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NATURAL GAS CONSUMPTION AND ECONOMIC GROWTH NEXUS: PANEL CAUSALITY METHOD FOR MIKTA COUNTRIES

DOĞALGAZ TÜKETİMİ VE EKONOMİK BÜYÜME ARASINDAKİ İLİŞKİNİN İNCELENMESİ: MIKTA ÜLKELERİ ÖRNEĞİ

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ABSTRACT

This study investigates the relationship between economic growth (EG) and natural gas consumption (NGC) in Mexico, Indonesia, South Korea, Turkey and Australia (MIKTA) with panel data analysis. The study was conducted between 1986 and 2018 using panel cointegration tests, a common correlated effects mean group (CCEMG) estimator and panel causality tests. From the results of the study, it was concluded that there is a long-term relationship between NGC and EG. The CCEMG estimation results show that NGC on EG differs across countries. The panel causality results show bidirectional causality between EG and NGC for MIKTA countries. The results confirm the feedback hypothesis for MIKTA.

Keywords: MIKTA, Energy, EG, Panel Data Analysis.

JEL Codes: P48, Q43, F43.

ÖZET

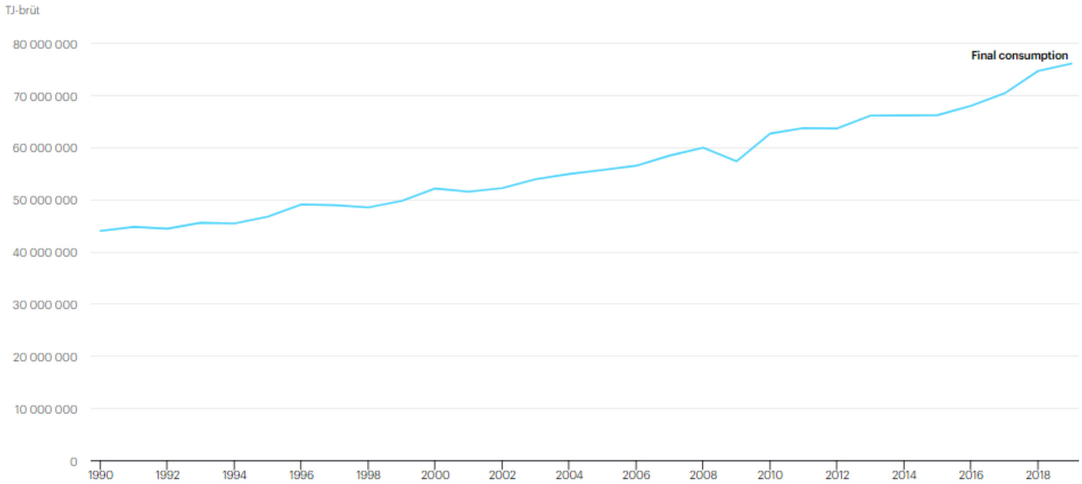
Bu çalışma, Meksika, Endonezya, Güney Kore, Türkiye and Avustralya'da (MIKTA) doğal gaz tüketimi ile ekonomik büyüme arasındaki ilişkiyi panel andri analizi ile incelemektedir. Çalışma, panel eşbütünleşme testleri, ortak korelasyonlu etkiler ortalama grubu (CCEMG) tahmincisi and panel nedensellik testleri kullanılarak 1986'dan 2018'e kadar uzanmaktadır. Çalışma sonucunda doğal gaz tüketimi ile ekonomik büyüme arasında uzun dönemli bir ilişki olduğu sonucuna varılmıştır. CCEMG tahmin sonuçları doğalgaz tüketiminin ekonomik büyüme üzerindeki etkisinin ülkeler kapsamında farklı olduğunu göstermektedir. Panel nedensellik sonuçları MIKTA ülkeleri için doğalgaz tüketimi and ekonomik büyüme arasında çift yönlü nedensellik olduğunu göstermiştir. Sonuçlar MIKTA için geri bildirim hipotezini onaylamaktadır.

Keywords: MIKTA, Enerji, Ekonomik Büyüme, Panel Veri Analizi.

JEL Kodları: P48, Q43, F43.

