



Causality Nexus Between GDP and Energy Consumption in Türkiye and Romania¹

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Abstract

Keywords:

Economic growth,
Energy
consumption, Engle-
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integration,

The nexus between economic growth and energy consumption was investigated during the period from 1960 to 2015 in Türkiye and from 1990 to 2015 in Romania, utilizing the Engle-Granger co-integration test. Data are acquired from the Development Indicators generated by the World Bank. Two variables were employed from the database: energy use (kg of oil equivalent per capita) and GDP per capita (constant 2015 US\$). Accessibility of data on energy consumption restrained the option of the starting period. The results revealed that the investigated variables were not co-integrated for Türkiye and Romania during the studied interval.

Türkiye ve Romanya'da GSYİH ve Enerji Tüketimi Arasındaki Nedensellik İlişkisi

Özet

Anahtar Kelimeler:

Ekonomik büyüme,
enerji tüketimi,
Engle-Granger eş-
bütünleşme testi,

1960'tan 2015'e kadar Türkiye'de ve 1990'dan 2015'e kadar Romanya'da ekonomik büyüme ile enerji tüketimi arasındaki ilişki, Engle-Granger eş-bütünleşme testi kullanılarak araştırılmıştır. Veriler, Dünya Bankası tarafından oluşturulan Kalkınma Göstergeleri'nden elde edilmiştir. Veritabanından iki değişken kullanılmıştır: kişi başına enerji kullanımı (kişi başına petrol eşdeğeri kg) ve kişi başına GSYİH (sabit 2015 ABD doları). Enerji tüketimi verilerine erişilebilirlik, başlangıç döneminin seçimini sınırlamıştır. Sonuçlar, incelenen süre zarfında Türkiye ve Romanya için araştırılan değişkenlerin eş-bütünleşmediğini ortaya koymuştur.

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INTRODUCTION

The nexus between energy consumption and economic evolution is garnering significant interest in the field of energy economics, and the nature of this relationship plays a crucial role in tailoring energy policies, devising economic growth strategies, and achieving sustainable development goals. This paper endeavors to delve deep into the causal association between energy consumption and economic evolution, further accentuating this fundamental connection in the field of energy economics. The complex nexus between Energy Consumption (EC) and Economic Growth (EG) holds a pivotal importance as a research topic concerning energy economics and theories of economic growth. The prevailing literature bifurcates into two dominant perspectives: Some researchers contend that energy is a critical input for production and thus argue that EC promotes economic growth, while others dispute that EC has little mien on EG as energy efficiency increases, economic growth might require less energy. The nexus between EC and EG is crucial in setting energy strategies and forming economic growth policies. It is imperative for policymakers to grasp the causal nexus between EC and EG to ensure the effective implementation of energy conservation strategies and achieve a balance between economic growth and energy consumption. That is to say, the decrease in energy consumption may lead to a budget deficit, unemployment, or lower income if EG is caused by EC. However, an energy conservation policy can be implemented if the EG isn't caused by EC. This paper contributes to the literature by providing an up-to-date inspection of the association between EG and EC in two countries with distinct economic and geographical structures, Turkiye and Romania. The period from 1960-2015 for Turkey and 1990-2015 for Romania provides a suitable timeframe for this analysis. Mixed results have been revealed in the literature on the nexus between EG and EC due to the various time periods, variables, samples, and methodologies used. This research endeavors to make significant insights for designing energy policies and shaping economic growth strategies. In the second section, a literature review and theoretical framework will be presented, in order to examine the conclusions and theoretical foundations of previous studies. The third section will include data sources, analytical methods, and the findings obtained. Finally, in the fourth section, the findings will be evaluated and conclusions drawn.

