Edited By: Okyay UCAN

# DISCUSSIONS BETWEEN ECONOMIC AGENTS: Panel Data Analysis


Asuda YUNUSOVA
Aysegul DAVAL
Didem BALKAYA
Ecem TURGUT
Emine Dilara AKTEKIN
Gamzenur COSKUN
Hilal BUDAK
Nursaç DEGERLI
Kübra UZBOYALI
Rukiye AYKOC
Zerife YILDIRIM



İKSAD
Publishing House

# DISCUSSIONS BETWEEN ECONOMIC AGENTS:

# Panel Data Analysis

**Edited By**

Prof. Dr. Okyay UCAN

**Authors**

Asuda YUNUSOVA

Ayşegül DAVAL

Didem BALKAYA

Ecem TURGUT

Emine Dilara AKTEKİN

Gamzenur COŞKUN

Hilal BUDAK

Nursaç DEĞERLİ

Kübra UZBOYALI

Rukiye AYKOÇ

Zerife YILDIRIM

İKSAD Publishing House

Copyright © 2021 by iksad publishing house
All rights reserved. No part of this publication may be reproduced, distributed or transmitted in any form or by
any means, including photocopying, recording or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other non-commercial uses permitted by copyright law. Institution of Economic Development and Social Researches Publications®
(The Licence Number of Publicator: 2014/31220)
TURKEY TR: +90 342 606 06 75
USA: +1 631 685 0 853
E mail: iksadyayinevi@gmail.com
www.iksadyayinevi.com

It is responsibility of the author to abide by the publishing ethics rules.
Iksad Publications – 2021©

**ISBN: 978-625-7562-38-6**

Cover Design: İbrahim KAYA
August / 2021
Ankara / Turkey
Size = 16x24 cm

## CONTENTS

# PREFACE

The new subject of the series of "Discussion Between Economic Agents" is Panel Data Analysis. All the works are the accumulation of the lessons learned by graduate and doctoral students. The fact that all the article authors are women shows the importance they attach to the literature. I congratulate them for their dedication and seriousness. Panel Data consists of a combination of time series and cross section series and allows analysis of more than one country, firm or individual. In this context, articles mentioned below are discussed together. There are nine valuable works in the book.

In the first chapter of the book, Ecem TURGUT prepared an analysis with Mean Group Estimator Auto Regressive Distributed Lag Model in the study named "Unemployment and Factors Affecting Unemployment in Developing Countries". In this study is aimed to investigate the factors affecting unemployment considering that unemployment has become an important problem for world economies.

In the second chapter Asuda YUNUSOVA in her work called "Bitcoin: Is it an Alternative for The Gold as an Investment Tool? Evidence from BRICS Countries and Turkey", aimed to learn whether bitcoin behaves itself as an investment tool compared to gold in BRICS and Turkish stock market. She used Dumitrescu and Hurlin Panel Causality Test to compare the variables.

In the third part of the book, Didem BALKAYA, author of the study called" The Relationship Between $CO^2$ Emissions, Renewable Energy Consumption and Economic Growth: Panel Data Analysis", analyzed real GDP, renewable energy consumption and carbon emission which were obtained from Worldbank using annually data in the period of 1990 and 2015. Author used Granger Causality Test to give the relationship between the variables. In the study, , $CO^2$ emissions are directly proportional to economic growth due to the high consumption of fossil fuels to ensure the continuity of production, i.e. economic growth.

In the forth chapter of the book, Nursaç DEĞERLİ conducted the study named "Testing the Twin Deficits Hypothesis in G7 Countries: Panel Data Analysis (2001-2020)", in which she has analyzed the validity of the twin deficit hypothesis in G7 countries. Panel LS method was used to reach the aim set out in the study. Finally, she reached that there is a bidirectional causality relationship between budget deficit and current account deficit for G-7 countries.

In the fifth chapter, Gamzenur COŞKUN conducted a panel data analysis using 1990-2019 period in the study named "The Relationship Between Economic Growth and Income Distribution Injustice: OECD Countries". The main objective of this study is to analyze the existence of the relationship between the economic growth rates of OECD countries and the injustice of income distribution and to determine the direction, if any. Author used causality test to get the result. According to the findings of the Dumitrescu-Hurlin (2012) causality test it was

observed that there was a causality relationship between some of the variables.

In the sixth chapter of the book, Rukiye AYKOÇ prepared a medical performance analysis in the study named "Impact of Health and Education Expenditures on Economic Growth: Panel Data Analysis on G8 Countries". In this study, the aim is to examine the relationship between health and education expenditures and economic growth in human capital in G8 countries using the data between 2000 and 2018. As a result, she concluded that health, education and economic growth are integral parts of one, and that the change in one variable significantly affects the other variable.

In the seventh chapter, Emine Dilara AKTEKİN and Hilal BUDAK in their work called "The Validity of The Environmental Kuznets Curve Hypothesis in G7 Countries: A Panel Data Analysis", the annual data set for the period 1990-2018 was used, the per capita Gross Domestic Product , the square of the Gross Domestic Product per capita and Carbon Dioxide Emission values per capita were arranged in accordance with the panel data set. In the created model; Carbon Dioxide Emission per capita was used as the dependent variable. In line with the results obtained from E7 countries, it is seen that the turning point in the EKC hypothesis could not be achieved and economic growth increased environmental pollution. It has been determined that E7 countries do not take environmental problems into account in order to generate high income. Accordingly, it is seen that the E7 countries

could not achieve a growth in harmony with the environment and harm the environmental quality.

In the eighth part of the book, Kübra UZBOYALI, the author of the study called “Effect of R&D Activities on Economic Growth for G20 Selected Countries: Panel Data Analysis” ensured that R&D activities for 8 selected G-20 countries analyze its effect on growth. The effects of R&D expenditures, R&D employees (researchers) and state employees on economic growth for 8 selected G-20 countries were analyzed for the period between 2000-2017. Author, finally concluded that bidirectional causality was determined from the number of researchers and government researchers to economic growth, and from economic growth to the number of researchers and government researchers.

“The Relationship Between Energy Consumption and Economic Growth in BRICS Countries and Turkey: Panel Cointegration Analysis” is the last chapter of the book. The authors, Ayşegül DAVAL and Zerife YILDIRIM, investigated the relationship between energy consumption and economic growth. The study consists of Panel Data Analysis that determines a cointegration i.e long run relationship. According to the panel DOLSMG test result, the t-statistic of the long-term parameter estimation in the 1rd, 2rd, 3rd, 5rd and 6th countries for LOGELKTK among the LOGGDP, LOGELKTK and LOGINF variables on the basis of units in the output is significant. For LOGINF, the t-statistic of long-term parameter estimation is significant in countries 2rd, 5rd ve 6rd.

I would like to express my sincere gratitude to all the authors for their high-quality contributions. All errors and references use are the responsibility of the authors. In addition, I would like to thank the IKSAD publishing house and members for their support during the publishing process of this book.

Prof. Dr. Okyay UCAN

# CHAPTER 1

# UNEMPLOYMENT AND FACTORS AFFECTING UNEMPLOYMENT IN DEVELOPING COUNTRIES

Ecem TURGUT[1]

[1] PhD Student, Nigde Omer Halisdemir University, Department of Economics, ecemtrgtt@gmail.com, https://orcid.org/0000-0003-2385-1580

## INTRODUCTION

Unemployment is a problem created by those who seek a job by willing to work at the current wage level and make an effort in this way but cannot find a job. Unemployment has manifested itself in many countries with the industrial revolution and has become an important problem especially in developing countries until the 1980s. Since then, the problem of unemployment has started to be encountered in developed countries. Unemployment is one of the most important macroeconomic problems that all the countries of the world want to solve and have been the subject of constant debate. Because unemployment has social effects as well as economic effects. In this regard, countries have made efforts to understand which variables increasing unemployment and have tried to develop solution policies for unemployment. Therefore, factors affecting unemployment in the economics literature have become the subject of constant investigation.

In this study is aimed to investigate the factors affecting unemployment considering that unemployment has become an important problem for world economies. In this direction, it has benefited from the data of 13 developing countries in order to obtain the most comprehensive result. In addition, the factors that can affect unemployment are inflation, growth, population, fertility rate, technological development, industrialization, saving and foreign direct investment, and the effects of these variables on unemployment have been analyzed. Thus, the most accurate result is achieved by analyzing the data of a wide range of countries. Within the scope of the analysis, firstly the cross section

dependency of the variables is examined. Subsequently, the Peseran and Yamagata (2008) homogeneity test is applied and Im, Pesaran and Shin (IPS) unit root test is performed to the variables. Finally, the Mean Group Estimator Autoregressive Distributed Lag Model (MG ARDL) test is applied and the analysis is finalized.

## 1. DEFINITION AND THEORY OF UNEMPLOYMENT

Although unemployment has manifested itself in different dimensions socially and economically in every country throughout history, it has maintained its place among the most serious problems of countries. The unemployment problem has emerged at different levels in many countries with the industrial revolution and has manifested itself especially in developing countries until the 1980s. Since this date, with the adoption of the neo-liberal approach in many countries, the problem of unemployment has started to be encountered in developed countries. Unemployment has been an important problem with its social and personal dimensions, which continuously increase its impact and have a negative impact on the economic system, despite the social and economic policy measures taken during the 20th century (Akyurt, 2020: 78).

Unemployed are those who look for a job and want to work at the current wage level but cannot find a job, the existence of the population who cannot find a job despite the strength and willingness to work is called unemployment. The point that should not be overlooked here is that the person who will be deemed unemployed should have the desire to work and should be in an effort to seek a job (Sungur, 2019: 3-4).

According to the International Labour Organization (ILO), the unemployed are those who are suitable for work, are included in the active workforce and constantly looking for work. Unemployment in accordance with international standards; not having a job, being ready to work and actively searching for a job. Unemployment according to the European Union; Those who are registered in the offices that employ labor force and institutions that support workers, are always ready to work and still cannot find a job. (Ünal, 2019: 40).

According to Turkey Statistical Institute, the unemployed; Individuals aged 15 and over who have used at least one of the job search channels in the last 4 weeks to search a job in the reference period and are able to start work within 2 weeks. In addition, those who have found a job that they can start within 3 months or have established their own business but wait to complete their various deficiencies in order to start work in the unemployed population (Öztürk, 2020: 30).

Unemployment has been the subject of controversy and examination throughout economic history. Until the great depression of 1929, when neo-classical economics dominated, unemployment was seen as a purely voluntary problem. The neo-classical theory is a full employment analysis and the unemployment problem is simply a voluntary unemployment. Under the assumption of perfect competition, labor supply and labor demand face off in the labor market, forming an equilibrium wage level. In this equilibrium situation, there is no unemployment, since labor supply will be equal to labor demand. The only reason for unemployment is to prevent real wages from falling. As

long as these obstacles do not exist, there will be forces in the economy that can eliminate temporary unemployment and keep the economy at full employment level. Consequently, neo-classical employment theory is a full employment theory (Ceylan Ataman, 1998: 61).

After the 1929 great depression, the number of unemployed has doubled and the traditional school's view that the labor market will be balanced without interfering with the price system and the idea that each supply will create its own demand has been fundamentally shaken in the world. Keynes presented a different perspective to the problem of unemployment in his "General Theory of Employment, Interest and Money" in 1936. Keynes rejected the view that every supply creates its own demand, arguing that demand must exist before supply exist, so he did not accept the Say's law in Classical School. He approached with a different thought that voluntary unemployment claim put forward by the classical school and drew attention to the existence of involuntary unemployment. Because according to him workers will continue to labor supply at low current wage level. According to Keynes, the main factor determining the general level of prices, income level and employment level is aggregate demand. According to him, when there is a decrease in the level of total demand in an economy, there will be an excess of labor supply in the labor market, which will operate at a lower output level than the natural product level, and thus unemployment will occur. According to Keynes, reduce nominal wages will not eliminate unemployment in such a situation. At this point, what needs to be done is to increase the total demand with expansionary fiscal policy or monetary policies (Yıldırım, 2020: 7-8).

Keynes's approach to intervention in economic life and reducing unemployment in this way continued to be effective until the end of the 1960s. However, the continuous state intervention has led to budget deficits by increasing public expenditures. Problems in the economy have become more apparent with the increase in inflation rates. The Monetarist School of Economics emerged after the Keynesian approach could not be a solution to these problems. The coexistence of inflation and unemployment phenomena in the 1970s could not be explained with current economic theories, but this phenomenon is named as stagflation in the following process. Policies increasing demand implemented to solve this problem remained unfavorable. Because fiscal policies applied to reduce inflation caused unemployment, and monetary policies applied to reduce unemployment caused inflation. Developments in the 1970s played an active role in the acceptance of the Monetarist understanding and the concept of natural unemployment. The monetarist view and rate of natural unemployment have led to significant changes in economic theory. With this understanding, the main goal of economic policies has changed, abandoning the goal of full employment because it is inflationary, and price stability has become the main target. According to this view, trying to differentiate the unemployment rate by applying a fiscal policy only causes the general level of prices to increase (Koç, 2020: 12-13).

Unemployment is the relationship between the population and the economic system in Marxist theory. Marx dealt with the problem of unemployment in the internal contradictions of capitalism and in a dynamic analysis process; He stated that unemployment is the

relationship between the population and the economic system. In the Marxist analysis, there are two types of unemployment related to each other. The first of these is technological unemployment, which is stated as a result of the capitalist production process giving birth to a reserve army of unemployed. The second of these is unemployment resulting from the decrease in profit that causes accumulation and accumulation with reserve army of the unemployed. In other words, accumulation and technological development will enable the emergence of new technologies and means of production with the surplus it produces. Marx said that the population exists in all possible forms; He acknowledged that if cyclical fluctuations are not taken into account, unemployment always exists in three forms: fluid, hidden and stagnant. “Fluent unemployed” workers who are temporarily unemployed; “Hidden unemployed” are meant the hidden unemployed of the rural areas that will meet the demand of new workers needed by the city, and “stagnant unemployed” workers who work in a job like those in the home industry and small workshops are meant to be extremely disorderly (Solak, 2012: 35-37).

The New Classical Macroeconomics is a school of economic thought that emerged in the early 1970s in the work of Robert Lucas, Thomas Sargent, Neil Wallace, and Edward Prescott. This school rejected Keynesian economics and led to the revival of classical economics. According to Keynes's opinion, private investments are decreasing as a result of the high decrease in general demand. As a result of this, firms operate under capacity and economic recessions occur. Firms that produce less, require fewer workers and thus unemployment increases.

With wages not being reduced to the level acceptable to job seekers, involuntary unemployment is increasing. The New Classics accepted this step of the Keynesians as irrational. According to the New Classics, involuntary unemployment offers the opportunity to increase the profits of firms by paying a lower wage to workers. The New Classics adopting the rational expectation hypothesis, accept any deviation in the rate of natural unemployment as accidental. They think that such deviations take place in the form of errors in price level estimation and unexpected changes in monetary authorities' policies. From this point of view, they argue that the Phillips curve represents a trade-off between unemployment and inflation not only in the long run but also in the short run. This determination is based on the proposition of the New Classics that macroeconomic policies are completely ineffective in reducing unemployment (Güney, 2019: 19-20).

The New Keynesian school of economics differs from the Keynesian school in terms of the need for full state intervention in the functioning of the economy. Although the new Keynesian view does not completely ignore state intervention, it adopts the view that intervention should be intervened only when and at the rate of need. The New Keynesian view of the unemployment phenomenon is in line with the wage stickiness, which is the biggest obstacle in front of the labor market. In this context, the New Keynesian school of economics tries to answer this problem by explaining wage stickiness around three basic theories: the inside-outs model, the wage efficiency model and the implicit contracts model (Koç, 2020: 14).

According to the insider-outs model, The cost is extremely high situation that hiring a worker who is looking for work outside by removing the worker working inside. Because on one side there is a cost of layoffs, on the other side, they have work experience with jobs that are running, this is a factor that increases productivity and therefore production. In this regard, companies prefer to negotiate a wage with those who are working, this is a causes the wages to be increased even more. Since firms do not want to bear this risk, the labor market is being cleared (Ceylan Ataman, 1998: 69).

Firms do not reduce wages even in the event of permanent unemployment in the wage efficiency model. Because there is a directly proportional link between wages and labor productivity and workers commitment to work. In other words, if there is a decrease in wages, the productivity of labor will decrease in rate of commitment to work. In the implicit contracts model, the assumption that there is asymmetric information in terms of workers and employers in the labor market is emphasized. According to this model, workers have less information about the workplace's issues such as productivity and profitability, while the employer group has less information about the non-labor income of workers. Therefore, this model explains the wage rigidities to be created by the existence of these two groups with different risk sensitivity (Koç, 2020: 14-15).

Throughout history, working has been an indispensable value of human life and has been constantly discussed in this way. While working brought the concept of work to the agenda, the concept of

unemployment also brought reveal. Although there is unemployment in every period, the reasons of unemployment differed according to the periods. In today's conditions, these reasons are; globalization accelerating with the development of mass media, different economic structures of countries, rapidly developing technology, acceleration of population growth, insufficient education and migration, ineffective labor market and lack of desire to work as individually, the structure of society, customs and traditions of society, reasons such as high labor costs and more are seen as the main causes of unemployment. The reasons for unemployment differ by country. While unemployment in developed countries is mostly caused by developing technology and economic factors, unemployment in developing countries is due to the inability to achieve the necessary industrial transformations and the inability to reach the developing world standards as a result of staying too far from today's information age (Yıldırım, 2020: 11).

## 2. LITERATURE

The fact that unemployment is among the most important economics problems for the world countries has led to constant discussion and analysis of unemployment. Preventing unemployment has gained an important dimension, especially by examining the factors affecting unemployment. Analyzing the relationship between unemployment and factors determining unemployment has attracted much attention in the literature. Studies on this subject are analyzed using panel data analysis in a multi-country sample as in Salama and Judit (2019), Güriş and Yaman (2018) and Gur (2015), as well as are analyzed using time series

analysis in a single country sample as in Ayhan (2019), Gaber (2018), Dalmar, Ali and Ali (2017) and Xuen (2017) et al. In this part of the study, studies conducted in the literature to analyze the relationship between unemployment and factors determining unemployment are included. The summary of these studies is shown in Table 1.

**Table 1:** Studies Examining the Relationship Between Unemployment and Factors Determining Unemployment

| Authors | Period | Country | Explanation |
|---|---|---|---|
| Ayhan (2019) | 2005:01-2018:11 | Turkey | It has been found that industrial production affects negatively and the consumer price index and interest rate affects positively the number of unemployed. |
| Salama and Judit (2019) | 2000-2016 | 9 Arab Countries | It has been determined that economic freedom has negative relationships with total unemployment and unemployment for women and men. In addition, it is observed that the impact of the 2008 financial crisis don't have a significant impact on total unemployment. |
| Abugamea (2018) | 1994-2017 | Palestine | While gross domestic product affects unemployment negatively; It has been observed that inflation, labor and restrictions on the labor force have a significant and positive effect on unemployment. It is also observed in the study that foreign trade does not significantly affect unemployment. |

| | | | |
|---|---|---|---|
| Güriş and Yaman (2018) | 2000-2015 | 23 OECD Countries | It is observed that the variable that has the most decreasing effect on unemployment is the investment rate, as well as economic growth, inflation, budget deficit and current account balance have a decreasing effect on unemployment. |
| Ümit and Karataş (2018) | 2000:Q1-2013:Q4 | Turkey | Inflation, growth, foreign direct investment, real effective exchange rate and unemployment rate variables are used to analyze the relationship between unemployment and macroeconomic variables that are thought to decrease/increase unemployment. Only one-way causality relationship from growth to unemployment rate has been determined. |
| Dalmar, Ali and Ali (2017) | 1995-2014 | Somalia | While a positive relationship is found between population growth, foreign debt and gross domestic product with unemployment; A negative relationship is found with gross capital formation and exchange rate. |

| | | | |
|---|---|---|---|
| Tarı and Bakkal (2017) | 1980-2012 | Turkey | According to the results obtained from the analysis, the most important reason for the increasing unemployment in Turkey is economic crisis. Respectively, minimum wages, unionization rate and productivity rate are other factors that contribute to the increase in unemployment. Unemployment reduction effect is not found for the population and gross domestic product. |
| Xuen et al. (2017) | 1982-2014 | China | While gross domestic product growth and population are important for the unemployment rate; inflation and foreign direct investment show an insignificant relationship with the unemployment rate. |
| Gur (2015) | 2001-2012 | BRIC Countries | While it is understood that the most important cause of increasing unemployment is inflation, these are followed by population growth and inflation. Respectively, gross domestic product growth, trade volume, total investment and industrial product growth are among the main economic factors that lead to a decrease in unemployment. |

## 3. DATA SET AND MODEL

In the economics literature, it has been a constantly discussed topic which variables are effective on unemployment. In this direction, it has been tried to reach a final result by considering different variables in

the literature. In this study *(Brazil, China, Colombia, Ecuador, Fiji, Jamaica, Jordan, Malaysia, Mexico, Peru, South Africa, Thailand, Turkey)* benefit from the data between 1991-2018 years of the 13 developing countries is aimed to analyze the factors that determine unemployment. While determining the developing country group in the model are taken into account countries in upper-middle income group that determining by the world bank. In addition, variables that are thought to have an effect on unemployment are examined and while unemployment is considered as a dependent variable, 8 different variables thought to affect unemployment are evaluated as independent variables. These independent variables are inflation, growth, population, fertility rate, technological development, industrialization, saving and foreign direct investment. The model consisting of 9 variables in total is shown below:

$$\begin{aligned} une_{it} = \; & b_0 + b_1 inf_{it} + b_2 gdp_{it} + b_3 pop_{it} + b_4 frt_{it} + b_5 tech_{it} \\ & + b_6 ind_{it} + b_7 svn_{it} + b_8 fdi_{it} \end{aligned} \qquad (1)$$

Equation (1) shows that the (i) cross-section and (t) time dimensions within the scope of panel data analysis. $\mu_{it}$ refers to the error term. une, unemployment; inf, inflation; gdp, growh; pop, population; frt, fertility rate, tech, technological development; ind, industrialization; svn, savings, and finally fdi, foreign direct investment within the model. Explanations and data sources for these variables are shown in Table 2.

