International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(1), 28-34.

Which Energy-Growth Hypothesis is Valid in OECD Countries? Evidence from Panel Granger Causality

Aynur Pala*

Department of Finance-Banking and Insurance, Okan University, Kadıkoy, Turkey. *Email: aynur.pala@okan.edu.tr

ABSTRACT

This paper aims to determine which energy consumption-economic growth hypothesis is valid in OECD countries. For this purpose, we used panel cointegration, panel Granger causality and panel vector error correction model (VECM) for the period of 1995-2013. Panel cointegration test outcomes support the long-term equilibrium link among economic growth, energy consumption, labor force and capital formation. The consequences obtained from panel VECM suggests that there is evidence of bi-directional causality between energy consumption and economic growth in the short-term. However, a long-run causality is not found between energy consumption and economic growth. This implies indicated that the OECD countries' economies are founded on energy and the feedback hypothesis is valid in OECD countries. Policy makers in OECD countries consider the feedback effect by employing arrangements to cut energy consumption.

Keywords: Energy Consumption, Economic Growth, Cointegration, Causality, OECD Countries
JEL Classifications: C23, Q43

1. INTRODUCTION

The growth in world energy demand is the main cause of the increase in CO_2 emissions and climate change. In the last 30 years, global total primary energy supply increased by 85%, it rose to 524.076 quadrillion BTU (2012). At the same period, total carbon dioxide emission from the consumption of the energy rose to 31,155 million metric tons (2010) by 69%[1]. The lower energy consumption is required to cut greenhouse gas emissions. The decline in energy consumption will negatively effect on economic growth. In this case, countries are facing a dilemma. Investigation nexus between energy consumption and economic growth can relief to overcome this dilemma. On a global scale efforts to reduce carbon emissions have attracted to investigation concern with the relation between energy consumption and economic growth.

The literature bring forward four possible hypothesis between energy consumption and economic growth (Squalli, 2007). The growth hypothesis means that energy consumption contributes to economic growth. The conservation hypothesis implies that energy conservation policies have no adverse effects on real gross domestic product (GDP). Uni-directional causality running from GDP to energy consumption supports the conservation hypothesis. The feedback hypothesis suggests that there is an bi-directional causal relation between energy consumption and GDP. The neutrality hypothesis means that there is no causality between energy consumption and economic growth.

There are two perspective relation with energy-output: Energy demand function (demand side) and the aggregate production function (production side). Energy demand function should be used with energy, GDP, and energy price variables. The aggregate production function includes energy, GDP, capital stock and labor.

We follow the production side model used by Oh and Lee (2004a and b) to investigate the relationship between energy consumption and economic growth.

$$Y_{tj} = f\left(K_{tj}, L_{tj}, EC_{tj}\right) \quad (1)$$

1 U.S. Energy Information Administration, International Energy Statistics, www.eis.gov.

where aggregate output/economic output/real GDP (Y) is a function of the real capital stock (K), labor (L) and energy input (EC).

This paper differs from other valuable contributions in the area in several aspects. Firstly, the sample includes all of OECD countries. Secondly, it uses methodology which allows for inference in case of cross-sectional dependence (CD). And, this paper contributes to energy-growth literature by employing the panel granger causality and panel vector error correction model (VECM) to analyze both short-run and long-run causality.

The remainder of the paper is organized as follows: Section 2 introduces the selected literature, Section 3 presents data, econometric methodology and empirical results and Section 4 presents conclusions.

2. LITERATURE REVIEW

The relation between energy consumption and economic growth literature consist of four sub-section (Costantini and Martini, 2010). First-generation studies includes VAR methodology (Sims, 1972) and Granger causality (1969). This studies assumed that data were stationary. Kraft and Kraft (1978) found that the strong evidence of causality running from income to energy consumption. Engle-Granger two-step procedure (Engle and Granger, 1987) considered non-stationarity generated second-generation studies.

