THE RELATIONSHIP BETWEEN ECONOMIC GROWTH, ENERGY CONSUMPTION AND TRADE OPENNESS: THE CASE OF SHANGHAI COOPERATION ORGANISATION COUNTRIES[1] [2]

Kafkas University
Economics and Administrative Sciences Faculty
KAUJEASF
Vol. 13, Issue 25, 2022
ISSN: 1309 – 4289
E – ISSN: 2149-9136

Article Submission Date: 13.12.2021 *Accepted Date: 01.05.2022*

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ABSTRACT | This paper aims to analyze the relationship between energy consumption, trade openness and economic growth for the countries of the Shanghai Cooperation Organization that have started to follow open foreign trade policies with the transition to market economy since the early 1990s. The study examines validity and aspect of the relationship between variables for the eight countries studied covering the period of 1990-2018 by using panel causality, panel cointegration and panel vector error correction model methods. According to the results of the study, there is a causal relationship among three variables mentioned. While there is a bidirectional causality between economic growth and trade openness and economic growth and energy consumption; there is unilateral causality between energy consumption and trade openness from trade openness to energy consumption. The results support long-term equilibrium among the variables, but the direction and validity of the relationship are different in the short term. Therefore, periodic differences need to be taken into consideration when determining the energy policies that will be implemented in the economic growth process by these countries' policymakers.

Keywords: *Economic growth, energy consumption, Shanghai cooperation organization*
JEL Codes: *C33, O40, Q43*
Scope: *Economics*
Type: *Research*

DOI: 10.36543/kauiibfd.2022.017

Atıfta bulunmak için: Çeştepe, H., & Bahtiyar, B. (2022). The relationship between economic growth, energy consumption and trade openness: The case of Shanghai Cooperation Organisation countries. *KAÜİİBFD,* 13(25), 393-416.

[1] Ethical rules are followed in the study.
[2] This study was presented as a summary paper at the II. International Congress of Multidisciplinary Studies organized in 4-5 May 2018.

EKONOMİK BÜYÜME, ENERJİ TÜKETİMİ VE TİCARİ AÇIKLIK İLİŞKİSİ: ŞANGHAY İŞBİRLİĞİ ÖRGÜTÜ ÜLKELERİ ÖRNEĞİ

Kafkas Üniversitesi
İktisadi ve İdari Bilimler Fakültesi
KAÜİİBFD
Cilt, 13, Sayı 25, 2022
ISSN: 1309 – 4289
E – ISSN: 2149-9136

Makale Gönderim Tarihi: 13.12.2021 *Yayına Kabul Tarihi: 01.05.2022*

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ÖZ | Bu çalışmada, çoğu 1990'ların başından itibaren piyasa ekonomisine geçişle birlikte dışa açık ticaret politikaları izlemeye başlayan Şanghay İşbirliği Örgütü ülkeleri için enerji tüketimi, ticari açıklık ve ekonomik büyüme arasındaki dinamik ilişkinin incelenmesi amaçlanmaktadır. 1990-2018 dönemini kapsayan çalışmada panel nedensellik, panel eşbütünleşme ve panel vektör hata düzeltme modeli yöntemi kullanılarak, çalışmaya konu olan sekiz ülke için değişkenler arasındaki ilişkinin geçerliliği ve yönü incelenmiştir. Çalışmanın sonuçlarına göre, söz konusu üç değişken arasında nedensellik ilişkisi bulunmaktadır. Ekonomik büyüme ve ticari açıklık ile ekonomik büyüme ve enerji tüketimi arasında çift yönlü bir nedensellik varken; enerji tüketimi ve ticari açıklık arasında yalnızca ticari açıklıktan enerji tüketimine doğru tek yönlü bir nedensellik ilişkisi bulunmaktadır. Sonuçlar, değişkenler arasında uzun dönemde dengenin varlığını desteklemekte, ilişkinin yönü ve geçerliliği ise kısa dönemde farklılaşmaktadır. Bu nedenle, adı geçen ülkelerin ekonomik büyüme sürecinde uygulayacakları enerji politikalarını belirlerken, dönemsel farklılıkları göz önünde bulundurmaları gerekmektedir.

Anahtar Kelimeler: *Ekonomik büyüme, enerji tüketimi, Şanghay işbirliği örgütü*
JEL Kodları*: C33, O40, Q43*

Alan: *İktisat*
Türü: *Araştırma*

1. INTRODUCTION

One of the main objectives of economists is to search the sources of economic growth and the reasons of the differences in economic growth between countries. In this regard, there have been many different growth models that have used the factors such as labour, capital, technology, foreign trade and institutions to explain economic growth. With the acceleration of globalization and the disappearance of borders between countries, it has became more important for countries to be involved in the ever increasing international competitive market. Within this context, for the purpose of achieving and sustaining economic growth, it is necessary to ensure the economic and political stability of the countries and to strengthen their macroeconomic fundamentals.

Previous literature review showed that energy began to be considered as a production factor and is included in production functions along with two oil crises in the 1970s. It is also one of the basic inputs of economic growth and development process and plays a key role in the social and economic life of countries. As producing and transferring goods and services is a part of production process, energy is one of the most required input for this. Especially, after the Industrial Revolution, with the existence of production process based on machine power instead of production process based on manpower, the need for energy has increased for the economic development. Since producing and transferring goods is a part of production process, energy is one of the most required input for countries (Austin, 2017, p. 282). In the face of increasing energy demand, some countries have become dependent on foreign resources due to the fact that energy resources are not distributed evenly throught the World. Therefore, it has become more important for countries to (carry out) sustainable growth policies that are proper for their own structures and to support these policies with compatible energy policies. This has led economists and policy makers to research the nature of the energy factor and its interaction with other factors to examine the economic impacts of energy supply and demand and consumption and production of energy (Carley et al., 2011, p. 284).

In recent years, there has been a significant increase in trade, economic growth and energy consumption in both developed and developing countries. It is observed that these factors tend to act in unison in time and among countries (Uysal et al., 2015, p. 65) and as a result of this, there is a growing interest in examining the dynamic relationship between these variables in the literature. Explaining the relationship between these variables is very important to understand current energy and environmental policies of the countries and to develop more effective policies. Although the relationship between energy consumption and trade is a subject that has been examined in recent years in energy economy, the relationship between energy consumption and economic growth is widely discussed in the literature.

