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An Empirical Analysis for Energy Consumption, Trade Openness and Economic Growth of OECD Countries

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Abstract
This study analyzes the relationship of causality between energy consumption, trade openness and economic growth for 24 OECD countries. In the study undertaken during 1971 to 2014, the cross section dependency and the homogeneity of slope coefficients were investigated. The heterogeneity of slope coefficients was determined under the cross-sectional dependence which is the prerequisite for the causality test of Kónya (2006). According to the results of panel causality analysis between energy consumption and trade openness to economic growth, it was found that unidirectional causality relationship between energy consumption and trade openness to economic growth in Canada, Chile, Iceland, Spain and Sweden. Policy makers should be targeted to increase economic growth by addressing the policies of openness and energy consumption in OECD countries.

Keywords: Economic Growth, Kónya Causality Test, Energy Consumption, Trade Openness, OECD Countries
JEL Classification Codes: F4, N7, Q43.

OECD Ülkelerinin Enerji Tüketimi, Ticaret Açıklığı ve Ekonomik Büyümesi Üzerine Ampirik Bir Analiz

Öz
Bu çalışmada, enerji tüketimi, dışa açıklık ve ekonomik büyüme arasındaki nedensellik ilişkisi 24 OECD ülkesi için analiz edilmiştir. 1971 ile 2014 dönemi kullanılan çalışmada, öncelikle yatay kesit bağımlılığı ve eğim katsayılarının homojenliği incelenmiştir. Kónya (2006) nedensellik testinin ön koşulu olan yatay kesit bağımlılığı altında eğim katsayılarının heterojenliği tespit edilmiştir. Enerji tüketimi ve dışa açıklık ile ekonomik büyüme arasındaki panel nedensellik ilişkisi analiz sonuçlarına göre, Kanada, Şili, İzlanda, İspanya ve İsveç ülkelerinde enerji tüketimi ve dışa açıklığın ekonomik büyümenin nedenseli olduğu tespit edilmiştir. Politika yapıcılar, OECD ülkelerinde açıklık ve enerji tüketimi politikalarını birlikte ele alarak ekonomik büyümeyi arttırmayı hedeflemelidir.

Anahtar Kelimeler: Ekonomik Büyüme, Kónya Nedensellik Testi, Enerji Tüketimi, Dışa Açıklık, OECD Ülkeleri
JEL Sınıflandırma Kodları: F4, N7, Q43.

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1. Introduction

Country economies have become interdependent with globalization. The 2008 crisis has proved the interdependence of financial markets. Despite nearly 10 years since the crisis, many countries still have low growth rates, high unemployment, budget deficits and public debt problems. The continuing question of openness policy providing benefits for countries is still being debated by policy makers globally.

The relationship between energy consumption and economic growth has been explored by researchers for more than 30 years. After major energy crises in 1974 and 1981, the number of studies examining the relationship between energy consumption and economic growth has notably increased (Kraft and Kraft, 1978; Akara and Long, 1980; Erol and Yu, 1987; Cheng, 1999; Asafu-Adjaye, 2000; Alshehry ve Belloumi, 2015).

The relationship between energy consumption, openness and economic growth is very important for environmental policies for the following reasons. If the relationship between energy consumption and economic growth is quite strong, policy makers can struggle to focus on increasing economic growth in areas other than energy. In addition, the relationship between energy consumption and economic growth is less flexible, meaning policy makers can put forward policies of environmental protection with greater ease. In today's economies, energy is an indispensable factor in production factors. Openness is an important element of economic growth and is an opportunity for countries. According to Sadorsky (2012), the increase in foreign trade leads to an increase in economic activity and an increase in energy demand. Moreover, the increase in energy demand is boosting the production of relevant traded commodities (Aslan, Ocal and Shahbaz, 2017, pp. 71-72).

The aim of the study is to analyze the relationship between energy consumption, openness and economic growth in the 24 OECD countries. This study differs from other studies and the literature contribution is that causality relationship between tourism incomes and trade openness to economic growth. While previous studies have investigated the causality relationship between a single variable (tourism incomes or outward opening) and economic growth, this study investigates the causality relationship between two variables together with economic growth. The study consists of four chapters. The first chapter consists of the introduction, the second chapter is the literature study. The third chapter introduces the material and method section. For this purpose, a cross section dependence analysis and homogeneity test were first performed. The results obtained from Kónya (2006) provided the preconditions causality test. Subsequently, the main purpose of working was achieved with the help of Kónya (2006) causality test. The study concludes with the final and fourth chapter, the results.

