THE RELATONSHIP BETWEEN FEMALE UNEMPLOYMENT AND ENERGY CONSUMPTION: THE CASE OF OECD COUNTRIES[1]

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Abstract

In this study, the short- and long-term relationships between energy consumption and female unemployment in 29 OECD countries are investigated using panel data for the period 1991-2015. For the empirical analysis, Panel ARDL method and Granger causality tests are used. The results of the analyses reveal that both short- and long-term energy consumptions have significant adverse effects on female unemployment. That is to say; energy consumption has a negative and statistically significant impact on the female unemployment rate. In addition, according to the Granger causality test result, it is found that there is bidirectional causality between energy consumption and female unemployment rate.

Key Words: *Female Unemployment Rate, Energy Consumption, Panel ARDL, OECD*
Jel Classification Codes: *C33, E24, Q43*

KADIN İŞSİZLİĞİ VE ENERJİ TÜKETİMİ ARASINDAKİ İLİŞKİ: OECD ÖRNEĞİ

Öz

Bu çalışmada, 29 OECD ülkesinde enerji tüketimi ile kadın işsizliği arasındaki kısa ve uzun dönemli ilişki, 1991-2015 dönemine ait panel verileri kullanılarak araştırılmaktadır. Ampirik analiz için, Panel ARDL yöntemi ve Granger nedensellik testi kullanılmıştır. Analizler sonucunda, hem kısa dönemde hem de uzun dönemde enerji tüketimi anlamlı bir biçimde kadın işsizliğini negatif yönde etkilediği görülmüştür. Yani enerji tüketimi, kadın işsizlik oranı açısından negatif ve istatistiksel olarak anlamlı bir etkiye sahiptir. Ayrıca, Granger nedensellik testi sonucuna göre enerji tüketimi ile kadın işsizlik oranı arasında çift yönlü (bidirectional) bir nedensellik olduğu saptanmıştır.

Anahtar Kelime: *Kadın İşsizlik Oranı, Enerji Tüketimi, Panel ARDL, OECD*
Jel Sınıflandırma Kodları: *C33, E24, Q43*

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1. Introduction

Today, unemployment is a phenomena with both economical and social dimensions. Unemployment can also be said to have an important factor in reducing the welfare of society of individuals. Unemployment is among the key issues that economy politicians in the world are trying to deal with. Women make up a considerable part of this issue within the segments of societies. Unemployed women may lose their reputation and confidence in the social environment they are in. For this reason the prosperity of women is constributed by the labor market, at most. Myatt and Murrell (1990) emphasized that the most important determinant of the female unemployment rate is the minimum wage level, indicating that women are more sensitive to changes in marginal opportunity cost of unemployment if their commitment to work is lower than men. Female employment was increased with the industrial revolution and as the working conditions improved in time, the female labor force participation rate increased and the female unemployment rate decreased. However, over time, developments in production techniques have led to an increase in unemployment rates, which has also reduced female employment. However, with economic growth, countries have inclined toward service-intensive sectors from industry. With this transition, new jobs and new business opportunities for women workers (in the health, education and tourism sectors) have emerged. Therefore, the reduction in female unemployment rates has occurred.

Table 1 shows the labor force participation rates of female in some OECD countries. Numeral in the table include 3-year averages for the period 2015-2017 and 5-year averages for the other periods. In the United States, Australia, Denmark and Switzerland, the labor force participation rate of women in OECD countries was above 50% for all periods when the labor force participation rates of the women in the OECD countries were assessed. In addition, in some of these countries, the participation rate in the labor force has increased in spite of the decrease in the labor force participation rate of women in some periods.

Table 1: **Labor Force Participation Rates of Female in Some OECD Countries (1990-2017)**

Countries	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2017
United States	56.57	58.42	58.60	58.28	56.70	55.85
Germany	47.25	48.33	49.57	51.77	53.79	54.86
Australia	52.14	53.73	55.41	58.06	58.76	59.16
Belgium	38.54	41.32	42.85	46.19	47.35	47.86
Denmark	60.60	58.85	60.02	60.83	59.02	58.73
France	46.81	48.05	49.00	50.48	50.91	50.65
Netherlands	44.85	49.61	54.80	58.24	58.26	58.06
Spain	34.76	37.86	42.00	48.46	52.26	52.25
Switzerland	56.82	57.24	58.96	60.50	60.94	62.71
Italy	34.45	34.28	36.65	37.97	38.66	39.38
Japan	50.45	50.08	48.76	48.55	48.76	50.31
Turkey	31.63	29.70	26.05	23.78	28.91	32.22

Source: World Development Indicator, World Bank (2017).

In Germany, Belgium, France, Netherlands and Japan, the labor force participation rate of female has remained above 40%. In these countries, except for Japan, the labor force participation rate of female has increased in recent years. In Spain from remaining countries, female labor force participation rate has been above 50% in the last two periods, while in the period 1990-1994 and 1995-1999 it was at the level of 30%. In Italy female labor force participation rate for the entire period there has been a steady increase but remained at 30%. When Turkey is assessed in terms of female labor force participation rate, a bumpy situation occurs. However, in the last two periods, there has been an increase in the labor force participation rate of female. All in all, the increase in the labor force participation rate of female has been occured. This result empirically supports our conclusion.

