \beta_1 BIO + \beta_2 GDP + u \quad (2)$$

BEC and FDI inflows are the primary explanatory variables in the models, while GDP is the control variable.

Methods such as time series, cross-sectional analysis and panel data analysis are used in econometric analyses. The structure of the data determines which method to prefer for a specific study. The fact that the data used in our study are on an annual frequency and accordingly there are only 47 periods of data for each country as well as the aim to reach a general judgment on the country communities such as lower-middle, upper-middle and high-income groups including more than one country made the use of panel data analyses suitable for this study.

Since slope homogeneity and cross-section dependence are econometric methodologies widely known in the literature, there is no need to present them here. Accordingly, following the investigation of slope homogeneity and cross-sectional dependence, it has been applied the Fourier PANKPSS panel unit root test developed by Nazlioglu and Karul (2017). This method makes calculations using cross-section dependence, heterogeneity and smooth transition structural breaks. The zero hypothesis of the method has signified that the panels are stationary, whereas the alternative hypothesis has signified the presence of a unit root. This method is essentially based on the common structural break panel unit root test of Carrion-i-Silvestre et al. (2009) with the addition of the Fourier form calculated by Becker et al. (2006). The individual test statistic calculated by Becker et al. (2006) are computed as follows:

$$n_i(k) = \frac{1}{T^2} \frac{\sum_{t=1}^{T} S_{it}(k)^2}{\sigma_n^2} \quad (3)$$

Panel statistics are calculated by averaging individual statistics. In this context, panel test statistics are calculated as follows:

$$FP(k) = \frac{1}{N} \sum_{i=1}^{N} n_i(k) \quad (4)$$

Following the determination of the unit root levels of the panels, it has been identified the appropriate cointegration and causality tests and performed certain analyses. The next step of research after homogeneity, cross-sectional dependence and unit root tests is to investigate the causality relationship in the panel. Dumitrescu and Hurlin (2012) test is used in the panel when all series are stationary at the same level. As seen in the empirical findings, Dumitrescu and Hurlin's (2012) panel causality test is used for these panels, which use the cross-section

dependence, have a greater time dimension than its cross-section dimension and whose all series are stationary at the same level in this paper. This method explores whether there is causality in the panels using the wald statistics. That is;

$$W_{N,T}^{Hnc} = \frac{1}{N} \sum_{i=1}^{N} W_{i,t} \qquad (5)$$

Here, W_{it} signifies the Wald test statistics used to test causality for the i. country. Because individual Wald statistics for small values of T do not converge to the same chi-square distribution, Dumitrescu and Hurlin (2012) have proposed using estimated standardized statistics for WHNC employing estimated values for the mean and variance of this unknown distribution. This statistic is calculated as follows:

$$Z_{N,T}^{HNC} = \frac{\sqrt{N}\,[W_{N,T}^{Hnc} - \sum_{i=1}^{N} E(W_{i,t}]}{\sqrt{\sum_{i=1}^{N} Var(W_{i,t})}} \qquad (6)$$

In equation, i is the total number of countries, W is the Wald Statistics, T is the number of periods. Following this section explaining the methods used in the paper, it will be tried to interpret the findings obtained through analyses and the results obtained through these findings.

4. EMPIRICAL FINDINGS AND DISCUSSIONS

At this stage of the paper, before examining the causality relationship between the variables subject to the research, firstly, it will be investigated the homogeneity of panels and the existence of cross-sectional dependence and then determine the stationarity levels of the panels. The results obtained from homogeneity and cross-sectional dependence tests are the guiding factors in the selection of unit root, cointegration and causality tests to be applied to the panels. Whether the panel does or does not contain cross-section dependence and whether it has a homogeneous or heterogeneous structure leads the researcher to different unit root, cointegration and causality tests.