Examining the relationship between economic growth and energy consumption is one of the most attractive subjects in energy economics due to ever-growing energy need in the face of existence of limited energy resources. Studies that analyzing the relationship between energy consumption and economic growth since the 1970s have different results about the direction of this relationship. Ozturk (2010) states that, there are 4 diffferent possible hypotheses that examine the relationship between energy consumption and economic growth. *Growth hypothesis* indicates that a unidirectional causality relationship from energy consumption to economic growth. The hypothesis suggests that any restriction in energy consumption could adversely affect economic growth. The second hypothesis is known as *conservation hypothesis* and points to a one-way causality from economic growth to energy consumption. It suggests that increasing economic activities that occurs economic growth also needs more energy consumption. *The feedback hypotesis* shows that the birectional relationship between energy consumption and economic growth. The last hypothesis is called as *neutrality hypothesis* and means that there is no reltionship between energy consumption and economic growth. Accordingly, in the literature, there are studies that have concluded that there is a one-way causality relationship from economic growth to energy consumption, as well as studies that show a bi-directional causality relationship between energy consumption and economic growth (Komal & Abbas, 2015, p. 216). In the case of a one-way relationship from energy consumption to economic growth, a decrease in energy consumption may result in a decline in economic growth. Conversely, a unidirectional causality relationship running from economic growth to energy consumption imply that policies to reduce energy consumption have a bit or no effect on economic growth (Hamit-Haggar, 2016, p. 1238).

Studying the relationship between energy and trade that involves mutual interaction is an important topic in economy literature. The studies make explicit that energy is an important factor in explaining export and import movements and similarly these foreign trade transactions affect the volume of supply and demand of energy (Sadorsky, 2011, p. 742). The idea that exporting was one of the accelerators factors of economic growth began to be discussed further on the empirical ground with the integration of developing countries in international trade since 1970's. In this context, determining the factors that are interacting with exports has become important and the studies that aim to explain the relationship between exports and energy have emerged as a result of this efforts. As energy is an important input that used in the production and transportation of the goods subject to exports, it is expected that changes in energy usage affect the volume of exports. Energy is required for the export of raw materials and manufactured goods and if there is not enough energy, the increase in exports and the lack of sufficient energy leads to a decrease of the volume of exports. According to energy conservation policies, a decrease in energy usage may result in a reduction in exports volume and economic growth (Lean & Smyth, 2010, p. 3640) and the increase in energy demand and energy consumption may have a positive effect on the production of goods subject to trade. Similarly, studies that aim to examine the relationship between energy and imports show that a decrease in energy usage brings along a decrease in the volume of imports. This could lead to undesirable effects of imports of machinery, equipment and new technology products -that increase productivity and economic prosperity- on economies (Jayanthakumaran et al., 2012, p. 452-453). Accordingly, it is very important for governments to strike a balance between energy consumption, employment, production, international trade and economic growth. Any restrictions in energy consumption could lead to a reduction in international trade volume and total production, which could result in countries not reaching their target gross product level (Ahmad et al., 2019). Within this context, a strong export structure is the key to sustainable economic growth. High export growth increases the total efficiency by providing capital accumulation and contributes to imports of capital goods through exchange rate advantages. Furthermore, increasing export level may create effective pricing by strengthening the rivalry with overseas markets and this could lead to efficient allocation of resourses to markets that produce exports products (Zeng et al., 2021).

Considering the amount of research about energy and foreign trade transactions, it is expected that the changes in the export level also affect the energy consumption and energy demand because of the interaction between the energy and volume of exports. In order to increase exports volume of countries, it is necessary to product goods and services subject to exports and to provide the machinery and equipment that are used in transffering stations like airports, ports and other docking stations and energy is one of the main required factors that manage these machines and equipment used in the production and transportation of goods and services. An increase in export leads to an increase in economic activity, which may results in an increase in energy demand and this reveals a process that enhances each other reciprocally (Sadorsky, 2011, p. 741). The impact of import on energy consumption and energy prices is revealed in two ways. Accordingly, the distribution of imported goods in countries requires a transport network and this transportation network works with energy. On the other hand, durable goods such as cars, air-conditioners and refrigerators consume too much energy and the increase in import of these goods may increase energy consumption and prices.

The aim of this study is to examine the relationship between energy consumption, economic growth and trade by using panel causality and panel cointegration tests for the members of Shanghai Cooperation Organization (SCO) covering the period 1990-2018. Shanghai Cooperation Organization, that established in 1996, consisted of China, Russia, Kazakhstan, Kyrgyz Republic and Tajikistan and was originally termed as The Shanghai Five. Then, in 2001, the name was changed to SCO with the addition of Uzbekistan. Today, organization continues its existence as 8 countries with the participation of India and Pakistan in 2017. The Shanghai Cooperation Organization, which has started to attract more attention in recent years, constitutes only a quarter of the world population with member countries. When observers and dialogue partners are added to this, it includes about half of the world population. The total economic size of the SCO exceeded $ 15 trillion with the participation of Pakistan and India and corresponded to about 20 percent of the world economy.

There are many economic cooperations involving different countries and regions in the world. However, Shanghai Cooperation Organization is different from other cooperations by energy potential, population density, density of feedstock resources of the members of cooperation. SCO has important potential in each of many economic and social parameters, and with ongoing new opportunities, it determines the direction of development for the Eurasia region. SCO member states that collectively have a large market for the world economy and a significant proportion of the world's mineral resources and energy inputs, are also an important industrial force in the implementation of joint trade and economic projects (Alimov, 2018; Pierri, 2020). Therefore, the economic policies and political decisions of these countries are quite important for the world economy. On the other hand, the SCO countries take place near the top of Turkey's foreign trade transactions along with the EU countries. In recent years, the volume of trade relations between SCO countries and Turkey has increased and especially the products necessary for economic growth as raw materials and energy inputs are imported from these countries (Karakaş et al., 2019).

The number of studies on SCO countries in the literature is small, but it has been increasing relatively in recent years. In addition, although there are some studies on the relationship between economic growth, energy consumption and trade openness in the literature, there is no such study on SCO countries. In this sense, analyzing this relationship for SCO members that as an important source of raw material and energy input, is expected to contribute to the literature.

The rest of the study is organized as follows. The empirical literature is discussed with some selected studies in the first section. The second section includes the methodology and data used in the study. The empirical findings are presented in third section and the final section concludes a general evaluation and policy recommendations of the study.

2. LITERATURE REVIEW

Analyzing the relationship between energy, economic growth and trade is very significant to implement suitable policies in development processes of countries. Therefore, studies that examine this relationship increase in recent years and the interest varies for different country groups and the results of the studies have a mixed and controversial structure.