Table 2: **Female Unemployment Rates in Some OECD Countries (2015)**

Country	Female Unemployment Rate(%)	Country	Female Unemployment Rate(%)
U. States	5.2	Japan	3.1
Germany	4.2	Norway	4
Belgium	7.8	Portugal	12.8
Finland	8.8	Slovenia	10.1
France	9.9	Turkey	12.5
Ireland	7.7	Greece	28.9
Spain	23.6	Italy	12.7
Switzerland	4.6	Mexico	4.5

Source: World Development Indicator, World Bank (2017)

In Table 2, female unemployment rates in some OECD countries 2015 are given. Here, the countries that draw attention to female unemployment rates are Spain and Greece. In Spain, female unemployment rate is 23.6% while Greece is 28.9%. Female unemployment rates in Portugal, Slovenia, Turkey and Italy were above 10%. In other countries, female unemployment rate was relatively low.

The fact that the world's great economic powers try to exercise control over energy-based regions around the world is proof that energy will continue to be a major focus in the near future. Therefore, energy consumption can affect countries' macroeconomic indicators such as unemployment, being in the first place, and also economic growth, foreign trade and budget deficit now and in the future. Hence, it is important for policy-makers to know the causal relationship between these two variables to determine the appropriate policy. Because the increasing energy consumption causes economic growth, this increase may lead to an increase in income and a decrease in unemployment, while decreasing energy consumption can result in low income and high unemployment. In this context, there are many studies of the causal relationship between energy consumption and economic growth. As one of the studies about this relationship, Mbarek et al. (2016) examined the relationship between energy consumption, economic growth and unemployment rates in Tunisia for the period of 1980-2012. In the study, which used nonlinear causality test, it was concluded that there is a unidirectional causality from total energy consumption to unemployment rates. Payne (2009) analyzed the causal relationship between energy consumption and employment in Illinois for the period 1976-2006. As a result of Toda-Yamamoto long-run causality tests, it was concluded that there is a positive and statistically significant unidirectional causality from energy consumption to employment in Illinois.

The relationship between energy consumption and unemployment has recently been addressed by energy economists as an important issue. Because in terms of an economy, energy is both an input and an output. Energy problems do not only affect growth but may also affect the demographic structure and the development of human capital (Bekmez and Ağpak, 2016: 33). Arouri et. al., (2014) theoretically explained the relationship between energy consumption and unemployment through six different types of effect, namely the demographic effect, income effect, price effect, substitution effect, technological effect and structural effect. According to the demographic effect, while the increase in birth rates in the short-run increases the need for energy, the problem of unemployment does not show up, but in the long-run both energy demand and unemployment will increase. According to the income effect, the rapid growth in the economy will increase the energy consumption because it causes employment to increase. According to the price effect, external shocks affecting energy sources have direct and indirect effects on economic growth and employment. According to the substitution effect, restricting the use of any of the energy sources may lead to further use of the labor. Otherwise, the limitation on labor may increase energy use. The technological effect relates to the replacement of old energies with new energies. While new energy sources have reduced unemployment in developed countries, some of the developing countries have adopted these new technologies, while others have had to import these technologies. According to the structural effect, countries on course for development substantially need energy, while trying to maintain their economic growth. These effects suggest that there is a theoretical relationship between unemployment and energy consumption. Apergis and Salim (2015) stated that energy consumption in an economy can affect the unemployment rate, an important leading indicator of current and future economic growth. They have the link between energy consumption and unemployment in two forms, namely employment effect and import effect. According to the first, high investment levels and large capacities have a positive impact on employment directly in the relevant industries. According to the second, it is economized from the imports of fossil fuels replaced by renewable energy sources. Since these effects have a net impact on the whole economy, net employment effects will also be relevant among these. The increase in energy consumption can lead to an increase in female employment by increasing the number of employment opportunities through increasing the production. This situation may affect women's self-esteem positively and create a multiplier effect on production. Moreover, the emergence of new employment opportunities for women through energy consumption does not only contribute to economic growth, but can also lead to social solidarity and social peace. Thus, the employment of women is very important for social balances. In the report, published by the International Labor Organization (ILO) in 2018, it is indicated that some progress has been achieved in terms of women and social gender equality over the past 20 years in the business world. In the report, it is emphasized that women are more educated than ever and they participate more in the labor market. Moreover, it is reported that female labor force participation rates have gradually been approximated to the male labor force participation rate in many developed countries. Therefore, it is important to examine how investments in the energy field affect women's job creation today, as female labor participation rates increase. Hence, in this study, the effect of energy consumption on unemployment is taken into account. The most important reason that motivates to address the issue between energy consumption and female unemployment is the lack of research in the energy and/or economic literature on the relationship between female unemployment and energy consumption. The main focus of this work is to determine the size and direction of the effect of energy consumption, which is the most basic input of production, on female unemployment, which is specifically a part of total unemployment.