In the studies have conducted up to 2008 to investigate the existence of cross-sectional dependence, the CDLM test of Breusch and Pagan (1980), which give correct results when the group average values are zero; but give unreliable results in cases where individual averages differ from zero, have been used. In Breusch and Pagan's (1980) study, along with the studies of Pesaran et al. (2008), this deficiency is eliminated by adding the variance and mean to the test statistics. In this respect, the adjusted CDLM test by Pesaran et al. (2008), whose results are more reliable, is used in this study and the findings obtained have been presented in Table 2. According to the results, it has been seen that all panels have cross section depedency.

Table 2. Cross Section Dependency Test Results

	Biomass	**FDI**	**GDP**
High-Income Countries	10.808 (0.00)	4.197 (0.00)	8.761 (0.00)
Upper-Middle Countries	7.146 (0.00)	4.322 (0.00)	4.460 (0.00)
Lower-Middle Countries	25.086 (0.00)	7.397 (0.00)	13.600 (0.00)

Another pre-test following the investigation of the cross-sectional dependence is to determine whether the panels have a homogeneous or heterogeneous structure. Thus, Pesaran and Yamagata's (2008) slope homogeneity test has been used in the paper. Findings indicated that all panels had a heterogeneous structure for each country group. The fact that these countries have different macroeconomic structures even though they are in the same income group confirmed the findings.

Table 3. Slope Homogeneity Test Results

	Biomass	FDI	GDP
		Δ	
High-Income Countries	9.887 (0.00)	15.989 (0.00)	11.391 (0.00)
Upper-Middle Countries	6.193 (0.00)	6.607 (0.00)	4.192 (0.00)
Lower-Middle Countries	10.966 (0.00)	3.645 (0.00)	2.55 (0.005)
		Δ_{adj}	
High-Income Countries	10.212 (0.00)	16.513 (0.00)	11.764 (0.00)
Upper-Middle Countries	6.396 (0.00)	6. 824 (0.00)	4.33 (0.00)
Lower-Middle Countries	11.325 (0.00)	3.764 (0.00)	2.633 (0.004)

Note: Values in parentheses indicate probability values.

Another preliminary test identifies the levels at which the panels become stationary. It is possible to determine cointegration and causality tests to be employed according to the findings obtained from unit root tests. In line with the findings indicating the existence of the cross-sectional dependence as well as the heterogeneous structure of the panels, it has been concluded that the use of the panel KPSS test will be applicable in in the study. However, using the Fourier form of Panel KPSS test developed by Nazlioglu and Karul (2017) will provide more advanced and reliable results. Because, in addition to the common Panel KPSS test of Carrion-i-Silvestre et al. (2009), Nazlioglu and Karul (2017) has took into account numerous transient structural breaks as a result of the smooth-transitional structure of the Fourier Panel KPSS test. Thanks to this test, cross-section dependence, heterogeneity and smooth-transitional structural breaks in the panels will be taken into consideration. Fourier Panel KPSS unit root test results obtained from the mentioned points are presented in Table 4.

When the findings have been examined, it has been seen that the BEC panel has a unit root at the level in all three fourier forms and these panels become stationary after the first differences of all panels have been taken. For FDI and GDP panels, panels with 2 and 3 fourier forms of unit root at level has become stationary with 99% reliability after the first difference; however, in the case of 1 Fourier figure, when the first differences of these panels are taken, it has been seen that they became stationary with 90% or 95% reliability (Nazlioglu and Karul, 2017; Saglam and Ampountolas, 2020). According to the results obtained, the panels generally has appeared to become stationary in their first differences except for small deviations in certain fourier forms.