**Table 2:** Descriptions of Variables and Data Sources

| Variable | Symbol | Explanation | Source |
|---|---|---|---|
| Unemployment | une | "It is the labor force or the economically active portion of the population that serves as the base for this indicator, not the total population. The series is part of the ILO estimates and is harmonized to ensure comparability across countries and over time by accounting for differences in data source, scope of coverage, methodology, and other country-specific factors. The estimates are based mainly on nationally representative labor force surveys." | World Bank, 2021 |
| Inflation | inf | "It is inflation according to the consumer price index. Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly." | World Bank, 2021 |
| Growth | gdp | "Data are in constant 2010 U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2010 official exchange rates." | World Bank, 2021 |
| Population | pop | "Represents a variable total population. Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values are mid year estimates." | World Bank, 2021 |
| Fertility Rate | frt | "Variable is the total fertility rate. Total fertility rates are based on data on registered live births from vital registration systems or, in the absence of such systems, from censuses or sample surveys." | World Bank, 2021 |

| | | | |
|---|---|---|---|
| Technological Development | tech | "Share of medium and high-tech manufactured exports in total manufactured exports." | World Bank, 2021 |
| Industrialization | ind | "Industry includes manufacturing. It comprises value added in mining, manufacturing, construction, electricity, water, and gas." | World Bank, 2021 |
| Savings | svn | "Gross savings are calculated as gross national income less total consumption, plus net transfers" | World Bank, 2021 |
| Foreign Direct Investment | fdi | "Foreign direct investment are the net inflows of investment to acquire a lasting management interest in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital. This series shows net inflows in the reporting economy from foreign investors, and is divided by GDP." | World Bank, 2021 |

## 4. METHODOLOGY AND EMPIRICAL FINDINGS

The method of estimating economic relationships with the help of panel data models created using cross-section data with time dimensions is called panel data analysis. In panel data analysis, regression is performed by using the observations of more than one cross section object using observations during the analysis period and therefore cross section fluctuation with time series is allowed. In a typical panel data analysis, analysis is performed using time series data of T period of individuals in N number for the dependent variable (Güneş, 2019: 169).

Over time, unit root tests have been developed, which are used to detect stationarity in panel data analysis. The panel unit root tests developed consist of two groups: first generation and second generation panel unit

root tests. This grouping is made according to the presence of cross section dependency. Cross section dependency can be defined as the presence of correlation between cross sections. The first generation panel unit root tests assume that the cross sections that make up the series are independent from each other, and the shock occurring in any unit in the series will be equally affected by all units in the series. Featured first generation panel unit root tests; Levin, Lin and Chu (2002), Breitung (2005), Hadri (2000), Im, Pesaran and Shin (2003) and Harris and Tzavalis (1999). In the second generation panel unit root tests, it is assumed that each unit in the series will be affected differently from the shock that occurs in one of the series within the panel. Breuer et al. (2001), Moon and Perron (2004), Bai and Ng (2004), Pesaran (2007) and Hadri and Kurozumi (2012) are among the second generation panel unit root tests (Gençoğlu, Kuşkaya and Büyüknalbant, 2020: 1287). Accordingly, the analysis is primarily to look at the cross section dependency of the variable. In this study, cross section dependency is examined as a group and the results are given in Table 3.

**Table 3:** Cross Section Dependence Test

| Test | Statistic | p-value |
|---|---|---|
| LM | 142.1 | 0.000 |
| LM adj* | -1.667 | 0.095 |
| LM CD* | -1.041 | 0.297 |
| H0: Cov(uit,ujt) = 0 | | |

When Table 3 is looked at, it is seen that the H0 hypothesis that the cross section independence is accepted in line with the results of both LM adj and LM CD tests. In other words, it is concluded that there is

cross section independence as a result of the test. This result shows that first generation unit root tests should be applied to the variables. However, it is important to look at the homogeneity and heterogeneity of the variables in the first generation unit root tests. For this purpose, homogeneity and heterogeneity tests are carried out after the cross sectional dependency is tested in the study. In this study, the Peseran and Yamagata (2008) Homogeneity Test is conducted and the results are given in Table 4.

**Table 4:** Peseran and Yamagata (2008) Homogeneity Test

| Peseran and Yamagata (2008) Test | Delta | p-value |
|---|---|---|
| Delta | 8.974 | 0.000 |
| Delta Adj. | 11.193 | 0.000 |
| H0: slope coefficients are homogenous | | |

In line with the results obtained from Table 4, the H0 hypothesis, which accepts homogeneity, is rejected, and the alternative hypothesis is accepted and heterogeneity is concluded. Therefore, the test that accepts heterogeneity among the first generation unit root tests should be applied to variables. Im, Pesaran and Shin (IPS) test, which is one of the first generation unit root tests is used to determine the stationarity of the series in this study. Im, Pesaran and Shin unit root test results are given in Table 5.

**Table 5:** Im, Pesaran & Shin Unit Root Test

| Variables | Level | | First Difference | | Result |
|---|---|---|---|---|---|
| | Statistics | Probability | Statistics | Probability | |
| une | 1.290 | 0.098 | 5.695 | 0.000 | I(1) |
| inf | 7.780 | 0.000 | - | - | I(0) |
| gdp | 2.606 | 0.955 | 3.331 | 0.000 | I(1) |
| pop | 20.074 | 0.000 | - | - | I(0) |
| frt | 13.091 | 0.000 | - | - | I(0) |
| tech | 0.706 | 0.240 | 7.896 | 0.000 | I(1) |
| ind | 0.085 | 0.534 | 6.834 | 0.000 | I(1) |
| svn | 0.959 | 0.168 | 7.320 | 0.000 | I(1) |
| fdi | 3.913 | 0.000 | - | - | I(0) |

Table 5 shows the unit root test results applied to variables. According to the results, it is understood that the unemployment that dependent variable is stable at the first difference. it is observed that the variables of growth, technological development, industrialization and savings among the independent variables, are stable in the first difference, while the variables of inflation, population, fertility rate, and foreign direct investment are stable at the level. These results show that the variables are stationary at different levels. In line with these results, it has been determined that ARDL analysis method is the most accurate cointegration test method in order to determine to relationship between variables. Because ARDL analysis allows the analysis of variables when the first difference of the dependent variable is stationary, while the independent variables show the characteristic of being stationary at different levels**.**

Paseran et al. (1999) developed two estimators for the ARDL model; Mean Group Estimator (MG) and Pooled Mean Group Estimator (PMG). The MG estimator places no constraints on the parameters of

the ARDL specification and derives to long-term parameters from the average of the long-term parameters obtained from the individual ARDL estimates. The main drawback of this estimator is that it does not allow certain parameters to be the same between the units that make up the panel. This shortcoming in the MG estimator is overcome by using PMG. The PMG estimator restricts the long-term parameters to be the same between the countries that make up the panel, but allows the constant, error variances, and short-term parameters to differ between countries. Thus, in the panel ARDL model allows in short-term heterogeneity as connection with long-term homogeneity in variables (Güler and Özyurt, 2011: 14-15). MG ARDL test is applied to the variables in the study and the results of the applied ARDL test are shown in Table 6.

**Table 6:** MG ARDL Analysis Results

**Dependent Variable:** une
**Mean Squared Error (sigma):** 0.7297
**Wald chi2:** 6.87

| Variable | Coefficient | Std. Error | t-Statistic | Probability |
|---|---|---|---|---|
| inf | 0.005 | 0.010 | 0.57 | 0.570 |
| gdp | -0.000 | 0.000 | -1.25 | 0.211 |
| pop | -0.000 | 0.000 | -0.12 | 0.903 |
| frt | 1.788 | 2.552 | 0.70 | 0.484 |
| tech | 0.028 | 0.030 | 0.93 | 0.354 |
| ind | -0.037 | 0.049 | -0.76 | 0.446 |
| svn | -0.042 | 0.050 | -0.83 | 0.404 |
| fdi | -0.046 | 0.048 | -0.96 | 0.336 |
| Constant | -7.334 | 18.455 | -0.40 | 0.691 |

When Table 6 is analyzed for the whole panel, it is seen that all variables are meaningless in explaining unemployment. Therefore, the coefficients could not be interpreted. However, the results differ from each other when viewed on a unit basis (look at the appendix). For example, it is understood that the increase in growth will decrease unemployment, while the increase in population will increase unemployment in Brazil. It is also seen that 1 unit increase in the fertility rate would increase unemployment by 7,489 units. Finally, it is concluded that a 1unit increase in inflation would reduce unemployment by 0.001 units at the 10% significance level in the Brazilian example. In China, it has been revealed that the increase in growth at the level of 10% significance, as in Colombia, decreases unemployment while the increase in savings increases unemployment.

It is understood that 1 unit increase in industrialization increased unemployment by 0.074 units at significance level of 5% in Fiji among the developing countries, 1 unit increase in savings decreased unemployment by 0.012 units and 1 unit increase in foreign direct investments increased unemployment by 0.021 units. In Jamaica, it has been reveal that increase of 1 unit in inflation decreased unemployment by 0.068 units at the level of 10% significance.

In Jordan among the countries considered within the scope of the study, it is understood that the increase in fertility rate increased unemployment by 6,201 units, and the increase in technological development decreased unemployment by 0.143 units. In Malaysia, the results are showing the opposite of Jordan. Because it has been

determine that 1 unit increase in fertility rate decreased unemployment by 3.787 units. In addition, it has been observe that industrialization reduces unemployment by 0.124 units in Malaysia.

In Mexico, it has been demonstrate that while growth decreases unemployment, population growth increases unemployment. the results obtained in Mexico confirme the results obtained in Peru, South Africa and Thailand. It is also understood that 1 unit increase in industrialization reduced unemployment by 0.216 units in Peru. In addition, it is concluded that 1 unit increase in fertility rate in Thailand increased unemployment by 14,804 units and increase in industrialization decreased unemployment by 0.197 units. 1 unit increase in savings and foreign direct investments increased unemployment by 0.140 and 0.202 units, respectively.

Finally, when the data are analyzed in Turkey, it is understood that increase of 1 unit fertility rate increased unemployment by 17.180 units. This result confirm the results obtained from Thailand. In addition, 1 unit increase in technological development increased unemployment by 0.306 units increase in Turkey.

## CONCLUSION

Throughout the history of economics, unemployment has been among the most important problems for countries and has been a subject of constant debate. In this regard, it has been tried to understand which variables increase unemployment and in this direction, it has been tried to develop solution policies for unemployment. For this purpose, in this

study, it is aimed to investigate the factors affecting unemployment and unemployment by using the data between 1991-2018 of 13 developing countries. Accordingly, the effects of inflation, growth, population, fertility rate, technological development, industrialization, saving and foreign direct investment variables which are thought to have an impact on unemployment have been analyzed.

Whether the variables include cross sectional dependency or not is of great importance in panel data analysis. Therefore, the cross section dependency test is performed primarily in the study and it is concluded that there is no cross section dependency. This result showed that the first generation unit root test should be applied to the variables. However, at this point, it is important to conduct first generation unit root tests that accept the assumption of homogeneity and heterogeneity. Therefore, Peseran and Yamagata (2008) homogeneity test is applied to variables and heterogeneity is concluded. Therefore, Im, Pesaran and Shin (IPS) unit root test which accept the assumption of heterogeneity are applied to the variables. It is concluded that the variables are stationary at different levels. Therefore, MG ARDL analysis is applied for variables. However, since the coefficients are not significant as a group, the relationship between the variables could not be interpreted.

When analyzed on the basis of countries, it is seen that the results are different from each other. However, the study reveal that there is an inverse relationship between growth and unemployment. This result has confirm the validity of Okun's Law, which is an important theory in economics literature. It has also been shown that when there is an

increase in the population, as expected, unemployment tends to increase. Similar to the population, when the fertility rate increases, unemployment is expected to rise. This situation is confirmed when the coefficients are examined. Only Malaysia faced a situation opposite to what is expected and it is concluded that increase of fertility rate decrease unemployment. In addition to these results, when the relationship between inflation and unemployment is evaluated, it has been reveal that there is an inverse relationship between inflation and unemployment in Brazil and Jamaica. This result confirm the philips curve assumption, which has an important place in the economics literature. In addition, it has been confirm within the context of countries that unemployment decreases as industrialization increases. Only in Fiji is faced with a situation opposite to what is expected, and it is observed that industrialization increase unemployment. Finally, it has been determined that there is a positive relationship between foreign direct investment and unemployment.

## REFERENCES

Abugamea, G. (2018). Determinants of Unemployment: Empirical Evidence from Palestine. *Munich Personal RePEc Archive (MPRA),* MPRA Paper No: 89424.

Akyurt, Y. A. (2020). *İktisat Teorisi Çerçevesinde Emek Piyasası ve İşsizlik: Oyun Teorisindeki Karşılıkları.* Yüksek Lisans Tezi, Maltepe Üniversitesi Lisansüstü Eğitim Enstitüsü, İstanbul.

Ayhan, F. (2019). Türkiye Ekonomisinde İşsizliğin Belirleyicisi Olan Temel Makroekonomik Değişkenlerin Tespitine İlişkini Bir Uygulama. *Uluslararası İktisadi ve İdari İncelemeler Dergisi-International Journal of Economic and Administrative Studies,*25, 235-252. ISSN 1307-9832

Ceylan Ataman, B. (1998). İşsizlik Sorununa Yeni Yaklaşımlar. *Ankara Üniversitesi SBF Dergisi*, *53*(01), 59-72.

Dalmar, M. S., Ali, A. Y. S., & Ali, A. A. (2017). Factors Affecting Unemployment in Somalia. *Journal of Economics and Sustainable Development,* 8(22), 200-210.

Gençoğlu, P., Kuşkaya, S. & Büyüknalbant, T. (2020). Seçilmiş OECD Ülkelerinde Sağlık Haramalarının Sürdürülebilirliğinin Panel Birim Kök Testleri ile Değerlendirilmesi. *Ankara Üniversitesi SBF Dergisi,* 75, 1283-1297.

Gur, B. (2015). An analysis of unemployment determinants in BRIC countries. *International Journal of Business and Social Science,* 6(1), 192-198.

Güler, A. & Özyurt, H. (2011). Merkez Bankası Bağımsızlığı ve Reel Ekonomik Performans: Panel ARDL Analizi. *Ekonomi Bilimleri Dergisi*, *3*(2), 11-20.

Güneş, H. (2019). Ar-Ge Harcamaları ile Ekonomik Büyüme İlişkisi: OECD Ülkeleri için Panel Veri Analizi. *Sakarya İktisat Dergisi*, *8*(2), 160-176.

Güney, K. (2019). *Avrupa Birliği ve Türkiye'de Genç İşsizlik Sorunu ve Kaynakları.* Yüksek Lisans Tezi, Çukurova Üniversitesi Sosyal Bilimler Enstitüsü, Adana.

Güriş, S. & Yaman, B. (2018). OECD Ülkelerinde İşsizliği Etkileyen Faktörlerin Panel Veri Modelleri ile Analizi. *Social Sciences Research Journal,* 7(1), 136-146. ISSN: 2147-5237

Koç, F. (2020). *İşsizlik ve Suç İlişkisi: Türkiye Üzerine Bir Uygulama (1991-2018).* Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi Sosyal Bilimler Enstitüsü, Trabzon.

Öztürk, Y. (2020). *Enflasyon ve İşsizlik Sarmalında Türkiye.* Yüksek Lisans Tezi, Bandırma Onyedi Eylül Üniversitesi Sosyal Bilimler Enstitüsü, Bandırma.

Salama, A., Oláh, J. (2019). Key factors affecting unemployment in the Arab world. *Central European Journal of Labour Law and Personnel Management,* 2(2), 60-72. doi: 10.33382/cejllpm.2019.03.05

Solak, L. (2012). *İşsizlik Sorunu, Türkiye'de İşsizlikle Asgari Ücret, Sanayi İstihdam Oranı ve Yolsuzluk Arasındaki İlişkinin Analizi.* Yüksek Lisans Tezi, Nevşehir Üniversitesi Sosyal Bilimler Enstitüsü, Nevşehir.

Sungur, M. (2019). *Türkiye'de Ekonomik Büyüme ve İşsizlik Oranları Arasındaki İlişkinin Analizi.* Yüksek Lisans Tezi, Tekirdağ Namık Kemal Üniversitesi Sosyal Bilimler Enstitüsü, Tekirdağ.

Tarı, R. & Bakkal, H. (2017). Türkiye'de işsizliğin belirleyicileri. *Kocaeli Üniversitesi Sosyal Bilimler Dergisi,* (33), 1-18.

Ümit, Ö. & Karataş, Ö. (2018). Türkiye'de İşsizlik ve İşsizliği Etkileyen Makroekonomik Faktörlerin Ekonometrik Analizi. *Uluslararası Yönetim İktisat ve İşletme Dergisi,* 14(2), 311-333.

Ünal, E. (2019). *Türkiye'de Ekonomik Büyüme İşsizlik ve Enflasyon İlişkisi Üzerine Bir Analiz.* Yüksek Lisans Tezi, Süleyman Demirel Üniversitesi Sosyal Bilimler Enstitüsü, Isparta.

Xuen, C. L., Bee, C. Y., Hsıen, R. L. L., Yen, T. W. & Yee, T. K. (2017). *Macroeconomic Factors Affecting Unemployment Rate in China.* PhD Thesis. UTAR.

Yıldırım, O. (2020*). Genç İşsizlik Ekonomik Büyüme İlişkisi: Türkiye Örneği.* Yüksek Lisans Tezi, Giresun Üniversitesi Sosyal Bilimler Enstitüsü, Giresun.