2. Empiricial Literature

2.1. Energy Consumption and Economic Growth

The causality relationship between economic growth and energy consumption is summarized by four hypotheses: i) growth hypothesis; this hypothesis has a one-way causality relationship from energy consumption to economic growth, and argues that slowing down policies on energy consumption will adversely affect economic growth (Bowden and Payne, 2010), (Payne, 2011), (Belke, Dobnik and Dreger, 2011), (Salahuddin and Gow, 2014), (Charfeddine and Khediri, 2016). ii) bi-directional hypothesis; the causal relationship between the two variables is bi-directional, the increase in energy consumption will affect economic growth positively, and the increase in economic activity will increase energy consumption (Tugcu, Ozturk and Aslan, 2012), (Shahbaz, Tang and Shabbir, 2011), (Bölük and Mert, 2014), (Al Mulali, Fereidouni and Lee, 2014), (Islam vd. 2013), (Rasoulinezhad and Saboori, 2018), (Tiba and Frikha, 2018). iii) neutrality hypothesis; the fact that the share of energy consumption in total output is very small infers that there is no causal relationship between energy consumption and economic growth (Menegaki, 2011), (Menyah and Wolde-Rufael, 2010), (Abosedra, Shahbaz and Sbia, 2015), (Acaravci and Ozturk, 2010), (Odhiambo, 2009). iv) the protection hypothesis; one-way causality relation from economic growth to energy consumption, and the increase in real GDP leads to an increase in energy consumption (Gurgul and Lach, 2012), (Sadorsky, 2009), (Esso, 2010), (Apergis and Payne, 2009).

Kahia et al. (2016) examined the relationship between renewable and non-renewable energy consumption and economic growth. They investigated the MENA countries for the period of 1980 to 2012. From the results obtained, a one-way causality relationship from economic growth to renewable energy consumption in the short term was discovered. There is one-way causality relationship between non-renewable energy consumption and economic growth in the short term. In the long term, there is a bidirectional causality relationship between renewable energy consumption and economic growth as well as between non-renewable energy consumption and economic growth.

Ouedraogo (2013), a study of 15 countries in Africa during 1980 to 2008 identified unidirectional causality for the short term and long term. According to the findings, a causality relationship between economic growth to energy consumption in the short term and causality relationship between energy consumption to economic growth in the long term was identified. Adhikari and Chen (2013) analyzed 80 countries for the period from1990 to 2009. From the findings, the causality relationship from energy consumption to economic growth in the upper-middle income countries and low-middle income countries and the causality relationship from economic growth to energy consumption in low income countries was proven.

Mohammadi and Parvaresh (2014) analyzed 14 oil exporting countries for the period from 1980 to 2008. The obtained results identified bidirectional causality between economic growth to energy consumption. Meanwhile, Tiwari (2011) analyzed the study of 16 European and Eurasian countries for the years between 1965 and 2009. A bidirectional causality relationship was found between energy consumption and economic growth. Eggoh, Bangaké and Rault (2011) found a bidirectional causality relationship between energy consumption and economic growth in a study of 21 African countries for the period 1970 to 2006.

Damette and Seghir (2013) analyzed 12 oil exporting countries for the period of 1990 and 2010. According to the results obtained, one-way causality relationship from energy consumption to economic growth was identified.

2.2. Trade Openness and Economic Growth

In the literature, the relationship between trade openness and economic growth is an increasingly becoming a researched issue in recent years. Over the years, the global trading system has become more transparent and more competitive. Outward openness plays an important role in the economy, because it encourages efficient allocation of resources through comparative superiority. As a result, openness transmits the information to the workforce and invigorates the competition on the international and domestic markets (Chang, Kaltani and Loayza, 2009). Yanikkaya (2003) analyzed 100 developed and developing countries and concluded that the conventional vision will affect growth positively, contrary to the rhetoric of commercial barriers that will negatively affect growth.

Romer (1987) analyzed the relationship between openness and economic growth in a study of 90 developing countries and surmised that trade openness will open the way for innovations. The research provided by Dritsakis and Stamatiou (2016), covered 13 newly adopted European Union countries from the between 1995 to 2013. In the resulting outcomes, a one-way causality relationship from trade openness to economic growth was discovered. In addition, Gries and Redline (2012) have analyzed 158 countries during 1970 and 2009 and from their data emerged a causality running from trade openness to economic growth.