THEORETICAL AND LITERATURE REVIEW

Literature has proposed four testable hypotheses regarding the nexus between EG and EC (Ozturk, 2010; Shahbaz et al., 2015); namely, the Growth Hypothesis, the Conservative Hypothesis, the Feedback Hypothesis, and the Neutrality Hypothesis. The Growth Hypothesis suggests that EC directly impacts EG, even factoring in the contributions of capital and labor. This premise holds that EC causes EG. This suggests that if measures are taken to reduce energy usage for conservation objectives, it could result in an adverse outcome for EG. Considering factors like financial development, international trade, and capital; Shahbaz et al. (2013) investigated the nexus between China's energy use and economic growth during the period from 1971 to 2011. Utilizing the ARDL method, they concluded that all the mentioned factors positively affected economic growth. The results revealed a one-way causal relationship running from energy use to growth, energy use, and financial development Granger causes each other and bidirectional interactions among other factors. The research underscores the need for alternative energy solutions to meet China's increasing energy requirements due to its economic progress. Adegbenmi et al. (2013) investigated the nexus between Nigeria's economic growth and energy consumption during the period from 1975 to 2010, utilizing Co-integration and OLS techniques and variables such as coal, oil, gas, economic growth, and electricity. Their results supported the growth hypothesis. Apergis and Tang (2013) argued that the link between energy consumption and economic growth is frequently contested, with mixed findings making it challenging to ascertain if energy consumption spurs economic growth. Utilizing varied model specifications and stages of economic development, they re-examine the energy-led growth hypothesis for 85 countries. Their results indicate that models containing three or four variables better support the hypothesis compared to ones having two variables. Notably, both developed and developing countries align more with the energy-led growth theory

than nations that are less developed or have a low income. Ultimately, the nexus hinges on the selection of the model and a nation's economic phase, implying that energy conservation policies should primarily target low-income countries without obstructing their economic expansion. Utilizing wavelet transformation, a method first introduced by Ramsey and Lampart, Aslan et al. (2013) investigated the causal relationship between energy consumption and economic growth in the U.S., employing data from 1973q1 to 2012q1. The conclusions revealed that the causal relationship between energy consumption and economic growth is clearer at finer time scales and becomes vaguer over longer time horizons. Moreover, while energy consumption causes economic growth, the inverse isn't observed at the original data frequency, however, feedback is seen at coarser scales. Utilizing the neoclassical Solow growth model, Tang et al. (2016) investigated the nexus between energy consumption and economic growth from 1971 to 2011 in Vietnam, employing cointegration and Granger causality methods. The results revealed that energy consumption, FDI, and capital stock have a positive mien on Vietnam's economic growth, with a one-way causality running from energy to growth. These conclusions highlight Vietnam's dependence on energy for its economic progress. Hence, prioritizing renewable energy strategies can ensure energy supply for continued growth. Investments in R&D can spark advancements in this domain, and public awareness campaigns can enhance these endeavors, harmonizing them with socio-economic development goals. Inglesi-Lotz (2016) underscores the growing global recognition of the significance of renewable energy. While its benefits for energy assurance and environmental protection are well-documented, the impacts on economic well-being are not as thoroughly investigated. Inglesi-Lotz (2016) aims to quantify renewable energy consumption's mien on economic well-being by employing panel data techniques. A positive and significant nexus between renewable energy use and economic growth has been recorded. Moreover, they concluded that promoting renewable energy doesn't solely cater to environmental challenges but also positively influences a country's economic conditions.

The Conservative Hypothesis proposes that EG is the predominant catalyst for EC. Following this notion, EG causes EC. This indicates that measures introduced to reduce energy usage for conservation purposes won't have a harmful effect on the economic framework. Utilizing dynamic simultaneous-equation panel data models, Omri et al. (2015) investigate the causal nexus between two types of energy variables and economic growth in 17 developed and developing countries. The results revealed varied energy-growth relationships across countries. While economic growth causes nuclear consumption in Bulgaria, Canada, Netherlands, and Sweden; nuclear consumption causes economic growth in Belgium and Spain. In Argentina and the USA, both nuclear consumption and economic growth influence each other, however, there's no such nexus in Japan and the U.K. Similarly, for renewable energy, in India, renewables cause growth, while in Argentina, growth causes renewable consumption. Furthermore, the two-way nexus is supported in countries like Canada, but no causality in Brazil and Finland. Jacques (2010) delved into the nexus between energy consumption and economic growth in seven Sub-Saharan African countries during the period from 1970 to 2007. The results found a cointegration between energy consumption and economic growth in Cameroon, Congo, Cote d'Ivoire, and South Africa, with economic growth positively affecting energy consumption. Moreover, in Cote d'Ivoire, there's a bidirectional causality between energy use and GDP, however, in Congo, there's a unidirectional causality running from economic growth to energy consumption. Sadorsky (2009) highlights that in emerging economies, economic growth provides an opportunity to enhance renewable energy usage. Analyzing two empirical models for a group of these economies, the results revealed that rises in real per capita income markedly amplify per capita renewable energy consumption. Particularly, a 1% augmentation in real income per capita leads to roughly a 3.5% surge in renewable energy consumption. Furthermore, the long-term price elasticity for per capita renewable energy consumption is close to -0.70. Ocal and Aslan (2013) delve into the causality nexus between renewable energy consumption and economic growth in Turkey. Utilizing the ARDL method, they revealed that renewable energy

consumption negatively impacts economic growth. Moreover, the conclusions of Toda–Yamamoto causality tests reveal a one-way causality from economic growth to renewable energy consumption.