Multivariate estimators proved by Johansen (1991) which allowed for more than two variables in cointegration relationship (Masih and Masih, 1996; Stern, 2000; Oh and Lee, 2004) used to analyse that relationship. This approach applied third-generation studies. Paul and Bhattacharya (2004) employ the Johansen multivariate cointegration technique on energy consumption, GDP, capital, and labor. The evidence showed that bi-directional causality between energy consumption and economic growth. Fourth generation literatures used panel methods to test for unit-roots, cointegration and Granger causality (Costantini and Martini 2010). They found that in short-run, there is bi-directional causality between energy consumption and real GDP for 26 OECD countries by using a panel VECM. In the long-run, they found that, there is uni-directional causality from real GDP to energy consumption.

Lee and Chang (2008) examined the relation between energy use and economic growth for 16 Asian countries using by panel cointegration technique and they found a long-run causal relationship from energy consumption to economic growth. Bozoklu and Yılancı (2013) examines the causal relationship between energy consumption and economic growth for 20 OECD countries. They apply a Granger causality test in the frequency domain which allows to distinguish temporary and permanent causality. The evidence showed that uni-directional causality from energy consumption to GDP. There is a temporary relationship for Denmark, Norway and a permanent relationship for Belgium, Finland, and Greece.

Solarin and Ozturk (2015) investigates the relationship between hydroelectricity consumption and economic growth in seven Latin America countries including Argentina, Brazil, Chile, Colombia, Ecuador, Peru and Venezuela over the period of 1970-2012 using Granger causality and VECM. There is evidence uni-directional causality from hydroelectricity consumption to economic growth in Brazil, Chile, Colombia, Ecuador and Peru in the long run. Bilgili and Ozturk (2015) reveals the long run dynamics of biomass energy consumption and economic growth for G7 countries over the period of 1980-2009. They use conventional OLS and dynamic OLS analyses. Findings confirmed the growth hypothesis in which biomass energy consumption have positive effects on economic growth in G7 countries. Bozkurt and Destek (2015) investigates the relationship between economic growth, renewable energy consumption, gross fixed capital and total number of labor for 1980-2012 in selected OECD countries. The results of ARDL approach present that renewable energy consumption has positive effect on economic growth in more developed countries. These studies confirmed the growth hypothesis.

Hatzigeorgiou et al. (2011) employed that relationship for Greece by using Johansen Cointegration and VECM causality, they found a causal relationship from economic growth to energy consumption. Zachariadis (2007) showed that there is uni-directional relation from economic growth to energy consumption for Canada and United Kingdom (UK). Soytas and Sarı (2006) found uni-directional relation from economic growth to energy consumption for Austria, Belgium, Denmark and France. Bozoklu and Yılancı (2013) empirical results shows that there is uni-directional and temporary relation from GDP to energy for Australia, Canada, Mexico, the UK, the USA, and a permanent relationship for Belgium, Germany, Norway, and the USA. Omri and Kahouli (2014) examines the relationship between energy consumption, foreign direct investment and economic growth using dynamic panel data models for 65 countries over the period of 1990-2011. They investigate this interrelationship for sub-panels which are constructed based on the income level of countries; namely, high income, middle income, and low income panels. For the low-income panel, the findings reveal that there is uni-directional causal relationship from economic growth to energy consumption. Salahuddin and Gow (2014) examines the causal relationship among economic growth, energy consumption and carbon dioxide emissions using panel granger causality in Gulf Cooperation Council (GCC) countries. Findings indicate that there is uni-directional causal link running from economic growth to energy consumption. Jebli et al. (2016) investigates the causal relationship between per capita CO_2 emissions, GDP, renewable energy consumption, non-renewable energy consumption, and international trade in 25 OECD countries over the period 1980-2010. Granger causality tests show the presence of uni-directional causality running from output to renewable energy in short-run. These studies confirmed the conservation hypothesis.