# APPENDIX

**Table 7:** MG ARDL Analysis Results for Countries

| **Dependent Variable:** une | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **t-Statistic** | **Probability** |
| **Brazil** | | | | |
| inf | -0.001 | 0.000 | -1.90 | 0.057 |
| gdp | -0.000 | 0.000 | -6.92 | 0.000 |
| pop | 0.000 | 0.000 | 8.06 | 0.000 |
| frt | 7.489 | 2.653 | 2.82 | 0.005 |
| tech | -0.034 | 0.055 | -0.62 | 0.533 |
| ind | 0.233 | 0.167 | 1.39 | 0.163 |
| svn | -0.156 | 0.162 | -0.96 | 0.336 |
| fdi | 0.146 | 0.139 | 1.05 | 0.296 |
| C | -84.533 | 15.841 | -5.34 | 0.000 |
| **China** | | | | |
| inf | 0.012 | 0.012 | 1.00 | 0.319 |
| gdp | -0.000 | 0.000 | -1.69 | 0.090 |
| pop | 0.000 | 0.000 | 1.22 | 0.223 |
| frt | -0.178 | 1.337 | -0.13 | 0.894 |
| tech | 0.021 | 0.033 | 0.64 | 0.525 |
| ind | -0.070 | 0.056 | -1.24 | 0.216 |
| svn | 0.043 | 0.025 | 1.71 | 0.088 |
| fdi | -0.013 | 0.075 | -0.18 | 0.860 |
| C | -13.039 | 15.537 | -0.84 | 0.401 |
| **Colombia** | | | | |
| inf | 0.037 | 0.271 | 0.14 | 0.891 |
| gdp | -0.000 | 0.000 | -1.92 | 0.055 |
| pop | -0.000 | 0.000 | -0.18 | 0.857 |
| frt | -18.361 | 23.033 | -0.80 | 0.425 |
| tech | 0.037 | 0.205 | 0.18 | 0.855 |
| ind | -0.364 | 0.808 | -0.45 | 0.652 |
| svn | -0.552 | 0.338 | -1.63 | 0.103 |
| fdi | -0.377 | 0.349 | -1.08 | 0.280 |
| C | 112.424 | 170.571 | 0.66 | 0.510 |
| **Ecuador** | | | | |
| inf | 0.003 | 0.007 | 0.46 | 0.649 |
| gdp | -0.000 | 0.000 | -1.08 | 0.279 |
| pop | 0.000 | 0.000 | 0.53 | 0.598 |
| frt | 0.372 | 2.888 | 0.13 | 0.898 |
| tech | -0.012 | 0.031 | -0.38 | 0.705 |

| | | | | |
|---|---|---|---|---|
| ind | -0.064 | 0.082 | -0.77 | 0.439 |
| svn | -0.021 | 0.083 | -0.26 | 0.798 |
| fdi | 0.044 | 0.146 | 0.30 | 0.763 |
| C | 2.942 | 18.259 | 0.16 | 0.872 |
| **Fiji** | | | | |
| inf | -0.011 | 0.013 | -0.84 | 0.399 |
| gdp | 0.000 | 0.000 | 0.37 | 0.711 |
| pop | 0.000 | 0.000 | 2.25 | 0.025 |
| frt | -0.686 | 0.665 | -1.03 | 0.302 |
| tech | -0.015 | 0.020 | -0.77 | 0.441 |
| ind | 0.074 | 0.368 | 2.01 | 0.044 |
| svn | -0.012 | 0.004 | -2.78 | 0.005 |
| fdi | -0.021 | 0.007 | -2.74 | 0.006 |
| C | -0.334 | 3.594 | -0.09 | 0.926 |
| **Jamaica** | | | | |
| inf | -0.068 | 0.035 | -1.90 | 0.057 |
| gdp | -0.000 | 0.000 | -3.92 | 0.000 |
| pop | -0.000 | 0.000 | -0.56 | 0.575 |
| frt | -8.279 | 11.745 | -0.70 | 0.481 |
| tech | -0.039 | 0.092 | -0.42 | 0.672 |
| ind | 0.029 | 0.424 | 0.07 | 0.945 |
| svn | 0.022 | 0.091 | 0.24 | 0.808 |
| fdi | -0.144 | 0.154 | -0.93 | 0.351 |
| C | 112.497 | 104.872 | 1.07 | 0.283 |
| **Jordan** | | | | |
| inf | -0.035 | 0.094 | -0.38 | 0.705 |
| gdp | -0.000 | 0.000 | -0.85 | 0.393 |
| pop | 0.000 | 0.000 | 1.55 | 0.122 |
| frt | 6.201 | 2.130 | 2.91 | 0.004 |
| tech | -0.143 | 0.046 | -3.05 | 0.002 |
| ind | 0.238 | 0.317 | 0.75 | 0.453 |
| svn | -0.113 | 0.067 | -1.66 | 0.096 |
| fdi | -0.120 | 0.089 | -1.34 | 0.182 |
| C | -13.630 | 13.118 | -1.04 | 0.299 |
| **Malaysia** | | | | |
| inf | 0.066 | 0.074 | 0.89 | 0.371 |
| gdp | 0.000 | 0.000 | 0.57 | 0.569 |
| pop | -0.000 | 0.000 | -1.83 | 0.067 |
| frt | -3.787 | 1.372 | -2.76 | 0.006 |
| tech | 0.023 | 0.021 | 1.06 | 0.290 |
| ind | -0.124 | 0.051 | -2.42 | 0.015 |
| svn | -0.046 | 0.030 | -1.50 | 0.133 |
| fdi | -0.002 | 0.056 | -0.04 | 0.968 |
| C | 33.548 | 11.829 | 2.84 | 0.005 |

| | | | | |
|---|---|---|---|---|
| **Mexico** | | | | |
| inf | 0.008 | 0.022 | 0.40 | 0.687 |
| gdp | -0.000 | 0.000 | -7.17 | 0.000 |
| pop | 0.000 | 0.000 | 5.81 | 0.000 |
| frt | 4.347 | 2.369 | 1.83 | 0.067 |
| tech | 0.048 | 0.086 | 0.56 | 0.576 |
| ind | 0.077 | 0.105 | 0.73 | 0.464 |
| svn | 0.127 | 0.115 | 1.11 | 0.269 |
| fdi | 0.141 | 0.198 | 0.72 | 0.474 |
| C | -48.515 | 15.823 | -3.07 | 0.002 |
| **Peru** | | | | |
| inf | -0.001 | 0.001 | -1.35 | 0.178 |
| gdp | -0.000 | 0.000 | -5.87 | 0.000 |
| pop | 0.000 | 0.000 | 1.78 | 0.075 |
| frt | 1.315 | 1.242 | 1.06 | 0.290 |
| tech | -0.052 | 0.055 | -0.96 | 0.339 |
| ind | -0.216 | 0.058 | -3.71 | 0.000 |
| svn | 0.119 | 0.072 | 1.64 | 0.100 |
| fdi | 0.037 | 0.041 | 0.91 | 0.360 |
| C | -3.673 | 10.683 | -0.34 | 0.731 |
| **South Africa** | | | | |
| inf | 0.064 | 0.186 | 0.35 | 0.730 |
| gdp | -0.000 | 0.000 | -3.67 | 0.000 |
| pop | 0.000 | 0.000 | 2.79 | 0.005 |
| frt | 2.831 | 5.030 | 0.56 | 0.573 |
| tech | 0.178 | 0.095 | 1.88 | 0.061 |
| ind | -0.183 | 0.812 | -0.23 | 0.822 |
| svn | 0.052 | 0.428 | 0.12 | 0.903 |
| fdi | -0.220 | 0.328 | -0.67 | 0.502 |
| C | -6.105 | 23.262 | -0.26 | 0.793 |
| **Thailand** | | | | |
| inf | 0.021 | 0.036 | 0.60 | 0.551 |
| gdp | -0.000 | 0.000 | -6.87 | 0.000 |
| pop | 0.000 | 0.000 | 5.44 | 0.000 |
| frt | 14.804 | 4.282 | 3.46 | 0.001 |
| tech | 0.055 | 0.044 | 1.25 | 0.211 |
| ind | -0.197 | 0.056 | -3.52 | 0.000 |
| svn | 0.140 | 0.043 | 3.23 | 0.001 |
| fdi | 0.202 | 0.055 | 3.66 | 0.000 |
| C | -96.718 | 22.695 | -4.26 | 0.000 |
| **Turkey** | | | | |
| inf | -0.020 | 0.027 | -0.73 | 0.463 |
| gdp | -0.000 | 0.000 | -0.96 | 0.335 |
| pop | 0.000 | 0.000 | 1.35 | 0.176 |

| | | | | |
|---|---|---|---|---|
| frt | 17.180 | 6.609 | 2.60 | 0.009 |
| tech | 0.306 | 0.174 | 1.76 | 0.079 |
| ind | 0.074 | 0.372 | 0.20 | 0.842 |
| svn | -0.152 | 0.177 | -0.86 | 0.392 |
| fdi | -0.272 | 0.397 | -0.69 | 0.492 |
| C | -90.248 | 53.727 | -1.68 | 0.093 |

# CHAPTER 2

# BITCOIN: IS IT AN ALTERNATIVE FOR THE GOLD AS AN INVESTMENT TOOL? EVIDENCE FROM BRICS COUNTRIES AND TURKEY.

Asuda YUNUSOVA[1]

[1] PhD student, Nigde Omer Halisdemir University, Department of Business Administration, asude.yunus@gmail.com, ORC-ID: 0000-0001-8284-5557

## INTRODUCTION

The aim of this study is whether bitcoin behaves itself as an investment tool compared to gold in BRICS and Turkish stock market. Limited studies have investigated bitcoin and gold relationship as an investment tool among the BRICS and Turkey stock markets.

In 2001, Goldman Sachs chief economist Jim O`Neill (2001) coined the acronym term BRICs to refer to Brazil, Russia, India and China. These group countries come together to seek out opportunities to make corporation in trade, investment and other spheres. China invited South Africa to join the group of BRIC in December, 2010. BRICS countries have grandiosely integrated to the global economy landscape. BRICs contributed 36.3% of world GDP growth in PPP terms (or 27.8% in USD) during the first decade of the century (Dominic et al 2010). The main reason why of these countries are named as a group is that, they must have young and growing population, potential of attracting direct foreign investment in the country economy because of the high growth opportunity, low production cost, and consequently cheap labor (Yilmaz, 2017).

Beside these, BRICS block countries Turkey also has attracted the attention of financial media with its immense economic growth and stock market performance (Bayar, 2014). Young and dynamic population, recent economic growth, and importance of geopolitical position of Turkey manages to make a name for itself among the BRICS countries.

It has been forecasted by O`Neil (2001) that in the very near future BRICS countries may will put G7 countries behind in stock market relations and economic growth. However, stock market performance of BRICS countries individually doesn`t sound as good as O`Neil has emphasized. Their Stock markets are useful for portfolio diversification and sensitive to changes in country risk rating (Shahzad et al.2021).

Bitcoin is a today`s hottest financial asset buzzword. The cryptocurrency under the name Bitcoin firstly was mentioned in Nakamoto`s (2008) study as a peer-to-peer electronic cash system. This cash system is not controlled by any government financial structures; it does not have national borders. Bitcoin is a decentralized digital currency without a single administrator and Bitcoin can be transferred directly through computers or smartphones without the need for any financial institution. The security of Bitcoin transactions is provided by servers called bitcoin miner. A user can have one or more bitcoin accounts to receive or transfer bitcoins to another account. Bitcoin account can be obtained online or by downloading a program called "digital wallet" to a computer or smartphone. A Bitcoin account consists of 33 characters and the account number starts with 1 or 3.

It`s seen that the first publication of Bitcoin’s name coincided with the 2008 financial crisis. The mentioned crisis results the lack of confidence towards financial institutions, and central governments. During this turmoil Bitcoin has gained its power as a financial asset.

Some studies showed it as a hedging role against stocks and US dollar Dyhrberg (2015, a) and it also made as a safe haven sound (Dyhrberg 2016, b). Several studies focus on it as a speculative investment (Dirk et al. 2017), speculative asset (Helene et al.2019), and benefits of diversification (Shahzad et al. (2021), Bouri et al. (2020), (Anton and Moro 2018)

Since and till Bretton Woods agreement gold always has kept its glow in history. Gold was a currency for thousands of years and it has psychological power on the market. Moreover, gold always plays a safe haven role for stocks in the short run (Beckman et al.2015), (Baur et al.2010) hedging against inflation (Dipak et al 2001). During the economic slump and uncertainty, gold in the long run became an opportunity for the investors as a safe investment and hedging against inflation because its positive correlation with inflation (Bampinas and Panagiotidis 2015), offering high diversification benefits gold always has kept its reliability function as an investment tool (Nelson et al.2013).

Bitcoin since its remarkable emerges has captured attention by financial press comparing to gold under name of “digital gold” Douglas et al. (2018). After this, the studies started to compare specifically these two commodities Elie et al. (2020), Chi et al.(2020), Bauoiyour et al (2019), Bouri et al (2020), Irene et al (2018), Helene et al. (2019), Klein et al (2018). While gold retains its store of value function due to its historical reputation, bitcoin remains unknown with its abilities and functions. Some studies have found it acceptable for

gold and bitcoin to complement each other rather than compete (Selmi et al 2019).

The plan of this paper as follows: Section 1 provides literature review, section 2 presents methodology and model, section 3 reports data and preliminary analysis, section 4 will present the empirical analysis of bitcoin and gold returns, lastly, the conclusion will be reported in section 5.

## 1. Literature Review

Due to the popularity of Bitcoin and its many features, relationship with gold has begun to attract more attention. Klein et al. (2018, 4) indicated that while gold plays a positive role in financial markets with flight-to-quality in times, bitcoin behaves in the opposite direction, following positive trends in downward markets. Beside this, they found out that Bitcoin as a portfolio component is not capable to compete with gold. In contrast to the above study, Dyherberg (2015a) brought out that bitcoin has a place in portfolio management and it can be classified as a store value and medium of exchange between gold and dollar. Moreover, Dyherberg (2015b) emphasized that Bitcoin plays hedging role against stocks in the Financial Times Stock Exchange Index and against the US dollar in the short term.

Henriques and Sadorsky (2018) considered both short and long portfolio. They used three different multivariable GARCH models (DCC, ADCC, and GO) to estimate optimal portfolio weights. Data span the period from 4 January 2011 to 31 October 2017. Empirical

results showed that even risk-averse investors will be willing to pay a high performance fee to convert their gold portfolio to a bitcoin portfolio and they will earn a higher risk-adjusted return.

In their study, Al-Yahyaee et al. (2018) apply the multiracial detrended fluctuation analysis (MF-DFA) approach in order to estimate the efficiency of Bitcoin market compared to gold, stock and foreign exchange markets. The period covers from 18 July 2010 until 31 October 2017. The findings support that Bitcoin is more inefficient than the gold, stock and currency markets.

Bouoiyour et al. (2019) find out there is a high resemblance between Bitcoin and Gold. So that, employing a dynamic Markov-switching copula model they tested the complementarily and substitutability of bitcoin and gold on 18 July 2010 and 31 March 2018 time span. Econometric outcomes reveal that, there is a strong and positive correlation between gold and bitcoin in low and high risk regimes. Gold and bitcoin can play a complementary role, because they benefit from the same economic situation. Furthermore, they believe that bitcoin will gain value with popularity over time and gold with a long history of confidence can come together and can play as safe haven investment role.

Shahzad et al. (2019) displayed that there is high dissimilarities between gold and bitocin in safe haven, hedging, and diversifying abilities for G7 countries. In term of safe haven ability G7 stock

indices respond positively only to gold. Gold with the hedging effectiveness and diversification benefits is much higher than Bitocin.

Jin et al. (2019) focus their research on investigating consisting of these three hedging assets whether Bitcoin, gold, or crude oil is more aware of price fluctuations in stock market values. The data sample used in this paper consists of three time series of weekly Bitcoin, gold and WTI oil prices through 10 May, 2013 to 7 September, 2018. The result showed that gold is definitely superior to Bitcoin and crude oil in absorbing and reacting to market news, and can lead the price movements/volatilities in the three hedging assets. Bitcoin is more easily inclined to the price instability of gold and crude oil. In general, gold is more powerful as a hedger over the stressed time period in the market.

Bouri et al. (2020) by employing wavelet coherency approach they compared the safe-haven roles of gold, commodities, and Bitcoin against USA and Chinese stock market indices for the period 20 July 2010-22 February 2018. The main results of this study are; according the wavelet coherence approach, although, bitcoin as the least dependent, and commodities as the most dependent emerges dependency of these listed assets and stock market is not very strong. In term of the benefits of diversification through wavelet value-at-risk (VaR) level showed that bitcoin leaves gold and commodities behind.

Shahzad et al. (2021) they examined the hedge and safe haven assets of gold, bitcoin,VIX futures weak and strong abilities against BRICS

stock market indices via a time-varying hedge strategy. The sample period was chosen July 19, 2010–July 2, 2020 for this study. They figured out that in the time of COVID-19 although gold and bitcoin are very weak as a safe haven, gold had a stable diversity in China and India stock market. However, in the early sample period it was difficult to say the same things for bitcoin as for the gold. In the late sample period VIX futures has shown more volatile diversification, but in term of the diversification subject VIX futures played striking role in Russia, Brazil, India, and South Africa stock market. They also noted that, even though, bitcoin is becoming closer to the center of the financial world, in terms of liquidity it cannot compete with gold and VIX futures.

## 2. Methodology and model

### 2.1. Method

In the study, the existence of sectional dependency among countries was checked through Breusch-Pagan (1980) LM, Pesaran (2004) scaled LM (LMS), Baltagi, Feng and Kao (2012) bias-adjusted scaled LM (LMBC) and Pesaran (2004) CD tests. The stationarity of the series was measured by second generation unit root tests; Bai and NG, Pesaran CIPS, Hadri Kurazmi. Panel ELGS (two way random effect) were appropriate in this paper after the Hausman, Chow and LM test results. The homogeneity coefficients were investigated by Pesaran and Yamagata (2008) delta (Δ) method and Hsiao (1986) test. In addition, existence of causality relations between the series was examined by Dumitrescu and Hurlin (2012) panel causality test.

### 2.2. Model

In this study relationship among stock exchange, bitcoin and gold was analyzed through this equation. It is seen in equation that constant parameter is ($\beta_0$) varies by the units.

$$Lnstock\,market_{it} = \beta_{i0} + \beta_{i1} bitcoin_t + \beta_{i2} gold_t + u_{it}$$

Here $Lnstock\,market_{it}$ represents the closing value of the *i*. stock exchange at the day t, while $\beta_{i1} bitcoin_t$ represents Bitcoin and $\beta_{i2} gold_t$ represents gold the closing value of the *i,* at the day t. In the Random Effect model constant parameter $\beta_0$ affected by error term $u_{it}$

## 3. Data And Preliminary Analysis

The paper considers weekly prices of two potential investment assets (Bitcoin, gold) and the stock market indices of BRICS and Turkey. The reason of using weekly data instead of daily data is that Bitcoin is traded through all seven days a week. The stock market indices of those six BRICS and Turkey (BRICS-T thereafter) countries are Turkey`s BIST100, Brazil`s BOVESPA, China`s Shanghai SSE Composite Index, India`s NIFTY50, Russia`s MOEX, South Africa`s JTOPI. All indices were taken from the investing.com. The sample covers the period from January 1, 2017 to December 31, 2020, with 1248 observations. Table 1 provides some summary statistics.

**Table1.** Descriptive statistics

| | Mean | Median | Max. | Min. | Std.Dev. | Skewness | Kurtosis | Obs. | Jarque-Bera | prob. |
|---|---|---|---|---|---|---|---|---|---|---|
| Lnstmark | 8.53349 | 8.60496 | 11.69649 | 4.423528 | 2.286608 | -0.3373 | 1.933728 | 1248 | 82.78512 | 0.000 |
| Bitcoin | 8128.66 | 7800.15 | 33233.5 | 928.9 | 4795.358 | 1.342053 | 7.155808 | 1248 | 1272.709 | 0.000 |
| Gold | 1494.44 | 1393.05 | 2089.2 | 1256 | 216.5274 | 1.115083 | 3.002636 | 1248 | 258.6296 | 0.000 |

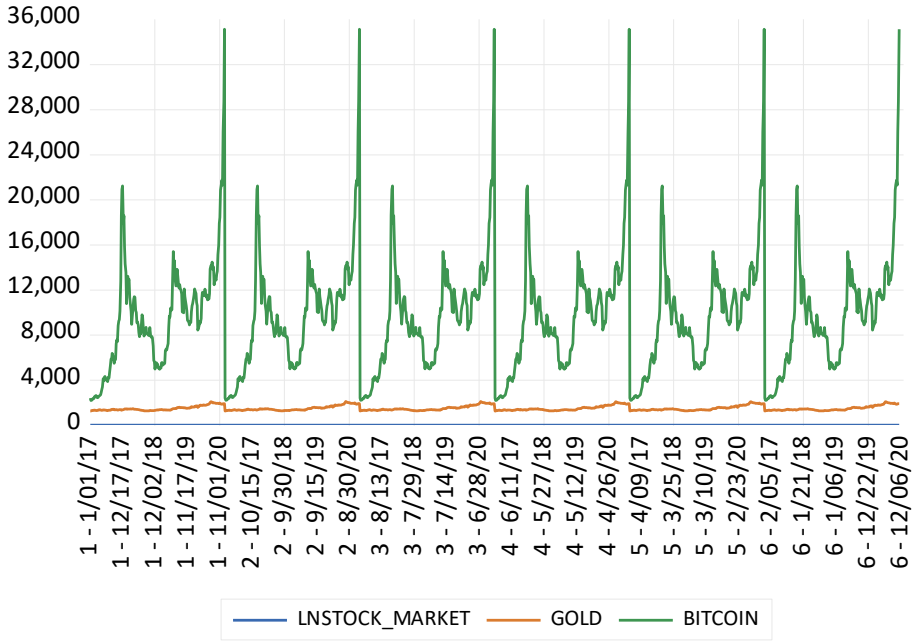
**Source:** Author`s computation. Notes: Max. = maximum, Min. = minimum, Std.Dev. = Standart Deviation, Obs. = number of observations, prob. = corresponds to the test of normality based on the Jarque-Bera test.

Table1 shows that the means of Bitcoin 8128.66, Gold 1494.44, and lnstock 8.83349 series are concentrated at the shown numbers. The average returns are positive for all series. Bitcoin presents the highest average returns followed by gold and the BRICS-T stock market. The standart deviation shows the fluctuations of time series, it is clearly shown in table that bitcoin is more volatile than the gold. The positive skewness displays that bitcoin and gold are in right-skewed, while lnstock_market is in left-skewed. The kurtosis of bitcoin and gold are larger than 3, it demonstrates leptokurtic distributions, whereas lnstock_market carries the kurtosis number of less than 3 which named is platycurtic. According to probability values the Jarque-Bera test results strongly reject the normal distributions.

Fig. 1 displays the weekly price dynamics of the bitcoin-gold-stock market relationship throughout the sampling period. The graphics show that bitcoin is more volatile than gold and gold doesn`t move the same direction as bitcoin. It is obvious that in bitcoin direciton there are two sharp increase which coincide with the 2017 and 2020 years.

The beginning of the year 2017 bitcoin was traded around $2000. In December, it reached $20.000. The key difference lies in who's buying Bitcoin and why. In 2017, most demand came from individual, retail investors buying with their own personal funds, many of whom had varying degrees of experience with and knowledge of cryptocurrency (Chainalysis Team, 2020).

**Figure1:** Graphical price comparison (January 1.2017-December 31.2020)




***Source:*** *author`s computation*

In 2018 bitcoin prices dropped around $4.000. In the following year bitcoin tried to catch the price dominance as in 2017, and since 2016 it has caught its the highest price level $ 30.000 in 2020 year. Studies

explain the reason of this price trajectory in 2020 as a geopolitical turmoil, growing acceptance of bitcoin by well-known investors (hedge fund manager Paul Toder Jones who compared buying bitcoin to investing in Apple and Google (Kevin Helms (2020)), COVID-19 outbreak and etc. Recently, El Salvador has passed a resolution to make Bitcoin a legal currency. Besides, Japanese government accepted in April 2011 Bitcoin as a legal payment method. On 16 April 2021 Central Bank of the Republic of Turkey issued a regulation the use of cryptocurrencies including bitcoin.