Habibi (2015) classified 120 countries as low, low-middle, high-middle and high income economies assessed between 2000 to 2013. A bidirectional causality relationship between openness and economic growth in lower middle, upper middle and high income countries was discovered (Habibi, 2015) This research found a one-way causality relationship from openness to economic growth in the low income countries.

Gries and Redlin (2012) reviewed 158 countries for the short and long term from 1970 to 2009. In the long term, they found positive causality relation between trade openness and economic growth. Thus, in the long term, international

integration is an effective strategy for growth. However, short-run coefficients indicate that openness is negatively associated with economic growth and trade openness leads to economic damage in the short term. Suleiman and Suleiman (2017) analyzed East African Countries for the period of 1990-2015. According to the results obtained, there is a negative relationship between openness and economic growth and a one-way causality relationship from economic growth to openness. There are also other studies that express the negative relationship between trade openness and economic growth (Vamvakidis (2002), Kim (2011), Hye (2012)).

Seetanah, Matadeen and Matadeen (2012) examined the relationship between the trade openness and economic growth for African countries. They concluded that there is a bidirectional causality relationship between trade openness and economic growth of the period 1990 to 2009. Zeren and Ari (2013) analyzed G7 countries between 1970 to 2011. According to empirical results, there is a bidirectional causality relationship between openness and economic growth. Idris et al. (2016) analyzed 87 countries, including 28 OECD countries and 59 developing countries, for the period of 1977 to 2011. In the findings obtained, a bidirectional causality relationship was found in OECD countries and developing countries. Korkmaz (2018) examined the relationship between the trade openness, financial openness and energy consumption in Turkey and Italy fort he period of 1970 to 2016. According to empirical evidence, trade openness positively affects the energy consumption in Turkey.

3. Data and Method

In this study, the model used is described as follows:

$$lnGDP_t = \alpha_0 + \alpha_1 lnE_t + \alpha_2 OP_t + \varepsilon_t \quad (1)$$

In Equation 1, GDP_t; Real GDP per capita at annual 2010 prices in US dollars, E_t; per capita energy consumption; kg of petroleum equivalent, OP_t; trade openness = [(Export + Import) / (Real GDP)] calculated with this formula. Exports, Imports and Real GDP data are used as constant 2010 prices. All data taken from the World Development Indicators. In the study, 24 OECD countries were included in the analysis and annual data for the period 1971 to 2014 was analyzed.

3.1. Cross Section Dependence Tests and Homogeneity

In this study, the cross section dependent test was tested to determine the panel unit root tests. If there is no cross section dependency on the panel data, the 1st generation panel unit root tests can be used. However, if the panel data has a cross section dependency, using the second generation panel unit root tests allows for more efficient and powerful forecasting.

The methods used to test the cross section dependency in panel data sets are Breusch-Pagan (1980) $CDLM_1$ test, Pesaran (2004) $CDLM_2$, Pesaran (2004) $CDLM$ and Pesaran et al. (2008) Bias Adjusted LM_{adj} tests. The null hypothesis of no cross sectional dependency for all tests. When the probability values of the tests are smaller than 0.05, null hypothesis is rejected at the level of 5% significance and the cross section dependence is determined between the units forming the panel.

$$CDLM_1 = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2 \quad (2)$$

$\hat{\rho}_{ij}$: predicts the cross section correlations between residues.

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^{T}\hat{v}_{it}\hat{v}_{jt}}{\left(\sum_{t=1}^{T}\hat{v}_{it}\right)^{1/2}\left(\sum_{t=1}^{T}\hat{v}_{jt}\right)^{1/2}} \quad (3)$$

Under the null hypothesis, N is constant and T → ∞. the statistic has N (N-1) / 2 degrees of freedom and Chi-square asymptotic distribution. The $CDLM_1$ test gives better results when the time dimension is larger than cross section size (T> N).

$$\mathrm{CDLM}_2 = \left(\frac{1}{\mathrm{N(N-1)}}\right)^{1/2}\sum_{\mathrm{i=1}}^{\mathrm{N-1}}\sum_{j=i+1}^{\mathrm{N}}(\mathrm{T}\hat{\rho}_{\mathrm{ij}}^2 - 1) \quad (4)$$

Pesaran (2004) CDLM_2 statistic is standard normal distribution in the case of T → ∞ and N → ∞ under null hypothesis. The $CDLM_2$ test gives better results when the time dimension is larger than cross section size (T> N).

$$\mathrm{CDLM} = \left(\frac{2\mathrm{T}}{\mathrm{N(N-1)}}\right)^{1/2}\sum_{\mathrm{i=1}}^{\mathrm{N-1}}\sum_{j=i+1}^{\mathrm{N}}\hat{\rho}_{\mathrm{ij}}^2 \quad (5)$$