Table 4. Nazlioglu and Karul (2017) Fourier Panel KPSS Unit Root Test Results

	Biomass			FDI			GDP		
				Level					
Fourier Forms (k)	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
High-Income	8.24	4.60	4.82	8.81	10.49	9.50	13.25	6.67	4.02
Countries	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Upper-Middle	5.71	6.11	5.58	6.44	8.68	7.79	7.06	3.11	2.42
Countries	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lower-Middle	6.24	5.50	5.67	4.27	1.55	0.31	7.87	2.57	1.58
Countries	(0.00)	(0.00)	(0.00)	(0.00)	(0.06)	(0.37)	(0.00)	(0.00)	(0.06)
				First Difference					
Fourier Forms (k)	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
High-Income	2.17	-0.18	0.77	3.98	1.23	0.87	2.19	1.21	1.49
Countries	(0.02)	(0.57)	(0.22)	(0.00)	(0.10)	(0.19)	(0.02)	(0.11)	(0.07)
Upper-Middle	1.03	-0.73	-1.03	2.05	0.62	0.42	1.49	0.39	0.49
Countries	(0.15)	(0.77)	(0.85)	(0.02)	(0.26)	(0.33)	(0.06)	(0.34)	(0.41)
Lower-Middle	1.40	0.42	0.005	2.48	0.42	-	1.70	2.17	0.87
Countries	(0.08)	(0.33)	(0.49)	(0.05)	(0.33)		(0.04)	(0.02)	(0.19)

Note: Values in parentheses indicate probability values.

In such a case where the panels are stationary in the first differences, using the Dumitrescu Hurlin (2012) Panel causality test, which considers the cross-sectional dependence and accepts the existence of heterogeneous structures, would be appropriate. The causality results obtained in this regard are presented in Table 5.

Table 5. Dumitrescu and Hurlin (2012) Panel Causality Test Results

	High-Income Countries	**Upper-Middle Countries**	**Lower-Middle Countries**
BIO >>> FDI	18.15 (0.00)	15.81 (0.00)	8.94 (0.00)
FDI >>> BIO	1.31 (0.19)	1.75 (0.08)	5.33 (0.00)
BIO >>> GDP	3.70 (0.00)	0.92 (0.356)	4.80 (0.00)
GDP >>> BIO	13.13 (0.00)	5.67 (0.00)	8.16 (0.00)

Based on Table 5, one can say that there is a two-way causality relationship between BEC and FDI inflows in upper-middle and lower-middle-income countries. The findings suggest that the feedback hypothesis is valid in the countries concerned; in other words, the variables act complementary to each other. Another finding obtained according to Table 5 is the existence of a one-way causality relationship from BEC to FDI inflows in high-income countries. This finding proves the validity of the growth hypothesis in these countries.

Finally, according to Table 5, there is a two-way causality relationship between EG has used as a control variable and BEC in high-income and low-middle income countries, when in fact, there is a one-way causality relationship from EG to BEC in upper-middle-income countries. The findings reveal that EG and BEC act complementary of each other in high and low-middle income groups while a protective policy is followed in upper-middle-income countries.

5. CONCLUSION REMARKS

Nowadays, energy is of vital importance for all countries. In recent years, fluctuations in energy prices, environmental problems of countries, climate change, energy supply and security and the lack of a balanced distribution of energy resources throughout the world have increased countries' dependence on foreign energy supplies. In order to reduce or eliminate this foreign dependence, countries need to achieve the production and consumption of biomass energy, which can be easily obtained and renewed anywhere. In this respect, countries formulate their national RE action plans based on sustainable energy sources, such as modern biomass energy production and consumption and explore the elements associated with biomass energy production and consumption studiously.

This study aims to reveal the causality relationship between BEC and FDI inflows of the countries classified as lower-middle, upper-middle and high-income countries by the World Bank for the period 1970- 2017. Accordingly, it has been used in the study countries' biomass energy extraction in kilotonnes of oil equivalent to represent the consumption of biomass energy, whereas it has been used the FDI net inflows data of the balance of payments of the relevant countries in current US dollars to represent the FDI inflows. Furthermore, the current US dollar GDP data of the related countries have been used to represent the EG adopted as the control variable in the study. it has been investigated that in the study the existence of a causality relationship between the series by Dumitrescu and Hurlin (2012) panel causality test and identified a two-way causality relationship between BEC and FDI inflows in upper-middle and lower-middle-income countries. The findings indicate that multinational firms in developed countries where producers are subject to strict environmental regulations tend to maintain high environmental standards in the lower-middle and upper-middle-income group countries. In this respect, FDI inflows can bring energy-saving technologies to lower-middle and upper-middle-income countries and increase the demand for biomass energy. The increase in the demand for biomass energy can lead to the inflow of high

value-added investments into the country. Furthermore, this finding shows that the feedback hypothesis is valid in the countries concerned. The reason for this is that the variables act complementary to each other. In other words, energy-saving policies that reduce BEC may give rise to the possibility that FDI inflows might be affected and fluctuations in FDIs can be transmitted back to BEC.