The Feedback Hypothesis suggests that EC and EG share a dual-directional causal nexus, pointing to their shared influence on one another. With this perspective, introducing policies focused on energy conservation with the intention of reducing EC could adversely bear on EG, and such transformations might simultaneously reverberate on energy usage. Solarin and Shahbaz (2013) examined the casual nexus between economic growth, urbanization, and electricity consumption in Angola during the period from 1971–2009, utilizing Lee and Strazicich's unit root tests for stationarity and the Gregory–Hansen structural break cointegration method. The results revealed long-term relationships among the studied factors. Moreover, the VECM Granger causality test revealed a two-way causality between electricity consumption and economic growth. Furthermore, urbanization and economic growth had a feedback nexus, with urbanization and electricity consumption Granger cause each other. The investigation affirmed that Angola heavily relies on energy, the imperative to boost electricity production for sustainable long-term economic development. Tang and Tan (2013) explored the nexus between Malaysia's electricity consumption, economic growth, energy prices, and technological innovation spanning 1970–2009. The conclusions affirm that these elements are cointegrated. While energy prices and technological advancements show a negative impact, economic growth positively correlates with electricity consumption. Crucially, technological innovation Granger causes both economic growth and electricity consumption. Moreover, the results revealed mutual causality between electricity consumption and economic growth in both the short and long terms. Hence, Malaysia's policymakers should prioritize enhancing electricity infrastructure and simultaneously promote technology innovations to diminish dependence on fossil fuels, striking a balance between environmental conservation and economic growth. Kyophilavong et al. (2015) delve into the nexus between trade openness, energy consumption, and economic growth in Thailand, utilizing the Bayer and Hanck cointegration approach. The results affirm a long-term nexus among the mentioned variables. The results revealed that energy consumption promotes economic growth, and trade openness contributes positively to this growth. Causality analyses show a bidirectional nexus: energy consumption causes economic growth and vice versa, and trade openness and energy consumption also cause each other. The study emphasizes the necessity for Thailand's policymakers to formulate cohesive energy and trade policies to ensure maintained economic growth in the long run. Ohler and Feters (2014) investigate the relationship between electricity generation from renewable sources and economic growth spanning 1990 to 2008 in 20 OECD countries. Conclusions reveal a bidirectional nexus between overall renewable generation and GDP. In the long run, biomass, hydroelectricity, waste, and wind energy are positively associated with GDP, with biomass, hydroelectric, and waste making the most substantial contribution. When considering potential structural breaks and cross-sectional dependence, short-term conclusions affirm that biomass and waste have a negative mien on GDP, however, overall renewable and hydroelectricity stimulate GDP. Hence, energy conservation strategies that diminish dependence on biomass or waste while promoting hydroelectric and wind energy will positively impact GDP. Lin and Moubarak (2014) investigated the nexus between renewable energy consumption and economic growth in China spanning 1977 to 2011, utilizing the ARDL and Johansen cointegration techniques and including variables like carbon dioxide emissions and labor. The conclusions revealed a bidirectional long-term causality between renewable energy consumption and economic growth. This infers a symbiotic association where China's economic growth invigorates the renewable sector, which reciprocally energizes the economy. Short-term findings shed light on labor's mien on renewable energy consumption. However, no evidence for causality was found between carbon emissions and renewable energy consumption, suggesting that China's current renewable energy consumption doesn't markedly cut down CO₂ emissions. Utilizing the Augmented Granger Causality model by Toda–Yamamoto, Medee et al. (2018) explored the nexus between economic growth and energy consumption in ten OPEC countries spanning 1970 to 2014, employing data from the 2016 World Development Indicators bulletin. The proxy for economic