Pesaran (2004) CDLM statistic is standard normal distribution in the case of T → ∞ and N → ∞ under null hypothesis. The CDLM test gives better results when the cross section size time dimension is larger than time dimension (N> T).

$$\mathrm{LMadj} = \left(\frac{2}{\mathrm{N(N-1)}}\right)^{1/2}\sum_{\mathrm{i=1}}^{\mathrm{N-1}}\sum_{j=i+1}^{\mathrm{N}}\hat{\rho}_{\mathrm{ij}}^2\ \frac{(T-K-1)\hat{\rho}_{ij}-\hat{\mu}_{Tij}}{v_{Tij}} \sim N(0,1) \quad (6)$$

In Equation 6, $\hat{\mu}_{Tij}$; means, v_{Tij}; variance and the test statistic to be obtained will be asymptotically normal. The LMadj test gives better results when the cross section size time dimension is larger than time dimension (N> T) (Pesaran et al., 2008).

Swamy (1970) tested the homogeneity of the slope coefficients in the cointegration equations. Pesaran and Yamagata (2008) have also improved the Swamy test to improve the literature. In this test:

$$Y_{it} = \alpha + \beta_i X_{it} + \varepsilon_{it} \quad (7)$$

The general equation of cointegration above shows, β_i slope coefficients are tested to be different between cross sections. Test hypotheses:

H_0: $\beta_i = \beta$ the slope coefficients are homogeneous.

H_1: $\beta_i \neq \beta$ the slope coefficients are heterogeneous.

The panel is estimated with Ordinary Least Squares and then Weighted Fixed Effect model to generate the necessary test statistics.

Pesaran and Yamagata (2008) developed two different test statistics to test hypotheses:

For large samples: $\tilde{\Delta} = \sqrt{N}\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}$ (8)

For small samples: $\tilde{\Delta}_{adj} = \sqrt{N}\frac{N^{-1}\tilde{S}-k}{\sqrt{Var(t,k)}}$ (9)

Where, N; cross section number, S; Swamy test statistic, k; number of explanatory variables and Var (t, k) refers to the standard error. When the calculated probability values are less than 0.05, the H0 hypothesis is rejected at the level of 5% significance, H1 hypothesis is accepted. Thus, it is determined that the cointegration coefficients are heterogeneous (Pesaran and Yamagata, 2008).

3.2. Kónya Causality Test

Kónya (2006) causality test, Seemingly Unrelated Regressions (SUR) and country specific bootstrap critical values are based on Wald tests. This test has two advantages, the first advantage assumes that the panel is not homogeneous. Thus, the Granger causality will be tested separately for each country involved in the panel. Secondly, because of the simultaneous correlation allowed between countries, additional information provided by the panel data is available. On the other hand, this application can be analyzed without the need for unit root and cointegration analyses. The bootstrap panel causal model using two variable model is given below:

$$y_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly_1} \beta_{1,1,l} y_{1,t-1} + \sum_{l=1}^{mlx_1} \varphi_{1,1,l} x_{1,t-1} + \mu_{1,1,t} \quad (10)$$

$$y_{1,t} = \alpha_{1,2} + \sum_{l=1}^{mly_1} \beta_{1,2,l} y_{2,t-1} + \sum_{l=1}^{mlx_1} \varphi_{1,2,l} x_{2,t-1} + \mu_{1,2,t} \quad (11)$$

⋮

$$y_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly_1} \beta_{1,N,l} y_{N,t-1} + \sum_{l=1}^{mlx_1} \varphi_{1,N,l} x_{N,t-1} + \mu_{1,N,t} \quad (12)$$

and

$$x_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly_2} \beta_{2,1,l} y_{1,t-1} + \sum_{l=1}^{mlx_2} \varphi_{2,1,l} x_{1,t-1} + \mu_{2,1,t} \quad (13)$$

$$x_{1,t} = \alpha_{2,2} + \sum_{l=1}^{mly_2} \beta_{2,2,l} y_{2,t-1} + \sum_{l=1}^{mlx_2} \varphi_{2,2,l} x_{2,t-1} + \mu_{2,2,t} \quad (14)$$

$$\vdots$$

$$x_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly_2} \beta_{2,N,l} y_{N,t-1} + \sum_{l=1}^{mlx_2} \varphi_{2,N,l} x_{N,t-1} + \mu_{2,N,t} \quad (15)$$