There is a growing literature that aims to examine economic growth-energy consumption nexus. Kraft and Kraft (1978) analyzed the impact of energy consumption on national income for USA covering the period 1947-1974 and showed that there is a unidirectional relationship between economic growth and energy consumption. Similar results are also seen in the studies of Hamilton (1983) and Burbridge & Harrison (1984).

Erol and Yu (1987) investigated the relationship between energy consumption and macroeconomic performance by using national income for 6 developed countries (Great Britain, Italy, France, Germany, Japan and Canada) in the 1952-1982 period. They concluded that while the intensity of the relationship differs among countries, there is a significant bilateral relationship between energy consumption and economic growth. Energy consumption-economic growth nexus was also studied by Masih and Masih (1996) for 6 Asian (India, Pakistan, Malaysia, Singapore, Indonesia and the Philliphines) economies from 1955 to 1990. The results suggest that there is a significant relationship betweeen economic growth and energy consumption, but the causality results differ among contries. There is a one-way causality from energy consumption to economic growth in India and from economic growth to energy consumption in Indonesia, while there is a bilateral relationship for Pakistan. The results of the studies of Asafu-Adjaye (2000), Wolde-Rufael (2005), Lee (2005), Al İriani (2006) that discuss the relationship of economic growth and energy consumption for different countries in different time periods support the findings of Erol and Yu (1987) showed that energy consumption is an important explanatory of economic growth and economic growth affects the level of energy consumption.

Ghosh (2002) and Gollagari and Rena (2013) investigated the causal relationship between economic growth and energy consumption for India. Ghosh (2002) used per capita electricity consumption and per capita GDP covering the period 1950-51 to 1996-97. The results suggest that there is a causal unidirectional relationship from economic growth to energy consumption. However, Gollagari & Rena (2013) reveal that there is a bidirectional causality both from economic growth to energy consumption and from energy consumption to economic growth in their study covering the period 1981-2010. More recently, Pao et al. (2014) examined the relationship between economic growth and energy consumption for Brazil during the 1980-2008 period and they found a positive strong relationship between them. The findings of the study reveal that there is a unidirectional relationship from energy consumption to economic growth in the short run, while there is a bidirectional causality in the long-run. Energy and economic growth nexus is analyzed for Kyrgyzstan in the period 1992-2016 by using oil production and consumption, electricity production and consumption by Pirimbaev et al. (2020). They found that only oil consumption positively affects the GDP per capita in the long term. According to the results of the study, if Kyrgyzstan can increase the share of renewable energy sources in total energy consumption, it can reduce its foreign trade deficit and use its resources more efficiently.

The number and scope of studies examining the relationship between energy consumption, trade and economic growth by using imports, exports and trade openness have increased in the literature in recent years. Narayan, Smyth (2009) studied the relationship of economic growth, trade and energy by analyzing a model that contains real GDP, electricity consumption and exports for Middle Eastern countries including Iran, Israel, Kuwait, Oman, Saudi Arabia and Syria. They conclude that causal relationship between variables differs in short-run and long-run. Accoordingly, there is a causallity from energy consumption to economic growth and from economic growth to trade in short-run and the causallity in long-run running from trade and energy consumption to economic growth and from trade to energy consumption. Hossain (2011) analyzed the relationship between chosen macroeconomic variables including economic growth, trade openness and energy consumption for new industrialized 9 countries (Brazil, China, India, Mexico, the Philliphines, South Africa, Thailand and Turkey) from 1971 to 2007. It is found that there is not a long-run causal relationship, yet there is a one-way causal relationship from economic growth to energy consumption and from trade openness to economic growth. The relationship beween economic growth, energy consumption and trade is examined for 15 Asian economies in 1980-2011 period by Nasreen & Anwar (2014). The results of the study indicate that economic growth and trade openness effect energy consumption positively. They also concluded that there is a bilateral causality between both economic growth and energy consumption and trade openness and energy consumption. Kasman & Duman (2015) also discussed macroeconomic performance of new European Union member and candidate countries covering the period 1992-2010 by analyzing a model that includes economic growth, urbanization, energy consumption, CO_2 emissions and trade openness. It is stated that there is a unidirectional causality from economic growth to energy consumption and from energy consumption and from economic growth to trade openness. Iheanacho (2018) investigates the impact of urbanization, population, economic growth, financial development and trade openness on energy consumption for Nigeria during 1971-2013. According to the results of the study using ARDL boundary test and VECM Granger causality approaches, trade openness positively and significantly affects energy consumption in the short and long term. The results found that trade openness in the long run increased energy consumption and that the causality between the two variables is bidirectional. The relationship between energy consumption, economic growth and trade was documented by Satrovic (2019) for Turkey from 1975 to 2015. The results suggest that there is not causal relationship between economic growth and energy consumption in short-run, while there is causal relationship between all variables in long-run.

Hdom and Fuinhas (2020) investigated the relationship between energy and trade openness by modeling economic growth and carbon emission variables. According to the results of the Toda-Yamamoto causality analysis, there is a bidirectional causality between the two variables. Ghazouani et al. (2020) analyzed the causal relationships between trade openness, economic growth and renewable energy consumption in Asia-Pacific countries with the Bootstrap ARDL technique. The results indicate that there is a unidirectional causality from renewable energy consumption to commercial openness in Indonesia and Thailand, and a bidirectional causality between variables in Malaysia and Pakistan. Similarly, Le (2020) examined the role of financial development, trade openness, government spending and institutions for the 46 emerging markets and developing economies in the period 1990-2014 in the energy-growth relationship. In the study in which panel data analysis was carried out, a positive relationship is found between trade openness and renewable energy consumption in the long term. Also, a bidirectional causality is determined between these two variables.

3. MATERIALS AND METHODS

We examine the dynamic relationship among the economic growth (Y), the energy consumption (EN) and the trade openness (TO) in The Shanghai Cooperation Organization countries by employing a panel data analysis. Panel data models ensure considering the correlation between the successive previous values of economic growth and including the separate country effects in the calculations. The method of estimating economic relationships by using time dimension cross-section series is called panel data analysis. In this analysis, time series and cross section series are combined to create a data set with both time and cross section dimensions. In panel data analysis, individual observations are taken into account for different time points in the sample, which allows multiple observations to be created for each individual data in the sample. In its general form, panel data regression model written as:

$$y_{it} \quad y_{it} = \alpha i + \beta \, x_{it} + \varepsilon_{it}, \; i = 1,2,....., N; \; t = 1,2,.....,T \tag{1}$$

where i and t represent individuals as firm, household, country and time respectively and i indicates the cross-section dimension, while the t indicates the time series dimension. $i\alpha$ is a constant that represents the individual effects and contains individual effects specific to the t time dimension and i cross-section dimension.