growth was depicted by the Gross Domestic Price at constant 2010 US Dollar, and energy consumption was explained by renewable and non-renewable sources. The results revealed a predominant bidirectional causality between economic growth and renewable energy consumption. Based on these revelations, the study suggests strategies that foster energy supply and distribution, aiming to amplify production and overall economic output. Bloch et al. (2015) investigated the nexus between China's total production and consumption of coal, oil, and renewable energy, utilizing both ARDL and VECM methods. The conclusions revealed that China's growth is driven by all three energy types. Economic growth boosts the consumption of these energy sources, despite that there's a negative cost impact for coal and oil, indicating possible fuel substitution. Moreover, the conclusions suggest that whereas renewable energy decreases emissions, coal consumption amplifies more pollution. In contrast, oil doesn't have a considerable mien on emissions. This research suggests that making coal pricier, both in absolute and relative terms compared to oil and renewables, could catalyze a shift towards cleaner energy sources, advancing both economic prosperity and environmental conservation. Mohammadi and Parvaresh (2014) explored the nexus between energy consumption and output across 14 oil-exporting countries spanning 1980-2007. Their research utilizes three-panel estimation techniques factoring in various levels of heterogeneity since panel unit root tests reveal non-stationarity in both energy consumption and output. The results revealed bi-directional causality in both the short and long term, with a stable relationship between energy consumption and output. Even with adding additional variables, the long-term causality remains robust. The study implies that measures curbing energy could significantly affect long-term economic growth. In contrast, strategies stimulating economic growth might negatively impact the environment. Shahbaz et al. (2015) delved into the nexus between renewable energy consumption and economic growth in Pakistan, incorporating capital and labor possible influencing factors within the production process, utilizing the auto-regressive distributed lag (ARDL) model and the rolling window approach (RWA) for cointegration, and employing quarterly data from 1972Q1 to 2011Q4. Moreover, utilizing the VECM Granger causality and innovative accounting method, the results indicate a long-term cointegration among the variables, suggesting that renewable energy consumption, coupled with capital and labor, has a positive mien on economic growth. Furthermore, feedback exists between economic growth and renewable energy consumption. Adams et al. (2016) investigated the nexus between energy consumption and economic growth in 16 sub-Saharan African (SSA) countries spanning 1971 to 2013, considering the moderating role of democracy, utilizing a panel vector autoregressive model (PVAR) within a generalized method of moments (GMM) technique. The conclusions confirm the feedback hypothesis. Notably, a substantial positive nexus between the combined impacts of energy consumption and democracy on economic growth was concluded, suggesting democracy's moderating role. In addition, the research points to a one-way nexus running from trade openness to energy consumption. The feedback relationships among energy consumption, economic growth, and energy prices are further reinforced by impulse responses and variance decompositions. Chang et al. (2015) probed into the causal nexus between renewable energy consumption and economic growth within the G7 countries spanning 1990–2011, employing Emirmahmutoglu and Kose (2011) causality methodology, which considers slope heterogeneity and cross-sectional dependency in a multivariate panel. The results revealed that for the entire G7 group, there's a two-way causal association between economic growth and renewable energy. Yet, on a country-by-country investigation, Canada, Italy, and the US exhibited no significant causality (adhering to the neutrality hypothesis). France and the UK reflected a causality running from GDP to renewable energy, while Germany and Japan showed causality from renewable energy to GDP.

The Neutrality Hypothesis asserts that there's no bearing of EC on EG. It posits that there is no causal linkage between EC and EG. When no indications of a causal linkage between EC and EG are presented, the hypothesis stands verified. Under this framework, implementing energy-saving policies to conserve energy by cutting EC wouldn't affect EG. Yildirim et al. (2014) investigated the causal nexus between economic growth and energy consumption in the "Next 11" countries, utilizing a bootstrapped autoregressive metric