2. Literature

As more energy is needed to meet the demand for future economic growth, such a control struggle will also increase. On the other hand, there is increasing pressure to reduce CO_2 emissions on developed economies to reduce global warming and climate change. For this reason, developing and industrialized countries are concerned about the negative effects of economic growth on the limited use of energy (Shahbaz et al., 2016:3). The relationship between energy consumption and economic growth has been extensively studied in the economics literature. In some of these studies, the relationship between renewable energy and economic growth has been reviewed (Amri, 2017; Rafindadi and Öztürk, 2017; Aslan and Öcal, 2016; Shahbaz et al., 2015; Lin and Moubarak, 2014; Apergis and Payne, 2010a; Apergis and Payne, 2010b) when in others the relationship between renewable/ non-renewable energy consumption and economic growth has been reviewed (Kaiha et al., 2016; Apergis and Payne, 2011; Ito, 2017; Inglesi-Lotz, 2016; Aneja et al., 2017).Unlike mentioned studies, this study examines the relationship between energy consumption and unemployment, a social and economic dimension of the economy.

In the theoretical literature, the causal relationship between energy consumption and economic growth is tested according to four hypotheses. These are growth, conservation, feedback and neutrality hypothesis. According to the growth hypothesis, energy consumption plays a vital role either directly in the economic growth process or as a complement to labor and capital. The growth hypothesis is supported by the existence of unidirectional causality from economical growth to energy consumption. In this case, energy conservation policies that reduce energy consumption will adversely affect economic growth. According to the conservation hypothesis, policies to reduce energy consumption or losses will have little or no effect on economic growth. The conservation hypothesis is supported if there is unidirectional causality from economic growth to economic consumption. According to the feedback hypothesis, energy consumption and economic growth are two interrelated and complementary variables. The feedback hypothesis is supported by the existence of bidirectional causality between energy consumption and economic growth. Neutrality hypothesis is based on the assumption that energy consumption has a relatively small role in the economic growth process. This hypothesis is supported by the lack of causality between energy consumption and economic growth. In this case, the reduction in energy consumption through energy conservation policies will not affect economic growth (Apergis and Payne, 2012: 734). Empirical studies have results that will back up one of these four hypotheses.

From these studies Amri (2017) investigated the relationship between economic growth and renewable energy consumption for the period 1990-2012 in developed and developing 72 countries with dynamic panel data approach. In his work, the results confirmed the feedback hypothesis between economic growth and renewable energy consumption. Kahia et al. (2016) analyzed the relationship between economic growth and energy consumption for two separate data sets of 18 MENA Petroleum Exporting Countries (NOECs) for the period 1980-2012 with a panel cointegration approach. They reached a conclusion that, in the short term, there is a unidirectional causality from economic growth to renewable energy consumption, and in the long term there is a bidirectional causality between economic growth and energy consumption for the entire MENA. Rafindadi and Öztürk, (2017) used the ARDL bounds test and the VECM Granger causality test in their research on Germany with trimester data between 1971Q1-2013Q4. As a result, they have come to the conclusion that renewable energy consumption positively affects the economic growth of the country. Cherni and Jouini (2017), 1990-2015 used the ARDL bounds test and the Granger causality test in their study for Tunisia. They found a bidirectional relationship between renewable energy consumption and economic growth. Apergis, and Payne (2012) have concluded that the results of the panel error correction model in the study of 80 countries have led to the bidirectional causation between short and long term renewable and non-renewable energy consumption and economic growth. Sadorsky (2009) stated that increasing economic growth and energy demand in developing countries have increased the use of renewable energy for these countries. Sadorsky (2009) used cointegration, FMOLS, DOLS methods in his work for the period of 1994-2003 in 18 developing countries. He reached a conclusion that, in the long term, the real 1% increase in per capita income has a 3.5% increase in per capita renewable energy consumption in emerging economies. Bhattacharya et al. (2016) used the DOLS and FMOLS methods for the 1991-2012 period in 38 countries. In the long term, they have reached a conclusion that renewable energy consumption has a positive effect on economic growth in selected countries. Inglesi-Lotz (2016) stated that energy consumption is beneficial not only to the environment but also to the economic conditions of the countries. It is concluded that the effect of economic growth on the share of renewable energy consumption or its share in the total energy mix is positive and statistically significant. Lin and Moubarak (2014) investigated the relationship between renewable energy consumption and economic growth in China from 1977 to 2011 with Johansen cointegration and Granger causality test. The results show a long-term bidirectional causality between renewable energy consumption and economic growth. This finding points that the growing economy in China is suitable for the development of the renewable energy sector, which also helps to grow economically. Energy consumption and economic growth in the relationship was analyzed using ARDL bounds test for the years 1981 to 2013 in Turkey by Tatlı (2015). The long-term effect of total energy consumption and employment on economic growth has been significant and positive. Ben Jebli (2015) emphasized that the increase in energy consumption plays a vital role in the output increase. Therefore, the significant increases and decreases in energy consumption will affect growth, as there is likely to be significant interactions between growth and unemployment. Developments in energy consumption will therefore indirectly affect unemployment. Odhiambo (2009) examined the causality between electricity consumption, economic growth and employment in his work on North Africa. As a result, no direct causality relationship between electricity consumption and employment was detected when unidirectional causality from employment to economic growth is achieved.