The bootstrap panel causal model using two variable model is given below.

$$y_{1,t} = \alpha_{1,1} + \sum_{l=1}^{mly_1} \beta_{1,1,l} y_{1,t-1} + \sum_{l=1}^{mlx_1} \varphi_{1,1,l} x_{1,t-1} + \sum_{l=1}^{mlz_1} \gamma_{1,1,l} z_{1,t-1} + \mu_{1,1,t} \quad (16)$$

$$\vdots$$

$$y_{N,t} = \alpha_{1,N} + \sum_{l=1}^{mly_1} \beta_{1,N,l} y_{N,t-1} + \sum_{l=1}^{mlx_1} \varphi_{1,N,l} x_{N,t-1} + \sum_{l=1}^{mlz_1} \gamma_{1,N,l} z_{N,t-1} + \mu_{1,N,t} \quad (17)$$

and

$$x_{1,t} = \alpha_{2,1} + \sum_{l=1}^{mly_2} \beta_{2,1,l} y_{1,t-1} + \sum_{l=1}^{mlx_2} \varphi_{2,1,l} x_{1,t-1} + \sum_{l=1}^{mlz_2} \gamma_{2,1,l} z_{1,t-1} + \mu_{2,1,t} \quad (18)$$

$$\vdots$$

$$x_{N,t} = \alpha_{2,N} + \sum_{l=1}^{mly_2} \beta_{2,N,l} y_{N,t-1} + \sum_{l=1}^{mlx_2} \varphi_{2,N,l} x_{N,t-1} + \sum_{l=1}^{mlz_2} \gamma_{2,N,l} z_{N,t-1} + \mu_{2,N,t} \quad (19)$$

and

$$z_{1,t} = \alpha_{3,1} + \sum_{l=1}^{mly_3} \beta_{3,1,l} y_{1,t-1} + \sum_{l=1}^{mlx_3} \varphi_{3,1,l} x_{1,t-1} + \sum_{l=1}^{mlz_3} \gamma_{3,1,l} z_{1,t-1} + \mu_{3,1,t} \quad (20)$$

$$\vdots$$

$$z_{N,t} = \alpha_{3,N} + \sum_{l=1}^{mly_3} \beta_{3,N,l} y_{N,t-1} + \sum_{l=1}^{mlx_3} \varphi_{3,N,l} x_{N,t-1} + \sum_{l=1}^{mlz_3} \gamma_{3,N,l} z_{N,t-1} + \mu_{3,N,t} \quad (21)$$

where, y: $lnGDP$; annual real GDP per capita at 2010 prices in US dollars, x: lnE; per capita energy consumption, kg of petroleum equivalent, $z = OP$; trade openness, N; the number of countries in the panel (i = 1, ..., N), t: time period (t = 1, ..., T) and l; lag length.

Each equation belongs to a different country, so it is estimated with a different sample. The variables are the same in all equations, but the observations are different. Each equation has predetermined variables and the possible link between individual regressions is the horizontal section dependency (Kónya, 2006: 981). Granger causality can be found for each country. For example, (i), when all $\varphi_{1,i}$ are not equal to zero and all $\beta_{2,i}$ are equal to zero, there is a one way Granger causality relationship from $lnGDP$ to lnE; (ii), when all $\beta_{2,i}$ are not equal to zero and all $\varphi_{1,i}$ are equal to zero, there is a one way Granger causality relationship from lnE to $lnGDP$; (iii) When neither all $\varphi_{1,i}$ nor all $\beta_{2,i}$ are equal to zero, there is a bidirectional causality relationship between $lnGDP$ and lnE. (iv) There is no causality relationship between lnGDP and lnE if both $\varphi_{1,i}$ and all $\beta_{2,i}$ are equal to zero. In the study, Kónya (2006) causality test was chosen because it gave the causality between two independent variables and the dependent variable (Gövdeli, 2018).

4. Findings

In this part of the study, the cross sectional dependence and homogeneity between the variables are tested and the findings are presented in Table 1.

Table 1: Result for Cross Section Dependence and Homogeneity Tests

Tests	Statistic	p-Value
$CDLM_1$	2125.619	0.000***
$CDLM_2$	78.725	0.000***
CDLM	28.136	0.000***
LM_{adj}	97.078	0.000***
$\tilde{\Delta}$	57.127	0.000***
$\tilde{\Delta}_{adj}$	59.848	0.000***

Note: *** shows significance level at 1%.