Lee et al. (2008) examined the relation between energy use and economic growth for 22 OECD countries using by panel cointegration technique and they found a bi-directional relationship. Belke et al. (2011) used dynamic panel causality method for 25 OECD countries, this study indicated that there is a bi-directional causal relationship between energy consumption and economic growth. Ozturk et al. (2010) examine the causal relationship between energy consumption and growth for

51 countries. Findings support that the feedback hypothesis is valid for middle income countries. Apergis and Payne (2010b) used a multivariate panel model for 13 Eurasian countries. The results show that the feedback hypothesis is valid. Apergis and Payne (2010a) and Apergis and Payne (2012) show that feedback hypothesis is valid for 20 OECD countries and 80 countries respectively. Yıldırım and Aslan (2012) investigates the relationship between energy consumption, economic growth, employment, and gross fixed capital formation using by Toda–Yamamoto procedure for 17 highly developed OECD countries. They found that bi-directional causal relationship between energy consumption and real GDP for Italy, New Zealand, Norway, and Spain. Bozoklu and Yılancı (2013) empirical evidence reveals that there is bi-directional causal and both temporary and permanent relationship for Austria, Italy, the Netherlands, Portugal, Denmark, and Japan. Nasreen and Anwar (2014) investigated the causal relationship between economic growth, trade openness and energy consumption for 15 Asian countries over the period of 1980-2011. They use panel cointegration and causality approaches to examine the long-run and causal relationship between variables. The result of panel Granger causality analysis reveals bi-directional causal relation between economic growth and energy consumption. Ozturk and Al-Mulali (2015) investigates the relationship between natural gas consumption and economic growth using Granger causality in GCC countries over the period of 1980-2012. The results revealed bi-directional causality between natural gas energy consumption and economic growth which confirms the feedback hypothesis. Jammazi and Aloui (2015) investigate the cross linkages between CO_2 emission, economic growth and energy consumption for six GCC countries (Saudi Arabia, Oman, Bahrain, Kuwait, UAE and Qatar) over the period 1980-2013. They consider wavelet window cross correlation that combines multiscaling decomposition, and lead/lag cross correlations. The results show the existence of bilateral causal effects between Energy Consumption and Economic Growth while only a uni-directional relationship was found from Energy Consumption to CO_2 emissions. Jebli et al. (2016) find that there are also long-run bi-directional causalities between per capita CO_2 emissions, GDP, renewable and non-renewable energy consumption, and international trade in 25 OECD countries over the period of 1980-2010. It approved the feedback hypothesis.

Ozturk and Acaravci (2010a, 2010b) examined ARDL approach for four Eastern and Southeastern European countries and Turkey. They found that there is no causality between energy consumption and economic growth. Yıldırım et al. (2014) analyze causal relation between economic growth and energy consumption in the Next 11 countries using bootstrapped autoregressive metric causality approach. The evidence shows that the neutrality hypothesis is valid for all of the countries except for Turkey. Salahuddin et al. (2015) examines the relationship between carbon dioxide emissions, economic growth, electricity consumption and financial development in the GCC countries, using Granger causality for the period of 1980-2012. Granger causality results reveal that there is no relation between economic growth and electricity consumption. It approved the neutarility hypothesis.

3. DATA AND METHODOLOGY

This study uses annual data from 1995 to 2013 for 34 OECD countries. These are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxemburg, Mexico, Netherlands, New Zeland, Norway, poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kindom, United States. Data on GDP growth (annual %) is used as a proxy for economic growth and energy consumption is represented by energy use (kg of oil equivalent per capita). And others variables are labor force, total (million) and gross capital formation (% of GDP). All variables are have been obtained from the World Bank's World Development Indicators. We use panel methods, because it allows for higher degree of freedom and minimize multicollinearity between variables.

We use the aggregate output model in Oh and Lee (2004 a and b) to investigate the relationship between energy consumption and economic growth.

$$Y_{tj} = f\left(K_{tj}, L_{tj}, EC_{tj}\right) \quad (1)$$

where aggregate output/economic output/real GDP (*Y*) is a function of the real capital stock (*K*), labor (*L*) and energy input (*EC*).