The relationship between energy consumption and GDP is very important for politicians. Governments and politicians deal with economic growth, on the one hand, and on the other, the environment and the scarcity of resources. If energy consumption does not have a significant impact on GDP, it will be easier for governments to adopt energy-saving or eco-friendly policies. However, if there is a significant relationship between energy consumption and GDP, the implementation of these policies will adversely affect economic growth and may lead to undesirable consequences (Fallahi, 2011: 4165). The use of different types of energy in production function as traditional production factors such as labor and capital and as additional production factors may lead to questioning how all these variables are related. However, while there is no clear explanation as to how capital and labor factors are related to each energy consumption in the economic literature, it has been shown in various empirical studies that renewable energy sources in employment are more labor intensive than traditional sources (Kahia et al., 2016: 105).

In 1973, OPEC cutting crude oil production and laying an embargo on crude oil shipments caused an oil crisis. Oil shortages and the embargo particularly affected the oil-dependent industrialized countries' economics and the whole world, deeply. As a result of the crisis, high unemployment and inflation rates have come to the fore. It could have been possible to get rid of this living crisis through changes in the field of energy once again. Crisis experienced countries diverge to technologies that save energy, develop alternative energy sources and consume energy resources more efficiently. The aim was to reduce the economy's dependence on imported energy (Soytas and Sarı, 2006:739). A possible energy shortage can adversely affect income. Energy use plays a very important role in the industrial economy, as it can affect the level of productivity of other basic production inputs. The debate between energy consumption and economic growth has been widespread since the oil shocks in the 1970s (Shahbaz et al., 2016: 2). Paul and Bhattacharya (2004) emphasized that energy is the key to economic growth, industrialization and urbanization at the same time, indicating that energy is an important input to all production and many consumption activities. On the other hand, they expressed that economic growth, industrialization and urbanization could lead to the use of more energy.

There are countless unemployment theories in the long term. These can be divided into some broad groups based on flow models and stock models. Firstly, unemployment should be in line with the level of demand in the short term and long term. Secondly, in the long term, demand and flexibility generally move towards a level consistent with stable inflation. Thirdly, the level of unemployment balance is affected by any factor that would make it easier for unemployed people to be matched to existing vacancies. Afterwards, the labor market is affected by any factor that tends to rise directly despite the surplus supply of wages (Nickell et al., 2005:3)

Dalton and Lewis (2011) categorized the definition of work or job creation related to wind energy as direct and indirect businesses. Direct businesses are sourced from the wind energy industry; wind energy project developers including employment, installation, operation and maintenance in manufacturing companies and manufacturers of wind turbines, public utilities selling electricity from wind energy, major research and development (R & D) and engineering and specialized wind energy services. Jobs arising from indirect business; intermediate products or components, service providing in any company consist of occasional work activities in wind-related activities.

Apart from addressing the need to help combat climate change and increase electricity generation capacity, the recent uptake of renewable energy technologies has also benefited positively through job creation (Dalton and Lewis, 2011: 2124). Energy policies address directly energy-related factors such as supply security, environmental impacts and costs. Yet another dimension to energy policy is direct employment and export opportunities and energy technologies created by the energy sector. Growing markets for new energy technologies and resources are really creating new employment and export markets (Lund, 2009:5). Moreno and Lopez (2008) focused on the employment prospects created by renewable energy consumption for

Spain in 2006-2010, indicating that the use of renewable energy has the potential to reduce energy dependence, reduce CO_2 emissions and create new jobs. The estimates obtained show that the development of renewable energies has an extraordinary effect on employment. Bilgili et al. (2017) examined the importance of energy politics to reduce youth unemployment rates and therefore, proposed politicians to monitor policies to encourage energy consumption and new potential energy investments to reduce youth unemployment rates. Bilgili et al. (2017) examined the effects of energy consumption on young unemployment in the period of 1990-2011 for 20 European countries. According to the estimation results, energy consumption has a negative effect on young unemployment rates. In addition, causality tests show that energy consumption has unidirectional causality to young unemployment rates.

When the studies in the literature are examined all in all, it is observed that empirical studies on the relationship between energy consumption and unemployment were carried out. There are also studies that specifically address the relationship between youth unemployment and energy consumption in recent years (Bilgili et al., 2017). However, there is not any study that specifically estimates the relationship between female unemployment and energy consumption. Hence, the relationship between female unemployment and energy consumption has been examined. This study is expected to contribute to ongoing energy consumption and unemployment relationship.

3. The Model

3.1. Data of the Study

The data set used in the study consisted of the female unemployment rate (ln*UNEMP*) and the per capita oil equivalent energy consumption (ln*EC*) in kg. The data are annual and cover the period 1991-2015 belonging to 29 OECD countries. The data set countiries are United States, Germany, Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Netherlands, United Kingdom, Ireland, Spain, Israel, Sweden, Switzerland, Italy, Japan, Canada, Luxembourg, Mexico, Hungary, Norway, Poland, Portugal, Slovenia, Turkey, New Zealand, Greece. The data were obtained from the World Bank database. Both variables are used in logarithmic form.