causality method, which provides greater resilience against issues of non-stationarity and breaks. The results revealed that except for Turkey, in all the studied countries changes in energy consumption don't affect economic growth (supporting the neutrality hypothesis). This inference implies that energy conservation strategies are viable for countries like Bangladesh, Egypt, and Korea among others, however, for Turkey, there's a one-way causality running from energy consumption to economic growth, implying that energy conservation efforts could potentially stymie its economic growth. Karanfil and Li (2015) explored the nexus between electricity consumption and economic activities in 160 countries spanning 1980-2010, utilizing per capita data while considering electricity dependence and urbanization levels. Moreover, they dissected the data according to the countries' income levels, regional affiliations, and OECD memberships. Significantly, the causal nexus and findings varied considerably across these subsamples. This suggests that the nexus between electricity and growth is impacted by regional variations, income levels, rates of urban transition, and supply risk factors. Mesbah (2016) discussed the energy difficulties Egypt encountered following the 2011 revolution, including frequent electricity blackouts and significant energy shortages. In reaction, the Egyptian government has responded by cutting energy subsidies, particularly for heavy industries and households, and has implemented fuel rationing for vehicles via a digital card mechanism. Mesbah (2016) delves into the nexus between energy consumption and economic growth in Egypt spanning 1980-2012, utilizing a multivariate method that incorporates capital and labor, and employing a modified Granger causality test, taking into consideration potential structural breaks. Moreover, Mesbah (2016) investigated specific energy components like oil, electricity, natural gas, and coal to moderate any aggregation biases. The conclusions revealed no direct causality between overall energy consumption and economic growth, thus, supporting the stance of the neutrality hypothesis. Yet, a one-way positive causality running from economic growth to electricity and oil consumption was evident, aligning with the conservation hypothesis. Therefore, the research indicates that energy conservation policies won't hinder Egypt's potential for economic growth in the long run. Menegaki (2011) investigated the nexus between economic growth and renewable energy consumption in 27 European countries spanning 1997-2007, utilizing a random effect model in a multivariate panel framework, incorporating additional variables like final energy consumption, greenhouse gas emissions, and employment. The results revealed no causal nexus between renewable energy consumption and GDP, yet, a short-term nexus was identified between renewable energy, greenhouse gas emissions, and employment. The deviation in the cointegration factor from the unity indicated a faint or possibly non-existent nexus between Europe's economic growth and renewable energy consumption, adhering to the neutrality hypothesis. This might stem from the inconsistent and underutilized renewable energy resources throughout the region.

The existing body of literature has manifested mixed results due to the disparity in chosen methods, timespans studied, and samples analyzed. Soytaş and Sari (2003) demonstrated a unidirectional nexus running from EC to EG in Türkiye by utilizing co-integration and vector error correction methods for the period (1950-1992). Contrarily, Yalta (2011) found no causality between EC and EG in Türkiye (both in the short- and long-run), employing the maximum entropy bootstrap method for the period (1950-2006). Moreover, Kaplan et al. (2011) exposed a bi-directional causality between EC and Turkish economic evolution in the long run, utilizing the vector error correction model for the period (1971-2006). This result had been supported by Fuinhas and Marques (2012) for the period (1965-2009). Furthermore, Ocal and Aslan (2013) supported the conservation hypothesis in Türkiye; by utilizing the Toda-Yamamoto causality approach for the period 1990-2010. This situation is similar in Romania. Ozturk and Acaravci (2010) find no unique equilibrium association between the EC and per capita real GDP in Romania during the period from 1980 to 2006. Pirlogea and Ciucea (2012) exposed that in Romania, renewable EC has a lasting mien on Romania's economic performance. The nexus between the two was unidirectional during the period from 1990 to 2010. Pirlogea and Ciucea (2011) found a long-term causal nexus between GDP and the consumption of energy only when the energy is generated by hydropower during the period (1965-2007).

However, this nexus has not existed in the short term. On the other hand, energy consumption from coal or oil sources does not have a pronounced consequence on long-term GDP. Kayhan et al. (2010) investigated the dynamic causal nexus between electricity consumption and EG in the Romanian economy over the span of 2001 to 2010. They discovered a causality runs from EC to EG. Shahbaz et al. (2011) conducted an analysis of the co-integration and causality nexus between electricity consumption, capital, and EG in Romania through the 1980-2008 timeframe. They uncovered that there is a two-way causality between the EC and EG. Further investigation is warranted to comprehensively elucidate the mechanism by which EC influences EG and vice versa. The principal intention of this paper is to provide an updated scrutiny of the nexus between EC and EG.