In this study, the relationship among the economic growth, energy consumption and trade openness analyzed for 8 SCO countries; namely, China, Russia, India, Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan and Pakistan over the period 1990-2018 by using annual data. The sample is limited to these countries for which data are available over this period. In the literature, the relationship between energy and development is addressed with different approaches. There are studies investigating this relationship in terms of demand, as well as studies examining the production side. The model used in the study was created with the Cobb-Douglas production function. The Cobb-Douglas production function is as follows:

$$Y = f(K, L) \tag{2}$$

Y in the function represents the total output, K and L respectively, labour and capital. Following Sadorsky (2012) and Lean & Smyth (2010b) who showed that trade openness can also be used as an explanatory variable in models examining the relationship between economic growth and energy consumption, we used a production function that includes capital, labour, trade openness and energy consumption:

$$Y = f(K, L, TO, EC) \tag{3}$$

Within this context, to examine the long-run relationship and any possible causality between these variables, we used the model[3] below:

$$Y_{it} = \beta_0 + \beta_1 C_{it} + \beta_2 L_{it} + \beta_3 TO_{it} + \beta_4 EC_{it} + u_{it} \tag{4}$$

[3] i= number of countries, T= time period and k=number of variables; we set a model that contains a [(i*T)*1] dimensional matrix for dependent variable and a [(i*T)*k] dimensional matrix for independent variables.

where i indicates SCO countries and t represents each year in 1990-2018 period. Y (per capita GDP in constant 2000 US dollars) is economic growth, C (per capita goss fixed capital formation in constant 2000 US dollars) denotes physical capital, L (labour force participation rate) is labour, TO (trade dependency ratio -export/GDP) indicates trade openness and EC (total energy consumption) represents energy consumption. u_{it} is the error term and the coefficients $\beta_1, \beta_2, \beta_3$ and β_4 show the impacts of the explanatories on the dependent variable. These indicators are often preferred by researchers to represent these variables in the literature (Munir et al, 2020; Zakarya et al., 2015; Le, 2020; Shahbaz et al., 2013; Shahbaz et al., 2014, Jayanthakumaran et al., 2012; Sadorsky, 2012; Squalli & Wilson, 2011; Lean & Smyth, 2010; Huchet-Bourdon et al. 2018). All variables are used in log-form in analysis. The data on Y, C, L and TO are obtained from the World Bank (WDI, 2021) and Penn World Table (PWT 10.0, 2021) and EC is extracted from International Energy Agency (IEA, 2021). The descriptive statistics of the variables used in this study is presented in Table 1.

Table 1: Descriptive Statistics

	Mean	**Std. Deviation**	**Min.**	**Max.**	**Kurtosis**	**Skewness**
Economic growth	1.233	1064.52	3909.48	6722.91	-0.61176	0.86662
Physical capital	2028.4	1493.85	1245.64	4935.23	0.31714	1245.57
Labour	1544.3	1144.76	42.34	97.57	0.43965	0.25651
Trade openness	23.6216	9472.27	63.46	107.62	0.36574	0.78286
Energy consumption	75.9071	6.242.56	5358.6	8140.2	-0.76518	-0.14591

4. RESULTS AND DISCUSSION

In order to examine the relationship of chosen variables in the study, we determine characteristc of indicators by considering both current values, logarithmic values and growth rates of the variables, and by testing a large number of models in different forms. After testing the stationarity of the series with unit root tests, the existence of the long-term relationships of the series were investigated by panel cointegration analysis. Finally, the direction and size of the long-term relationship between these variables were investigated by applying panel causality analysis.

Stationarity tests are considered as a prerequisite analysis to obtain unbiased, efficient and consistent parameter estimators in time series and panel data analysis. In this regard, it is important to examine whether the tendencies of the series over time are constant, in other words, the stationarity of the series, before statistical analysis (Tatoğlu, 2013, p. 199). If non-stationary series are used in the analysis, spurious regression problem may be emerged and the results of analysis may not be true (Granger & Newbold, 1974, p. 559). In addition, it is required to test the stationarity of the series, because investigating the existence of cointegration relationship between variables depends on the fact that these variables are stationary at the same level.

The panel unit root tests that examine the stationarity between panel series consist of two groups and cross-section dependency are taken into a basis in this classification. Accordingly, unit root tests that assume that there is no correlation between units, that is, there is no cross-sectional dependency, are first generation unit root tests. The most important and commonly used of these tests are Wu (1996) test, Im, Pesaran and Shin (1997) test, Maddala and Wu (1999) test, Fisher ADF test, Harris & Tzavalis (1999) test, Hadri (1999) test and Choi (2001) test and Levin, Li and Chu (2002) test (Baltagi, 2005, p. 239; Tatoğlu, 2013, p. 199). These tests were developed based on the univariate methods Dickey Fuller (1979) and Augmented Dickey Fuller (ADF) test statistics created for time series tests. The unit root tests that assume that there is correlation between units, that is, there is cross-sectional dependency, are second generation unit root tests. The commonly used of the second-generation unit root tests are O'Connell (1998), Philips and Sul (2003), Chang (2002, 2004), Bai and Ng (2004), Moon and Perron (2004) and Pesaran CADF (2007) tests (Hurlin & Mignon, 2007, p. 3; Barbieri, 2009, p. 121-122; Tatoğlu, 2013, p. 199).

Which unit root tests can be applied in order to test the stationarity of the series was determined according to the results of cross-sectional dependency test. In this context, Pesaran CD_{LM} (2004) test, that can be used when N and T are large, was used to test the interdivisional correlation. The results of test are shown in Table 2:

Table 2: Cross-sectional Dependence Test Results

	Pesaran CD_{LM} test statistics	**p-value**
Y	8.211	0.000
C	5.477	0.002
L	2.419	0.000
TO	3.541	0.003
EC	1.432	0.006

Note: Null hypothesis is, H_0= There is no interdivisional correlation.