The descriptive statistics and correlation matrix for the variables are given in Table 3. All descriptive statistics except the standard deviation of the ln*UNEMP* variable are lower than the descriptive statistics of the ln*EC* variable. Another point that is particularly noteworthy here is that the standard deviations of the two variables are very close to each other. In this sense, the consistency of the selected variables with each other is important in terms of eliminating the inconveniences caused by the discrepancies between the variables. The correlation matrix also shows that the ln*UNEMP* variable is negatively correlated with the ln*EC* variable.

Table 3: **Descriptive Statistics and Correlation Matrix for ln*UNEMP* ve ln*EC***

Statistics	ln*UNEMP*	ln*EC*
Descriptive statistics		
Mean	1.9879	8.2194
Median	1.9878	8.2323
Maximum	3.4468	9.1515
Minimum	0.6931	6.8540
Std. Dev.	0.4990	0.4530
Observations	725	725
Correlation Matrix	ln*UNEMP*	ln*EC*
ln*UNEMP*		-0.2840
ln*EC*	-0.2840	

As can be seen in Table 3, the growth rate of average unemployment in the 29 OECD countries for the period 1991-2015 was realized as 1.9879. The average rate of increase in energy consumption for these countries in the same period was realized as 8.2194.

3.2. Analysis Method of Study

In terms of results obtained from panel data models, it is important to test the presence of a cross-sectional dependence. If cross-sectional dependence should not be taken into account when selecting unit root and cointegration tests, this will make the results of the analysis inaccurate and inconsistent. At the same time, in order to decide whether to use the first generation tests or the second generation tests when testing the stationary of the panel data, it is necessary to first test the cross-sectional dependence between the units in the variables.

Therefore, the tests used to test the cross-sectional dependency in the panel data analysis are as follows: CD_{LM} test (Pesaran, 2004), CD_{LM1} test (Breusch and Pagan, 1980), CD_{LM2} test (Pesaran, 2004) and CD_{LMAdj} (Pesaran et al., 2008) test. The CD_{LM1} test developed by Breusch and Pagan (1980) is used when the time dimension of the panel data set (T) is greater than the section size (N) (T>N) (De Hoyos and Sarafidis, 2006: 2). Pesaran (2004) CD test can be used when both the time dimension is larger than the cross-section dimension and the size of the cross-section is greater than the time dimension (T> N, N> T). These tests are deviated when the group mean is zero but the individual mean is different from zero. Pesaran et al. (2008) adjusted this deviation by adding variance and averaging to test statistics. For this reason, the name deviation is expressed as adjusted LM test (CD_{LMAdj}) (Altintas and Mercan, 2015: 359).

The null hypothesis of the cross-sectional dependency test is that there is no cross-sectional dependence between units in the variables. The alternative hypothesis is that there is a cross-sectional dependence between the units in the variables.

Once the cross-sectional dependency has been tested, it is decided which generation unit root test will be performed according to the result of the cross-sectional dependency test. When econometric analyzes are performed between non-stationary series, a misleading result called spurious regression is encountered. For this, the stability of the series must be tested. In this study, PANIC (Panel Analysis of Nonstationarity in Idiosyncratic and Common) and CADF-Covariate Augmented Dickey-Fuller (CIPS- Cross-Sectionally Augmented) unit root tests were used to test the stability of the series. The null hypothesis for these tests is stated as the series is non-stationary (unit root exists), whereas the alternative hypothesis is stated as the series stationary (no unit root).

The values calculated for the CADF and CIPS unit root test are compared with the table values calculated by Pesaran (2007). When the calculated CADF statistic is smaller than the table critical value, H_0 is rejected. In other words, it is decided that there is no unit root in this country data and shocks are temporary. When the calculated CIPS value is less than the table critical value, H_0 is rejected. In this case, for all countries forming the panel, it is decided that the data in the relevant data is not unit root and that the shocks are temporary.

Pesaran et al. (1999) stated that in order to derive the asymptotic distributions of PMG estimators, stationary and non-stationary states of independent variables should be distinguished. According to them, although PMG estimators can basically be used in calculations, regardless of whether the same logarithmic independent variables are I(0) or I(1), the asymptotic theories for these two cases are fundamentally different and their derivatives require separate processing.

The main model prediction can be passed on to, once the unit root test is done. In this study, two estimators proposed by Panel ARDL method which are Mean Group (MG) developed by Pesaran and Smith (1995) and Pooled Mean Group (PMG) developed by Pesaran et al., (1999) will be used.

Our linear model to estimate by panel data analysis is presented in equation (1);

$$\ln UNEMP_{it} = \beta_0 + \beta_1 \ln EC_{it} + u_{it} \tag{1}$$

The panel unemployment equation in the ARDL form (p_i, q_i) can be expressed as:

$$\ln UNEMP_{it} = \alpha_i + \sum_{j=1}^{pi} \beta_{ij} \ln UNEMP_{i,t-j} + \sum_{j=0}^{qi} \delta_{ij} \ln EC_{i,t-j} + \varepsilon_{it} \quad (2)$$

For example, if the ARDL model is followed as noted below;

$$Y_t = \alpha_i + \gamma Y_{i,t-1} + \beta_i X_{it} + \varepsilon_{it}$$

i represent countries here (i=1,2,3,….., N).