The gold price is volatile in the given time period but to a less extent than bitcoin. There is a sharp increase on gold prices on July 2020. After over nine years gold prices hit in the world during COVID-19 pandemic. During this turbulence weak dollar, low-interest rates have increased the appetite for gold. A key factor behind this robust performance is the supply growth and COVID-19 helped gold to climb.

## 4. Emprical Results

Cross-sectional dependence, described as the interaction between cross-sectional units (e.g., households, firms and states etc.), has been well discussed in the spatial literature. (Baltagi, Feng and Kao 2012:1). Owing to spatial or spillover effects cross section dependence can occur or could be due to unobserved (or unobservable) common factors (Baltagi, Pesaran 2017). In order to lay the groundwork for heterogeneous panel tests, it is necessary for us to perform a cross

section dependence test. The results of cross sectional dependence tests are presented in Table 2. According the following test results, H0 hypothesis which is suggests that there is no cross-sectional dependence is rejected. By obtaining p=0.000 statistics the LM and CD tests support that there is a cross sectional dependence. In the light of this result second generation unit root tests will be employed.

**Table 2:** Cross Sectional Dependence Test

| Variables | Breusch Pagan LM | Pesaran scaled LM | Bias corrected scaled LM | Pesaran CD |
|---|---|---|---|---|
| Stock Market | 678.9993 (0.000) | 121.2291 (0.000) | 121.2147 (0.000) | 2.513484 (0.000) |
| Gold | 2827.895 (0.000) | 513.5619 (0.000) | 513.5475 (0.000) | 53.15929 (0.000) |
| Bitcoin | 2048.966 (0.000) | 371.3497 (0.000) | 371.3353 (0.000) | 44.91453 (0.000) |

***Note:*** *Figures in the parentheses are the probability values*

Moreover, table 3 displays correlation matrix of residuals. There are several methods have been paraphrased the correlation coefficient into descriptors like “weak,” “moderate,” or “strong” relationship (Schober, 2018). In our case the highest correlation coefficient is 0.60 between gold and bitcoin. Both variables move in tandem during uncertainty time of economy. That being said, bitcoin has caught higher returns compared to gold. Both gold and bitcoin don`t have strong correlation with BRICS-T stock market. A diversifier is defined as an asset that is positively (but not perfectly correlated) with another asset or portfolio in extreme adverse market conditions ( Baur and

Lucey, 2010). In this study, gold and bitcoin can be defined as diversifier assets because of the weak and positive correlation to BRICS-T stock market.

**Table 3:** Correlation Matrix

| Correlation | LNSTOCK_MARKET | BITCOIN | GOLD |
|---|---|---|---|
| LNSTOCK_MARKET | 1 | | |
| BITCOIN | 0.026568 | 1 | |
| GOLD | 0.024424 | 0.606394 | 1 |

### 4.1. Homogeneity Test

Homogeneity test is important in order to know that the unknown β slope coefficients remain constant across the sections and it does not always valid over time (Gündüz, 2017). In order to test slope homogeneity, Tests of Hsiao (1986) and Pesaran Yamagata (2008) tests are employed. Null hypothesis of Pesaran, Yamagata test is: "Slope Homogeneity". In Pesaran Yamagata two different test statistics are available. One is Δ, and other one is Δadj. Simple Δ is for large samples, and adjusted Δ is for small samples.

Hypothesis of Test of Hsiao are as following:

$H_1$ = Null Hypothesis: panel is homogeneous vs alternative hypothesis: $H_2$

$H_2$ = Null Hypothesis: $H_3$ vs alternative hypothesis panel is heterogeneous

$H_3$ = Null Hypothesis: panel is homogeneous vs alternative hypothesis: panel is partially homogeneous. In table 4 the results obviously are shown that null hypothesis are rejected, and slope of coefficients are heterogeneous.

**Table 4:** Homogeneity Tests

| Homogeneity Tests | | | | | |
|---|---|---|---|---|---|
| Tests Of Hsiao (1986) | | | Pesaran, Yamagata (2008) | | |
| Hypothesis | F-stat | p-value | Delta | | p-value |
| $H_1$ | 2608.02 | 0.000 | Δ | 8.824 | 0.000 |
| $H_2$ | 53.8323 | 5.81E-90 | Δ adj | 9.184 | 0.000 |
| $H_3$ | 5410.96 | 0.000 | | | |

$H_0$*: slope coefficients are homogenous*

### 4.2. Panel Unit Root Tests

To make further analysis it is important to know whether series are stationary or no stationary. To test presence of a unit root following tests were used. According cross section dependence test results the second generation unit root tests were applied. As second generation unit root tests, Bai and NG (2010), Hadri and Kurozumi (2011) and Pesaran CIPS were used. Panel data are considered stationary as long as the probability value of the panel data is less than 0.05 probability value. There is only dependent variable (stock market) doesn`t follow the stationary rule and $H_0$ was accepted, therefore first difference of

stock market taken into consideration as lnstock market and it became stationary. For using ARDL technique the dependent variable has to be I (1) and independent variable should be mix of I (0) and I (1). Independent variables with two I (0) don`t allow to go through ARDL technique. Therefore, unit root tests results took the study to apply Panel OLS.

**Table 5:** Unit Root Tests

| *Test names* | *Bitcoin* | | *Gold* | | *stock market* | | *Lnstock market* | |
|---|---|---|---|---|---|---|---|---|
| | *pvalue* | *t test* | *p value* | *t test* | *p value* | *t test* | *p value* | *t test* |
| *Bai and NG* | *0.000* | *16.168* | *0.000* | *20.111* | *0.7314* | *0.3431* | *0.0579* | *1.902* |
| *Pesaran CIPS* | *0.001* | *960405* | *0.01* | *11449* | *0.1* | *1.9084* | *0.01* | *2.604* |
| *Hadri Kurozumi* | *0.372* | *0.409* | *0.114* | *1.224* | *0.000* | *4.15* | | |

### 4.3. Panel Casuality Test

In this study, a panel causality test developed by Dumitrescu-Hurlin (2012) was used. This test examines whether there is a cause and effect relationship between two variables. It can be used when T>N and when N>T. The test, which is based on VAR, assumes that there is no cross-sectional dependency. After the Monte Carlo experiments even under the conditions of cross-sectional dependency, this test can produce strong results. This test is used for balanced and heterogeneous panels. The hypotheses are as follows:

$H_0$: There is no homogeneously cause between two variables

If the (probability) p > 5%, then the null hypotheses ($H_0$) is accepted.

$H_1$: There is homogeneously cause between two variables

If the (probability) p < 5%, then the null hypotheses ($H_0$) is rejected.

In our case while p value is > 5% there is no causation between gold and stock market. However, Bitcoin has a unidirectional causation between gold and stock market. They are both causes and both effects. This suggests that bitcoin market is interdependent with gold and stock market. BRICS-T bitcoin prices are not isolated from any movement in gold and stock market prices. The results obviously explain that bitcoin is now becoming an alternative investment tool for BRICS-T countries and it better integrated with the country`s stock market than gold over the sample period.

**Table 6:** Causality Test

| Null Hypothesis: | W-Stat. | Z bar-Stat. | Prob. |
|---|---|---|---|
| GOLD doesn`t cause LNSTOCK_MARKET | 2.56733 | 0.65691 | 0.5112 |
| LNSTOCK_MARKET doesn`t cause GOLD | 1.60309 | -0.50060 | 0.6167 |
| BITCOIN doesn`t cause LNSTOCK_MARKET | 41.1250 | 46.9426 | 0.0000 |
| LNSTOCK_MARKET doesn`t cause BITCOIN | 4.21889 | 2.63948 | 0.0083 |
| BITCOIN doesn`t cause GOLD | 25.6285 | 28.3402 | 0.0000 |
| GOLD doesn`t cause BITCOIN | 5.10177 | 3.69932 | 0.0002 |

***Source:*** *author`s calculation*

### 4.4. Selection Method of Regression Data Panel

To select the most appropriate model, there are several tests that can be done. Tests are followings:

1. The Chow Test proposed by econometrician Gregory Chow in 1960. Chow test determines whether to choose the model of Pooled Effect, or Fixed Effect. Hypothesis of Chow test is:

$H_0$: Pooled Effect Model, $H_1$: Fixed Effect Model.

If p value is greater than 0.05, $H_0$ is accepted, vice versa is for fixed one. In our result Chow test shows for cross section $H_0$ is rejected, for time period $H_0$ is accepted. Therefore, for time Pooled Effect model, for cross section Fixed Effect model is appropriate.

2. Breusch-Godfrey test determines whether Common (Pooled) Effect or Random Effect is more appropriate. Hypothesis of LM test is:

$H_0$: Pooled Effect Model, $H_1$: Random Effect Model.

The results show that LM test for cross section and period is Random Effect

3. Hausman Test also called the Hausman specification test. In this test hypothesis is:

$H_0$: Random Effect Model, $H_1$: Fixed Effect Model. The test results for both are Random.

| Fixed/Random Effects Test | | |
|---|---|---|
| | Cross section | Period |
| Chow | 6296.05<br>(0.000) | 0.163288<br>(1.000) |
| LM (Breush-Pagan) | *Fixed*<br>121917.5 (0.000) | *Pooled*<br>123.8001<br>(0.000) |
| Hausman | *Random*<br>0.0000<br>(1.000)<br>*Random* | *Random*<br>0.1297<br>(0.9372)<br>*Random* |

***Soruce:*** *author`s computiton.*

Above tests results showed that, the two-way random effect model is appropriate empirical technique for this paper.

**Table 8:** Panel EGLS (Two-way random effects)

| **Two-way random effects for balanced panel** | | | |
|---|---|---|---|
| Dependent Variable | Lnstock_market | | |
| | Coefficient | tstatistic | Probability |
| Independent variables | | | |
| BITCOIN | 8.56E-06 | 2.9397 | 0.0033 |
| GOLD | 0.0001 | 2.1912 | 0.0286 |
| CONSTANT | 8.2384 | 7.1780 | 0.0000 |
| Root MSE | 0.4143 | | |
| R-squared | 0.0263 | | |
| Adjusted R squared | 0.0248 | | |
| F-statistic | 16.953 | | |
| Prob (F-statistic) | 0.0000 | | |
| Durbin Watson | 0.3269 | | |

R-squared emphasizes that independent variables (gold and bitcoin) can explain only 2,6 % changes of BRICS-T stock market. This shows that the explanatory power of the model is low. There is a positive relationship among bitcoin, gold and stock market. Any change in variables is positively reflected in the market. Since bitcoin`s probability value is 0.0033 it is significant at the 0.05 significant level, gold is not significant at the same significant level with the 0.0286 probability value. According to Durbin Watson test result (0.3269) there is a negative autocorrelation in a data set. Probability of F statistic shows that the model as a whole is significant. We see that the effect of bitcoin on the stock market is higher than gold. Both gold and bitcoin significantly positive, but has a weak relation ($\beta_{gold}$ =0.0001, $\beta_{bitcoin}$=8.56E-06) between stock market. The positive coefficient indicates that an increase in the price of gold and bitcoin increases the price of stock market. Such result is consistent with Raza et al. (2016) gold price positively influence the BRICS-T stock prices and bitcoin price (Mina Sami and Wael Abdallah 2020). In this case the investors are willing to invest bitcoin and gold in the same time.

## CONCLUSION

This article documents cross-sectional data to analyze whether bitcoin behaves as an investment tool compare to gold in BRICS-T stock market over the weekly period 2017-2020. First of all, cross-sectional dependence in this model was tested, and H0 hypothesis suggestion was rejected. Afterward, homogeneity test of Hsiao and Pesaran

Yamagata resulted that dataset was suitable for heterogeneous panel data.

Homogeneity test gave an opportunity to test causality test. Causality relations between the series are examined by Dumitrescu and Hurlin (2012) and determined that Bitcoin had a unidirectional causation between gold and stock market. There weren`t cause and affect between gold and stock market. Cross-Sectional dependency tests took the paper to test second-generation panel data tests. The stationary of the series was examined by Bai and Ng, Hadri Kurozumi, and Pesaran CIPS. It was determined that independent variables are stationary with their original values, but dependent variable became stationary after taking into consideration first difference. After the several diagnostic tests, the two-way random effect models were used to measure how bitcoin behave itself in BRICS-T stock market compared to gold.

Our empirical results show bitcoin is now becoming an alternative investment tool for BRICS-T countries and it better integrated with the country`s stock market than gold over the sample period. Theoretically, gold and bitcoin positively correlated with stocks means that gold and bitcoin is not a safe haven, and hedge. However, we have seen an increase in the prices of bitcoin and gold under extreme stock market conditions. And that could mean that bitocin and gold play the role of safe haven in the short term. Bitcoin`s hedging potential is more proclaimed than gold. It might be due to comparatively more volatile and non stable than gold. Moreover, gold

and bitcoin in the short term and in extreme stock market conditions can offer diversification benefits.

In brief, outcome of this research, in the short term bitcoin could be an alternative investment to the gold; moreover, these two assets together will also perform the functions of safe haven and diversifier in portfolio in difficult stock market conditions.

## REFERENCES:

Adnen, B. N., Juncal C., and R. Demirer (2018). Country Risk Ratings and Stock Market Returns in Brazil, Russia, India, and China (BRICS) Countries: A Nonlinear Dynamic Approach.

Al-Yahyaee, K. H., W. Mensi, and S. M. Yoon (2018). Efficiency, multifractality, and the long-memory property of the Bitcoin market: A comparative analysis with stock, currency, and gold markets. Finance Research Letters 27: 228-34.

Anton, K. and A. Moro (2018). The role of bitcoin in well diversified portfolios: A comparative global study. International Review of Financial Analysis 61.

Bai, J. and Ng, S. (2010). Panel Unit Root Tests with cross section Dependence: A further investigation. Econometric Theory, vol (26).

Baltagi, Badi H., and M. Hashem Pesaran. (2007) "Heterogeneity and cross section dependence in panel data models: theory and applications." Journal of Applied Econometrics 22: 229-232

Bampinas, G., and Panagiotidis, T. (2015). Are gold and silver a hedge against inflation? A two-century perspective. International Review of Financial Analysis (41), 267–76.

Bayar, Y., Kaya, A., & Yıldırım, M. (2014). Effects of Stock Market Development on Economic Growth: Evidence from Turkey. International Journal of Financial Research, 5(1).

Bauoiyour, J., Selmi, R., and Wohar, M. (2019). Bitcoin: competitor or complement to gold? 39 (1), Economics Bulletin, (36), 843-850.

Baur, D.G. (2010), Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold. The Financial Review (45), 217–229.

Baur, D., Hong, K. and Adrian D. L. (2017) Bitcoin: Medium of Exchange or Speculative Assets. Journal of International Financial Markets Instutions and Money (54), 177-189

Beckmann, J., Berger, T., Czudaj, R. (2015), Does gold act as a hedge or a safe haven for stocks? A smooth transition approach. Economic Modelling, 48(1), 16-24.

Chi-Wei, S., Meng, Q., Ran, T. and Zhang, X. (2020). Is the status of gold threatened by Bitcoin?. Economic Research, 33(1), 420-437.

Dumitrescu, E.I. and Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. Economic Modelling, 29 (4), 1450-1460

Chainalysis Team (2020), https://blog.chainalysis.com/reports/bitcoin-price-surge-explained-2020

Douglas, R. M., Daniel A. P. (2018). Digital Gold: A Primer on Cryptocurrency. Plastic Surgery, 26(2), 137-138.

Dipak, G., Levin, E.J., Macmillan, P., Wright, R.E. (2002). Gold as an Inflation Hedge? Studies in Economics and Finance, 22 (1), 1-72.

Dyhburg A.H. (2015 a), "Bitcoin,gold and the dollar–AGARCH volatility analysis", Finance Research Letters 16: 85-92.

Dyhburg A.H.(2015 b), "Hedging capability of Bitcoin. Is it the virtual gold?" Working Papers 201521, School of Economics, University College Dublin.

Bouri, E., Shahzad, S. J. H., Roubaud, D., Ladislav, K., and Brian, L. (2020). Bitcoin, gold, and commodities as safe havens for stocks:New insight through wavelet analysis. The quarterly Review of Economics and Finance, (77), 156-164.

Bouri, E., Molnar, P., Azzi, G., Roubaud, D. and Hagfors, L.I. (2017). On the Hedge and Safe Haven Properties of Bitcoin: Is It Really More than a Diversifier? Finance Research Letters, (20), 192-198.

Gündüz H.İ. (2017). "Testing for slope homogeneity in dynamic panel using the bild bootstrap Δadj test. Ekonometri ve İstatistik e-Dergisi, (26), 53-59.

Hadri, K. and Kurozumi, E. (2011). A locally optimal test for no unit root in cross-sectionally dependent panel data. Hitotsubashi Journal of Economics (52), 165-184.

Helms, K. (2020). Billionaire Paul Tudor Jones sees massive upside in Bitcoin, like investing in Apple or Google early, internet news, available on this link: https://news.bitcoin.com/paul-tudor-jones-bitcoin-apple-google/.

Henriques, I. and Sadorsky, P. (2018). Can Bitcoin Replace Gold in an Investment Portfolio? Journal of Risk and Financial Management, 11(48), 2-19.

Jin, J., Yu, J., Hu, Y. and Shang, Y. (2019). Which one is more informative in determining price movements of hedging assets? Evidence from Bitcoin, gold and crude oil markets. Physica A Statistical Mechanics and Its Applications, 527: 121

Klein, T., Thu, H. P., Walther, T. (2018). Bitcoin is not the New Gold - A Comparison of Volatility, Correlation, and Portfolio Performance. International Review of Financial Analysis, (59), 105-116.

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Available online: https://bitcoin.org/ en/bitcoin-paper (accessed on 15 March 2018).

Naveed, R., Shahzad, S. J. H., Tiwari, A. K. and Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. Resources Policy, (49), 290–301.

Nelson, A., Benilde, O. and Sampaio, R. (2013). When times get tough, gold is golden. The European Journal of Finance, 21 (6), 507-526.

Nikolaos, A. K. (2020). Is Bitcoin Similar to Gold? An Integrated Overview of Empirical Findings. Journal of Risk and Financial Management, 13 (5), 2-19.

O'Neil, J. (2001). Building better global economic BRICS. Goldman Sachs Global Economic Paper (66), 1-16.

Pesaran, M.H., Yamagata, T. (2008). Testing slope homogeneity in large panels. Journal of Econometrics, (142), 50–93.

Raza, N., Shahzad, J., Tiwari, A., Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. Resources Policy (49), 290-301.

Sami, M., Abdallah, W. (2020). How does cryptocurrency market affect the stock market performance in the MENA region?. Journal of Economic and Administrative Sciences, 1026-4116.

Shahzad,S.J.H, Bouri, E., Rehman, M., Roubaud, D. (2021). The hedge asset for BRICS stock markets: Bitcoin, gold or VIX. The World Economy, 1-25.

Shahzad,S.J.H., Bouri, E., Rehman, M., Roubaud, and Kristoufek, L. (2019). Safe haven, hedge and diversification for G7 stock markets: Gold versus bitcoin. Economic Modelling (87), 212-224.

Schober, P., Boer, C., Schwarte, L.A. (2018). Correlation Coefficients: Appropriate Use and Interpretation. Anesthesia & Analgesia, 126 (5), 1763-1768.

Syed, H. Z., Syed, S.A.S. (2019). Bitocin and Gold Prices: A fledging long-term relationship. Theoretical Economics letters, (9), 2516-2525.

Wilson, D., Kelston, A.L. and Swarnali, A. (2010). Is this the 'BRICs Decade'. Goldman Sachs Global Economic, Commodities and Strategy, 10 (03).

Yilmaz, Ö. (2017). An alternative analysis of Economic Indicators of Turkey and BRICS Countries, European Journal of Alternative Education Studies, 2 (1), 152-162

# CHAPTER 3

# THE RELATIONSHIP BETWEEN, $CO^2$ EMISSION, RENEWABLE ENERGY CONSUMPTION AND ECONOMIC GROWTH: PANEL DATA ANALYSIS

Didem BALKAYA[1]

[1] PhD. Student, Niğde Ömer Halisdemir University, Department of Economics, hiradidembalkaya@gmail.com , https://orcid.org/0000-0003-0485-6634.

## INTRODUCTION

While economic activity raises the standard of living, a certain amount of waste is released into the environment as a result of the input used in production. From the past to the present, significant progress has been made in developed economies that generate carbon-based waste. Brown economy occurs when economic growth largly became dependent on environmentally destructive activities especially fossil fuels like coal, oil and gas. Following the industrial revolution, the brown economy concept has became dominant in order to increase the national product in the manufacturing, industrial and service sectors. Natural resource utilization, pollution and other environmental considerations become directly proportional of long-run economic growth. Natural resources have a double effect on economic growth and rising demand of natural resources increases the depletion ot the natural resources. This subject came to fore during Great Depression. Since the 1960s, when environmental problems have reached serious proportions, works have begun to change the concept of brown economic growth.

For the first time, in the report titled Our Common Future published by the United Nations World Commission on Environment and Growth, the concept of sustainable growth was defined as growth that does not impede production for tomorrow while production for today is being made. A green economy movement that consumes renewable energy resources aims to support economic growth by ensuring the sustainability of natural resources, reducing carbon emissions, increasing resource efficiency and creating new job opportunities.