According to the results in Table 2, the null hypothesis is rejected, so there is cross-sectional dependency between the series. It means that shocks that occur in any of these countries would affect other countries. Therefore, unit root tests that take into account the cross-section dependency are required for the efficiency of the estimation results. Accodingly, it is preferred to use Pesaran Cross-Sectional Augmented Dickey-Fuller (CADF) (2007) test, which is the second-generation unit root test, to investigate whether the series are stationary. Pesaran

CADF (2007) test is an expanded form of ADF regression with first differences of individual series and cross-section averages of lag-length level and and is valid both when T>N and T<N (Pesaran, 2007, p. 267-269). In CADF test, CIPS statistic, which is the unit root test statistic for the overall panel model, could be calculated with average of unit root test statistics of each cross-section (Pesaran, 2007, p. 276). Within this context, the unit root test results are summarized in Table 3:

Table 3. Unit Root Test Results

	Intercept		Intercept and Trend	
	level	1st difference	level	1st difference
Y	-1.198 (0.372)	-2.687* (0.023)	-1.309 (0.425)	-3.554* (0.002)
C	-1.378 (0.185)	-3.084* (0.000)	-2.114 (0.512)	-4.215* (0.000)
L	-2.114 (0.345)	-3.492* (0.000)	-2.977 (0.685)	-3.477* (0.008)
TO	-2.054 (0.742)	-2.540** (0.000)	-2.790 (0.715)	-2.965** (0.000)
EC	-1.231 (0.456)	-2.768** (0.041)	-1.154 (0.398)	-2.834** (0.036)

Note: Null hypothesis for test is, H_0 = Series are non-stationary. * and ** indicates stationary series at 1% and 5% significance level respectively. Values in parantheses show probabilty.

As shown in Table 3, unit root test results for both of the models with intercept and with intercept and trend support each other. According to Table 3, we can't reject the null hypothesis for all variables. That is, Pesaran CADF unit root test results show that, economic growth, physical capital, energy consumption and trade openness have unit root and these variables are non-stationary at the level. We took first differences of them in order to render the series stationary and they became stationary at first difference (DY, DC, DL, DTO, DEC). It means that a shock in SCO countries in the analysis does not lose its effect in short-run. The fact that the series are stationary at first difference [I(1)] enables to analyze cointegration relationship of these variables.

Cointegration analysis provides to examine the existence of long-term equilibrium relationship between series. If the series analyzed in an econometric analysis are non-stationary due to the effect of the trend, but each is integrated at same level [both are I(d)], then there is a cointegration between series and regression obtained from analysis indicates the real relationship. The integration of the two series in the same level ensures that the trends offset each other. This provides to occur a trend-free relationship (cointegration) and to be valid of t and F tests.

In order to examine the short-term and long-term relationship of the variables, we have applied Pedroni (1995, 1999) cointegration test that commonly used in panel data analysis. Pedroni presents four within-dimension based statistics *(panel-v, panel-ρ, panel PP and panel ADF)* and three between-dimension based statistics (group- *ρ, group-PP and group-ADF).* While a common value is estimated for ρ_i in within-dimension based statistics, a common value is not estimated in between-dimension based statistics. Table 4 gives the results of Pedroni panel cointegration test results:

Table 4. Pedroni Panel Cointegration Test Results

Pedroni within-dimension based statistics		
	Statistics	Prob.
Panel v-statistics	3.0435	0.0012*
Panel ρ-statistics	5.7986	0.9688
Panel PP-statistics	-3.2214	0.8879
Panel ADF-statistics	-8.7186	0.0035*
Pedroni between-dimension based statistics		
	Statistics	Prob.
Group ρ-statistics	5.3436	0.2781
Group PP-statistics	-4.3681	0.0000*
Group ADF-statistics	-2.8657	0.0000*

Note: Null hypothesis for both tests is, H_0 = There is no cointegration between series. * Series are tested at 5% significance level. We have applied Schwarz Information Criteria for determination of Lag-Length. The critical values for Pedroni cointegration tests are taken from the Pedroni (1999).

The results in Table 4 provide evidence of rejection of null hypothesis with the except of *Panel ρ*, *Panel PP* and *Group ρ* statistics. 4 of the 7 test statistics rejected the null hypothesis that indicates there is no cointegration and this means that there is a long-term systematic relationship between the variables. Pedroni (1999) showed that group-ADF and panel-ADF tests yield more meaningful results, especially for small samples. According to the results obtained from Pedroni-test in Table 4 show that *panel-ADF* and *group-ADF* test statistics are significant and so, this is a powerful indication of cointegration between physical capital, labour, economic growth, trade openness and energy consumption. That is, there is a long-term relationship between these variables.

Kao (1999) cointegration test was also applied in the study to verify the Pedroni cointegration test. The Kao test offers a cointegration test for panel data analysis using Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) tests. The results of the Kao cointegration test are shown in Table 5:

Table 5. Kao Panel Cointegration Test Results

	Test Statistics	p-value
ADF	-3.151922	0.028

Note: Null hypothesis is, H_0= There is no cointegration between series.

As in the Pedroni (1999) cointegration test, the 5% significance level was taken into account in rejecting the null hypothesis in the Kao Cointegration test. According to the results in Table 5, since the probability value is less than 0.05, the alternative hypothesis stating that cointegration exists is accepted. Kao Cointegration test results support the Pedroni cointegration test results. Accordingly, there is a long-term relationship between economic growth, energy consumption and trade openness.

If there is a relationship between the series after the cointegration tests are performed, the coefficients of this relationship can be estimated. For this purpose, two different methods were used, namely DOLS (Dynamic Ordinary Least Square) method and FMOLS (Full Modified Ordinary Least Square) method developed by Pedroni (2000 and 2001). FMOLS and DOLS coefficient estimators were developed upon the emergence of biased results by estimating the series that are related to each other in the long run using the least squares method. Table 6 shows the results obtained from panel DOLS and panel FMOLS analyzes:

Table 6. FMOLS and DOLS Test Results

Panel FMOLS *(Dependent Variable=Y_{it})*		
	Coefficient	***Prob.***
C_{it}	0.7864	0.0034*
L_{it}	0.5799	0.0004*
TO_{it}	0.3964	0.0000**
EC_{it}	0.2728	0.0150**
Panel DOLS *(Dependent Variable=Y_{it})*		
	Coefficient	***Prob.***
C_{it}	0.7195	0.0000*
L_{it}	0.6872	0.0016*
TO_{it}	0.2239	0.0002*
EC_{it}	0.1958	0.0106**

Note: * and ** indicates stationary series at 1% and 5% significance level respectively.