Another finding obtained in the study is the existence of a one-way causality relationship from BEC to FDI inflows in high-income countries. This finding proves the validity of the growth hypothesis in these countries. Foreign investors that consider investing in developed countries, which are rich in terms of modern biomass energy, equipped with energy-saving technologies and have the potential to create added value from RE sources such as biomass energy, can have the opportunity to increase their exports in the world markets by establishing production facilities in these countries as well as producing environmentally-friendly products from biomass energy. The increase in question may trigger various investment inflows with high added value in the country. However, no causal relationship has been identified from the FDI inflows to BEC in high-income countries. The increase in FDI inflows developing in line with biomass-based investment projects will escalate the biomass energy consumption until investment areas with high added value are created to stimulate the economy in countries that are rich in RE sources, such as biomass energy, but do not have alternative investment areas. Existing resources will preserve the country's economy in the process of transition from upper-middle-income groups to high-income groups and the country will not grow economically. The fact that no causal relationship between BEC and EG in upper-middle-income countries can be identified is the most important evidence of this situation. With the creation of different value-added investment areas in the country, the investment inflows will either develop based on a different RE project other than biomass energy or through non-renewable resources that increase pollution to reduce the resource costs. In this way, depending on the increase in income level, the impact of foreign investments on BEC might be eliminated. Based on the abovementioned facts, one can say that there is an inverse U-shaped relationship between FDI inflows and BEC; in other words, the Environmental Kuznets Curve Hypothesis is valid, partially, in this study.

Finally, a one-way causality relationship from EG to BEC in upper-middle-income countries has been identified in the study. This finding indicates that a protective policy is implemented in the relevant country group. In such a case, energy-saving policies such as efficiency optimization measures and demand management strategies have designed to reduce BEC and waste in the relevant country group are not expected to have a negative impact on EG. Moreover, BEC and FDI inflows have been found to have a two-way causality relationship in high-income and lower-middle-income countries. This finding suggests a mutual relationship between the series in the relevant country groups and that each of them acts in a direction complementary of another. This complementary relationship suggests that energy-saving policies aimed at reducing BEC and waste may cause fluctuations in EG; and points out that these fluctuations in EG can be transmitted back to BEC. These findings obtained in our study show similar to the findings of Bildirici and Ersin (2015), Shahbaz et al. (2016), Adewuyi and Awodumi (2017); however, our findings are diffent from the findings Payne (2011) and Aslan (2016) obtained for the USA, Bildirici (2016) for Finland and Australia, Destek (2017) for Italy and Aydin (2018) for Iran. These authors found that there is a one-way causality relationship from BEC to EG. Since there are currently no studies in the literature investigating the relationship between BEC and FDI inflows, it has been believed that in the study, with its unique structure, will contribute to the scientific world by filling the gap in the literature. It might be useful to investigate the relationship between the

series by adding different variables to the data set on samples and using different periods and methods in order to emphasize the importance of this issue in future studies.

In conclusion, policymakers need to aim more modern biomass energy production and consumption to tackle global warming and climate change problems that have serious negative impacts on the global economic environment, to achieve sustainable development, to reduce or eliminate foreign energy dependency levels attract high value-added (technology intensive) investments to their countries. The way to increase the potential of energy crops is through a tremendous increase in agricultural production efficiency. Therefore, the expansion and improvement of the existing agricultural production systems of the countries will play an important role in the sustainable development of modern biomass energy systems. For this, the states need to activate policies encouraging modern energy agriculture. Implementing modern biomass production and consumption rather than classical biomass production and consumption in the countries will advance the formation of high value-added investment areas in the agricultural and industrial sectors, strengthen the socio-economic structure of the labor force working in these sectors and contribute to employment.

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