1. INTRODUCTION

After the Industrial Revolution, energy use grew with increased production, and technology became widespread with industrialization. The technology factor, which replaced physical labor, was considered the driving force behind production. Industrialization, urbanization and rising population rates drove up energy demand. Primary energy sources comprised a significant share of increasing energy demand, especially in developing countries, and accordingly, natural gas consumption (NGC) increased significantly. Figure 1 shows global NGC for the 1990–2019 period.



Source: IEA, https://www.iea.org/data-and-statistics/data-browser?country=WORLD&fuel=Natural%20gas&indicator=NatGasCons (Date accessed: 01.05.2022)

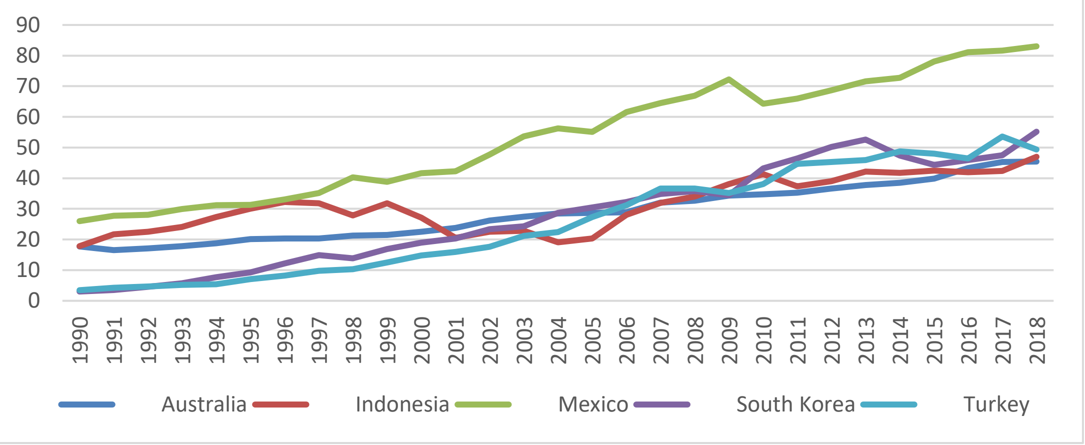
Figure 1. World NGC, 1990-2019

Figure 1 shows an increasing NGC trend for the relevant period. The increase in NGC and in industry and technology developments over the years, shows parallelism with the increase in natural gas usage areas. However, there were decreases in natural gas demand during periods of economic contraction. For example, there was a sudden decrease in world NGC in 2009, an effect of the 2008 global financial crisis.

Energy is an essential factor for the production of goods and services, and has a direct impact on economic growth (EG). However, the link between EG and energy remains unclear (Arora and Shi, 2016). Apergis and Payne (2010) examined the relationship between energy consumption (EC) and EG using four different hypotheses. Hypotheses-1 is the growth hypothesis, which suggests a one-way causal relationship from EC to EG. It is assumed that EC has a direct or complementary effect on EG. Hypothesis-2 is the conservation hypothesis, which posits a unidirectional causal relationship from EG to EC. It also argues that EC is explained by EG. Hypothesis-3 is the feedback hypothesis, which points to a bidirectional, causal relationship between EG and EC. Hypothesis-4 is the neutrality hypothesis, which argues that EC does not have a significant effect on EG; in other words, there is no relationship between EG and EC.

The grouping of Mexico, Indonesia, South Korea, Turkey and Australia (MIKTA) was established to leverage regional power, especially in the areas of finance, economy, security, environment and sustainable development. These countries, which are in different regions of the world, also have different cultures. Capitalizing on these features, MIKTA aimed to be a regional power that could act as a bridge between developed and developing countries. Additionally, MIKTA is an example of interregional unification, encouraging and developing business collaboration on different issues (mikta.org). For example, MIKTA generates ideas and introduces reforms on the future of natural gas (Haug, 2017), and cooperation between MIKTA countries is expected to increase in the future (Colakoglu, 2016).