EMPIRICAL IMPLEMENTATION

The Engle-Granger method comes with various advantages, one of which is that the long-run equilibrium nexus can be modeled using a simple regression based on the variables' levels. In the initial phase, the cointegrating regression is determined utilizing the OLS. The cointegrating regression is given by the following equation:

$$Y_t = \alpha + \beta X_t + u_t \quad (1)$$

where both Y_t (in this paper denotes economic growth) and X_t (in this paper denotes energy consumption) are nonstationary variables and integrated of order one $I(1)$. In order for Y_t and X_t to be cointegrated, the requisite condition dictates that the calculated residuals from equation (1) ought to exhibit stationarity (i.e. $u_t \sim I(0)$). The empirical research uses the annual time series data of EC (kg of oil equivalent per capita) and GDP per capita (constant 2015 US\$) from 1960 to 2015 in Türkiye and from 1990 to 2015 in Romania. Data are retrieved from the World Development Indicators produced by the World Bank. Accessibility of data on energy consumption restrained the option of the period. All variables incorporated in the model are specified in natural logarithmic units. The Augmented Dickey-Fuller (ADF) unit root test was performed to examine the time-series properties of the data. It was conducted on both levels and the first differences of all variables. Table 1 below summarizes the conclusions of the unit root test. Only with constant results had been reported.

Table 1. Results of Unit Root Test

Variables	Türkiye		Romania	
	At level	First Difference	At level	First Difference
GDP	0.3284	-7.3679 ***	-2.0071	-4.2705 ***
	0.9778	0.0000	0.282	0.0029
EC	-1.0487	-7.2334 ***	0.5758	-3.7744 ***
	0.7295	0.0000	0.986	0.0092

Note: ***denotes a 1% significance level

The results show that there is a unit root in the two variables at the level. However, this hypothesis is dismissed when the first difference is taken. These findings imply that all of the variables under consideration are integrated into order one $I(1)$. Table 2 below summarizes the conclusions from the Engle-Granger (EG) co-integration test.

Table 2. Results for Engle-Granger Co-integration Tests

Country	Model	ADF
Turkiye	$\text{LOGGDP} = 2.10 + 0.95 \cdot \text{LOGEC}$	-1.04 ^x
Romania	$\text{LOGGDP} = 16.56 - 1.05 \cdot \text{LOGEC}$	-2.45 ^x

Note: ^x denotes insignificant at a 1% significance level.

The Engle-Granger residual-based Augmented Dickey-Fuller (ADF) test is used to weigh up the presence of a unit root in a time series data set after determining that all the variables have the same order of integration. Firstly, an Ordinary Least Squares (OLS) regression equation is estimated. Secondly, the stationarity of the residuals from the OLS regression is examined using the Augmented Dickey-Fuller (ADF) test. These results reveal that Türkiye and Romania have no long-run equilibrium between LOGGDP and LOGEC.

CONCLUSION

In this paper, we attempted to scrutinize the nexus between EG and EC across the span of 1960 to 2015 in Türkiye and from 1990 to 2015 in Romania, utilizing the Engle-Granger co-integration test. The results demonstrate that there is no evidence of long-term equilibrium between LOGGDP and LOGEC for both Türkiye and Romania. For Türkiye, the results agree with Yalta (2011) but don't agree with Soytas and Sari (2003), Kaplan et al. (2011), Fuinhas and Marques (2012), and Ocal and Aslan (2013). For Romania, the results agree with Ozturk and Acaravci (2010) but don't agree with Pirlogea and Ciucea (2011, 2012), Shahbaz et al. (2011) and Kayhan et al. (2010). For policymakers, both countries might weigh the idea of diversifying their energy sources. This might involve exploring other renewable and alternative energy channels, guaranteeing that the economy isn't anchored solely to conventional energy methods. Taking into account the absence of co-integration, it's implied that economic growth tactics in both Türkiye and Romania can be framed without a heavy emphasis on energy consumption dynamics. Furthermore, both countries can seize the moment to adopt energy-saving protocols without concern about detrimental repercussions on economic expansion. Moreover, both countries ought to gauge the sturdiness of their infrastructure, positioning themselves for economic fluctuations that don't parallel with alterations in energy consumption. Further research utilizing different variables and econometric models is required such as the role of globalization Nas et al. (2022), which might assist in grasping any prospective nexus between economic growth and energy consumption that could surface down the line.