The present empirical analysis is based on the following panel regression model,

$$GDP_{it} = \alpha_{0it} + \beta_{1it}GCF + \beta_{2it}LF + \beta_{3it}ENU + \varepsilon_{it} \quad (2)$$

where i=1,…,N represents each of the OECD countries and t=1,….T denotes each year during the period 1995 to 2013. Where GDP is Gross Domestic Product Growth (%); GCF is gross capital formation (% of GDP); LF is labor force, total (million); ENU is energy use (kg of oil equivalent per capita) and α_0, β_1, β_2, β_3, β_4 are the unknown parameters to be estimated while ε is an error term.

4. EMPIRICAL RESULTS

Urbain and Westerlund (2006) advocated that the assumption of cross-sectional independence is usually not verify on the stregth of strong inter-economy linkages. The main problem of panel approach is CD. Firstly, determine whether the CD or not. If there is CD, panel unit-root tests are used allowed CD.

When T<N, the LM test statistics, developed by Breusgh and Pagan (1980), exhibits substantial size distortion[2]. "Pesaran's (2004) CD test, Friedman's (1937) statistic, and the test statistic proposed by Free's (1995) designed to test for CD in large-N, small-T panels" (Hoyos and Sarafidis, 2006). In our study, because T<N, we use Pesaran's (2004) CD test, Friedman's (1937) statistic, and the test statistic proposed by Free's (1995).

2 U.S. Energy Information Administration, International Energy Statistics, www.eis.gov.

Pesaran (2004) CD test has proposed the following[3],

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

and showed that under the null hypothesis of no cross-sectional dependence CD $\xrightarrow{d}$ N (0,1) for N→∞ and T sufficiently large.

For unbalanced panels, Pesaran (2004) proposes a slightly modified version of (3), which is given by

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

Friedman (1937) proposed a nonparametric test based on Spearman's rank correlation coefficient. Friedman's statistic is based on the average Spearman's correlation and is given by

$$R_{average} = \frac{2}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} r_{ij}$$

where r_{ij} is the sample estimate of rank correlation coefficient of the residuals. Large values of Raverage show the presence of nonzero cross-sectional correlations. Friedman indicated that $(T-1)\{(N-1)R_{average}+1\}$ is asimptotically X^2 distributed with T-1 degrees of freedom, for fixed T as N gets large.

istic is based on the sum of squared rank correlation coefficients and is given by

$$R^2_{average} = \frac{2}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} r_{ij}^2$$

Frees shows that $N\left\{R^2_{average} - (T-1)^{-1}\right\}$ is asimptotically distributed with T-1 and T(T-3)/2 degrees of freedom, respectively.

The analysis of the dataset is started by testing the CD tests. Table 1. present the results obtained for three different CD test statistics: CD (Pesaran, 2004), Frees' and Friedman's tests. The results show that there is enough evidence to reject the null hypothesis of cross-sectional independence. The results indicate that for the OECD countries at significance level p=0.01 we rejected the null hypothesis indicating cross-sectional independence. This finding necessitates taking into account cross-section dependence when applying panel unit root tests.

A number of panel unit root tests that allow for cross-section dependence have been proposed in the literature that use orthogonalization type procedures to asymptotically eliminate the CD of the series before standard panel unit root tests are applied to the transformed series (Pesaran, 2003, 2005). Sequential asymptotic results are provided in the case where T → ∞, and then N → ∞.

Given that the previous section shows evidence in favor of cross-section dependence, we use the second-generation panel unit-root test of Pesaran (2003, 2005) CADF that take into account the dependence between countries.

Table 2 summarizes the results of CADF test. The null hypothesis of unit root can be rejected[4]. The result of test indicate that all variables are integrated of order 1.

In a granger causality framework, it is required to establish the presence of stationary between variables. To test whether variables are cointegrated, we refer to Westerlund (2007). Westerlund (2007) panel cointegration test are generalized versions of the tests proposed in Banerjee et al. (1998). In contrast to e.g. Pedroni (1999, 2004), no common factor restrictions are imposed because if the restriction is violated the tests lose power. The null hypothesis for Westerlund (2007) panel cointegration test is no cointegration.