According to the results of Table 1, there is no dependence on the null hypothesis is rejected in the cross section 1% significance level. Accordingly, if any OECD country shocks occur, it will affect the other OECD countries. Table 1 also shows the homogeneity of the slope coefficients. The slope coefficient of null hypothesis is rejected at the level that means homogeneous 1%. Therefore, the slope coefficients are heterogeneous. The Kónya (2006) test of causality is a causality preliminary that provides the heterogeneity of the slope coefficients under cross section dependency.

Table 2: Kónya Causality between Economic Growth and Energy Consumption

	$lnE \nrightarrow lnGDP$				$lnGDP \nrightarrow lnE$			
	Statistics	Critical Values			Statistics	Critical Values		
		1%	5%	10%		1%	5%	10%
Australia	0.320	29.154	16.029	10.944	8.535*	22.825	11.653	7.985
Austria	14.256*	34.824	19.756	13.489	24.431	62.332	39.222	28.572
Belgium	1.099	32.769	18.129	12.916	3.058	42.404	23.241	15.747
Canada	10.456	36.284	19.676	13.485	0.188	20.411	10.825	7.427
Chile	9.805	31.229	17.422	11.950	56.578***	27.517	15.321	10.581
Denmark	2.692	37.896	20.410	14.156	3.828	19.006	10.548	7.119
Finland	6.466	44.060	26.403	18.700	12.964*	28.539	15.847	10.857
France	16.372	42.472	23.419	16.506	1.970	42.578	23.200	16.062
Germany	0.370	32.199	17.694	12.153	15.257**	28.691	14.383	9.486
Greece	0.089	26.980	14.049	9.715	0.034	29.401	16.056	11.209
Iceland	1.193	23.950	13.122	8.986	18.346**	31.566	17.783	12.501
Ireland	22.960**	25.935	13.794	9.471	0.235	27.135	15.830	11.218
Italy	2.252	31.505	18.266	12.631	0.894	55.510	32.672	23.322
Japan	28.673***	23.732	13.560	9.275	9.914	54.246	30.860	22.139
Korea, Rep.	5.549	31.399	16.944	11.979	7.784	49.882	29.658	21.097
Luxembourg	21.100**	35.579	18.354	12.801	1.375	32.245	18.128	12.432
Mexico	0.724	39.251	21.510	15.101	0.108	32.733	17.481	11.753
Netherlands	0.001	43.387	25.474	17.710	1.942	19.978	10.673	7.498
Norway	7.296	50.285	26.607	18.380	109.964***	42.283	23.315	16.389
Portugal	24.980**	34.684	19.094	13.101	2.238	39.661	23.571	15.988
Spain	3.048	34.398	18.944	13.288	1.163	36.838	18.931	13.128
Sweden	0.155	33.710	20.016	13.961	0.219	20.645	10.285	6.997
United Kingdom	1.860	29.605	16.255	11.227	4.830	43.042	23.796	16.960
United States	20.554**	34.892	19.791	13.587	8.356	30.359	15.908	10.662

Note: ***, ** and * represent the level of significance at 1%, 5% and 10%, respectively. Critical values were obtained with 10,000 bootstrap replications.

The heterogeneity of the slope coefficients under the cross section dependency of the causality test in Kónya (2006) was determined (Table 1). If cross section dependence didn't exist, each country would have to use an OLS estimator. However, the cross section dependency we find in Table 1 requires the use of the SUR estimator (Zellner, 1962).

Table 2 gives the panel causality relationship between economic growth and energy consumption in OECD countries. In the findings, the causality relationship between energy consumption to economic growth was found in Austria, Ireland, Japan, Luxembourg, Portugal and United States. On the other hand, the causality relationship between economic growth to energy consumption was found in Chile, Germany, Iceland ve Norway. The results obtained are consistent with (Soytas, Sari and Ewing, 2007), (Bozoklu and Yilanci, 2013), (Soytas and Sari, 2007) and (Narayan and Smyth, 2008).