Countries use a variety of methods and strategies to promote green economic growth. The green economy strategy is a strategy that reduces carbon emissions and pollution, increases energy and resource efficiency, prevents bio diversity and ecosystem losses, allows public and private sector investments to be made in tandem to increase income and employment.

Following a brief theoretical introduction to the subject, similar studies were examined in the literature section of the study. Based on previous research, a model was developed and the analysis phase has began. First of all, the cross-section dependency and homogeneity of the data were examined within the scope of the analysis. Based on these findings, the unit root test was run, followed by the Granger causality test. The study was terminated based on the results of the causality test, which determined whether there was a relationship between the variables.

## 1. THEORETICAL STRUCTURE

One of the most important factor for economic growth is ensuring the continuity of production by increasing. However, increased in production raises the level of pollution in the environment. Since the 1980s, Turkey has used incentive policies to promote industrial development and escalation of a production. The fast growth of the economies that accompanied the industrial revolution naturally increased consumption and as a result, energy consumption. Significant increases in carbon emissions have been observed in tandem with

increases in energy consumption (Doğan and Topal, 2016; Farhani and Rejeb, 2012).

The European Union has established strategies to reduce green house gas emissions, increase the proportion of renewable energy and improve energy efficiently. In line with its, 2020 and 2030 the targets have reduced green house gas emissions even further, completed the domestic energy market by advancing infrastructure projects and determined green employment-based strategies that do not over look the environment. In addition to these developments, we will explain some activities based on member countries using the table below:

**Table 1:** Shows A List Of Activities By Member Country

| YEAR | COUNTRY | APPLICATIONS & DEVELOPMENTS |
|---|---|---|
| 1990 | Poland | The Polluter Pays application seeks to ensure the continuity of sustainability by establishing independent source of environmental financing. |
| 1996 | Hungary | The goal of the National Environment Council is to adopt a broad model of growth that is sustainable without ignoring the environment. |
| 2000 | Germany | The goal of Sustainable Synthetic Bio-Fuel Production is to create low-carbon, environmentally friendly bio-fuels. |
| 2003 | İtaly | Eco-Efficient Ready Meals cause less environmental harm by reducing the use of plastic meal packaging. |
| 2004 | Austria | The goal of Energy Generating Windows is to generate energy from the sun while causing the least amount of environmental damage. |
| 2004 | France | It is an application developed in collaboration with the Fuel Cell Application in Paris to broaden the application area of fuel cells while lowering the carbon ratio. |
| 2007 | Sweden | The goal of Stockholm's Green Capital is to achieve sustainable growth in collaboration with the environment across of Sweden |
| 2007 | İtaly | The Mediterranean Local Energy Projects main goal is to develop an integrated sustainable growth model. |
| 2007 - 2008 | United Kingdom | The goal of the Environment Agency application is to protect the environment and ensuring the achievement of the goal of sustainable growth. |

**Source:** Prepared by Author, 2021.

When the Accession Partnership Document for Turkey was investigated; it was clear that the issues concerning urban policies are classified as a transportation energy, environment, consumer protection and health. The document addresses the transposition and implementation of regulations governing environmental protection, water quality, pollution control and waste management. The EU's progress report for Turkey addresses issues such as air quality, waste management, noise and water quality as part of urban policy (Duru, 2005: 59-76).

## 2. REVIEW OF LITERATURE

The global impact of environmental pollution is endangering life on a daily basis. According to studies, the use of fossil fuels has increased with industrialization and resulting in increased greenhouse gas emissions. Because of the negative effects of fossil fuels on the environment and the future depletion of these fuels, the search for alternative energy sources has began. In this context the use of environmentally friendly renewable energy sources (wind, solar, geothermal, hydraulic etc.) has increased. In this section of our research, we summarize studies on the relationship between the use of renewable energy sources, $CO^2$ emissions and economic growth. These investigations are Kahia and Charfeddine (2019), Abdieva, Akay and Oskonbaeva (2018), Antonakakis et al. (2017), Bekhet et al. (2017), Özşahin et al. (2016), Farhani (2015), Salahuddin et al. (2015), Sulaiman and Saboori (2013), Silva, Soares and Pinho (2011), Lean and Smyth (2009).

Kahia and Charfeddine (2019) used Panel (VAR) analysis to examine the effects of renewable energy consumption, financial development, $CO^2$ emissions and growth in 24 Middle Eastern and North African countries between 1980 and 2015. It demonstrated that both renewable energy consumption and financial growth account for little of $CO^2$ emissions and economic growth.

Abdieva, Akay and Oskonbaeva (2015) studied the relationship between renewable energy consumption, growth, and carbon dioxide emissions in nine MENA countries in 1988 to 2010 time span. They looked at bidirectional causality between growth and renewable energy consumption, one-way causality from carbon dioxide emissions to renewable energy and one-way causality from growth to carbon dioxide emissions in this study, which used panel data analysis.

Antonakakis et al. (2017) investigated between 1971 and 2001, the Panel Action-Response Function and Panel Vector Automatic Regression (PVAR) models were used to examine the relationship between economic growth, energy consumption and carbon emissions for 106 countries divided into different income levels. According to the findings, there is a two-way relationship between economic growth and energy consumption. It has also been discovered that the impact of energy consumption on economic growth and carbon emissions varies.

Bekhet et al. (2017) investigated the long-run relationship between carbon emissions, financial development, energy consumption and economic growth for Gulf Cooperation Council countries between 1980

and 2011.But for the United Arab Emirates, the studies findings indicate that there is a long-term relationship between the variables.

Özşahin et al. (2016) determine the relationship between renewable energy consumption and economic growth using data from the BRICS countries and Turkey from 2000 to 2013. By applying Pedroni, Westerlund, Panel CUSUM cointegration and Panel ARDL estimator tests, they concluded that there is a positive long-run relationship between renewable energy consumption and economic growth.

Farhani (2015) investigated the relationship between renewable energy consumption, growth and emissions in 12 MENA countries between 1975 and 2008. Between the variables, there was no evidence of Granger causality. In the lon-grun, there is unidirectional causality from economic growth and $CO^2$ emissions to renewable energy consumption.

Salahuddin et al. (2015) examine the long-term relationship between economic growth, carbon emissions, financial growth and electricity consumption for Gulf Cooperation Council (GCC) countries between 1980 and 2012 using dynamic least squares (DOLS), fully modified least squares (FMOLS) and dynamic fixed-effects model (DFE). According to the findings of this analysis, there is a long-term positive relationship between economic growth, electricity consumption and carbon emissions and a negative relationship between carbon emissions and financial development.

Sulaiman and Saboori (2013) examined the cointegration and causality relationship between economic development, carbon dioxide emissions and energy consumption for the Association of Southeast Asian Nations (ASEAN) between 1971 and 2008 using Granger causality analyses and the ARDL test approach.According to the findings found results of the study, a positive and statistically significant relationship was discovered between the variables for all countries, both in the short and longrun; Granger causality analysis revealed a bidirectional relationship between the variables in the longrun.

Silva, Soares and Pinho (2011) investigated the impact of renewable electricity consumption on GDP and $CO^2$ emissions. Between 1960 and 2004, they used a three-variable VAR model with four countries. It has been determined that the share of renewable electricity generation in all countries other than the United States has either low or high economic costs in terms of per capita GDP.

Lean and Smyth (2009) used a panel vector error correction model to examine the causality between energy consumption, carbon dioxide emissions and income in their study of ASEAN member countries. As a result of their research, they discovered a long-term bidirectional relationship between electricity consumption and $CO^2$ emissions.

## 3. DATA, METHODOLOGY AND ECONOMIC RESULTS

### 3.1. Data

We collected annual data from 1990 and 2015 from the World Bank Development and OECD indicators database for 15 different developed

and developing countries; Belgium, Canada, the Czech Republic, Denmark, Finland, France, Greece, Luxembourg, Mexico, the Netherlands, Norway, Slovenia, Sweden, the United States and Turkey. Above listed countries real GDP, renewable energy consumption and carbon emission datas considered. Table 2 presents detailed information on the variables.

**Table 2:** Variable Definitions And Sources

| VARIABLES | VARIABLE TYPE | DEFINITION | RESOURCES |
|---|---|---|---|
| **GDP** | Dependent Variable | Real Fixed GDP (in billions of dollars in 2010) | World Bank |
| **Renewable Energy Consumption** | Independent Variable | Terawatt/hour (Tw/h) | World Bank |
| **$CO^2$ Emission** | Independent Variable | Tons of Metric Tons Per Capita | OECD |

EViews statistical program was used to conduct panel data analysis tests. While the cross-sectional dimension (N=15) includes data from 15 countries, the time dimension (T=25) includes data spanning for 25 years. The results were interpreted using confidence intervals of %95.

### 3.2. Theoritical Model Formulation

The following model was developed to investigate whether renewable energy consumption and $CO^2$ emissions, as independent variables for the selected countries, have a causal relationship with real GDP to make economic comments. The dependent variable in the model is real GDP ($lnrgdp_{it}$) and the independent variables are renewable energy consumption ($\beta_1 lnrenergy_{it}$) and $CO^2$ emissions ($\beta_2 lncarbon_{it}$):

$lnrgdp_{it} = \beta_0 + \beta_1 lnrenergy_{it} + \beta_2 lncarbon_{it} + \varepsilon_{it}$

$i$: 1,….,15 T: 1990,…, 2015

- $\beta_0$= coefficient of constant regression.
- $\varepsilon_{it}$= the term "random error".

### 3.3. Methodology

The above theoritical model will be estimated using panel data techniques. Firstly, cross-section dependency test will be tested to determine which unit root and homogeneity tests in this paper will be used. For the homogeneity results Hasio (1986) homogeneity test will be applied. In the presence of cross-sectional dependence and heterogeneity assumptions second generation unit root The Bai Ng (2004) test will be employed to determine the stationarity of variables. To meet the requitements of Granger causality tests all the variables became stationary at the same level.

### 3.4. Testing for the Cross-Sectional Dependence

At the first stage of analysis, first needed to test cross-sectional dependence to decide which unit root test would be appropriate. Cross-section independence analysis is performed to determine whether all of the identified countries are equally affected by the shock that affects one of the units forming the panel or whether the shock experienced by one of these countries in macroeconomic terms has no effect on the other countries. Importance of the cross-section dependence test is results of analyses that do not account for cross-sectional dependence will be inconsistent and inconclusive. Cross-sectional test hypotheses:

- $H0$: *There is no reliance on the horizontal section.*
- $H1$: *There is a dependency on horizontal section.*

The first of the cross-section dependency tests developed under these assumptions is the Lagrance Multiplier (LM) test which developed by Breusch and Pagan (1980). The test is computed through the expression:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2$$

It will be used when T → ∞ and N are fixed, $\frac{N(N-1)}{2}$ degrees of freedom squared asymptotic distribution and T>N. The test exhibits distortions when N>T. As a result of this circumstance, Peseran (2004) developed the $CD_{LM}$ test as a new alternative solution to eliminate the deficiency. When both N and T are large, this test can be used:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\hat{\rho}_{ij}^2 - 1)$$

When T→ ∞ and N→ ∞ are present, the $CD_{LM}$ test is valid. It does, however, show deviations when N>T. As a result, Peseran et al. (2008) developed the deviation-corrected $LM_{adj}$ test.

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}T\hat{\rho}_{ij}\frac{(T-k)\hat{\rho}_{ij}^2}{\sqrt{v_{Tij}^2}}$$

Table 3 shows the results of the data's cross-sectional dependency in this context.

**Table 3:** Results of Cross-Section Dependency

| VARIABLES | TESTS | | |
|---|---|---|---|
| | LM | $CD_{LM}$ | $LM_{adj}$ |
| Lnrgdp | 0.0000 [2431.887] | 0.0000 [160.5705] | 0.0000 [49.25009] |
| Lnrenergy | 0.0000 [1226.501] | 0.0000 [77.39095] | 0.0000 [-2.868906] |
| Lncarbon | 0.0000 [941.9229] | 0.0000 [57.75317] | 0.0041 [9.063798] |

**Note**: "F-Statistics" values are in square brackets.

As seen in the table 3 above, the results of different tests show that the variables are cross-sectionally dependent. Therefore, the second generation unit root test will be appropriate for this study. At this point, the homogeneity test results should be used to determine second generation unit root test.

### 3.5. Test for Homogeneity

While the homogeneity assumption expresses that all units of the panel data exhibit the same characteristics, the heterogeneity assumption expresses that the units that comprise the panel data do not exhibit the same characteristics. For this test, the structure and properties of the data are critical (Turgut and Uçan, 2021: 10). The study examined the presence or absence of homogeneity in the slope coefficients by employing the Hsiao (1986) test. The followings are the test assumptions:

- $H1$: Homogeneous $\leftrightarrow$ $H1'$: Heterogeneous
- $H2$: Homogeneous $\leftrightarrow$ $H2'$: Heterogeneous
- $H3$: Homogeneous $\leftrightarrow$ $H3'$: Partially Heterogeneous

In the Hsiao test, the interpretation of the H2 hypothesis produce the best results. Table 4 shows the results of the data Homogeneity test.

**Table 4:** The Results of the Homogeneity Test

| HYPOTHESIS | F-STATS | P VALUE |
|---|---|---|
| H1 | [133.2896] | 1.3E-187 |
| H2 | [46.68226] | 7.2E-100 |
| H3 | [69.20037] | 1.91E-94 |

The Hsiao homogeneity test results show that it accepted the heterogeneity assumption by rejecting the homogeneity condition at the %5 significance level in its three hypotheses. While the alternative hypothesis of H1 and H2, namely the heterogeneity assumption, is accepted in this context, it is understood that the coefficients exhibit heterogeneous properties when the H3 hypothesis accepts the partial heterogeneity assumption. The stationarity levels of the variables were checked using the second generation unit root test, which was chosen with the assumption of cross-sectional dependence and heterogeneity in mind.

### 3.6. Panel Unit Root Tests

The integration features of the studied series were examined through second generation unit root tests. Theoritically, non- existence of cross section dependency means first generation unit root tests are appropriate and vice versa existence of cross-section dependency permits to apply second generation unit root tests.

There is no cross-sectional dependence under the assumption of homogeneity; Levin, Lin and Chu (2002) and Breitung (2005) tests can

be used. There is no cross-sectional dependence under the assumption of heterogeneity; Im, Pesaran and Shin (2003), Maddala and Wu (1999) and Choi (2001) tests can be used. Again, Hadri's (2000) test can be used with heterogeneity or homogeneity without cross-sectional dependence. Breuer et al. (2002) SURADF, Smith et al. (2004) Bootstrap, Bai and Ng (2004) PANIC, Pesaran (2007) CADF and CIPS, Hadri and Kurozumi (2012) HK tests are examples of second generation unit root tests that can be used in cases where is cross-section dependency.

Bai and Ng (2004) evaluated their assumptions in the test where both heterogeneous or homogeneous assumptions can be examined and the important criterion is cross-section dependence by developing a simple and one-factor analytical model (Bai ve Ng, 2004: 1127):

$X_{it=} D_{it}+\lambda_i F_t+e_{it}$

The time function is represented by t in the $D_{it}$ expression in the formula. $\lambda_i F_t$ is an uncontrolled variable. The error term in the formula is represented by $e_{it}$. In general, the formula is made up of three parts. The variables in the formula can be stationary at various levels and all variables can be stationary at the I (1) level. Because of this ambiguity, Bai and Ng (2004) proposed testing the existence of unit roots in specific and general items separately. They called this process PANIC (Bai ve Ng, 2004: 1128).

The results of the cross-section test and homogeneity test were considered when deciding on the unit root test within the scope of the

study. Bai and Ng (2004) conducted the PANIC test in this context under the assumption of cross-section dependence and heterogeneity. Table 5 shows the second generation unit root test results for the variables in this context.

**Table 5:** Unit Root Test Results for the Second Generation

| VARIABLES | TESTS | |
|---|---|---|
| | LEVEL | FIRST DIFFERENCE |
| lnrgdp | 0.03553 | - |
| lnrenergy | 0.94897 | 0.00206 |
| lncarbon | 0.21824 | 0.00000 |

As shown in table 5 the dependent variable lnrgdp is stationary at the level, according to the results of the PANIC test, one of the second generation unit root test which is developed by Bai and Ng (2004). Due to non-stationary at the level of the independent variables (lnrenergy and lncarbon) became stationary by taking the first difference. Following this, a causality analysis was performed to investigate the relationships between the variables.

### 3.7. Panel LS

Panel LS can also be used without taking into account the cross-section and time dimensions when performing panel data analysis. The model may become difficult to predict if the total number of predicted parameters in the model exceeds the number of observations. Different models can be obtained in such cases by varying the assumptions about the nature of the error term and the variability of the coefficients (Pazarlıoğlu and Gürler, 2007: 37). As a result, in cases where are cross-sectional or time dimension effects, Fixed Effects Model or

Random Effects Model can be used, whereas time Pooled Regression Model can be used in cases where there are no cross-sectional or time dimension effects (Gujaratı, 2004: 650). When the effect of the model was examined in the study, it was discovered that it had random effects. Table 6 shows the variables test results.

**Table 6:** Cross Section and Time Random Results

| VARIABLES | F-STATS | P VALUE |
|---|---|---|
| lnrgdp | -1.147154 | 0.2521 |
| lnrenergy | 2.237765 | 0.0258 |
| lncarbon | 54.57293 | 0.0000 |
| **Statistical Power** | $R^2$ = 0.016604 | P Value (F-Stats) = 0.044412 |

When the model is examined in this direction:

$$lnrgdp_{it} = 10.124160.084416 lnrenergy_{it} + 0.463413 lncarbon_{it} + \varepsilon_{it}$$

[-1.47154] (0.2367) [2.237765] (0.0159)

Although the results of the analysis were found to be meaningless when the variables were analyzed separately, a significant result was obtained when the model as a whole was considered. In other words, the model is economically significant even though it is not statistically significant. Economic growth has an elasticity of -0.084416 in relation to renewable energy consumption. In other words, a %1 increase in renewable energy consumption reduces economic growth by 0.084416 percent. Economic growth elasticity in relation to $CO^2$ emissions is 0.463413. To be more signifincat, a %1 increase in $CO^2$ emissions leads to a 0.463413 percent increase in economic growth.

### 3.8. Analysis Of Causality

To test the relationship between variables in panel data analysis, causality tests are used. Granger causality analysis serves as the foundation for these tests. To perform a causality analysis in this context, the data's stationarity must be first ensured. The followings are the assumptions of the Granger causality test for a model with a classical error term:

$$Y_t = \sum_{i=1}^{k} \beta i \; Y_{t-i} + \sum_{i=1}^{m} \delta i \, X_{t-i} + U_{it}$$

- $H0$: $\sum_{i=1}^{m} \delta i = 0$
- $H1$: $\sum_{i=1}^{m} \delta i \neq 0$

When Granger defined causality, he used the phrase, *"If the prediction of Y is more successful when the previous values of X are used than when the previous values of X are not used, then X is the Granger cause of Y."* If there is a relationship, the situation is expressed as X → Y, according to this definition. This expression will be X ↔ Y if the relationship is bidirectional. Because the series are not stationary during the analysis, the relationships will be detected incorrectly (Granger, 1974). Table 6 shows the results of the data's Classic Granger Causality Test.

**Table 7:** Results of the Causality Test

| VARIABLES | F-STATS | P VALUE | RESULT |
|---|---|---|---|
| Dlnrenergy ≠ lnrgdp | [0.09135] | 0.7626 | Reject |
| lnrgdp ≠ Dlnrenergy | [1.38090] | 0.2407 | Reject |
| Dlncarbon = lnrgdp | [10.9632] | 0.0010 | Accept |
| Lnrgdp = Dlncarbon | [25.8939] | 6.E-07 | Accept |
| Dlncarbon ≠ Dlnrenergy | [3.11226] | 0.0786 | Reject |
| Dlnrenergy ≠ Dlncarbon | [0.23500] | 0.6281 | Reject |

According to the causality analysis results, there is no casual relationship between Dlnrenergy and lnrgdp based on the p values at the %5 significance level. Similarly, there is no link between Dlncarbon and Dlnrenergy. However, a bidirectional causality relationship between lnrgdp and Dlncarbon was discovered. The findings of the study confirm the link between economic growth and $CO^2$ emissions, but they also show that there is no link between renewable energy consumption and economic growth.

## RESULT

In a world where globalization is accelerating and national economies are expanding on a daily basis, it is critical to pass on environmental conditions to future generations without deterioration. The energy factor must be provided in order to ensure the continuity of economic growth, and production. The tendency of fossil fuels to deplete and the high rates of $CO^2$ emissions as a result of their consumption have accelerated the search for new energy sources. The use of renewable energy sources is increasing in this direction. Within the scope of the study, the relationship between the variables was examined using data

from 15 different countries economic growth, $CO^2$ emissions and renewable energy consumption.

The results of the cross-section test performed as part of the panel data analysis revealed that the data contained cross-section dependence. Under the assumption of cross-section dependence and heterogeneity, Bai and Ng (2004) applied the PANIC test, one of the second generation unit root tests, to the variables that produced heterogeneous results in the following homogeneity test. According to the results of the unit root test, the variables were stationary at different levels. To investigate the causal relationship between the variables, Granger causality analysis was used. Economic growth and $CO^2$ emissions have a bidirectional relationship, according to the causality analysis. Renewable energy consumption, on the other hand, has an impact on economic growth.