The idea of this test is to test the null hypothesis of no cointegration by inferring whether the error-correction term in a conditional panel error-correction model is equal to zero. Test assumes the existence of an error correction for individual panel members (G_τ and G_α) and for the panel as a whole (P_τ and P_α) without any common-factor restriction.

Table 3 report the Westerlund (2007) results for the OECD panel. The null hypothesis of no cointegration among GDP, capital stock

4 See Pesaran (2007) for critic value.

Table 1: Cross-sectional dependence tests

Model	CD (Pesaran, 2004)	Friedman (1937)	Free's test
FE model	40.712* (0.000)	3.581* (0.000)	185.328* (0.000)
RE model	47.765* (0.000)	4.350* (0.000)	214.282* (0.000)

The P values are in parentheses. *The statistical significance at 1 percent level

Table 2: Pesaran CADF panel unit root test

Variables	t-bar	Z
Level		
GDP	−1.540	−0.490 (0.349)
GCF	−1.784	−0.309 (0.379)
ENU	−1.359	2.119 (0.983)
LF	−1.825	−0.544 (0.293)
First difference		
DGDP	−3.147	−8.103 (0.000)
DGCF	−2.692	−5.500 (0.000)
DENU	−2.715	−5.630 (0.000)
DLF	−2.537	−4.616 (0.000)

The Pesaran CADF test is based on the mean of individual ADF t-statistics of each unit in the panel. To remove the cross dependence, the standard ADF regressions are augmented with the cross-section averages of lagged levels and first-differences of the individual series. The lag lengths for the panel test are based on those employed in the univariate ADF test. Critical values for the t-bar statistics with trend at 1%, 5%, and 10% significance levels are−2.25, −2.11, and−2.03 respectively. Assuming cross-section dependence and T is the same for all countries, the normalized Z test statistic is computed by using the t-bar statistics. The Z test statistic is compared to the 1%, 5%, and 10% significance levels with the one-sided critical values of−2.326, −1.645, and−1.282 correspondingly

Table 3: Westerlund (2007) panel cointegration test

Statistics	Value	Z value
G_t	−2.639*	−5.291* (0.000)
G_a	−4.709	2.896 (0.998)
P_τ	−13.362*	−4.336* (0.000)
P_α	−4.979	−0.654 (0.256)

The cointegration tests take no cointegration as the null. G_τ and G_α are Group mean tests P_τ and P_α Panel tests. The Ga statistic may reject the null hypothesis of no cointegration in small panel data (Westerlund, 2007)*= indicate the statistical significance at 1 percent level

3 The CD test are performed using the STATA routine "xtcsd" proposed by de Hoyos abd Sarafidis (2006).

Table 4: Panel granger causality and VECM

Variable	Short-run causality				Long-run causality
	DGDP	DGCF	DENU	DLF	ECT
DGDP	-	32.279* (0.000)	16.683* (0.000)	1.866 (0.3932)	−0.777
DGCF	10.100* (0.000)	-	23.186* (0.000)	0.998 (0.607)	0.168
DENU	8.769* (0.012)	9.164* (0.010)	-	0.706 (0.702)	−1.330
DLF	1.815 (0.402)	1.212 (0.545)	0.447 (0.799)	-	−0.012*

The P values are in parentheses. *The statistical significance at 1% level. VECM: Vector error correction model

formation, energy use and labor force is strongly rejected by all test statistics (except G_α and P_α - may be because the sample size is smaller). These results should be taken as evidence of cointegration for the panel as a whole and/or at least for one of the countries in these panels.

Panel VECM is estimated to apply Granger causality tests (Pesaran et al., 1999) to examine causal relationship between the variables. We use the two-step procedure proved by Engle and Granger (1987). The first step is to estimate the long-run model for Equation 2 in order to obtain the estimated results (φ); (ECT). The second step is to estimate the Granger causality model with a dynamic error correction model (Lee et al., 2008) The panel VECM can be written as follows:

$$\Delta GDP_{it} = \delta_{1i} + \sum_{p=1}^{k} \delta_{11ip} \Delta GDP_{it-p} + \sum_{p=1}^{k} \delta_{12ip} \Delta GCF_{it-p} + \sum_{p=1}^{k} \delta_{13ip} \Delta LF_{it-p} + \sum_{p=1}^{k} \delta_{14ip} \Delta ENU_{it-p} + \varphi_{1i} \varepsilon_{it-1} + \vartheta_{1it} \tag{3a}$$

$$\Delta GCF_{it} = \delta_{2i} + \sum_{p=1}^{k} \delta_{21ip} \Delta GCF_{it-p} + \sum_{p=1}^{k} \delta_{22ip} \Delta GDP_{it-p} + \sum_{p=1}^{k} \delta_{23ip} \Delta LF_{it-p} + \sum_{p=1}^{k} \delta_{24ip} \Delta ENU_{it-p} + \sum_{p=1}^{k} \varphi_{2i} \varepsilon_{it-1} + \vartheta_{2it} \tag{3b}$$

$$\Delta LF_{it} = \delta_{3i} + \sum_{p=1}^{k} \delta_{31ip} \Delta LF_{it-p} + \sum_{p=1}^{k} \delta_{32ip} \Delta GDP_{it-p} + \sum_{p=1}^{k} \delta_{33ip} \Delta GCF_{it-p} + \sum_{p=1}^{k} \delta_{34ip} \Delta ENU_{it-p} + \varphi_{3i} \varepsilon_{it-1} + \vartheta_{3it} \tag{3c}$$

$$\Delta ENU_{it} = \delta_{4i} + \sum_{p=1}^{k} \delta_{41ip} \Delta ENU_{it-p} + \sum_{p=1}^{k} \delta_{42ip} \Delta GDP_{it-p} + \sum_{p=1}^{k} \delta_{43ip} \Delta GCF_{it-p} + \sum_{p=1}^{k} \delta_{44ip} \Delta LF_{it-p} + \varphi_{4i} \varepsilon_{it-1} + \vartheta_{4it} \tag{3d}$$

where Δ is the first-difference operator; p is the optimal lag legth(s) and ε_{it} is residuals from the panel FMOLS estimation of Equation 1. This specification allows determining both the short-run and long-run causalities. The short-run causality from one variable to other variable is tested with a Wald test by imposing zero restriction on parameters of first-differenced variables. The long-run causalities is examined by statistical significance of t-statistic of the error correction coefficients (φ) (ECT).

Table 4 reports the results of the short-run and the long-run Granger-causality tests. With respect to Equation 3a, gross capital formation, energy use and labor force have a positive and statistically significant impact on economic growth in the short-run. The error correction term is statistically insignificant. In terms of Equation 3b, economic growth and energy use have a positive and statistically significant impact on gross capital formation in the short-run. The error correction term is statistically insignificant. In terms of Equation 3c, economic growth and gross capital formation have a positive and statistically significant impact on energy use in the short-run. The error correction term is statistically insignificant. In terms of Equation 3d, economic growth, gross capital formation, energy use and labor force and have a positive and statistically insignificant impact on labor force. The statistical significance of the error correction term suggests that labor force responds to deviations from long-run equilibrium with an adjustment of −0.012. In summary, the short-run Granger causality tests reveal positive bi-directional causality between energy consumption and economic growth.

5. CONCLUSION

This paper empirically investigates the relationships between economic growth and energy consumption using panel data framework for OECD countries over the period of 1995-2013. Energy consumption plays an important role in OECD growth process. The results of panel cointegration test prove that there is a long-run equilibrium relationship among economic growth, energy consumption, labor force and gross capital formation. The estimation of panel VECM shows that the presence of short-run bi-directional causality between energy consumption and economic growth. This implies that energy consumption and economic growth are interconnected in short-run, which also supports the feedback hypothesis indicating that the OECD countries' economies are energy dependent. The empirical evidence in favor of bi-directional causality between energy consumption and economic growth confirms by, Costantini and Martini (2010), Belke et al. (2011), Dobnick (2011), Yıldırım and Aslan (2012), Ozturk and Al-Mulali (2015), Jammazi and Aloui (2015). Policy makers in OECD countries consider energy consumption on economic growth by appliying regulations to reduce energy consumption.