Table 3: Kónya Causality between Economic Growth and Trade Openness

	$lnOP \nrightarrow lnGDP$				$lnGDP \nrightarrow lnOP$			
	Statistics	Critical Values			Statistics	Critical Values		
		1%	5%	10%		1%	5%	10%
Australia	1.024	21.266	11.883	7.999	16.237	65.555	42.001	32.682
Austria	11.031*	21.117	12.137	8.371	14.044	71.385	43.447	31.338
Belgium	13.519**	24.199	13.001	8.865	2.639	90.647	60.574	48.176
Canada	74.639***	34.639	19.125	13.021	5.994	56.952	30.606	21.796
Chile	4.688	48.855	26.620	19.126	1.762	43.681	25.857	18.242
Denmark	1.711	24.346	14.383	9.933	7.428	60.067	38.886	29.094
Finland	11.918*	24.639	13.049	9.042	0.289	71.278	44.769	33.634
France	10.142	24.547	14.541	10.297	0.720	103.485	70.167	55.458
Germany	14.649**	19.471	10.877	7.425	2.492	103.146	70.694	57.724
Greece	0.012	18.065	9.675	6.723	0.002	45.830	26.338	18.607
Iceland	22.914**	26.514	14.204	9.752	0.245	24.091	13.132	9.177
Ireland	4.590	22.108	12.394	8.497	14.816	45.131	28.142	21.389
Italy	3.701	20.559	11.290	7.829	5.763	74.698	42.606	30.909
Japan	0.571	18.335	10.293	7.179	1.853	63.600	37.931	26.051
Korea, Rep.	4.270	19.178	10.461	7.418	1.968	84.974	56.182	44.821
Luxembourg	0.865	21.877	11.827	8.288	7.618	63.973	40.039	30.137
Mexico	14.186**	15.520	8.721	6.044	2.326	63.367	38.239	27.538
Netherlands	3.705	24.689	13.726	9.640	0.957	88.075	58.031	46.074
Norway	1.389	35.004	19.638	13.450	0.796	41.466	23.036	16.294
Portugal	5.708	26.776	14.702	10.406	0.046	52.699	32.355	24.268
Spain	32.830***	29.032	16.066	11.222	0.135	66.754	41.900	30.607
Sweden	17.626**	25.724	14.075	9.721	1.081	71.571	44.737	31.981
United Kingdom	0.133	25.931	14.148	9.792	8.668	59.596	36.362	26.562
United States	0.357	21.591	12.110	8.605	12.327	93.455	61.944	47.321

Note: ***, ** and * represent the level of significance at 1%, 5% and 10%, respectively. Critical values were obtained with 10,000 bootstrap replications.

Table 4: Kónya Causality between Energy Consumption and Trade Openness

	$lnOP \nrightarrow lnE$				$lnE \nrightarrow lnOP$			
	Statistics	Critical Values			Statistics	Critical Values		
		1%	5%	10%		1%	5%	10%
Australia	11.863**	17.964	9.218	6.323	5.431	29.728	17.176	11.767
Austria	6.005	28.491	16.319	11.284	8.427	59.620	34.783	25.345
Belgium	0.015	24.077	12.772	8.560	0.163	43.739	25.474	18.128
Canada	0.083	24.408	12.906	8.825	8.851	48.547	27.821	19.821
Chile	12.437	34.269	19.079	13.065	1.246	43.812	24.781	17.565
Denmark	8.131*	20.068	10.610	7.238	2.531	28.730	16.068	11.176
Finland	3.548	16.067	9.002	6.178	2.191	56.426	34.571	25.688
France	1.092	21.543	12.219	8.442	1.635	58.529	36.573	26.555
Germany	19.976**	23.282	11.934	8.126	5.960	51.403	30.069	21.654
Greece	0.015	23.557	12.780	8.812	0.364	41.651	23.675	16.203
Iceland	41.160***	26.069	14.287	9.851	0.398	24.221	13.164	8.924
Ireland	3.331	20.550	11.559	8.113	0.092	21.043	11.892	8.389
Italy	10.740*	24.455	12.842	8.841	0.671	52.816	31.900	22.743
Japan	4.369	21.764	12.342	8.550	0.187	47.625	28.800	20.606
Korea, Rep.	3.843	18.793	10.624	7.430	6.796	66.142	41.207	31.582
Luxembourg	1.313	24.666	13.052	9.022	0.669	35.608	20.491	14.217
Mexico	0.386	21.440	11.388	7.426	0.868	50.495	27.926	19.712
Netherlands	0.192	20.374	10.773	7.313	0.156	45.169	24.954	17.956
Norway	6.602	27.209	14.421	9.679	0.481	34.247	18.506	13.102
Portugal	1.738	25.326	13.881	9.384	0.339	35.977	19.649	14.208
Spain	1.146	27.301	14.511	9.685	2.283	60.631	36.579	26.213
Sweden	0.949	18.837	10.209	6.935	1.240	53.066	32.020	23.137
United Kingdom	11.396*	25.507	14.535	10.063	5.246	31.186	16.834	11.400
United States	8.018*	20.783	10.622	6.984	34.294**	52.892	31.725	23.373

Note: ***, ** and * represent the level of significance at 1%, 5% and 10%, respectively. Critical values were obtained with 10,000 bootstrap replications.