According to the findings of this study's analysis, $CO^2$ emissions are directly proportional to economic growth due to the high consumption of fossil fuels to ensure the continuity of production i.e. economic growth. Production is required for long-term economic growth. Promotions describing the dangers of using fossil fuels in manufacturing, on the other hand, should be increased. Incentives should be used to increase demand for renewable energy. Renewable energy access should be made easier. The use of renewable energy should be made more appealing by lowering the costs.

## REFERENCES

Akay E. Ç., Abdieva R. and Oskonbaeva, Z. (2015). Yenilenebilir enerji tüketimi, iktisadi büyüme ve karbondioksit emisyonu arasındaki nedensel ilişki: orta doğu ve kuzey Afrika ülkeleri örneği. Internaitonal Conference On Eurasian Economies, 628-636.

Antonakakis, N., Chatziantoniou, L. and Filis, G. (2017). Energy consumption, $CO_2$ emissions, and economic growth: an ethical dilemma. Renewable and Sustainable Energy Reviews, 808-824.

Bai, J. and Ng, S. (2004). A PANIC attack on unit roots and cointegration. Econometrica, (72), 1127–1178.

Bekhet, H. A., Matar, A. and Yasmin, T. (2017). $CO_2$ emissions, energy consumption, economic growth and financial development in GCC countries: dynamic simultaneous equation models. Renewable and Sustainable Energy Reviews, (70), 117-132.

Breusch, T. S. and Pagan, A. R. (1980). The lagrange multiplier test and its to modelspecification tests in econometrics. Review of Economic Studies, (47), 239-53.

Ciarreta, A. and Zarraga, A. (2010). Economic growth-electricity consumption causality in 12 European countries: a dynamic panel data approach. Energy Policy, (38), 3790–3796.

Doğan, İ. and Topallı, N. (2016). Milli gelir, karbon emisyonu ve enerji tüketimi: Türkiye için doğrusal ve doğrusal olmayan nedensellik analizi. Business and Economics Research Journal, (1), 107-121.

Duru B. (2005). Avrupa birliği kentsel politikası ve Türkiye kentleri üzerine. Mülkiye Dergisi, (246), 59-76.

Farhani, S. And Rejeb, J. B. (2012). Energy consumption, economic growth and CO2 emissions: evidence from panel data for MENA region. International Journal of Energy Economics and Policy, (2), 71-81.

Farhani, S. (2015). Renewable energy consumption, economic growth and CO2 emissions: evidence from selected MENA countries. France, Paris: Ipag Business School.

Granger, C. W. J. (1974). Spurious regressions in econometrics. Journal of Econometrics, (2), 111-120.

Gujaratı, D. N. (2004). Basic econometrics. 4th ed., The McGraw-Hill Companies.

Holtz-Eakin, D., Newey, W. and Rosen, H. (1988). Estimating vector autoregressions with panel data. Econometrica, (56), 1371–1395.

Hsiao, C. (1986). Analysis of panel data, econometric society monographs. New York: Cambridge University Press.

Kahia, M. and Charfeddine, L. (2019). Impact of renewable energy consumption and financial developmenton CO2 emissions and economic growth in the MENA region: a panel vector autoregressive (PVAR) analysis. Elsevier, 198-213.

Lean, H. H. and Smyth, R. (2010). CO2 emissions, electricity consumption and output in ASEAN. Monash Universty Business and Economics, 1858-1864.

Özşahin, Ş., Mucuk, M. and Gerçeker, M. (2016). Yenilenebilir enerji ve ekonomik büyüme arasındaki ilişki: BRICS ülkeleri üzerine panel ARDL analizi. Siyaset, Ekonomi ve Yönetim Araştırmaları Dergisi, (4), 111-130.

Pazarlıoğlu, V. And Gürler, Ö. K. (2007). Telekomünikasyon yatırımları ve ekonomik büyüme: panel veri yaklaşımı. Finans, Politik-Ekonomik Yorumlar, (44), 35-43.

Pesaran, H. M. (2004). General diagnostic tests for cross section dependence in panels. University of Cambridge Working Paper, 0435.

Pesaran, M. H., Ullah, A. and Yamagata, T. (2008). A bias-adjusted LM test of error cross section ındependence. The Econometrics Journal, (11), 105–127.

Saboori, B. and Sulaiman, J. (2013). CO2 emissions, energy consumption and economic growth in association of Southeast Asian Nations (ASEAN) countries: a cointegration approach. Low Carbon Economy**,** (1), 813-822.

Salahuddin, M., Gow, J. and Öztürk, I. (2015). Is the long-run relationship between economic growth, electricity consumption, carbon dioxide emissions and financial development in gulf cooperation council countries robust? Renewable and Sustainable Energy Reviews**,** (51), 317-326

Silva, S., Soares, I. and Pinho, C. (2012). Yenilenebilir enerji kaynaklarının ekonomik büyüme ve CO2 emisyonları üzerindeki etkisi: bir SVAR yaklaşımı. European Research Studies Journal, 133-144.

Turgut, E. and Uçan, O. (2021). Yolsuzluğun vergi oranları ile olan ilişkisinin OECD ülkeleri örnekleminde incelenmesi. Niğde Ömer Halisdemir Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (3), 1-17.

# CHAPTER 4

# TESTING THE TWIN DEFICITS HYPOTHESIS IN G-7 COUNTRIES: PANEL DATA ANALYSIS (2001-2020)

Nursaç DEĞERLİ[1]

[1] Phd. Student, Niğde Ömer Halisdemir University, Depertmant of Economics, nursacdegerli@hotmail.com , https://orcid.org/0000-0002-2605-2090.

## INTRODUCTION

The close relationship between the budget deficit and the current account is a phenomenon that has occurred in many countries at various times. In the economics literature, the simultaneous existence of a budget deficit and a current account deficit in an economy is referred to as "twin deficits". The first of these terms, budget deficit (fiscal deficit), is defined as government spending exceeding government revenue. The current account deficit, on the other hand, is defined as a country's imports of goods and services exceeding its exports, while it can be broadly defined as the import value of goods, services, income and current transfers exceeding the export value.

The current account balance measures the difference between a country's current earnings from abroad and its current payments made abroad in a given period; that is, the difference between liabilities and assets is used to calculate the current account balance. A sizable proportion of economists believe that large current account deficits are correlated with large budget deficits. This macroeconomic theory is known as the "twin deficit hypothesis." The relationship between these two variables captured attention in the 1980s, during Reagan's presidency, because the United States was experiencing both foreign and fiscal deficits. Most researchers have argued that the deterioration in the external balance is due to budget deficits as a result of the joint action in the budget deficit and external deficit. The fact that the current account and budget balances, as well as GDP, decreased by 3% and 4%, respectively, between 2001 and 2005 in the United States

raised the possibility of a relationship between these two variables at the time.

The relationship between public sector and the current account deficit is a fundamental issue in economic policy and open economy in macroeconomy field. It is argued that these two deficits have a strong and positive relationship. In addition to these factors, the relationship between the budget deficit and the current account deficit is influenced by the private sector savings-investment deficit. According to a basic equation for national accounts, the current account deficit consists of deficits in the public and private sectors.

In addition to the strong relationship between the budget deficit and the current account deficit, some argue that these two deficits do not move sequentially and even in opposite directions. According to the twin deficit hypothesis, a country's fiscal deficit rises in response to tax cuts. Domestic residents will respond to this situation by increasing their spending, lowering the total savings rate. A decrease in savings implies a decrease in domestic investments to the point where it balances the savings gap, requiring the country to borrow from abroad or reduce the amount of money it lends abroad. As a result, it is widely assumed that rising fiscal deficits will be accompanied by rising current account deficits. As a result, if the data obtained supports the twin deficit hypothesis, reducing budget deficits through tax increases can be implemented as a recovery policy. As a result, it is expected that disposable income will fall and thus demand

for imported goods will fall and the current account deficit will eventually shrink.

The validity of the twin deficit hypothesis, which has been the subject of numerous studies since its inception, was tested in this study. The effect of the budget deficit on the current account deficit and gross national product has been examined within the G-7 countries in the analysis. Panel LS was used in this case with cross-sectional dependence and the validity of the twin deficit hypothesis was investigated using the Dumitrecu-Hurlin causality test between 2001 and 2020.

## 1. THE TWIN DEFICIENCY HYPOTHESIS'S CONCEPTUAL FRAMEWORK

It is defined as the presence of a budget deficit as well as a current account deficit in a twin-deficit economy (Bocutoğlu, 2016: 47). The balance of variables in the economy, such as investment-savings, exports-imports and government income-expenses, is critical for maintaining economic stability. The government's budget balance and foreign trade balance are referred to as twin deficits in this context (Mankiw, 2010: 127). Economic schools analyze views on the budget deficit differently during the formulation of economic policies. Individuals, for example, use the logic of the "permanent income hypothesis" when spending, and they base their disposable income on the long term rather than the short term. Because markets are flexible, the government does not need to intervene in the economic balance,

which is already at full employment. The term "budget deficit" refers to a situation in which expenditures rise while income falls. In fact, the government's expenditures are both routine and ongoing. As a result, the fiscal deficit becomes a burden on future generations. This is why, in this approach, the balanced budget policy is advocated (Pınar, 2010: 137). Similarly, the Neoclassical approach imposes no duties on the public sector other than the production of some public and services. The state's intervention in the economy, according to neoclassicals, should be kept to a bare minimum. He contended that the government should only intervene in the event of an economic shock (Sayar and Bayar, 2019: 36).

Following the Great Depression of 1929, the budget deficit policy was implemented with an understanding of the interventionist state dominated by Keynesian economics. With the implementation of this policy, the goal of full employment, II. It laid the groundwork for countries to overcome economic contractions after World War II. Due to state intervention, policies implemented to achieve postwar social and economic restructuring and development goals have disrupted the balance between income and expenditure in fiscal policy. Budget deficits resulted as a result. During the aforementioned period, the preference for borrowing and emissions to close the budget deficit caused the economic balance to gradually deteriorate. In the 1970s, the phenomenon of stagflation, in which unemployment and inflation coexisted, emerged as a result of the preference for borrowing and emission. As an alternative to the discredited Keynesian school, new

schools arose. Milton Friedman's Monetarism school of thought argued that the main problem of an unstable economy is the volatility of the money supply. Friedman argued that the state, like the classics, should implement a balanced budget policy. Furthermore, he emphasized that “money supply increases” should not be used to close the budget deficit (Mucuk, 2008: 42).

The budget deficit issue affects both developed and developing countries. The budget and current account deficits play an important role in the formulation of macroeconomic policies. Even in developed economies, maintaining fiscal balance is regarded as a fundamental tenet of economic policy (Aslan, 2008: 409).

The theoretical framework of the twin deficit hypothesis will be explained more clearly using a calculation based on national income equality in open economies (Ay et al., 2004: 76).

$$MG = Y = C + I + G + X - M = C + S + T$$

In the equation, Y stands for gross domestic product (GDP), C for consumption, I for investment, G for government spending, X for exports, M for imports, S for savings and T stands for taxes. Due to equality of the leaks and injections calculation will be:

$I + G + X = S + T + M$ will be included in the form. If the equality is shifted,

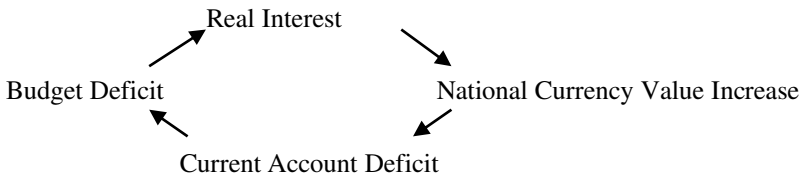
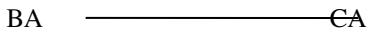
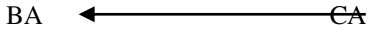
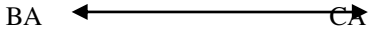
$$X - M = (T-G) + (S-I)$$

CA = BA – TA consisting of.

CA stands for current account deficit, which expresses the difference between goods and services exported and imported; BA for the difference between public expenditures and revenues, i.e. the budget deficit and TA for the difference between investments and private savings (savings gap).

Four different approaches have been proposed in the literature on economic studies to explain the causal relationship between the budget deficit and the current account deficit. The following is a simple illustration of this (Sayar and Bayar, 2019: 37).

**Table 1:** Theoretical Approaches to the Twin Deficit Hypothesis

| |
|---|
| **1. Traditional Point of View**<br>  |
| **2. The Hypothesis Of Ricardian Equivalence**<br>  |
| **3. Targeting the Current Account Deficit**<br>  |
| **4. Causality İn Both Directions**<br>  |

### 1.1. The Traditional (Keynesian) Twin Deficit Hypothesis

This traditional Keynesian approach explains the relationship between budget deficits and current account deficits using the tools of "Keynesian Income Spending", the "Mundell-Fleming Model" and the "Feldstein Chain Hypothesis". Using these tools in the traditional approach, Keynes emphasized the close relationship between the budget deficit and the current account deficit (Mucuk, 2008: 196).

According to the traditional view, if both a flexible exchange rate and capital mobility exist in an open economy, public spending will reduce private savings. Reduced national savings will cause interest rates to rise and rising interest rates will result in capital inflows, causing the national currency to appreciate. An increase in the value of the national currency reduces exports and in this case, creates a deficit in the net export account, causing the current account balance to deteriorate and result in a deficit (Ay et al., 2004: 76).

### 1.2. The Hypothesis Of Ricardian Equivalence

In the equivalence hypothesis, he contends that, contrary to traditional Keynesian thinking, there is no relationship between the budget deficit and the current account deficit. David Ricardo and later Barro claimed in the 18th century that the public budget (deficit or surplus) had no effect on the real interest rate or investments (Parkin, 2008: 76).

According to the Ricardian equivalence approach, if governments reduce taxes or increase public expenditures, rational individuals will

increase their savings in the current period as a precaution, knowing that taxes will rise again in the future and the costs that will arise will fall on them. As a result, measures will be taken to counteract the impending tax increase. In short, because an increase in the budget deficit will increase private savings equally, the variables will remain unchanged (Oğuz, 2013: 189).

### 1.3. Monetary Approach

While the monetarist approach and the Keynesian approach agree on the twin deficit hypothesis, they disagree on the proposals. The monetary approach emphasizes the close relationship between money supply and exchange rate in an economy with a flexible exchange rate regime. When the demand for money remains constant in an economy, nominal income rises when the money supply rises and this increased income is spent or saved. Assuming that it is spent, it is possible that demand for imported goods will rise. Furthermore, the portion set aside for savings may be transferred abroad, resulting in capital export. All of these factors will increase the demand for foreign currency among residents, causing the current exchange rate to rise. Exports will increase as the national currency depreciates, reducing the trade deficit and allowing the current account balance to balance (Özçalık and Erataş, 2014: 137-139).

### 1.4. Targeting the Current Account Deficit

In 1981, Summers used Current Account Deficit Targeting. It denotes a one-way causal relationship between the current account and budget

deficits. A current account imbalance slows growth and causes a budget deficit. In other words, a large capital inflow causes debt accumulation and the emergence of a fiscal deficit (Sayar and Bayar, 2019: 38).

### 1.5. Approach to Feedback (Bidirectional Causality)

One of the findings of the twin deficit studies is that the budget deficit and the current account have a reciprocal (two-way causality) relationship. According to Feldstein and Horioka (1980), there is a reciprocal causality relationship between budget and current account as a result of the interdependence of domestic investments and savings. The presence of feedback creates a significant level of causality that operates in both directions. As a result of the link between domestic investments and savings, current account and budget deficits interact. The budget deficit causes the current account deficit and the current account deficit causes the budget deficit, according to this approach. While the budget deficit causes the current account deficit, the presence of feedback allows causality to move in both directions. It is not enough to reduce the budget deficit to eliminate the current account deficit; exchange rate, interest rate and export incentive policies must also be implemented (Özdamar, 2015: 173).

## 2. LITERATURE REVIEW

According to the twin deficit hypothesis, there is a relation between the budget deficit and the current account deficit. Because it is no

longer possible to maintain a closed economy model in a globalizing world, countries manage their economic policies with the relationship between these two variables in mind. The existence of such a relationship is investigated and if it exists, the direction of causality directs policy. As a result, many studies have been conducted on the twin deficit hypothesis.

Yay and Tastan's 2007 review included the economies of the United States, Argentina, Brazil, Mexico, South Korea, the Philippines, Thailand and Turkey in order to test the validity of the twin deficits hypothesis. Along with Granger causality tests, frequency domain causality tests and spectral variance tests were used in the study. According to spectral causality tests, there is a strong and significant long-run relationship between budget deficit and external deficit in Thailand and Brazil, whereas the relationship at the frequency level is insignificant in Mexico, the Philippines and Turkey. In the short run, significant relationships were discovered in Korea, Argentina and the United States. In Turkey and Argentina, there is a significant long-run relationship between external deficits and budget deficits. The same relationship was discovered to be weak for the United States.

Uğur and Karatay (2009) emphasized that there is no consensus on the hypothesis. In their study, they conducted a theoretical analysis of the twin deficit hypothesis and discussed various approaches to the hypothesis. The Traditional Approach, Ricardian Equivalence Hypothesis, and Monetary Approach are all explained in the study.

In their collaborative study, Klavuz and Dumrul (2012) discussed the twin deficit hypothesis within the context of the Traditional and Ricardian Approaches. The monthly data of the budget deficit and current account deficit from 2006:01 to 2010:12 were used in the study and analyzed using the boundary test, VAR analysis and Granger causality test. The current account deficit is assumed to be equal to the foreign trade deficit in this study. According to the boundary test results, it was determined that there was no long-term relationship between the two variables. This result is consistent with the Ricardian Approach discussed in the theoretical section. VAR analysis was used to reveal the short-term effects and a two-way relationship between the two deficits was discovered.

Erataş and Özçalık (2014) discussed the twin deficits hypothesis, which states that there is a causal relationship between the budget deficit and the current account deficit. This causal link is explained by three theories. Classical, Keynesian and Monetary approaches are among them. The purpose of this research is to examine the validity of this theory in countries classified as "emerging market economies". The countries covered have a similar level of development as the Turkish economy and exhibit economic fragility as a result of balance of payments imbalances. The study on these countries included data from 1995 to 2010 and the sample of emerging market economies did not confirm the twin deficit hypothesis.

Özdamar (2015) examined the views explaining the theory in detail before analyzing the empirical results for Turkey to determine what

kind of relationship exists between the twin deficit and the current account deficit. The twin deficit hypothesis and various theoretical discussions related to the hypothesis are discussed first and foremost in the study. The factors influencing the twin deficit hypothesis are discussed in the following section. In the final section, it is demonstrated that, as most studies on Turkey have shown, the results supporting the traditional twin deficits hypothesis have been obtained.

Oktar and Yüksel (2016) conducted a study together in 2016 that included 17 of the 28 European Union member countries. The data used in the study were obtained from the World Bank, OECD and European Commission websites. The purpose of this research is to see if the twin deficit hypothesis holds true for countries in the European Union. Granger causality was used to solve the relationship between two variables for this purpose. The analysis included data from 17 countries between 1994 and 2014. According to the findings, the twin deficit hypothesis was valid in four countries (Finland, England, Spain and Hungary), but no such relationship could be found in the remaining 13 countries.

Sayar and Bayar (2019) investigated whether the twin deficit hypothesis is valid or not, using data from 23 European Union member countries and Turkey between 1996 and 2017. While time series analysis was used in the study for Turkey, panel data analysis was used for the other 23 European Union member countries. The Engle-Granger test was used to determine the long-term relationship between the two variables in Turkey, but no long-term cointegration

relationship was found. The Ricardian Equivalence Hypothesis has been proven to be correct for Turkey. While the Durbin-H cointegration test for European Union member countries reveals the existence of a long-term relationship between the two variables, the Dumitrescu-Hurlin causality test reveals the existence of a bidirectional causality relationship between the variables.

Çetin (2020) emphasized that if the budget deficit and current account deficit, two important indicators that reflect the internal and external balance of the economy, occur concurrently, there will be serious macroeconomic problems. The twin deficit hypothesis was tested in the study to see if it was valid in the late-nineteenth-century global depression and pre-war instability environment that lasted intermittently until World War I. In the analysis, 46 countries were divided into different country groups and tested using data from 1881 to 1913. According to the traditional approach to explaining the twin deficit hypothesis, the hypothesis was rejected as a result of the study. The causality test results, on the other hand, revealed a one-way relationship between the current account deficit and the budget deficit.

Baş (2020) investigated whether the twin deficit hypothesis is valid for the countries referred to as the fragile five. Panel data analysis methods were used in this study, which covered the years 2000-2017. The CADF and SURADF tests, which are among the root tests that account for cross-section dependency, were used in the study. Because stationarity could not be detected in all countries, the Westerlund Error Correction Model was chosen. According to the empirical

findings, a 1% increase in the budget deficit resulted in a 0.34 percent increase in the current account deficit in the long run. As a result, it was concluded in the study that the twin open mortgage is valid within the framework of the Traditional Keynesian Approach.