REFERENCES

Apergis, N., Payne, J.E. (2010a), Renewable energy consumption and growth in Eurasia. Energy Economics, 32, 1392-1397.

Apergis, N., Payne, J.E. (2010b), Renewable energy consumption and economic growth: Evedence from a panel of OECD countries. Energy Policy, 38, 656-660.

Apergis, N., Payne, J.E. (2012), Renewable and non-renewable energy consumption-growth nexus: Evidence from a panel error correction model. Energy Economics, 34, 733-738.

Banerjee, A., Dolado, J., Mestre, R. (1998), Error-correction mechanism tests for cointegration in a single-equation framework. Journal of Time Series Analysis, 19, 267-283.

Belke, A., Dobnik, F., Dreger, C. (2011), Energy consumption and economicgrowth: New insights into the cointegration relationship. Energy Economics, 33(5), 782-789.

Bilgili, F., Ozturk, I. (2015), Biomass energy and economic growth nexus in G7 countries: Evidence from dynamic panel data. Renewable and Sustainable Energy Reviews, 49, 132-138.

Bozkurt, C., Destek, M.A. (2015), Renewable energy and sustainable development nexus in selected OECD Countries. International Journal of Energy Economics and Policy, 5(2), 507-514.

Bozoklu, S., Yılancı, V. (2013), Energy consumption and economic growth for selected OECD countries: Further evidence from the Granger causality test in the frequency domain. Energy Policy, 63, 877-881.

Breusch, T.S., Pagan, A.R., (1980), The Lagrange Multiplier Test and Its Applications to Model Specification in Econometrics, Review of Economic Studies, 47(1), 239-253.

Costantini, V., Martini, C. (2010), The causality between energy consumption and economic growth: A multi-sectoral analysis using non-stationary cointegrated panel data. Energy Economics, 32, 591-603.

de Hoyos, R.E., Sarafidis, V. (2006), Testing for cross-sectional dependence in panel data models. The Stata Journal, 6(4), 482-496.

Dobnick, F., (2011), Energy consumption and economic growth revisited: structural breaks and cross section dependence, Ruhr Economic Papers, No: 303.

Engle, R., Granger, C. (1987), Cointegration and error correction: Representation, estimation, and testing. Econometrica, 55, 257-276.

Frees, E.W. (1995), Assessing cross-sectional correlation in panel data. Journal of Econometrics, 69, 393-414.

Friedman, M. (1937), The use of ranks to avoid the assumption of normalityiImplicit in the analysis of variance. Journal of the American Statistical Association, 32, 675-701.

Frees, E.W. (2004), Longitudinal and Panel Data: Analysis and Applications in the Social Sciences, Cambridge: Cambridge University Press.

Hatzigeorgiou, E., Polatidis, H., Haralambopoulos, D., (2011), CO2 emissions, GDP and energy intensity: A multivariate cointegration and causality analysis for Greece 1977–2007, Applied Energy, 88, 1377-1385.

Jammazi, R., Aloui, C. (2015), On the interplay between energy consumption, economic growth and CO2 emission nexus in the GCC countries: A comparative analysis through wavelet approaches. Renewable and Sustainable Energy Reviews, 51, 1737-1751.

Jebli, M.B., Youssef, S.B., Ozturk, I., (2016), Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries, Ecological Indicators, 60, 824-831.

Johansen, S. (1991), Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models. Econometrica, 59(6), 1551-1580.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. Journal of Energy and Development, 3, 401-403.

Lee, C.C., Chang, C.P. (2008), Energy consumption and economic growth in Asian economies: A more comprehensive analysis using panel data. Resource and Energy Economics, 30, 50-65.

Lee, C.C., Chang, C.P., Chen, P.F. (2008), Energy-income causality in OECD countries revisited: The key role of capital stock. Energy Economics, 30, 2359-2373.

Masih, A.M.M., Masih, R. (1996), Electricity consumption, real income and temporal causality: Results from a multicountry study based on cointegration and error correction modeling techniques. Energy Economics, 18, 165-183.