The MIKTA countries' share of global NGC reached 3% in 1990, 5% in 2000 and 7% in 2018. Figure 2 shows the NGC amounts of MIKTA countries between 1990 and 2018. Although there are periodic decreases, an increasing NGC trend can be seen between 1980 and 2018. An examination of the NGC amount during the last period—2018—shows that Mexico consumed 83 billion cubic meters of natural gas, Indonesia 46.9 billion, South Korea 55.1 billion, Turkey 49.3 billion and Australia approximately 45 billion. The breakdown of NGC shares among MIKTA countries are Mexico 2.5%, Indonesia 1.4%, South Korea 1.7%, Turkey 1.5% and Australia 1.4%.



Source: International Energy Agency, IEA

Figure 2. NGC of MIKTA Countries for the Period 1990 – 2018 (billion cubic meters)

This study investigates the relationship between NGC and EG for MIKTA countries between 1986 and 2018. The panel causality method was used in the research. Numerous studies have examined the relationship between NGC and EG. However, a specific examination of MIKTA countries has not yet been conducted and will make an essential contribution to the literature. Information about MIKTA countries and the energy sector is provided in the first part of the study. The second part examines the relationship between NGC and EG using different hypotheses. The third section outlines the model for the study and the estimation methods. The results and policy recommendations are discussed in the fourth and fifth sections.

2. LITERATURE

The relationship between EG and NGC during different periods has been investigated in many studies. Ordinary least squares (OLS) and causality analysis were used in some studies because the time dimension was not long enough. Zafar et al. (2019) investigated the relationship between renewable and non-renewable EC and EG for APEC countries from 1990 to 2015. For the study that used the panel data approach, different results were obtained for each country; according to the findings, renewable and non-renewable energy affects EG. Li et al. (2019) investigated the relationship between NGC and EG in thirty cities in China from 2000 to 2014. For this study, analysis was performed with the help of the Cobb-Douglas production function and panel OLS. According to the analysis results, the marginal effect of NGC on EG was significant. Azam et al. (2021) investigated the effects of nuclear EC, renewable EC and NGC on carbon dioxide emissions and gross domestic product from 1990 to 2014, determining that NGC leads to EG. In addition, the results indicated that NGC has a positive effect on EG in the long run, but the coefficient is negative.

In addition to panel data approaches, time series approaches examining a single country are also included in the literature (Lim and Yoo, 2012; Shahbaz et al., 2013; Solarin and Shahbaz, 2015; Bulkani et al., 2021). Işık (2010) investigated the relationship between NGC and EG in Turkey from 1977 to 2008 with the help of the autoregressive distributed lag (ARDL) model. The analysis results revealed that NGC positively affects EG in the short term, although there is a negative relationship between NGC and EG in the long run. Erdoğan et al. (2019) investigated the relationship between NGC and EG in Turkey from 1983 to 2017 using time-varying causality tests with Hacker and Hatemi-J. From the causality analysis results, the researchers concluded that the neutrality hypothesis is valid. Based on the causality test results for different sub-periods, the growth hypothesis was considered valid for the 1996 to 2010, 1997 to 2011 and 2001 to 2015 periods. They also concluded that the conservation hypothesis was valid in Turkey for the 2000 to 2014 period. Shahbaz et al. (2019) explored the relationship between EG and NGC in Pakistan from 1972 to 2011 using the Granger causality test, ARDL and the Johansen cointegration test. The cointegration tests showed a long-term relationship between capital, labor, NGC and EG variables. The Granger causality test results determined that the feedback hypothesis was valid in Pakistan for the research period. Ummalla and Samal (2019) investigated the effects of natural gas and renewable EC on carbon dioxide emissions and EG in China and India between 1965 and 2016. The ARDL cointegration test and the Granger causality approach were used in the study. According to the results of the analysis for India, there was no causal relationship between NGC and EG in the short run. However, the short-term results for China indicated that NGC is the cause of EG. Based on the long-term causality analysis results, it was concluded that the feedback hypothesis was valid for both countries. Galadima and Aminu (2020) investigated the relationship between Nigeria's EG and NGC with a nonlinear OLS and the Hatemi-J asymmetric causality test. Accordingly, it was determined that there is a two-way causal relationship between NGC and EG variables. The researchers also concluded that the feedback hypothesis is valid for Nigeria.