In addition, the long-term parameter is as $\theta_i = \dfrac{\beta_i}{1-\gamma_i}$.

The MG estimators for the entire panel will be given by the following equations.

$$\hat{\theta} = \frac{1}{N}\sum_{i=1}^{N}\theta_i$$
$$\hat{\alpha} = \frac{1}{N}\sum_{i=1}^{N}\alpha_i \quad (3)$$

The above equations calculate how the model predicts the individual regressions for each country and the coefficients are the weightless averages of the coefficients estimated for individual countries (Rafindadi and Yosuf, 2013:121).

The Mean Group (MG) model measures the long-term parameters by taking the average of the long-term coefficients of each cross-section. This model estimates the regressions for each country separately and then measures the parameters with the weightless averages of the coefficients estimated for individual countries. For this reason, the MG approach ensures that the long- and short-term specificity of the coefficients is heterogeneous.

According to the methodology of Pesaran et al. (1999), the PMG model that includes the long-term relationship between the variables is as follows:

$$\Delta \ln UNEMP_{it} = \alpha_i + \varphi_i \ln UNEMP_{i,t-1} + \sum_{j=1}^{m-1} \beta_{1ij} \Delta \ln UNEMP_{i,t-j} + \sum_{l=0}^{n-1} \beta_{2il} \Delta \ln EC_{i,t-l}$$
$$+ \delta_1 \ln UNEMP_{i,t-1} + \delta_2 \ln EC_{i,t-1} + \varepsilon_{it} \quad (4)$$

Here, the term φ_i refers to the error term coefficient. β_1 ve β_2 expresses short term coefficients when δ_1 ve δ_2 expresses long term coefficients.

The Pooled Mean Group (PMG) model provides the Autoregressive Distributed Lag (ARDL) version with the cointegration test of the error correction model. In this approach, the short-term coefficients provide heterogeneous adaptation to the equilibrium in the long-term and provide long-term homogeneous coefficients between countries. However, the estimated parameter of the long-term error correction term should be negative and statistically significant (Ahmed et al., 2016:204). The PMG model is used instead of the Three Stage Least Squares (3SLS) and the General Method of Moments (GMM) because the PMG is an interim estimator involving pooling and averaging. It also has advantages over Ordinary Least Squares (OLS) and especially Dynamic Ordinary Least Squares (DOLS), as it allows differences in the countries in terms of short-term dynamics. If the variables are cointegrated, the PMG can be used for the Granger causality test, like other estimators (Bildirici and Kayıkçı, 2013:159).

The negative and statistically significant significance of *ECT* indicates that there is a cointegration relationship between variables. Since the variables are cointegrated, the PMG model can be used for the Granger causality test. Therefore, the causality analysis developed by Granger (1969) was used to determine direction of the present relationship. The Vector Error Correction model, which is used to analyze the short-term relationship between variables, is set as follows:

$$\Delta \ln UNEMP_{it} = \beta_0 + \sum_{i=1}^{m} \alpha_{ik} \Delta \ln UNEMP_{j,t-1} + \sum_{i=1}^{n} \phi_{ik} \Delta \ln EC_{j,t-1} + \varphi_1 ECT_{t-1} + \varepsilon_{1t} \quad (5)$$

$$\Delta \ln EC_{it} = \beta_0 + \sum_{i=1}^{m} \theta_{ik} \Delta \ln EC_{j,t-1} + \sum_{i=1}^{n} \vartheta_{ik} \Delta \ln UNEMP_{j,t-1} + \varphi_2 ECT_{t-1} + \varepsilon_{2t} \quad (6)$$

Here, *ECT* is the term error correction resulting from long term equilibrium relation. φ is a parameter that indicates the rate of harmonization to a shock equilibrium level. It shows how quickly the variables adapt to variability and have a statistically significant coefficient with negative sign. Error correction model is estimated by the estimators MG and PMG which were developed by Pesaran et al. (1999). While MG allows short- and long-term heterogeneity, PMG only allows short-term heterogeneity (Bildirici ve Kayıkçı, 2013: 159).

4. Empirical Findings

In the study, variables were first subjected to unit root test. Then the PMG and MG models suggested by the Panel ARDL method were estimated and the short- and long-term coefficients of the variables are reached. Applied Hausman (1978) test result obtained that the effective estimator is the PMG. Finally, the application part of the study was concluded with the Granger causality test.

4.1. Cross-Section Dependency Test

When testing the stability of the series and when deciding which generation unit root tests to select, the cross-sectional dependency needs to be tested. The results of this test have been tested by using the CD_{LMAdj} test to determine whether there is a cross-sectional dependence of the variables in the direction of this match.