Nasreen, S., Anwar, S. (2014), Causal relationship between trade openness, economic growth and energy consumption: A panel data analysis of Asian countries. Energy Policy, 69, 82-91.

Oh, W., Lee, K. (2004a), Causal relationship between energy consumption and GDP revisited: The case of Korea 1970-1999. Energy Economics, 26, 51-59.

Oh, W., Lee, K. (2004b), Energy consumption and economic growth in Korea: Testing the causality relation. Journal of Policy Modeling, 26, 973-981.

Omri, A., Kahouli, B. (2014), Causal relationships between energy consumption, foreign direct investment and economic growth: Fresh evidence from dynamic simultaneous-equations models. Energy Policy, 67, 913-922.

Ozturk, I., Al-Mulali, U. (2015), Natural gas consumption and economic growth nexus: Panel data analysis for GCC countries. Renewable and Sustainable Energy Reviews, 51, 998-1003.

Ozturk, I., Acaravci, A. (2010a), The causal relationship between energy consumption and GDP in Albania, Bulgaria, Hungary and Romania: Evidence from ARDL bound testing approach. Applied Energy, 87, 1938-1943.

Ozturk, I., Acaravci, A. (2010b), CO^2 emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14, 3220-3225.

Ozturk, I., Aslan, A., Kalyoncu, H. (2010), Energy consumption and economic growth relationship: Evidence from panel data for low and middle ıncome Countries. Energy Policy, 38(8), 4422-4428.

Paul, S., Bhattacharya, R.N. (2004), Causality between energy consumption and economic growth in India: A note on conflicting results. Energy Economics, 26, 977-983.

Pesaran, H.M. (2003), A Simple Panel Unit Root Test in the Presence of Cross Section Dependence. Mimeo: University of Southern California.

Pesaran, M.H., (2004), General diagnostic tests for cross section dependence in panels, University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435.

Pesaran, H.M. (2005), A simple panel unit roor test in the presence of cross section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Salahuddin, M., Gow, J. (2014), Economic growth, energy consumption and CO^2 emissions in gulf cooperation Council countries. Energy, 73, 44-58.

Salahuddin, M., Gow, J., Ozturk, I. (2015), Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in Gulf Cooperation Council Countries robust?. Renewable and Sustainable Energy Reviews, 51, 317-326.

Sims, C., (1972), Money, Income, and Causality, American Economic Review, 62(4), 540–552.

Squalli, J. (2007), Electricity consumption and economic growth: Bounds and causality analyses of OPEC countries. Energy Economics, 29, 1192-1205.

Solarin, S.A., Ozturk, I. (2015), On the causal dynamics between hydroelectricity consumption and economic growth in Latin America countries. Renewable and Sustainable Energy Reviews, 52, 1857-1868.

Soytas, U., Sarı, R., (2006), Energy consumption and income in G-7 countries, Journal of Policy Modeling, 28(7), 739-750.

Stern, D.I., (2000), A multivariate cointegration analysis of the role of

energy in the U.S. macroeconomy, Energy Economics, 22, 267-283.
Urbain, J.P., Westerlund, J., 2006, Spurious Regression in Nonstationary Panels with Cross-Unit Cointegration, Research Memorandum 057, Maastricht University, Maastricht Research School of Economics of Technology and Organization (METEOR).
Westerlund, J. (2007), Testing for error correction in panel data. Oxford Bulletin of Economics and Statistics, 69, 709-748.
Yıldırım, E., Aslan, A. (2012), Energy consumption and economic growth nexus for 17 highly developed OECD countries: Further evidence based on bootstrap-corrected causality tests. Energy Policy, 51, 985-993.
Yıldırım, E., Sukruoglu, D., Aslan, A. (2014), Energy consumption and economic growth in the next 11 countries: The bootstrapped autoregressive metric causality approach. Energy Economics, 44, 14-21.
Zachariadis, T. (2007), Exploring the relationship between energy consumption and economic growth with bivariate models: New evidence from G-7 countries. Energy Economics, 29, 1233-1253.