The panel causality relationship between economic growth and openness is presented in Table 3. In the results obtained, the causality relationship between

trade openness to economic growth was found in, Austria, Belgium, Canada, Finland, Germany, Iceland, Mexico, Spain and Sweden. The results obtained are consistent with (Gries, Kraft and Meierrieks, 2011) and (Gries and Redlin, 2012).

Table 4 demonstrates the panel causality relationship between energy consumption and trade openness. Australia, Denmark, Germany, Iceland, Italy and United Kingdom was found to have a unidirectional causality relationship between trade openness to energy consumption. The results obtained are consistent with (Sadorsky, 2012) and (Shahbaz et al., 2014).

Table 5: Kónya Causality between Energy Consumption, Trade Openness and Economic Growth

	$lnOP\ and\ lnE \nrightarrow lnGDP$			
	Statistics	Critical Values		
		1%	5%	10%
Australia	0.593	16.861	9.636	6.823
Austria	2.965	30.002	16.639	11.660
Belgium	2.064	26.962	14.619	10.328
Canada	28.689**	28.941	15.446	10.929
Chile	14.299*	37.398	20.039	13.547
Denmark	1.855	25.252	14.066	9.757
Finland	0.010	32.986	18.233	12.788
France	1.916	28.428	15.799	11.573
Germany	2.495	23.846	13.415	9.282
Greece	3.310	21.124	11.562	8.024
Iceland	15.628**	28.400	14.676	9.967
Ireland	3.443	18.625	10.441	7.370
Italy	9.766	25.797	13.990	9.910
Japan	5.546	15.760	9.054	6.385
Korea, Rep.	2.012	19.634	10.954	7.648
Luxembourg	12.359	32.301	18.780	13.064
Mexico	3.644	28.254	16.223	11.497
Netherlands	0.224	34.289	20.248	14.008
Norway	1.839	28.189	15.297	10.732
Portugal	0.386	24.847	14.151	9.740
Spain	19.306**	23.878	13.679	9.485
Sweden	10.343*	20.984	11.663	7.952
United Kingdom	0.036	19.568	11.219	7.830
United States	1.422	19.039	10.623	7.465

Note: ***, ** and * represent the level of significance at 1%, 5% and 10%, respectively. Critical values were obtained with 10,000 bootstrap replications.

The panel causality relationship between energy consumption, trade openness and economic growth is presented in Table 5. According to the findings obtained, Canada, Chile, Iceland, Spain and Sweden have reached the conclusion that the causality relationship between energy consumption and openness to economic growth. Thus, the causality in these countries shows that energy consumption and openness have a significant effect on growth.

4. Conclusion

Trade openness and energy consumption are important factors that reveal the level of development of countries. Trade openness and energy are necessary factors for the growth of economies. The rate of outward opening is very important while ensuring economic growth. In the growing economy, if trade openness is not implemented in a planned manner, it can cause permanent damage to the

economy. In this study, the causality relationship between energy consumption, openness and economic growth was analyzed. 24 OECD countries have been examined during the period 1971 to 2014 within a unique context. The most important factor that distinguishes this study from other studies is the energy consumption and openness exploring the panel causality relation on economic growth. As previous studies have generally only examined the causality relationship between two variables, in which the causality of two variables on one variable was analyzed, this study leads the way in analyzing the causality relationship between energy consumption and openness to economic growth in later research.

The main aim of the study is to determine the causality relationship between trade openness and energy consumption to economic growth. According to the empirical findings, causality from trade openness and energy consumption to economic growth has been determined in Canada, Chile, Iceland, Spain and Sweden. The findings are consistent with the studies of Charfeddine and Khediri (2016), Salahuddin and Gow (2014), Dritsakis and Stamatiou (2016).

Trade openness can affect the economic growth performance of the country's economies. Policy makers need to manage the openness rates very well. While trade openness may increase economic growth at certain times, misspelling balance may lead to adversities for the country's economy. As a result of the empirical analyzes made, the policy makers of the above-mentioned countries pay attention to this, and it will be positive for the country's economies.

Energy is one of the indispensable elements of today's economy. Economic growth and development of countries depend on energy dependency. The fact that policies are energy shows that in the medium and long term, the country will stand out against other countries. Especially developed economies have very good conception. In this respect, they have created self-sufficient energy sources instead of outsourced dependent energy sources of the countries. Making energy investments will affect the country's economy and its relationship to other countries.

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