Table 1. Summary of Studies on NGC and EG

Author(s)	Period	Country(s)	Method	Findings
Kum, Ocal and Aslan (2012)	1970-2008	G-7 countries	Granger causality test with Bootstrap correction	Italy → the growth hypothesis England → the conservation hypothesis France, Germany and USA → The feedback hypothesis Canada and Japan → neutrality hypothesis is valid
Lim and Yoo (2012)	1991Q1–2008Q2	South Korea	Granger Causality Test, Johansen – Juselius Cointegration Test	The feedback hypothesis is valid.
Shahbaz, Lean and Farooq (2013)	1972-2010	Pakistan	ARDL cointegration test, Johansen Cointegration Test	The growth hypothesis is valid.
Bildirici and Bakırtaş (2014)	1980-2011	BRICS-T Countries	ARDL cointegration test, Granger causality test	Brazil, Turkey, Russia → Feedback hypothesis South Africa, China and India → The neutrality hypothesis is valid.
Doğan (2015)	1995-2012	Turkey	ARDL cointegration test, Granger causality test	The feedback hypothesis is valid.
Lach (2015)	2001Q1-2009Q4	Poland	Toda-Yamamoto and nonlinear	In the short run → The growth hypothesis The long run → The conservation hypothesis is valid

			Granger causality tests,	
Öztürk and Al-Mulali (2015)	1980-2012	Gulf Arab States Cooperation Council	Pedroni panel cointegration test, Panel Granger causality test	The feedback hypothesis is valid.
Solarin and Shahbaz (2015)	1971-2012	Malaysia	ARDL, Bayer-Hanck cointegration test, Granger causality test	The feedback hypothesis is valid.
Balitskiy, Bilan, Strielkowski and Štreimikienė (2016)	1997-2011	EU member 26 countries	Pedroni cointegration test, Panel EKK and Panel GMM regressions, Panel causality test	The growth hypothesis is valid.
Chang et al. (2016)	1965-2011	England and other countries	Panel causality test	England → the conservation hypothesis For all other countries → the neutrality hypothesis is valid.
Solarin and Öztürk (2016)	1980-2012	OPEC	Panel Granger causality test	Iraq, Kuwait, Libya, Nigeria and Saudi Arabia → The growth hypothesis, Algeria, Iran, United Arab Emirates, Andnezuela → conservation hypothesis Equator → The feedback hypothesis Angola and Qatar → The neutrality hypothesis
Aydın (2018)	1994-2015	10 countries with the most NGC	Kao cointegration test, Pedroni cointegration test, Panel Granger causality test	England and Germany → Conservation hypothesis For Thailand → the feedback hypothesis USA, Russia, Mexico, China, Japan, Canada and India → The neutrality hypothesis is valid
Zhi-Guo, Cheng and Dong-Ming (2018)	1991-2015	Northeast Asian countries	Pedroni cointegration test, Kao cointegration test, Panel causality test	Japan and Korea →Neutrality hypothesis China → The growth hypothesis is valid
Fadiran, Adebusuyi and Fadiran (2019)	1991–2016	12 countries in Europe	Panel cointegration test, Dumitrescu-Hurlin panel Granger causality test	Austria, Bulgaria and Switzerland → The growth hypothesis United Kingdom and Italy → conservation hypothesis is valid.
Sinaga, Saudi, Roespinoedji and Razimi (2019)	1980-2017	Indonesia	ARDL cointegration test	The feedback hypothesis is valid.
Etokakpan, Solarin, Yorucu, Bekun and Sarkodie (2020)	1980-2014	Malaysia	ARDL cointegration test, Granger causality test	The growth hypothesis is valid.
Cui et al. (2021)	1989-2020	Chine	Wavelet Coherence	The feedback hypothesis is valid.
Sohail et al. (2021)	1965-2019	Pakistan	Gregory-Hansen Co-integration Analysis	The growth hypothesis is valid
Galadima et al. (2022)	1981-2019	Nigeria	ARDL cointegration test	The growth hypothesis is valid

3. DATA AND METHOD

In this study, the relationship between NGC and EG for MIKTA countries was examined from 1986 to 2018 using annual data. The causal relationship between MIKTA country variables was investigated using the panel causality test. The 2010 fixed price gross domestic product values of countries for EG were obtained from the World Bank database. NGC values were obtained from the International Energy Agency (IEA) website for dry NGC (billion cubic meters).