Table 6 showed that the findings obtained from both panel FMOLS and panel DOLS, the long term coefficients of all the variables are positive and significant. It is important for the consistency of the model that the results obtained from both analyzes are the same. Results of FMOLS reveal that 1%

increase in physical capital increases economic growth by about 0.79%. Similarly, 1% increase in labour and trade openness increases economic growth 0.58% and 0.40% and 1% increase in energy consumption positively affects economic growth with an increase of approximately 0.28% in the long run. According to DOLS test results in Table 6, 1% increase in physical capital, labour, trade openness and energy consumption increases economic growth by 0.72% and 0.69%, 0.23% and 0.20%, respectively.

It is important to explain the direction of the long-term relationship by using causality tests. According to Granger (1969), the knowledge of the past values of one variable (X) affects the future values of another variable (Y). Engle & Granger (1987) state that using standard Granger causality may give erroneous results in case of cointegration between variables. Within this context, we applied the generalized Granger panel causality (obtained by adding error correction term to model) in order to determine the direction of short and long term relationship between the coherent series in this study in which there is a cointegration relationship. The panel vector error correction model equation used in the analysis is as follows:

$$Y_{it} = \alpha_i + \sum_{k=1}^{k} \gamma_i^{(k)} y_{it-k} + \sum_{k=1}^{k} \beta_i^{(k)} x_{it-k} + \varepsilon_t \quad (5)$$

In equation 5, α_i denotes the unit-specific effects. $\gamma_i^{(k)}$ and $\beta_i^{(k)}$ differs for the *i* units and so it is allowed to form a difference in causality analysis by units. Null hypothesis of the study of Holtz-Eakin, Newey & Rosen (1988) is stated as $\beta^{(1)} = \cdots = \beta^{(k)} = 0$ and means that there is no causality relationship from X to Y. Accordingly, causality analysis was carried out for 5 different models where dependent variables were economic growth, physical capital, trade openness and energy consumption respectively:

$$\Delta Y_{it} = \delta_{1i} + \sum_{p=1}^{k} \delta_{11ip} \Delta Y_{it-p} + \sum_{p=1}^{k} \delta_{12ip} \Delta K_{it-p} + \sum_{p=1}^{k} \delta_{13ip} \Delta TO_{it-p} + \sum_{p=1}^{k} \delta_{14ip} \Delta EN_{it-p} + \theta_{1i} ECT_{it-1} + \varepsilon_{1it} \quad (6)$$

$$\Delta K_{it} = \delta_{2i} + \sum_{p=1}^{k} \delta_{21ip} \Delta K_{it-p} + \sum_{p=1}^{k} \delta_{22ip} \Delta Y_{it-p} + \sum_{p=1}^{k} \delta_{23ip} \Delta TO_{it-p} + \sum_{p=1}^{k} \delta_{24ip} \Delta EN_{it-p} + \theta_{2i} ECT_{it-1} + \varepsilon_{2it} \quad (7)$$

$$\Delta L_{it} = \delta_{3i} + \sum_{p=1}^{k} \delta_{31ip} \Delta L_{it-p} + \sum_{p=1}^{k} \delta_{32ip} \Delta Y_{it-p} + \sum_{p=1}^{k} \delta_{33ip} \Delta TO_{it-p} + \sum_{p=1}^{k} \delta_{34ip} \Delta EN_{it-p} + \theta_{3i} ECT_{it-1} + \varepsilon_{3it} \quad (8)$$

$$\Delta TO_{it} = \delta_{4i} + \sum_{p=1}^{k} \delta_{41ip}\, \Delta TO_{it-p} + \sum_{p=1}^{k} \delta_{42ip}\, \Delta Y_{it-p} + \sum_{p=1}^{k} \delta_{43ip}\, \Delta K_{it-p} + \sum_{p=1}^{k} \delta_{44ip}\, \Delta EN_{it-p} + \theta_{4i} ECT_{it-1} + \varepsilon_{4it} \quad (9)$$

$$\Delta EN_{it} = \delta_{5i} + \sum_{p=1}^{k} \delta_{51ip}\, \Delta EN_{it-p} + \sum_{p=1}^{k} \delta_{52ip}\, \Delta Y_{it-p} + \sum_{p=1}^{k} \delta_{53ip}\, \Delta K_{it-p} + \sum_{p=1}^{k} \delta_{54ip}\, \Delta TO_{it-p} + \theta_{5i} ECT_{it-1} + \varepsilon_{5it} \quad (10)$$

where $i=1,....,N$, $t= 1,..., T$ and p denotes the number of countries, time period and optimal lag-length respectively. The *ECT* is error correction term which indicates the long-term relationship. Table 7 reports the results of Granger panel causality test based on error correction model:

Table 7. Panel Causality Test Results for SCO Countries

	Short-term Causality Relationship					**Long-term Causality Relationship**
	ΔY	*ΔC*	*ΔL*	*ΔTO*	*ΔEC*	*ECT*
ΔY	-	5.998* (0.000)	4.823* (0.000)	3.165* (0.015)	2.686* (0.027)	-1.342* [0.015]
ΔC	3.079* (0.000)	-	1.204 (0.156)	2.409 (0845)	3.934 (0.623)	-0.763* [0.033]
ΔL	5.047* (0.026)	2.716 (0.185)	-	3.136* (0.004)	1.782 (0.291)	1.024* [0.021]
ΔTO	3.879* (0.000)	2.994* (0.002)	4.348 (0.743)	-	7.879 (0.574)	2.176* [0.019]
ΔEC	4.212* (0.000)	6.782 (0.328)	1.212* (0.007)	2.133* (0.005)	-	-1.412* [0.042]

Note: Null hypothesis is, H_0 = *X does not cause Y.* * denotes the significance at 5%. Values in parantheses show probability and values in box brackets denotes t-staistics.

According to results in Table 7, the short-term effect of energy consumption, trade openness, labour and physical capital on economic growth is positive and statistically significant. However, there is a causality only from economic growth to physical capital in the short-run, therefore the causal relationship between economic growth and physical capital is bilateral. Only the impact of economic growth and trade openness on labour is positive and significant. The results also show that there is a bilateral relationship between economic growth and labour, while the causal relationship between economic growth and trade openness and the causal relationship between economic growth and energy consumption are unilateral. The results of the fourth equation indicate that the impact of economic growth and physical capital on trade openness is positive and statistically significant in the short-run, but energy consumption has no significant impact on trade openness; that is, there is no causal relationship from energy consumption to trade openness, while economic growth and physical capital are positively related with trade openness. In the short-run, the impact of trade openness, labour and economic growth on energy consumption is positive and significant; so, there is a causality towards energy consumption from these variables. Briefly, in the short term; while there is a bilateral causality from energy consumption and trade openness to economic growth; there is a unilateral causality from trade openness to energy consumption. Table 7 also presented the long-term causal relationship of the variables. As seen in Table 7, the error correction term that provides analysis of long-term causal relationships is statistically significant for all relationships. This result shows that these five variables play an important role to correct of long-term deviations. Economic growth, physical capital, labour trade openness and energy consumption respond to the deviation from external shocks in the long term with a correction of 0.015, 0.033, 0.021, 0.019 and 0.042 unit respectively and tend towards the long-term equilibrium.