Soylu (2021) tested the existence of a relationship between the budget deficit and the current account deficit using data from 2000 to 2018 for Indonesia, India, South Africa, Turkey and Brazil, which were referred to in the literature as the "fragile five" in this 2021 study. Dumitrescu-Hurlin panel causality analysis was used to test the existence of the twin deficit hypothesis. Panel causality results show that there is unidirectional causality from budget deficits to current account deficits. The direction of causality, according to the Dumitrescu-Hurlin causality test, is from current account deficits to budget deficits. As a result, the twin deficit hypothesis is invalid for the fragile five countries.

## 3. METHODOLOGY, DATASET and ANALYSIS

### 3.1. Dataset

The panel dataset used in this paper is obtained from IMF world economic outlook over the 2001 and 2020 time period. Using this dataset the twin deficit hypothesis and their relationship is investigated for the selected G7 countries via Eviews statistical program. Budget deficit as a dependent variable and current account deficit and gross national product as an independent variable took their place in the paper. In the study, while determining the model, it

was primarily aimed to examine the relationship between the budget deficit (Net Dept/Nd) and the current account deficit (Current Account/Ca). However, since the budget deficit and current account deficit have an effect on gross national product, it is added to the model as a control variable and shown as GDP (Gross Domestic Product). Hereby, the relationship between the budget deficit and the current account deficit was better understood. The cross-sectional dimension (N=7) consists of 7 countries, while the time dimension (T=20) consists of 20 years of data. The model was determined within the framework of the analysis and the results of the tests performed in accordance with the data were explained methodologically.

### 3.2. Methodology

In the emprical analysis of the study, firstly cross-sectional dependence was tested followed by homogeneity tests. To control homogeneity, test of Hsiao (1986) was employed. By following the panel data hierarchy after homogeneity test Bai and Ng unit root test was tested. To find the best fit for a set of data points panel least squares regression was used. Dumitrescu-Hurlin (2012) causality tests were employed to investigate the causality relationship between pair of variables.

## 3.3. Emprical Analysis

### 3.3.1. Cross-Sectional Dependency Test

To identify and test all phases for panel data, cross-sectional dependency test play a vital role. By examining the integration levels of the variables with the panel unit root tests cross-sectional dependency test has to be determined. The presence or absence of cross-section dependency is important to decide which unit root tests will be applied. Theoritically, the case of cross section dependency, second generation unit root tests and in the case of cross section independence, first generation unit root tests should be used. Ignorance of these tests will lead the results of this paper to the inaccuarcy.

In the analysis of cross-section dependence, there are several tests. The time and size of these tests should be taken into account when selecting them. If the panel's time dimension (T) exceeds its cross-section dimension (N), the Lagrange Multiplier (LM) test developed by Breush-Pagan (1980) should be used. When both N and T are large and the cross-section and time dimensions are large, the CDLM test developed by Pesaran (2004) can be used. However, significant deviations in the analysis results may occur when N>T. As a result, Pesaran (2004) devised the CD (Cross Section Dependent) test for situations in which N>T. In addition to these tests, there is the LMadj (Bias-Adjusted Cross Sectionally Dependence Lagrange Multiplier)

test developed by Pesaran in 2008, which has the advantage of being free of deviations (Turgut and Uçan, 2021: 9).

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{P}\,i^2 j$$

This test is used with the assumption that there is no cross-sectional dependence, as well as the movement (T→ ∞) and when N(N-1)/2 is constant (T>N).

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\hat{P}_{i^2 j} - 1)}$$

It was discovered by expanding on the Breusch-Pagan test. It is used when (T→ ∞) and (N→ ∞) are present.

$$\boldsymbol{CD = \sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{P}_{ij}}$$

It is employed in the case of (N>T) under the assumption of no cross-sectional dependence.

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}T\hat{P}_{ij}\frac{(T-k)\hat{P}_{i^2 J} - u_{Tij}}{\sqrt{u^2}_{Tij}}$$

The assumption (T>N) is used in this aberration-free test.

**Table 2:** Results of the Cross-Sectional Dependency Test

| Test | Statistics Value | Probability Value | Result |
|---|---|---|---|
| Breush-Pagan LM | 84.87950 | 0.0000 | Reject |
| Pesaran scaled LM | 9.856820 | 0.0000 | Reject |
| Bias-corrected scaled LM | 9.672610 | 0.0000 | Reject |

Ho: There is No Cross-Sectional Dependency

According to the results of three tests performed to determine whether the variables considered in the analysis have a cross-sectional dependence, it was determined that the variables had a cross-sectional dependence. In the case of cross-section dependence, the second generation unit root test will be used to determine the level at which the variables are stationary. Aside from that, another critical point is the homogeneity test, which is used to determine which second generation unit root test to use.

### 3.2. Homogeneity Test

The homogeneity test is used in panel data analysis to determine whether other countries are affected to the same extent by a change in any of the selected countries. The similarity or difference in the economic structures of the countries is significant in this regard. If the economic structures of the countries under consideration differ, the coefficients in the model are likely to be heterogeneous. On the contrary, if their economic structures are comparable, the coefficients should be homogeneous (Kar vd., 2019: 42).

In the study, the Hsiao (1986) test was used for homogeneity testing. The Hsiao test considers three hypotheses: H1, H2 and H3. The H1 hypothesis asserts that the slope coefficients are homogeneous, whereas the alternative allows for heterogeneity. While the H2 hypothesis accepts homogeneity in the same way that the H1 hypothesis does, the alternative H2 hypothesis operates under the heterogeneous assumption. H3, the final hypothesis, contends that the slope coefficients are homogeneous, whereas the alternative accepts that they are partially homogeneous.

**Table 3:** Hsiao Test Hypotheses

| | |
|---|---|
| H1(0) : The Panel İs Homogeneous. | H1(A) : It is Heteregeneous. |
| H2(0) : The Panel İs Homogeneous. | H2(A) : It is Heteregeneous. |
| H3(0) : The Panel İs Homogeneous. | H3(A) : Partially Heteregeneous. |

**Table 4:** Homogeneity Test Results

| **Hypothesis** | **F-Statistics** | **Possibility** |
|---|---|---|
| H1 | 6.253241 | 1.57E-10 |
| H2 | 0.678697 | 0.769006 |
| H3 | 17.93005 | 4.18E-15 |

Based on the findings, two of the three hypotheses accepting homogeneity were rejected at the 5% significance level. H1 and H3 hypotheses are rejected and their alternatives are accepted, within the

framework of these probability values. On the other hand, since the probability values of the H3 hypothesis are greater than 0.05, it is concluded that the hypothesis cannot be rejected and the coefficients are homogeneous. In accordance with these findings, the unit root test will be performed to defend the homogeneity assumption under cross-sectional dependence and the stationarity levels of the variables will be determined.

### 3.3. Panel Unit Root Tests

Panel unit root tests, which consider both the time and cross-sectional dimensions of the data, are thought to be more stable than time series unit root tests, which only consider the time dimension. The reason for this is that the variability in the data increases when the cross section is included in the analysis. The first issue that arises in panel unit root tests is whether the cross sections that comprise the panel are independent of one another. In this case, panel unit root tests are classified as first or second generation based on whether or not they have cross-sectional dependence. When there is no cross-section dependency, first generation unit root tests are divided into homogeneous and heterogeneous models. Levin-Lin-Chu (2002), Breitung (2005) and Hadri (2000) are tests that assume homogeneity. Im-Pesaran-Shin (2003), Maddala-Wu (1999) and Choi (2001) are heterogeneous assumption tests. First generation unit root tests are based on the assumption that the cross-section units that comprise the panel are independent and that a shock to one of the units affects all cross-section units at the same level. However, as a result of

globalization, international economies are now increasingly intertwined. It is more realistic for the horizontal section units that comprise the panel to be affected differently by the shock that affects one of them. To address this shortcoming, second generation unit root tests that suggest dependency between cross sections have been developed. MADF (Taylor and Sarno, 1998), SURADF (Breueri Mcknown and Wallace, 2002), Bai and Ng (2004), CADF (Pesaan, 2006) and PANKPSS (Carrion-I Silveste et al. 2005) are major second generation unit root tests (Yıldırım et al., 2013: 88).

For the first test, Bai and Ng proposed the unit root null hypothesis, taking into account the cross-sectional relationship. Bai and Ng developed an analytical model by using a straight forward approach (Yıldırım, 2019: 36).

$$y_{i,t} = D_{i,t} + \lambda_i^{`} F_t + e_{i,t}$$

Di,t is the time function, Ft is the vector of general factors and λi is the vector of factor loading, according to this equation. If the vector Ft lacks at least one general factor or if ei,t is a stationary process, yi,t is said to be non-stationary. While one of these terms is in a stationary process, the other may or may not be. The stationarity of the variables can be tested separately using this equation. This situation was dubbed PANIC by BAI and NG (Panel Analysis of Nonstationarity in the Idiosyncratic and Common Components). PANIC provides information about the series' non-stationarity as a result of specific or general factors.

Bai and Ng Test Statistics;

$$P_{\hat{e}}^{c} = \frac{-2\sum_{i=1}^{N} P_{\hat{e}}^{c}(i) - 2N}{\sqrt{4N}} \longrightarrow N(0,1)$$

The p-values of the ADF tests of the estimated residual shocks for I for the cross section are given by $P_{\acute{e}}^{c}$.

Because the cross-sectional dependence between the panel countries was tested for the variables used in this analysis, the series' stationarity was examined using Bai-Ng (2004), one of the second generation unit root tests. The results of the second generation unit root test in Table 5 are examined separately for each variable in this context.

**Table 5:** Panel Unit Root Test Results

| **Variables** | **Bai-Ng Probability Results** | | |
|---|---|---|---|
| | **Level I0** | **First Difference I1** | **Second Difference I2** |
| Budget Deficit (Bd) | 0.00820 | - | - |
| Current Account (Ca) | 0.34002 | 0.00614 | - |
| Gdp | 0.07083 | 0.82875 | 0.0000 |

Ho: Contains Unit Root.

According to the test results of Bai and Ng (2004), while the dependent variable Bd is stationary at the level, the independent variables Ca and Gdp are taken as their difference because they

contain unit root. While Ca becomes stationary in the first difference, Gdp becomes stationary in the second. Because the dependent variable is stationary at the panel data analysis level, Least Square (LS) estimation is performed here. Following the completion of panel LS, the causality test will be carried out to reveal the relationship between the variables.

### 3.4. Panel LS

$$netdebt_{it} = \beta_0 + \beta_1\, currentac_{it} + \beta_2\, gdp_{it} + \varepsilon_{it}$$

$i = 1,\ldots,7$

$t = 2001,\ldots,2020$

$\beta_0$= coefficient of constant regression $\varepsilon_{it}$ = random error term

Panel LS can be performed without using the cross-section and time dimensions in panel data analysis, but if the number of parameters estimated in the model exceeds the number of observations, problems with model estimation may arise. Different models can be obtained in such cases by multiplying the assumptions about the nature of the error term and the variability of the coefficients (Pazarlıoğlu and Gürler, 2007: 37). In panel data analyses with cross-sectional and time dimension effects, Fixed Effects Model or Random Effects Model can be chosen, whereas Pooled Regression Model can be chosen in a model where both have no effects.

**Table 6:** Panel LS Method

| | | |
|---|---|---|
| **1. Hausman Test** | Ho: Random, H1: Fixed | The Hausman test is used if it is opened with a random model. |
| **2. Chow (F) Test** | Ho: Pooled, H1: Fixed | When a fixed model is opened, the F test is run. |
| **3. LM(Breusch-Pagan) Test** | Ho: Pooled, H1: Random | If a pooled model is opened, the LM test is run. |

**Source:** Author's computation, 2021.

When the model's effect was investigated in the study, the results were determined at random in both the cross-section and time (period) sections. It is accepted that the model contains random effects based on the data obtained from Panel LS. When the model is examined in this direction;

$netdebt_{it}$=-3265.635 + 0.133311$currentac_{it}$+ 0.743543$gdp_{it}$ obtained.

**Table 7:** Random Effect Model

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| C | -3265.635 | -4.096386 | 0.0001 |
| Dca | 0.133311 | 0.757498 | 0.4502 |
| DDgdp | 0.743543 | 1.809138 | 0.0729 |

Ho: b1 = 0 (meaningless)

The value of Ca in such a model is statistically insignificant, but economically, as Ca increases by one unit, Bd increases by 0.13. Similarly, when GDP rises by one unit, Bd (budget deficit) rises by 0.74. As a result, while statistically insignificant, this model is economically significant.

### 3.5. Causality Analysis

To confirm the robustness of the results Dumitrescu-Hurlin (2012) test applied on each pair of variables (Table 8). According to the requirements of the mentioned test all the non-stationary variables ought to become stationary. While the panel causality test provides information for a specific country in the panel, it also provides information for the panel as a whole. There are five types of causality tests used in panel data analysis: Coining and Pedroni (2008), Panel VECM, Emiroğlu and Köse (2011), Konya (2006) and Dumitrescu-Hurlin. (2012). While all of the tests work under the assumption that there is no cross-section dependency, what distinguishes the Dumitresc-Hurlin (2012) test from the others is that it makes predictions in the case of cross-section dependency (Bostan et al., 2016: 32).

The following are the characteristics of the Dumitrescu-Hurlin (2012) causality test (Alper and Oransay, 2015: 80):

- ✓ It considers both cross-sectional dependence and heterogeneity. Furthermore, the Dumitrescu-Hurlin Test produces homogeneous results in Eviews.

- ✓ In an unbalanced panel data set, it produces effective results.
- ✓ When the time section is larger than the horizontal dimension (T>N), it produces effective results.
- ✓ It can be used whether or not there is cointegration.

The model in the causality test, which defines stable y and x values, is as follows (Dumitrescu-Hurlin, 2012: 1457).

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{k} Y_i^{(k)} Y_{i,t-k} + \sum_{k=1}^{k} \beta_i^{(k)} X_{i,t-k} + e_{i,t}$$

The variable x is checked in the equation to see if it is the cause of the variable y. The causality relationship is easily tested in this case using the H0 hypothesis and a F test. Furthermore, if the H0 hypothesis is rejected, the variables can be changed and bidirectional causality obtained by switching the direction of causality (Lopez and Weber, 2017: 2).

**Table 8:** Causality Test Results

| **Variables** | **W-Stat.** | **Zbar-Stat** | **Prob.** | **Relationship Status** |
|---|---|---|---|---|
| Dac = Bd | 345.044 | 308.415 | 0.0000 | Accept |
| Bd = Dac | 4567497 | 4111215 | 0.0000 | Accept |
| DDgdp ≠ Bd | 1.49596 | -0.81894 | 0.4128 | Reject |
| Bd ≠ DDgdp | 2.57186 | 0.11002 | 0.9124 | Reject |
| DDgdp ≠ Dac | 2.84040 | 0.34188 | 0.7324 | Reject |
| Dac ≠ DDgdp | 4.31458 | 1.61471 | 0.1064 | Reject |

Ho: There is No Causal Relationship

At the 5% significance level, the Dumitrescu-Hurlin causality test concluded that there is a bidirectional causality relationship between the budget deficit and the current account deficit.

## 4. CONCLUSION

When the US economy began to exist in other countries with a concurrent budget deficit and current account deficit in the 1980s, the validity of the twin deficit hypothesis was retested. The emergence of the twin deficit problem in many countries has necessitated an examination of the situation. The spread of understanding of the social state and the ideal of sustainable growth and development is increasing day by day. The state has been given a large role in this context and the weight of the public sector has increased. When developing economic policies, budget balance is critical; however, a sustainable current account deficit is something that every economy desires. As a result, it is critical to maintain the budget balance and current account balance, as well as to assess the validity of the twin deficit hypothesis.

Panel data analysis was used in the study, which was based on annual data from 2001 to 2020. Cross-section dependency was used to determine the correlation between units and second generation unit root tests were used to analyze the series' stationarity. After the series were made stationary, the Panel LS method was used and it was determined that the model contained random effects. The Dumitrescu-Hurlin (2012) test was applied as the final step of the analysis to test

the causality relationship between the variables and it was discovered that there is a bidirectional causality relationship between budget deficit and current account deficit for G-7 countries.

Based on the data obtained, it is necessary to take some serious measures to ensure fiscal discipline and current account balance. Imports of energy and technology that cause a current account deficit will become unsustainable over time. In this context, countries must develop alternative energy resources, focus on R&D activities, increase incentive programs to be used by states for the production of technology products subject to import, increase strategic plans for human capital, ensure effective and efficient growth and ensure its continuity. Countries must take structural measures to carry out their economic and fiscal disciplines in a coordinated manner in order to avoid a budget deficit. Increasing technological investments in the country, effective use of natural resources, and increasing output by capitalizing on the current young population's dynamic advantage should be planned.

## REFERENCES

ALPER, A. ve ORANSAY, G., 2015. "Cari Açık ve Finansal Gelişmişlik İlişkisinin Panel Nedensellik Analizi Ekseninde Değerlendirilmesi", Uluslararası Ekonomi ve Yenilik Dergisi, 1 (2), ss. 73-85.

ASLAN, M. H., 2008. Makro İktisat Politikası, Alfa Aktüel, Bursa, 580s.

AY, A., KARAÇOR, Z., MUCUK, M. ve ERDOĞAN, S., 2004. "Bütçe Açığı-Cari İşlemler Açığı Arasındaki İlişki: Türkiye Örneği (1992-2003)", Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, sayı: 12, ss. 75-82.

BAİ, J. and NG, S., 2004. "A PANIC Attack on Unit Roots and Cointegration", Econometrica, 72 (4), pp. 1127-1178.

BAŞ, S., 2020. "İkiz Açık Hipotezinin Geçerliliğinin Kırılgan Beşli Ülkeleri İçin Test Edilmesi", Manisa Celal Bayar Üniversitesi Yönetim ve Ekonomi Dergisi, 27 (1), ss. 143-158.

BOCUTOĞLU, E., 2016. Makro İktisat Teoriler ve Politikalar, Ekin Yayınevi, Bursa, 614s.

BOSTAN, A., KELLECİ, Ü. S. ve YILMAZ, A., 2016. "Doğrudan Yabancı Sermaye Yatırımları ve Ekonomik Büyüme Arasındaki İlişki: Avrasya Ekonomisi Örneği", MANAS Sosyal Araştırmalar Dergisi, 5 (5), ss. 23-36.

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

ÇETİN, M., 2020. "İkiz Açık Hipotezinin Tarihsel Geçerliliğinin Panel Veri Yaklaşımı ile Analizi", OPUS-Uluslararası Toplum Araştırmaları Dergisi, 16 (32), ss. 4939-4965.

DUMITRESCU, E. I. and HURLIN, C., 2012. "Testing for Granger Noncausality in Heterogeneous Panels", Economic Modelling, 29 (4), pp. 1450-1460.

DUMRUL, Y. ve KILAVUZ, E., 2012. "İkiz Açıklar Hipotezinin Geçerliliği: Teori ve Uygulama", Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi, 26 (3-4), ss. 239-258.

ERATAŞ, F. ve ÖZÇALIK, M., 2014. "İkiz Açıklar Hipotezinin Geçerliliği: Yükselen Piyasa Ekonomileri İçin Bir Örnek", Yönetim ve Ekonomi Araştırmaları Dergisi, sayı:22, ss.136-151.

HSİAO, C., 1986. Analysis of Panel Data, Econometric Society Monographs, no: 11, New York: Cambridge Univeristy Press.

KAR, M., AĞIR, H. ve TÜRKMEN, S., 2019. "Seçilmiş Gelişmekte Olan Ülkelerde Elektrik Tüketiminin Ekonomik Büyümeye Etkisinin Panel Ekonometrik Analizi", Uluslararası Ekonomik Araştırmalar Dergisi, 5 (3), ss. 37-48.

LOPEZ, L. and WEBER, S., 2017. "Testing for Granger Causality in Panel Data", University of Neuchatel Institute of Economic Research, IRENE Working paper 17-03.

MANKİW, G. N., 2010. Makroekonomi, Çev.: Çolak, Ö. F., Efil Yayınevi, Ankara, 643s.

MUCUK, M., 2008. "Bütçe ve Cari İşlemler Dengesi Arasındaki İlişki: Türkiye Örneği (1989-2004)", Doktora Tezi, Selçuk Üniversitesi Sosyal Bilimler Enstitüsü, Konya.

OĞUZ, S., 2013. "İkiz Açıklarda Nedensellik İlişkisi: 1998-2012 Dönemi İçin Türkiye Uygulaması", Doktora Tezi, Hacettepe Üniversitesi, Ankara.

OKTAR, S. ve YÜKSEL, S., 2016. "Avrupa Birliği Ülkelerinde İkiz Açık Hipotezinin Geçerliliği", Kastamonu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, sayı:11, ss. 46-61.

ÖZDAMAR, G., 2015. "İkiz Açıklar Hipotezi: Teorik Yaklaşımlar ve Türkiye Üzerine Ampirik Literatür İncelemesi", Uluslararası Alanya İşletme Fakültesi Dergisi, 7 (2), ss. 165-186.

PARKIN, M., 2010. İktisat, Çev.: UZUN, S. ve GÜNEŞ, S., Akademi Yayıncılık, Ankara, 780s.

PAZARLIOĞLU, V. ve GÜRLER, Ö. K., 2007. "Telekomünikasyon Yatırımları ve Ekonomik Büyüme: Panel Veri Yaklaşımı", Finans, Politik-Ekonomik Yorumlar, 44 (508), ss. 35-43.