3.1. Cross Sectional Dependence and Panel Unit Root Tests

In order to apply panel cointegration and causality tests, it is important to determine the integrated levels of the series. To achieve this, panel unit root tests were used. Panel unit root tests, which test whether the series has a unit root, need to be selected correctly. Therefore, the concept of cross-sectional dependence (CSD) is important in panel data series. In this study, Pesaran’s (2004) approach was used first to test whether the series has CSD.

Pesaran’s (2007) panel unit root test, which considers CSD, is one of the most widely used approaches in the literature. Pesaran’s (2007) CIPS test, one of the second generation approaches, was used because the series in our study had CSD. This test was based on the standard Augmented Dickey-Fuller (ADF) equation, based on the cross-sectional mean of the lagged leandls and the difference in the series. The cross-sectional ADF (CADF) equation developed by Pesaran (2007) was arranged as follows:

$$\Delta \mathbf{y_{it}} = \boldsymbol{\alpha_i} + \mathbf{b_i y_{i,t-1}} + \mathbf{c_i \bar{y}_{t-1}} + \sum_{j=0}^{p} \mathbf{d_{ij}}\, \Delta \mathbf{\bar{y}_{t-j}} + \sum_{j=1}^{p} \boldsymbol{\delta_{ij}}\, \Delta \mathbf{y_{i,t-j}} + \boldsymbol{\varepsilon_{it}} \qquad (3.1.1)$$

In this equation, $\mathbf{\bar{y}_t}$ represents the average of the units in N observation numbers and time t. The first difference delay values of $\mathbf{y_{it}}$ and $\mathbf{\bar{y}_t}$ were selected with the help of information criterion. Based on this equation, Im, Pesaran, and Shin produced a statistic that considers CSD. The CIPS statistics were obtained by averaging the CADF statistics as follows:

$$\mathbf{CIPS} = \frac{\sum_{i=1}^{N} \mathbf{CADF_i}}{\mathbf{N}} \qquad (3.1.2)$$

3.2. Homogeneity Test

The Swamy (1970) test can be performed in panel data models where the cross-section size may be larger than the time series size. Testing slope homogeneity in this test depends on the distribution of individual slope estimates obtained from the pooled estimator. Pesaran and Yamagata (2008) introduced an approach where the cross-section size (N) can be larger than the time series size (T) for panel data models. The basis of this approach is based on Swamy’s test of slope homogeneity. Pesaran and Yamagata (2008) proposed a standardized version of this test ($\tilde{\Delta}$) for testing slope homogeneity.

$$\tilde{\mathbf{S}} = \sum_{i=1}^{N} \left(\hat{\boldsymbol{\beta}}_i - \tilde{\boldsymbol{\beta}}_{WFE}\right)' \frac{\mathbf{x}_i' \mathbf{M_T} \mathbf{x}_i}{\tilde{\boldsymbol{\sigma}}_i^2} \left(\hat{\boldsymbol{\beta}}_i - \tilde{\boldsymbol{\beta}}_{WFE}\right) \qquad (3.2.1)$$

In Equation (3.2.1.), $\hat{\boldsymbol{\beta}}_i$ is the EKK estimator, $\tilde{\boldsymbol{\beta}}_{WFE}$ is the weighted fixed effects estimator, and $\mathbf{M_T}$ is the unit matrix. The $\tilde{\Delta}$ test statistic proposed by Pesaran and Yamagata (2008) is the same as in equation (3.2.2).

$$\tilde{\Delta} = \sqrt{\mathbf{N}} \left(\frac{\mathbf{N^{-1}\tilde{S} - k}}{\sqrt{\mathbf{2k}}}\right) \qquad (3.2.2)$$