REFERENCES

- Adams, S., Klobodu, E. K. M. and Opoku, E. E. O. (2016). Energy consumption, political regime and economic growth in sub-Saharan Africa. *Energy Policy*, 96, 36–44. <https://doi.org/10.1016/j.enpol.2016.05.029>
- Adegbeni O. O., A. J. Olalekan and O. O. Babatunde (2013). The Causal Nexus Between Energy Consumption and Nigeria's Economy Growth. *European Scientific Journal*, 9(1).
- Apergis, N. and Tang, C. F. (2013). Is the energy-led growth hypothesis valid? New evidence from a sample of 85 countries. *Energy Economics*, 38, 24–31. <https://doi.org/10.1016/j.eneco.2013.02.007>
- Aslan, A., Apergis, N. and Yildirim, S. (2013). Causality between energy consumption and GDP in the U.S.: evidence from wavelet analysis. *Frontiers in Energy*, 8(1), 1–8. <https://doi.org/10.1007/s11708-013-0290-6>.
- Bloch, H., Rafiq, S. and Salim, R. (2015). Economic growth with coal, oil and renewable energy consumption in China: Prospects for fuel substitution. *Economic Modelling*, 44, 104–115. <https://doi.org/10.1016/j.econmod.2014.09.017>

- Chang, T., Gupta, R., Inglesi-Lotz, R., Simo-Kengne, B., Smithers, D. and Trembling, A. (2015). Renewable energy and growth: Evidence from heterogeneous panel of G7 countries using Granger causality. *Renewable and Sustainable Energy Reviews*, 52, 1405–1412. <https://doi.org/10.1016/j.rser.2015.08.022>
- Fuinhas, J.A. and Marques, A.C. (2012). Energy consumption and economic growth Nexus in Portugal, Italy, Greece, Spain and Türkiye: An ardl bounds test approach (1965–2009). *Energy Economics*, 34(2), pp. 511–517. Available at: <https://doi.org/10.1016/j.eneco.2011.10.003>.
- Jacques L. E., (2010). The Energy Consumption-Growth Nexus in Seven Sub-Saharan African Countries. *Economics Bulletin*, 30(2), 1191–1209.
- Inglesi-Lotz, R. (2016). The impact of renewable energy consumption to economic growth: A panel data application. *Energy Economics*, 53, 58–63. <https://doi.org/10.1016/j.eneco.2015.01.003>.
- Kaplan, M., Ozturk, I. and Kalyoncu, H. (2011), Energy Consumption and Economic Growth in Türkiye: Cointegration and Causality Analysis. *Romanian Journal of Economic Forecasting* (2), 31-41.
- Karanfil, F. and Li, Y. (2015). Electricity Consumption and Economic Growth: Exploring Panel Specific Differences. *Energy Policy*. 82, 264–277.
- Kayhan, S., Adiguzel, U., Bayat, T. and Lebe, F. (2010), Causality relationships between real GDP and electricity consumption in Romania (2001–2010). *Romanian Journal of Economic Forecasting*, 4, 169-183.
- Kyophilavong, P., Shahbaz, M., Anwar, S. and Masood, S. (2015). The energy-growth nexus in Thailand: Does trade openness boost up energy consumption? *Renewable and Sustainable Energy Reviews*, 46, 265–274. <https://doi.org/10.1016/j.rser.2015.02.004>
- Lin, B. and Moubarak, M. (2014). Renewable energy consumption – economic growth nexus for China. *Renewable and Sustainable Energy Reviews*, 40, pp. 111–117. Available at: <https://doi.org/10.1016/j.rser.2014.07.128>.
- Medee, P. N., Ikue-John, N. and Amabuike, I. L. (2018). Granger Causality of Energy Consumption and Economic Growth in the Organization of Petroleum Exporting Countries: Evidence from the Toda–Yamamoto approach. *Millennium Development Goals (MDGs)*, 11(1); 95-102
- Menegaki, A. N. (2011). Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. *Energy Economics*, 33(2), 257–263. <https://doi.org/10.1016/j.eneco.2010.10.004>.
- Mesbah F. S. (2016). Energy Consumption and Economic Growth In Egypt: A Disaggregated Causality Analysis With Structural Breaks. *Topics In Middle Eastern And African Economies*, 18 (2).
- Mohammadi, H. and Parvaresh, S. (2014). Energy Consumption and Output: Evidence from A Panel of 14 Oil-Exporting Countries. *Energy Economics*, 41, 41-46.
- Nas, Ş., Miçooğulları S. A. and Alancioğlu, E. (2022). Küreselleşme, yeni ekonomi ve kalkınmacı devlet. Arslan, İ., Akçacı, T., Bozgeyik, Y. (Ed.), *Küreselleşme çağında kalkınma ve yeni ekonomi* (ss. 109-134) Ankara: Orion Kitabevi.
- Ocal, O. and Aslan, A. (2013). Renewable energy consumption–economic growth nexus in Türkiye. *Renewable and Sustainable Energy Reviews*, 28, pp. 494–499. Available at: <https://doi.org/10.1016/j.rser.2013.08.036>.
- Ohler, A. and Fetters, I. (2014). The causal relationship between renewable electricity generation and GDP growth: A Study of Energy Sources. *Energy Economics*, 43, pp. 125–139. Available at: <https://doi.org/10.1016/j.eneco.2014.02.009>.
- Omri, A., Ben Mabrouk, N. and Sassi-Tmar, A. (2015). Modeling the causal linkages between nuclear energy, renewable energy and economic growth in developed and developing countries. *Renewable and Sustainable Energy Reviews*, 42, 1012–1022. <https://doi.org/10.1016/j.rser.2014.10.046>.
- Ozturk, I. (2010). A literature survey on Energy–Growth Nexus. *Energy Policy*, 38(1), pp. 340–349. Available at: <https://doi.org/10.1016/j.enpol.2009.09.024>.