Table 4: **Cross-Section Dependency Test Result**

Variables	CD_{LM1}		CD_{LM2}		CD_{LM}		CD_{LMAdj}	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
ln*UNEMP*	2025.84	2094.384	56.845	59.251	-0.919	-0.911	34.108	32.934
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0.179)	(0,181)	(0.000)*	(0.000)*
ln*EC*	2781.8	2812.579	83.374	84.454	-2.531	-2.353	53.532	61.293
	(0.000)*	(0.000)*	(0.000)*	(0.000)*	(0,006)*	(0,009)*	(0.000)*	(0.000)*

Note : *, illustrates 1% statistical significance. CD_{LM1} (Breusch ve Pagan, 1980), CD_{LM2} (Pesaran, 2004), CD_{LM} (Pesaran, 2004), CD_{LM-Adj} (Peseran vd. 2008)

As seen in Table 4, since the probability values of the variables were less than 0.01, the null hypothesis of this test was strongly rejected and it was decided that there is a cross-section dependency. Therefore, it is concluded that there is a cross-sectional dependency between the panel forming countries. A shock to unemployment and energy consumption in one of the countries due to the presence of cross-sectional dependence also affects other countries. Therefore, the second generation unit root tests will be used when performing unit root tests.

4.2. Unit Root Tests

As a result of the cross-sectional dependency test, there is no cross-sectional dependence and the null hypothesis is rejected. In other words, it is concluded that there is a cross-sectional dependence between the series. Therefore, since the cross-sectional dependence of the panel was determined in this study, the stability of the series was tested with the second-generation unit root tests PANIC and CADF (CIPS) tests and the results of this test are shown in Table 5.

Table 5: **PANIC Unit Root Test Result**

Variables	PANIC			
	Constant		Constant and Trend	
	Choi	MW	Choi	MW
ln*UNEMP*	10.2809	168.729	9.719	162.677
	(0.000)*	(0.000)*	(0.000)*	(0.000)*
ln*EC*	8.7475	152.213	7.2347	135.92
	(0.000)*	(0.000)*	(0.000)*	(0.000)*

Note: Expressions in parentheses indicate probability values (p-value). *,Illustrates 1% statistical significance.

According to the PANIC unit root test result given in Table 5, the variables do not contain both constant and constant and trend unit roots in the level, ie the variables are stable at the level.

Table 6: **CADF (CIPS) Unit Root Test Result**

Variables	Constant	Constant and Trend
ln*UNEMP*	-3.52*	-3.79*
ln*EC*	-3.573*	-3.609*
Critical Values		
1%	-2.30	-2.81
5%	-2.15	-2.66
10%	-2.07	-2.58

Note: *, illustrate 1% statistical significance.

Table 6 shows the results of the CADF (CIPS) unit root test. The null hypothesis was rejected because the calculated value was less than the table critical value. In other words, the series is stationary and stable at the level. Therefore, for all countries forming the panel, it is decided that the data is not unit root and the shocks are temporary. Also, CADF (CIPS) unit root test results calculated for countries are given in Appendix I. We can observe that all of the variables seem to be stationary especially for the constant and constant and trend case.

4.3. PMG and MG Estimation Results

Estimation results of MG and PMG models obtained by estimating the following equation (1) are given in Table 7 and Table 8.

Table 7: **Pooled Mean Group (PMG) Results**

Long Run Result	Coefficient	Z-Statistic	Prob.
ln*EC*	-3.3379 (0.2865)	-11.65	0.000*
Short Run Result	Coefficient	Z-Statistic	Prob.
ECT	-0.1701 (0.0283)	-6.00	0.000*
*Δ*ln*EC*	-0.3172 (0.2162)	-1.47	0.142
CONSTANT	5.0546 (0.8483)	5.96	0.000*

Note: *, Illustrate 1% statistical significance. Expressions in parentheses indicate standard deviation.

Table 8: **Mean Group (MG) Results**

Long Run Result	Coefficient	Z-Statistic	Prob.
ln*EC*	0.5969 (3.0132)	0.843	-5.308
Short Run Result	Coefficient	Z-Statistic	Prob.
ECT	-0.2391 (0.0295)	-8.09	0.000*
*Δ*ln*EC*	-0.5237 (0.2265)	-2.31	0.021*
CONSTANT	2.5401 (1.6064	0.114	-0.608

Note: *, Illustrates 1% statistical significance. Expressions in parentheses indicate standard deviation.

If the probability value of Hausman test statistic is greater than 0.05, PMG is decided to be the effective estimator. If the probability value is less than 0.05, MG is decided to be the effective estimator. Hausman test result concluded that the effective estimator is PMG. The result of the Hausman test is shown in Table 9.

Thus, PMG estimation results will be interpreted on the assessment. As a result of PMG model estimation, the coefficient of energy consumption is negative. In other words, energy consumption affects female unemployment rates in a negative way. When analyzed in terms of coefficient, 1% increase in energy consumption reduces female unemployment rate by 3.3%. In addition, while there is not a statistically significant relationship between energy consumption and female unemployment rates in the short term, there is a negative and statistically significant relationship between these two variables in the long term.

Table 9: **Hausman Test Statistic**

Prob > chi2= 0.1531

Note: H_0= The variables are homogenous in the long run. Since the null hypothesis can not be rejected, the effective estimator is PMG estimator.