Under the null hypothesis with the (N,T)→∞ condition, the error terms will be normally distributed when $(\sqrt{\mathbf{N}}/\mathbf{T}) \rightarrow \infty$. Pesaran and Yamagata (2008) can be consulted for detailed theoretical information about this approach.

$$\tilde{\Delta}_{\mathbf{adj}} = \sqrt{\mathbf{N}}\left(\frac{\mathbf{N}^{-1}\tilde{\mathbf{S}} - \mathbf{E}(\tilde{\mathbf{z}}_{\mathbf{it}})}{\sqrt{\mathbf{var}(\tilde{\mathbf{z}}_{\mathbf{it}})}}\right) \qquad (\mathbf{3.2.3})$$

Here, the mean is $\mathbf{E}(\tilde{\mathbf{z}}_{\mathbf{it}}) = \mathbf{k}$ and the variance is expressed as $\mathbf{var}(\tilde{\mathbf{z}}_{\mathbf{it}}) = \frac{\mathbf{2k(T-k-1)}}{\mathbf{T}} + \mathbf{1}$. Accordingly, since the small sample characteristics of the $\tilde{\Delta}$ test may cause deviation, normally distributed errors can be obtained using the $\tilde{\Delta}_{\mathbf{adj}}$ statistic (Chang et al., 2016).

3.3. Panel Cointegration Tests

Panel cointegration approaches indicate the existence of a long-term relationship between variables and for this reason, many panel cointegration approaches are used in the literature. Westerlund's (2007) cointegration approaches were preferred in this study. Westerlund (2007) suggested panel tests that reveal the long-run relationship between error correction dependent and integrated variables. This cointegration test, based on four different panel tests, may include unit-specific short-term dynamics and unit-specific slope parameters. The tests reveal whether the panel as a whole, and at least one unit, is cointegrated. Westerlund (2007) suggests that the panel approach can be applied to bootstrap tests for variables with CSD. In this approach, $\boldsymbol{G_\tau}$ and $\boldsymbol{G_\alpha}$ group mean tests, and $\boldsymbol{P_\tau}$ and $\boldsymbol{P_\alpha}$ panel statistics, are calculated as follows (Persyn and Westerlund, 2008):

$$\boldsymbol{G_\tau = \frac{1}{N}\sum_{i=!}^{N}\frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}}, \qquad \boldsymbol{G_\alpha = \frac{1}{N}\sum_{i=!}^{N}\frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}}$$

$$\boldsymbol{P_\tau = \frac{\hat{\alpha}}{SE\hat{\alpha}}}, \qquad \boldsymbol{P_\alpha = T\hat{\alpha}}$$

In these calculations, $\boldsymbol{\hat{\alpha}_i(1) = 1 - \sum_{j=1}^{p_i}\hat{\alpha}_i}$ was obtained and $\boldsymbol{SE(\hat{\alpha}_i)}$ was the standard error of the $\boldsymbol{\hat{\alpha}_i}$ error correction parameter. Critical values were gained from the study of Westerlund (2007).

3.4. Correlated Effects Mean Group Estimator

Pesaran (2006) proposed a new approach that filters the effects of unobserved common factors by using cross-section of unit-specific estimators. The auxiliary regression equations established within the scope of this approach are estimated by the least squares method. These are the estimations that are made when the variables are tested for cointegration.

The variance of the correlated effects mean group (CCEMG) estimator can be calculated whether the slope coefficients are homogeneous or heterogeneous. The CCEMG estimator can be obtained by considering the coefficients obtained from the cross-section ranges of the $\boldsymbol{\beta_i}$ slope coefficients in the random coefficient equation and the range group estimator. The CCEMG estimator was obtained by taking the simple range of the unit of the common correlated effect estimator (CCE) (Pesaran, 2006).

$$\boldsymbol{\hat{b}_{MG} = N^{-1}\sum_{i=1}^{N}\hat{b}_i} \qquad (\mathbf{3.4.1})$$

In Equation (3.4.1.), the CCEMG estimator is obtained asymptotically unbiased if $\boldsymbol{N} \rightarrow \infty$ and $\boldsymbol{T} \rightarrow \infty$ or T are constant.