5. CONCLUSION

This study explores the relationship between economic growth, energy consumption and trade openness for members of the Shanghai Cooperation Organization covering the period 1990-2018 by using the panel cointegration and panel causality apprach. In this context, firstly, we determined whether series were stationary or not by using panel unit root tests. As a result of Pesaran CD_{LM} (2004) cross-sectional dependency test, we used Pesaran CADF (2007) second generation unit root test which assumes that there is correlation between units, and we found that all the variables were stationary at first level. After determining that the first differences of the variables were stationary, panel cointegration and panel causality tests were performed. According to Pedroni & Kao cointegration tests, it is concluded that there is a relationship between economic growth, physical capital, trade openness and energy consumption in the long run. FMOLS and DOLS estimation analysis reveals that there is a positive relationship between all variables. Within this context, the results of the analysis indicate that while there is a bidirectional causality relationship between economic growth and energy consumption and between economic growth and trade openness in the short term; there is a Granger causality between trade openness and energy consumption which from trade openness to energy consumption. Furthermore, panel cointegration results indicate the existence of long-term equilibrium between these variables. Therefore, energy consumption, trade openness and economic growth are important factors that affect each other in these countries and they should consider these effects while forming their short- and long-term economic policies. These findings are similar to the empirical findings of Erol and Yu (1987), Gollagori and Rena (2013), Pao (2014), and Nasreen and Anwar (2014).

Energy is an important input for members of the SCO. The bidirectional causality relationship between energy consumption and economic growth shows that these two variables interact with each other. That is, the increases in economic growth increase the energy consumption and similarly this increasing energy consumption would be one of the main reasons of economic growth in these countries. In this respect, it can be said that the empirical results of the study support the *feedback hypothesis* (Ozturk, 2010) in SCO countries which suggests that energy consumption and economic growth are variables that determine, feed and affect each other. Hence, the energy policies that are implemented by policy makers of these countries' have important effects on economy. In this scope, it is really necessary to form policies which reveal to become able to produce their own energy resources and to verge to alternative energy sources by following the innovation in energy production for development process of these countries. The causality relationship between trade openness and economic growth in our study show that these countries need to give more weight to exports in order to ensure more effective growth process. Because the increasing in income, savings and investments and occurring of economies of scale would accelerate through exports, implementing policies to render exports efficient should be one of the closest targets of these developing countries. In order for more effective results of the effect of trade openness on economic growth to emerge in these countries, the share of the energy sector in exports should be taken into account in the forming of economic policies. In addition, since economic growth also increases energy consumption, the economic growth rate should be taken into account when determining energy policies.

6. CONFLICT OF INTEREST STATEMENT

There is no conflict of interest between the authors.

7. FUNDING ACKNOWLEDGEMENTS

No funding or support was used in this study.

8. AUTHOR CONTRIBUTIONS

HÇ, BB: Idea
HÇ, BB: Design
HÇ: Check
BB: Literature Review
BB: Data Collection
HÇ, BB: Analysis and Interpretation

HÇ, BB: Writing of Article
HÇ: Critical Review of Article

9. ETHICS COMMITTEE STATEMENT AND INTELLECTUAL PROPERTY COPYRIGHTS

Ethics committee principles were followed in the study. There has been no situation requiring permission within the framework of intellectual property and copyrights.

10. REFERENCES

Ahmad, M., Zhao, Z. Y., Irfan, M., Mukeshimana & M. C. (2019). Empirics on influencing mechanisms among energy, finance, trade, environment, and economic growth: a heterogeneous dynamic panel data analysis of China. *Environmental Science and Pollution Research*, 26(14), 14148-14170.

Alimov, R. (2018). The Shanghai cooperation organisation: Its role and place in the development of Eurasia. *Journal of Eurasian Studies*, 9(2), 114-124.

Al-Iriani, M. A. (2006). Energy-GDP relationship revisited: An example from GCC countries using panel causality. *Energy Policy*, 34(17), 3342-3350.

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy Economics*, 22(6), 615-625.

Austin, G. (Ed.). (2017). *Economic development and environmental history in the anthropocene: Perspectives on Asia and Africa*. Bloomsbury Publishing.

Baltagi, B. H. (2005). *Econometric analysis of panel data*, John Wiley&Sons Ltd. West Sussex, England.

Barbieri, L. (2009). Panel unit root tests under cross-sectional dependence: an overview. *Journal of Statistics: Advances in Theory and Applications*, 1(2), 117-158.

Burbidge, J. & Harrison, A. (1984). Testing for the effects of oil-price rises using vector autoregressions. *International Economic Review*, 25, 459-484.

Carley, S., Lawrence, S., Brown, A., Nourafshan, A. & Benami, E. (2011). Energy-based economic development. *Renewable and Sustainable Energy Reviews*, 15(1), 282-295.

Engle, R. F. & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Erol, U., Yu & E. S. (1987). On the causal relationship between energy and income for industrialized countries. *The Journal of Energy and Development*, 113-122.

Ghazouani, T., Boukhatem, J. & Sam, C.Y. (2020). Causal interactions between trade openness, renewable electricity consumption, and economic growth in Asia-Pacific countries: Fresh evidence from a bootstrap ARDL approach. *Renewable and Sustainable Energy Reviews*, 133, 110094.

Ghosh, S. (2002). Electricity consumption and economic growth in India. *Energy Policy*, 30 (2), 125-129.

Gollagari, R. & Rena, R. (2013). An empirical analysis of energy consumption and economic growth in India: are they causally related? *Studia Oeconomica*, 58 (2), 22-40.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 424-438.

Granger, C. W. & Newbold, P., (1974). Spurious regressions in econometrics. *Journal of Econometrics*, 2(2), 111-120.

Hamilton, J. D. (1983). Oil and the macroeconomy since World War II. *Journal of Political Economy*, 91, 228-248.