- Ozturk, I. and Acaravci, A. (2010). The causal relationship between energy consumption and GDP in Albania, Bulgaria, Hungary and Romania: evidence from the ADRL bound testing approach. *Applied Energy*, 87, 1938-1943.
- Pirlogea, C. and Ciucea, C. (2012). Econometric perspective of the energy consumption and economic growth relation in European Union. *Renewable and Sustainable Energy Reviews*, 16, 5718-5726.
- Pirlogea, C. and Ciucea, C. (2011). Obtaining economic growth from energy consumption in urban areas. *Theoretical and Empirical Researches in Urban Management* 6, 73-83.
- Sadorsky, P. (2009). Renewable energy consumption and income in emerging economies. *Energy Policy*, 37(10), pp. 4021–4028. Available at: <https://doi.org/10.1016/j.enpol.2009.05.003>.
- Shahbaz, M., Khan, S. and Tahir, M.I. (2013). The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from Multivariate Framework Analysis. *Energy Economics*, 40, pp. 8–21. Available at: <https://doi.org/10.1016/j.eneco.2013.06.006>.
- Shahbaz, M., Loganathan, N., Zeshan, M. and Zaman, K. (2015). Does renewable energy consumption add in economic growth? An application of auto-regressive distributed lag model in Pakistan. *Renewable and Sustainable Energy Reviews*, 44, 576–585. <https://doi.org/10.1016/j.rser.2015.01.017>
- Shahbaz, M., Mutascu, M. and Tiwari, A. (2011). Revisiting the relationship between electricity consumption, capital and economic growth: cointegration and causality analysis in Romania. *MPRA*, University Library of Munich, online at: <http://mpra.ub.uni-muenchen.de/29233/>.
- Solarin, S.A. and Shahbaz, M. (2013). Trivariate causality between economic growth, urbanisation and electricity consumption in Angola: Cointegration and causality analysis. *Energy Policy*, 60, pp. 876–884. Available at: <https://doi.org/10.1016/j.enpol.2013.05.058>.
- Soytaş, U. and Sari, R. (2003). Energy consumption and GDP: Causality relationship in G-7 countries and emerging markets. *Energy Economics*, 25(1), pp. 33–37. Available at: [https://doi.org/10.1016/s0140-9883\(02\)00009-9](https://doi.org/10.1016/s0140-9883(02)00009-9).
- Tang, C.F. and Tan, E.C. (2013). Exploring the nexus of electricity consumption, economic growth, energy prices and technology innovation in Malaysia. *Applied Energy*, 104, pp. 297–305. Available at: <https://doi.org/10.1016/j.apenergy.2012.10.061>.
- Tang, C.F., Tan, B.W. and Ozturk, I. (2016). Energy consumption and economic growth in Vietnam. *Renewable and Sustainable Energy Reviews*, 54, pp. 1506–1514. Available at: <https://doi.org/10.1016/j.rser.2015.10.083>.
- Yalta, T. (2011). Analyzing energy consumption and GDP nexus using maximum entropy bootstrap: The case of Türkiye. *Energy Economics*, 3, 453-460.
- Yıldırım, E., Sukruoglu, D. and Aslan, A. (2014). Energy Consumption and Economic Growth in the Next 11 Countries: The Bootstrapped Autoregressive Metric Causality Approach. *Energy Economics*, 44, 14-21