3.5. Panel Granger Causality Test

In this study, the panel Granger causality approach was employed to investigate the relationship between NGC and EG for MIKTA countries. For this purpose, the panel vector autoregression (VAR) model was used. The panel VAR models created within the scope of this study are as follows:

$$gdp_t = \delta_0 + \sum_{i=1}^{\mathbf{n_1}} \boldsymbol{\theta}_i \Delta gdp_{t-i} + \sum_{j=1}^{\mathbf{n_2}} \beta_j \mathbf{gas_{t-j}} + \boldsymbol{\varepsilon}_{1t} \qquad (\mathbf{3.5.1})$$

$$gas_t = \mu_0 + \sum_{i=1}^{\mathbf{n_1}} \emptyset_i \Delta gdp_{t-i} + \sum_{j=1}^{\mathbf{n_2}} \boldsymbol{\gamma}_j \mathbf{gas_{t-j}} + \boldsymbol{\varepsilon}_{2t} \qquad (\mathbf{3.5.2})$$

Through a causal analysis of the panel VAR equations, the existence of a causal relationship between the variables and the direction of the causality can be determined. The empirical results will play a significant role in the policy recommendations that are formed (Saidi and Mbarek, 2016; Hussain et al., 2020).

4. RESULTS

The study examined whether the variables had CSD with the help of Breusch-Pagan LM and Pesaran (2004) CD tests. According to the results shown in Table 2, the variables had a CSD at the 1% significance level. Using the Pesaran (2007) CIPS test, which takes into account the CSD, the variables were analyzed for a unit root. In the panel unit root test results shown in Table 3, it was observed that lgas and lgdp variables had unit roots at the level and at other lag lengths, except for the case where the lgas variable did not have a delay (k=0). The variables became stationary when the first difference was taken.

Table 2. Cross Sectional Dependence Analysis Results

Variables	CD test statistic	Breusch-Pagan LM
lgas	15.88*** (0.00)	253.67*** (0.00)
lgdp	17.80*** (0.00)	316.81*** (0.00)

Note: *** denotes significance at 1% significance level. The logarithmic transformation of the variables was done.

The homogeneity test of the coefficients can be done with the null hypothesis that the coefficients are homogeneous, and with the alternate hypothesis that they are heterogeneous. Table 4 shows the test statistics for the Pesaran and Yamagata (2008) approach for MIKTA. According to the analysis results, the null hypothesis that the coefficients are homogeneous could not be rejected. This means that the coefficients are homogeneous and do not change according to the units.

Table 3. Results of Panel Unit Root Test and Homogeneity Tests

Variables	k=1	k=2	k=3
lgas	-1.15 (0.13)	0.64 (0.74)	0.83 (0.80)
lgdp	-0.39 (0.35)	-0.90 (0.19)	-0.51 (0.31)
Δlgas	-6.58*** (0.00)	-3.54*** (0.00)	-2.98*** (0.00)
Δlgdp	-3.00*** (0.00)	-2.18** (0.01)	-1.50* (0.07)
Homogeneity tests	Statistic	p-value	
$\tilde{\Delta}$	1.24	0.22	
$\tilde{\Delta}_{\mathbf{adj}}$	1.30	0.19	

Note: ***,**, * significance at the 1%, 5% and 10% leandls, respectively. Δ denotes the first difference of the series.

In order to examine the long-term relationship between NGC and EG for MIKTA, the results of the cointegration test from Westerlund's (2007) approach, which considers CSD, are shown in Table 4. The Akaike information criterion value was used as the appropriate lag length for this test. The results of the analysis show that the $\boldsymbol{G_\alpha}$ statistic was significant at the 1% significance level, and the $\boldsymbol{P_\alpha}$ statistic was significant at the 5% significance level. Accordingly, it can be said that there is a long-term relationship between NGC and EG for MIKTA countries.

Table 4. Results of Panel Cointegration Tests

Tests	Statistics	Probability
$\boldsymbol{G_\tau}$	-1.704	0.498
$\boldsymbol{G_\alpha}$	-9.375**	0.008
$\boldsymbol{P_\tau}$	-1.539	0.495
$\boldsymbol{P_\alpha}$	-11.492*	0.011

Note: **, * significance at the 1%, 5% leandls, respectively.