In Table 7, the error correction term (*ECT*), which expresses the long term relation between the variables, is negative and statistically significant in accordance with the theory. Error correction term (*ECT*) specifies the correction rate and shows how fast the variables return to the long term equilibrium. Thus, the coefficient (-0.1701) of the ECT term indicates that, about 17% of a variant in the period t_{-1} will be corrected in the t period. In other words, if there is a long-term equilibrium deviations in the short term, the system will reach equilibrium in about 5 years (1 / 0.17 = 5).

4.4. Granger Causality Test

The fact that *ECT* is negative and statistically significant indicates that there is a long-term relationship between energy consumption and female unemployment rates. The causality test developed by Granger (1969) was applied to these variables to determine the direction of long-term relationship. The results of the Granger causality test are given in Table 10.

Table 10: **Granger Causality Test Result**

Variables	ln*UNEMP*	ln*EC*
ln*UNEMP*		3.4527(0.0322)**
ln*EC*	3.1969(0.0415)**	

Note:**, Illustrates 5% statistical significance. Expressions in parentheses indicate probability values (p-value).

As seen in the table, there is a causal relationship from energy consumption to female unemployment rates as well as from female unemployment rates to energy consumption. In other words, there is a bidirectional causality between female unemployment rates and energy consumption.

5. Conclusion

Energy, an important input to economic development, also plays a key role in ensuring output growth. As real GDP decreases in an economy, the amount of goods and services produced increases and therefore unemployment increases. On the other hand, as real GDP increases, the amount of goods and services produced and, consequently, unemployment decreases. There is therefore an important interaction between economic growth and unemployment. Ben Jebli et al.(2015), emphasized that the increase and decrease in energy consumption will affect growth. They also stated that developments in energy consumption will indirectly affect unemployment. In addition, Bilgili et al. (2017) noted that more energy consumption leads to a decline in youth unemployment rates. Encouragement policies that promote energy consumption and energy sectors with new investments have emphasized that young people can reduce unemployment by creating new jobs in many sectors and energy policies should be considered as an important employment policy. As a result, the effectiveness of energy politics have importance for employment. The increase in energy consumption in terms of our study has led to a decrease in female unemployment rates.

In this study, short- and long-term relationships between energy consumption and female unemployment in 29 OECD countries were examined using panel data for the period 1991-2015. For the empirical analysis, Panel ARDL method and Granger causality test were used. As a result of the analyzes, long-term energy consumption significantly affected female unemployment in the negative direction. In other words, energy consumption has a negative and statistically significant effect on the female unemployment rate. In addition, according to the Granger causality test result, it was found out that there is a bidirectional causality between energy consumption and female unemployment rate.

High unemployment is one of the most important social and economic problems that hinder the benefits provided to women. The empirical results of the study demonstrate that the increase in energy consumption reduces female unemployment in OECD countries. These results suggest that women's unemployment may be reduced as these economies have the effect of job creation through energy use. Therefore, women can take a more active role in production through investments in the energy sector. In addition, if policymakers want to ensure social solidarity, social peace and gender equality in society, women should produce incentives and policies to help them gain economic freedom. One of the ways to achieve this is that women's unemployment can be reduced through new business areas that will be created by increasing investments in the energy sector.

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APPENDİX I: **CADF and CIPS Test Results for Countries**

	lnUNEMP		*lnEC*	
Country	**CADF Statistic**		**CADF Statistic**	
	Constant	Constant and Trend	Constant	Constant and Trend
United States	-5.74	-5.569	-3.53	-3.938
Germany	-5.58	-5.444	-4.028	-4.292
Australia	-5.43	-5.478	-4.176	-4.292
Austria	-4.03	-4.000	-3.876	-4.121
Belgium	-3.80	-3.693	-3.636	-3.570
Czech Republic	-3.34	-3.250	-3.392	-3.342
Denmark	-3.24	-3.285	-3.282	-3.238
Finland	-3.18	-3.221	-2.292	-3.188
France	-3.16	-3.404	-2.758	-3.181
Netherlands	-2.55	-3.338	-2.910	-3.151
United Kingdom	-3.06	-3.295	-2.727	-3.014
Ireland	-3.82	-3.903	-3.380	-3.268
Spain	-4.46	-4.346	-3.070	-3.013
Israel	-3.65	-3.531	-2.932	-3.075
Sweden	-2.27	-2.240	-2.666	-2.753
Switzerland	-2.61	-2.596	-4.222	-4.314
Italy	-2.37	-2.743	-4.352	-4.275
Japan	-2.82	-3.205	-5.242	-5.097
Canada	-3.70	-4.456	-5.609	-5.437
Luxembourg	-2.67	-3.586	-4.728	-4.469
Mexico	-3.65	-4.637	-4.143	-3.865
Hungary	-3.19	-4.724	-4.954	-4.767
Norway	-4.02	-4.836	-4.365	-4.106
Poland	-4.93	-4.782	-4.270	-4.062
Portugal	-3.41	-3.812	-2.539	-2.406
Slovenia	-2.41	-3.102	-2.446	-2.276
Turkey	-2.14	-2.605	-2.582	-2.425
New Zealand	-2.82	-2.862	-2.652	-2.507
Greece	-4.06	-3.954	-2.868	-3.231
CIPS Statistic	-3.52	-3.79	-3.573	-3.609