Hamit-Haggar, M. (2016). Clean energy-growth nexus in sub-Saharan Africa: Evidence from cross-sectionally dependent heterogeneous panel with structural breaks. *Renewable and Sustainable Energy Reviews*, 57, 1237-1244.

Hdom, H.A.D. & Fuinhas, J. A. (2020). Energy production and trade openness: Assessing economic growth, CO2 emissions and the applicability of the cointegration analysis. *Energy Strategy Reviews*, 30, 1-13.

Holtz-Eakin, D., Newey, W. & Rosen, H. S. (1988). Estimating vector autoregressions with panel data. *Econometrica: Journal of the Econometric Society*, 1371-1395.

Hossain, M. S. (2011). Panel estimation for CO2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. *Energy Policy*, 39(11), 6991-6999.

Huchet-Bourdon, M., Le Mouël, C. & Vijil, M. (2018). The relationship between trade openness and economic growth: Some new insights on the openness measurement issue. *The World Economy*, 41(1), 59-76.

Hurlin, C. & Mignon, V. (2007). Second generation panel unit root tests. HAL Working Papers, halshs-00159842.

Ihenacho, E. (2018). The influence of urbanization, population age groups and trade on energy consumption in Nigeria: An empirical analysis. *International Journal of Economy, Energy and Environment*, 3(5), 38-44.

International Energy Agency (2021). Data. Retrieved from https://www.iea.org/data-and-statistics, (2021, 20 June).

Jayanthakumaran, K., Verma, R. & Liu, Y. (2012). CO2 emissions, energy consumption, trade and income: A comparative analysis of China and India. *Energy Policy*, 42, 450-460.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, 90(1), 1-44.

Karakaş, Ü. Ç., Karakaş, A. & Topal, S. (2019). Economic growth affects of economic integration: An economic analysis on Turkish economy in the context of the European Union and Shanghai Cooperation Organization. *Alphanumeric Journal*, 7(2), 185-204.

Kasman, A. & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. *Economic Modelling*, 44, 97-103.

Komal, R. & Abbas, F. (2015). Linking financial development, economic growth and energy consumption in Pakistan. *Renewable and Sustainable Energy Reviews*, 44, 211-220.

Kraft, J. & Kraft, A. (1978). On the relationship between energy and GNP. *Journal of Energy and Development*, 3(2), 401-403.

Lean, H. H. & Smyth, R. (2010). Multivariate Granger causality between electricity generation, exports, prices and GDP in Malaysia. *Energy*, 35 (9), 3640-3648.

Lean, H. H., & Smyth, R. (2010b). On the dynamics of aggregate output, electricity consumption and exports in Malaysia: evidence from multivariate Granger causality tests. *Applied Energy*, 87(6), 1963-1971.

Le, H.P. (2020). The energy-growth nexus revisited: the role of financial development, institutions, government expenditure and trade openness. *Heliyon*, 6, 1-11.

Lee, C. C. (2005). Energy consumption and GDP in developing countries: a cointegrated panel analysis. *Energy economics*, 27 (3), 415-427.

Masih, A. M. & Masih, R. (1996). Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modelling techniques. *Energy economics*, 18 (3), 165-183.

Munir, Q., Lean, H. H. & Smyth, R. (2020). CO2 emissions, energy consumption and economic growth in the ASEAN-5 countries: A cross-sectional dependence approach. *Energy Economics*, 85, 104571.

Narayan, P. K. & Smyth, R. (2009). Multivariate Granger causality between electricity consumption, exports and GDP: evidence from a panel of Middle Eastern countries. *Energy Policy*, 37 (1), 229-236.

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.

Ozturk, I. (2010). A literature survey on energy–growth nexus. *Energy Policy*, 38(1), 340-349.

Pao, H. T., Li, Y. Y. & Fu, H. C. (2014). Causality relationship between energy consumption and economic growth in Brazil. *Smart Grid and Renewable Energy*, 5, 198-205.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1), 653-670.

Pesaran, M. H. (2004) General diagnostic tests for cross-sectional dependence in panel data. *Cambridge University Working Paper Econ*, 0435.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265-312.

Pierri, B. (2020). A new balance of power for the twenty-first century: The Shanghai Cooperation Organisation, 2001-2007. *Eunomia. Rivista semestrale di Storia e Politica Internazionali,* (1), 5-50.

Pirimbaev, J., Ravanoglu, G. A. & Sulaimanova, B (2020). Enerjinin ekonomik büyümeye etkisi: Kırgızistan ekonomisi içın ARDL sınır testi. *Reforma*, 3(87), 48-63.

Sadorsky, P. (2011). Trade and energy consumption in the Middle East. *Energy Economics*, 33 (5), 739-749.

Sadorsky, P. (2012). Energy consumption, output and trade in South America. *Energy Economics*, 34(2), 476-488.

Satrovic, E. (2019). Energy consumption, trade openness and growth nexus in Turkey: evidence from VECM. *Cumhuriyet Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 20 (1), 1-12.

Shahbaz, M., Tiwari, A. K. & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. *Energy Policy*, 61, 1452-1459.

Shahbaz, M., Khraief, N., Uddin, G. S., & Ozturk, I. (2014). Environmental Kuznets curve in an open economy: A bounds testing and causality analysis for Tunisia. *Renewable and Sustainable Energy Reviews,* 34, 325-336.

Squalli, J. & Wilson, K. (2011). A new measure of trade openness. *The World Economy*, 34(10), 1745-1770.

Tatoğlu, F. Y. (2012). *Panel veri ekonometrisi*. Beta Yayınevi.

Uysal, D., Yılmaz, K. & Taner, T. A. Ş. (2015). Enerji ithalatı ve cari açık ilişkisi: Türkiye örneği. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, 3 (1), 63-78.

Wolde-Rufael, Y. (2005). Energy demand and economic growth: The African experience. *Journal of Policy Modeling*, 27 (8), 891-903.

World Bank (2021). World development indicators, Retrieved from https://databank.worldbank.org/source/world-development-indicators, (2021, 15 June)

Zakarya, G. Y., Mostefa, B., Abbes, S. M. & Seghir, G. M. (2015). Factors affecting CO2 emissions in the BRICS countries: A panel data analysis. *Procedia Economics and Finance,* 26, 114-125.

Zeng, S. & Zhou, Y. (2021). Foreign direct investment's impact on China's economic growth, technological innovation and pollution. *International Journal of Environmental Research and Public Health*, 18(6), 2839.