The CCEMG estimation results from the study are shown in Table 5. According to the estimation results for the whole panel, the effect of NGC on EG was negative and significant at the 5% significance level. According to the CCEMG estimation results for the units, the Indonesia and Mexico coefficients were significant at the 5% and 10% significance levels, respectively. The effect of NGC on EG was negative for those two countries. The estimation results for these two countries emphasize that NGC harms EG. In addition, these results suggest that Indonesia and Mexico should show a tendency to develop policies based on natural gas. The CCEMG estimation coefficients for NGC on EG for Austria and South Korea were negative but insignificant. According to the Turkey CCEMG estimation results, the effect of NGC on EG was positive but insignificant.

Table 5. Results of CCEMG Estimator

Dependent variable: Gdp		
Country	Coefficient	p-value
Australia	-0.021	0.910
Indonesia	-0.117**	0.018
South Korea	-0.031	0.536
Mexico	-0.134*	0.067
Turkey	0.011	0.793
All panel	-0.059	0.039

Note: **, * significance at the 5%, and 10% leandls, respectively.

The panel causality test was used to determine which hypothesis was valid for MIKTA countries. According to the panel causality test results in Table 6, NGC at the 1% significance level was the cause of EG for MIKTA. In studies conducted during different periods in South Korea, findings supporting the feedback hypothesis were obtained (Oh and Lee, 2004; Lim and Yoo, 2012). Salahuddin and Khan (2013) examined the relationship between EG, EC and carbon dioxide emissions for Australia from 1965 to 2007. According to the Granger causality analysis results, the feedback hypothesis was valid for Australia. Lin and Benjamin (2018) investigated the relationship between EC, foreign direct investment and EG for the period 1990 to 2014 for Mexico, Indonesia, Nigeria and Turkey (MINT). In the panel cointegration and causality analysis results, the findings supported the feedback hypothesis for each MINT country.

Table 6. Results of Panel Causality Test

	Test statistic	Prob.	Decision
gdp - gas	3.23*	0.07	EG is the cause of NGC
gas - gdp	16.60**	0.00	NGC is the cause of EG

Note: **, * significance at the 1%, and 10% leandls, respectively. The lag length is chosen as 1 according to the Bayesian Information criteria.

As can be seen in Table 6, EG was significant at the 10% significance level and the cause of NGC. Lee and Yoo (2016) analyzed the relationship between EC, carbon dioxide emissions and EG for Mexico from 1971 to 2007 with the help of time series methods. According to the findings, there was a causal relationship between EG and EC in Mexico. These findings explain the growth and development of the Mexican economy, as well as the increase in EC in different sectors. Alam et al. (2017) investigated the effect of NGC on EG in fifteen countries from 1990 to 2012. The findings from the panel study, which included Argentina, Indonesia, Mexico and Turkey, supported the short-term feedback hypothesis.

5. CONCLUSION

The relationship between NGC and EG was investigated for MIKTA countries using annual data from 1986 to 2018. Within the scope of this analysis, whether or not the variables had CSD was tested using the Breusch-Pagan LM and Pesaran (2004) CSD approaches. The Pesaran (2007) CIPS test was used for the variables with CSD, which takes this into account. According to the results of the CIPS test, analyzed with different lags, all the variables were stationary when the first difference was taken.

A panel causality test was conducted for the NGC and EG variables. According to the causality test results, there was a two-way causal relationship between NGC and EG for MIKTA. The results of the analysis revealed that the NGC and EG variables affect each other in MIKTA countries. This complementary relationship may indicate energy-saving policies that reduce NGC, which can impact EG. In addition, the negative impact of country EG may also impact NGC. At the same time, the results of the analysis support the feedback hypothesis for MIKTA.

The results of this study aim to contribute to the existing literature. We think the findings obtained in the study are valuable within the scope of the MIKTA countries examined. Future research on this subject examining the impact of the pandemic within the scope of both MIKTA countries and other country groups could be interesting. The research would improve knowledge about the impact of the pandemic on natural gas markets and consumption, as well as the impact on country EG.

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