PESARAN, M. H., 2004. "General Diagnostic Test for Cross Section Dependence in Panels", University of Cambridge orking Paper, 0435.

PESARAN, M. H., ULLAH, A. and YAMAGATA, T., 2008. "A Bias-Adjusted LM Test of Error Cross Section Independence", The Econometrics Journal, 11 (1), pp. 105-127.

PINAR, A., 2010. Maliye Politikası Teori ve Uygulama, Naturel Kitap, Ankara, 384s.

SAYAR, G. ve BAYAR, İ., 2019. "Türkiye ve Avrupa Birliği Ülkelerinde İkiz açık Hipotezinin Test Edilmesi: Zaman Serisi ve Panel Veri Analizi (1996-2017)", Aksaray Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 11 (4), ss. 35-48.

SOYLU, Ö. B., 2021. "Kırılgan Beşlide İkiz Açık Hipotezinin Panel Nedensellik Analizi İle Test Edilmesi", ASBİ Abant Sosyal Bilimler Dergisi, 21 (1), ss. 21-41.

TURGUT, E. ve UÇAN, O., 2021. "Yolsuzluğun Vergi Oranları ile Olan İlişkisinin OECD Ülkeleri Örnekleminde İncelenmesi", Niğde Ömer Halisdemir Üniversitesi SBE Dergisi, sayı:3, ss. 1-17.

UĞUR, A. A. ve KARATAY, P., 2009. "İkiz Açıklar Hipotezi: Teorik Çerçeve ve Hipoteze Yönelik Yaklaşımlar", Sosyoekonomi Dergisi, 2009-1, ss.101-122.

YAY, G. G. ve TASTAN, H., 2007. "İkiz Açıklar Olgusu: Frekans Alanında Nedensellik Yaklaşımı", İ.Ü. Siyasal Bilgiler Fakültesi Dergisi, no:37, Ekim, ss. 87-111.

YILDIRIM, F., 2019. "Panel Birim Kök Testleri ile Enerji Tüketiminin Durağanlığının İncelenmesi", Yüksek Lisans Tezi, Sakarya Üniversitesi SBE, Sakarya.

YILDIRIM, K., MERCAN, M. ve KOSTAKOĞLU, S. F., 2013. "Satın Alma Gücü Paritesinin Geçerliliğinin Test Edilmesi: Zaman Serisi ve Panel Veri Analizi", Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 8 (3), ss. 75-95.

# CHAPTER 5

# THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND INCOME DISTRIBUTION INJUSTICE: OECD COUNTRIES

Gamzenur COŞKUN[1]

[1] Master Student, Nigde Omer Halisdemir University, Department of Economics, coskung09@gmail.com. https://orcid.org/0000-0003-3027-1007

## INTRODUCTION

Income distribution; refers to the sharing of income earned in a particular economy or period between individuals or production factors. One of the ultimate goals of economic science is to eliminate income inequality between individuals and countries. In addition to being a problem in itself, income inequality also paves the way for many economic, social and even political problems. Therefore, the precondition for achieving order and prosperity in society and to rise to an improved society in many respects is to ensure justice in the distribution of income.

In 1955, Simon Kuznets investigated the connection between income inequality and economic growth, and as a result of the study, he stated that income inequality first increased during the process of economic growth and then justice was achieved. This relationship is included in the literature in the form of reverse-U hypothesis, and the curve expressing the connection between income inequality and per capita income level is called the Kuznets curve. Kuznets' work led many studies in later periods, but the relationship between economic growth and income inequality remains a topic of discussion today.

The main objective of this study is to analyze the existence of the relationship between the economic growth rates of OECD countries and the injustice of income distribution and to determine the direction, if any. For this purpose, the study consists of three parts. The first part provides the theoretical connection between the variables. In the second

part, the researches carried out on the subject are mentioned. The third part consists of theoretical information of the analysis techniques used in the study, data set used for the period 1990-2019 and empirical analysis results. Finally, there is the conclusion section where the general evaluation of the study is made.

## 1. THEORETICAL FRAMEWORK

The fact that income is a dynamic variable indicates that it can be measured over a period of time. Income is generated through a number of assets that individuals earn. Simply, disposable income is calculated by exempting taxes from the total income that joins the household. The type obtained in the household is usually formed by wages or salaries, while taxes and social security payments paid to the state are also exempted from the calculation (Keeley, 2015). The fair distribution of national product among individuals in any society is of utmost importance for social and economic life to continue without interruption. However, the fact that income is being distributed unfairly among existing groups, even for individuals in the same group, means that income inequality exists.

Studies on income distribution inequality and dimensions are quite a lot. However, it is possible to cluster inequality as monetary and non-monetary. Monetary inequality depends on variables such as income and wealth of the household or individual. However, non-monetary inequality is more about the level of well-being besides income and is a multidimensional concept (Atkinson and Bourguignon, 2014).

Accordingly, income inequality can be determined by many different methods such as Kuznet's Curve, Gini Coefficient, Theil Index and Atkinson Inequality Index. The Gini Coefficient, which describes the relationship between economic growth and income distribution injustice, forms the basis of the study.

One of the most important measures of the degree of relative income inequality in an economy can be achieved by dividing the area between the diagonal and the Lorenz curve, which refers to the 45-degree line in Figure 1, into the total area of the triangle where the curve is located. This method of calculation is known as the Gini coefficient, which was first introduced to the literature in 1912 by Corrado Gini, an Italian sociologist and statistician. The Lorenz curve is used in the calculation of the Gini coefficient. Gini coefficients are measures of total injustice, but differ in any proportion between 0 (perfect equality) and 1 (perfect inequality). It should be noted that for countries with a highly unfair income distribution, the Gini coefficient is usually between 0.50 and 0.70, and for countries with partially fair distribution, it is between 0.20 and 0.35.In other words, as the Gini coefficient approaches 0, income inequality decreases and a relatively equal society emerges; As we approach 1, income inequality increases and their quality of life varies among individuals in society. The ratios of 0 and 1 are statistically impossible (Todaro and Smith, 2012:222).

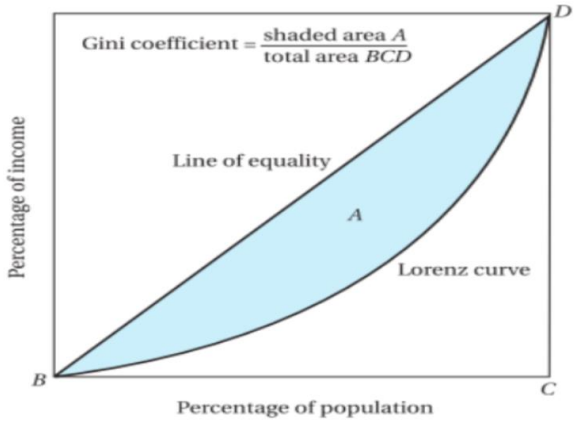



**Figure 1.** Gini Coefficient And Lorenz Curve (Todaro and Smith, 2012.)

The Gini coefficient is an inequality prevention approach that provides four factors such as uncertainty, scale independence, population independence and transfer principles. The first idea that income inequality has a positive effect on economic growth on two different planes is that when college-educated individuals have high productivity, differences in productivity will encourage many people in society to increase their education levels. Another aspect is that income inequality will lead to higher growth through investments, given that high income groups have high savings and investment aspirations.

However, there are theories that income inequality negatively affects economic growth. One theory in this perspective is that income inequality reduces the professional opportunities of disadvantaged groups in society. This reduces social mobility and limits the growth potential of the economy. For example, if an education and grant system is not established in the country, a high income inequality will cause

low-income individuals to invest less in human capital. Therefore, in countries with high income inequality, social mobility between generations is less. Income inequality can also lead to populist policies and increase domestic and foreign borrowing, slowing economic growth (Campos, 2017).

## 2. LITERATURE RESEARCH

Persson and Tabellini (1991) in their study, analyzed annual per capita growth data from 1830 to 1850 in the framework of Austria, England, Finland, Germany, Denmark, the Netherlands and the United States.They then divided their time intervals and included 67 countries in their studies between 1960 and 1985. After applying cross-sectional analysis to 5 different variables in modeling, Persson and Tabellini concluded that there was a statistically significant and negative connection between income inequality and economic growth.

Clarke (1995) in his analysis, took GDP data from the 23 countries he selected as dependent variables covering 1970-1988, while GDP per capita, primary and secondary education enrollment rates, impact numbers, assassination numbers, investments and the state share of GDP were taken as independent variables. As a result of cross-sectional analysis, it has been concluded that there is a negative connection between income distribution injustice and economic growth. In addition, when the maximum levels of income distribution injustice reached, he emphasized that increasing public expenditures to overcome this situation would negatively affect growth in the long term.

Alesina and Perotti (1996) in their study, used data on income inequality and investments from 1960 to 1985 in the 72 countries they chose. They emphasized that it is the state of political instability of the countries that binds these two variables together. In the article, they list the questions they are looking for answers as follows; The unfairness of income distribution is political instability and the direction in which it affects economic growth due to its investments. As a result of their cross-sectional analysis, it is stated that the injustice of income distribution triggers social dissatisfaction, causing political instability and thus reducing investments and creating obstacles to economic growth.

Deininger and Squire (1996) in their cross-sectional analysis, used GINI coefficients and income distribution indicator data from 108 countries between 1960 and 1974. The finding of the analysis is that there is a negative relationship between income inequality and economic growth. As a result of the analysis, the authors found that economic growth increased income distribution unfairness in 43 cases and reduced it in 45 cases; on the other hand, they concluded that economic contraction increases the distribution of income in 5 cases and reduces it in 2 cases. Within the framework of all the countries used in the article, there was no meaningful connection between the GINI coefficient and the current and delayed rates of income growth, so a stable connection was not found between economic growth and income distribution justice regardless of the characteristics of the countries.

Barro (2000) in his study, conducted panel data analysis with data such as GDP per capita in approximately 100 countries in 1960-1995, ratio of government expenditures to GDP, election rights index, democracy index, trade limits and inflation rate. Barro, divided countries into two clusters of low and high incomes, and that the injustice of income distribution in underdeveloped countries slowed economic growth; has concluded that it accelerates economic growth in developed countries. On the other hand, the ratio of investments to GDP through external openness gives positive and meaningful effects in the context of income inequality; the relations between income and GINI have been found to work according to the development rate of the countries in a way that confirms the Kuznets hypothesis.

Rosser and others (2000) in their study, tested whether there was a connection between the informal sector and income distribution inequality in the context of 16 transitional economies, taking their averages between 1987-1989 and 1993-1994. They also discussed GDP data representing the formal department and electricity consumption data representing the proportion of the unregistered sector. They expressed the injustices in the distribution of income with the GINI coefficient. According to the findings of the applied panel data analyses; it has been concluded that income distribution inequality is directly proportional to supply in an informal or informal economy. This is directly proportional to the theory that increases in income distribution inequality are also connected to increases in output in the illegal economy.

Cantarero and others (2005) in their panel data analysis, examined the connection between these variables using GDP data representing the life expectancy or mortality rates of 15 European Union countries between 1993 and 2000, and GINI coefficient data to represent income distribution unfairness. In general, it is accepted that increases in life expectancy or decreases in child mortality rates are among the important growth indicators when there is causality between variables in different analyses with these parameters. According to the findings of the authors' analysis, the GINI coefficient is negative in life expectancy; infant mortality rates were found to have positive effects. Therefore, parallel findings were obtained between economic growth indicators and GINI coefficient with theoretical expectations.

Majeed (2010) in his study, used variable data from 18 Asian countries between 1970 and 2007, such as GINI, education, investment, inflation rate and current account deficit. Majeed concluded that there is a statistically significant and positive connection between income distribution injustice and economic growth. It has concluded that income inequality causes growth by increasing the amount of savings and capital accumulation, and that credit market glitches are the main basis for the positive connection between growth and income distribution injustice. Majeed also found that with the development of financial markets in the countries, they gained momentum in growth and found that trade openness and physical and human capital investments had a positive effect on economic growth.

Herzer and Vollmer (2012) in their articles, GINI used data on per capita income and shares of investments in GDP between 1970 and 1995 within the framework of developed and developing country clusters for 46 countries. In addition, they evaluated the countries separately in the clusters of democratic and anti-democratic countries. In the panel's co-integration findings, it was found that there are long-term effects of income distribution injustice on growth. From another angle, the grouping of developed, developing and democratic-anti-democratic countries within the framework of income inequality and growth rates is not important; it has been determined that human capital has stronger effects in economic growth than physical capital.

Theyson and Heller (2015) in their panel data analysis, investigated the connection between income inequality and economic growth within the framework of Kuznet's hypothesis using data from the GINI, human development index (HDI), GDP per capita, life expectancy, health and education indices covering 1992-2007 of the 147 countries of their choice. As a result of their analysis, the "reverse-U" form of the curve when the GDP per capita and GDP index is used in the model; when the human development index, expected life expectancy and education indices were included, they found that it yielded results in the form of "S".

Lahouij (2017) in this study, was based on 12 countries including Comoros, Djibouti, Egypt, Mauritania, Tunisia, Yemen, Turkey, Lebanon, Jordan, Sudan, Israel and Morocco to test the connection between income distribution injustice and economic growth in oil-

importing Middle East and North African countries. GINI, per capita GDP, government expenditures, gross capital formation, foreign direct investment, inflation rate and fertility rate data were used in the selected countries covering 1980-2007. In line with the findings, it was determined that income inequality slows economic growth as well as market distortions accelerate economic growth. In addition, it was concluded that foreign direct investments, fertility rate and inflation rate did not have any effect on economic growth among the variables used.

Erkisi and Ceyhan (2020) in their articles, they used GINI coefficient and GDP data for the 14 European Union countries of their choice: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UNITED Kingdom. These data covering the years 1993-2016 were found in both short-term and long-term applications after cross-sectional dependency analysis. According to Pooled Average Group (PMG) findings, there is no short-term connection between economic growth and income distribution, but long-term economic growth negatively affects income distribution; they concluded that the 1% increase in economic growth is disrupting the distribution of income by 0.22% in the long term. They found that these findings were inversely proportional to Kuznets claim that income distribution justice would improve in the long term.

## 3. METHODOLOGY, DATA SET AND ANALYSIS FINDINGS

In the study, a model in which the GINI coefficient representing income inequality was determined as dependent variable and there were independent variables consisting of GDP growth and unemployment rates per capita was analyzed using Eviews and Stata programs. The data set of the study consists of statistics from 15 OECD member countries (Australia, Austria, Denmark, France, Italy, Spain, Turkey, USA, Switzerland, Netherlands, Norway, Poland, Portugal, Japan and Germany) for the 30 year period covering 1990-2019. The Standardized World Income Inequality Database (SWIID) was used to obtain the Gini coefficient (GINI) data covered in the study, while gdp growth and unemployment rate figures per capita were obtained from The World Bank Development Indicators database. The model created to establish the relationship between economic growth and income inequality in the example of selected countries is as follows. In this part of the study, the results of the analyses carried out in accordance with the data were shared.

$$GINI_{it} = \alpha_i + \beta_1 GDPPC_{it} + \beta_2 UNEMP_{it} + \varepsilon_{it}$$

### 3.1. Cross Section Dependency Test

In order to prevent the problem of false regression in panel data analysis, it is necessary to determine the level at which the series is stable. However, unlike time series analyses in panel data analysis, cross sectional dependence and homogeneity tests should be applied to

the variables in order to determine the level at which the variables are stable. Therefore, one of the most important problems in panel data analysis is whether the series contain cross section dependency. Therefore, before proceeding to the analysis, cross sectional dependency test is applied to the variables and according to the results reached, it is necessary to decide which of the first or second generation unit root tests to use the variables. In line with the test result, the first generation unit root test should be applied if the cross section is independent, and the second generation unit root test should be applied if the cross section is dependent (Turgut and Uçan, 2019:8).

The first of the cross-sectional dependency tests is the Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980) and seen in the following equation.

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{p}_{ij}^{2}$$

In the above equation, $\hat{p}$ is the sample estimate of the binary correlation of residues. In this test, the $H_0$ hypothesis is used in the condition N>T, where there is no relationship between cross sections and $N(N-1)/2$ has a chi-square asymptotic distribution in the degree of freedom if $T \rightarrow \infty$ is deciduous (Pesaran, 2004:4).

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T\hat{p}_{ij}^{2}-1)$$

The above equation shows the Pesaran (2004) $CD_{LM}$ test, an improved form of the Breusch-Pagan (1980) test. According to this test, it is assumed that there is no cross-section dependence under $T \to \infty$ and $N \to \infty$ conditions. For N>T conditions, Pesaran (2004) developed the CD test within the scope of cross-section dependence.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{p}_{ij}$$

CD testing, which is based on the sum of correlation coefficients between cross section residues, shows standard normal distribution of test statistics under the hypothesis, which states that there is no cross sectional dependency (Pesaran, 2004: 9).

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T\hat{p}_{ij} \frac{(T-k)\hat{p}_{ij}^2}{\sqrt{u_{Tij}^2}}$$

In equality, k refers to the regressor number, while $(u_{Tij})$ refers to the mean of $(T-k)\hat{p}_{i^2 j}$, $\left(u^2{}_{Tij}\right)$ refers to the variance of $(T-k)\hat{p}_{i^2 j}$. The test statistic shows that although there is no normal distribution in the asymptotic sense, $H_0$ does not have cross-section dependence, while $H_1$ shows that cross-section dependence exists (Pesaran et al., 2008:108).

According to the results of the analysis, if $H_0$ is not rejected, it is understood that there is no cross-section dependence between countries and that a first-generation panel deconstruction test should be

performed. If $H_0$ is rejected, a second-generation panel unit root test is applied, concluding that there is a cross-section dependence between countries (Baltagi, 2008: 284).

**Table 1.** Cross Section Dependency Test Results

| Test | Statistics | Probability | Decision |
|---|---|---|---|
| **LM** | 753.7 | 0.000 | Reject |
| **LM adj*** | 131.2 | 0.000 | Reject |
| **LM CD** | 7.815 | 0.000 | Reject |

As a result of three different tests, when the statistical data obtained were evaluated at the level of 5% signiability, it is concluded that there is a cross sectional dependency between the variables. It is then concluded that second generation unit root analysis should be performed to determine the level at which the selected variables are stable. At this stage, homogeneity testing should be applied to decide which test to perform.

### 3.2. Homogeneity Test

The homogeneity test of slope coefficients was used in the standard delta and corrected delta method developed by Pesaran and Yamagata (2008) and calculated as follows (Pesaran and Yamagata, 2008):

$$\tilde{\Delta} = \sqrt{N}\frac{N^{-1}\tilde{s}_{-K}}{\sqrt{2k}}$$

$$\tilde{\Delta}_{adj} = \sqrt{N}\frac{N^{-1}\tilde{S} - K}{\sqrt{2k}}$$

The Pesaran and Yamagata (2008) test is a homogeneity test that can be applied in cases of N>T or T>N, but it states that the slope coefficient $H_0$ is homogeneous, and $H_1$ is not homogeneous. If the probability data obtained as a result of the Test is less than 5%, The 0 hypothesis is rejected and the slope coefficients are considered heterogeneous.

**Table 2.** Homogeneity Test Results

| Test | Statistics | Probability |
|---|---|---|
| $\tilde{\Delta}$ | 8.885 | 0.000 |
| $\tilde{\Delta}_{adj}$ | 9.544 | 0.000 |

According to the test result, the 0 hypothesis was rejected because the probability values were small than 0.00 and 0.05, and it was concluded that the slope coefficients were heterogeneous. In line with these results, a unit root test that defends heterogeneity under cross sectional dependence should be performed and the level at which the variables are stable should be determined.

### 3.3. Panel Second Generation Unit Root Test

In the study, CADF test developed by Pesaran was used to determine the level at which the series is stable under cross section dependency in the model created for 15 OECD member countries. Pesaran (2007) CADF testing is an extended version of ADF regression with the first

differences of individual series and cross-sectional averages of latency levels. In the test, individual results are obtained for each cross section with CADF statistics and CIPS (Cross Sectionally ImPesaran Shin) statistics are expanded by taking the section averages and results are obtained for the whole panel. CADF panel unit root test is based on the model given below (Pesaran, 2007:266).

$$\Delta y_{it} = \alpha_i + \beta_i Y_{i,t-1} + Y_i f_t + \varepsilon_{it}$$

CIPS statistics are formulated as follows:

$$CIPS = \frac{\sum_{i=1}^{N} CADF_i}{N} \text{ or } CIPS = (N,T) = N^{-1} \sum_{i=1}^{N} t_i \ (N,T)$$

Since cross sectional dependence was detected between the countries that created the panel for the variables used in the study, the second generation unit used in such cases was examined with the CIPS statistics developed by Pesaran (2007), as mentioned above. CADF testing works under T>N and N>T conditions, but their hypothesis is as follows (Pesaran, 2007:267):

$H_0$: The variable is not stationary.

$H_1$: The variable is stationary.

**Table 3.** Pesaran CIPS Test Results

| Variables | Constant | | Constant and Trend | |
|---|---|---|---|---|
| | T-Stat. | P-value | T-Stat. | P-value |
| **GK** | -2.384 | <0.04 | -3.085 | <0.01 |
| **GDPPC** | -3.625 | <0.01 | -3.802 | <0.01 |
| **ΔUNEMP** | -3.424 | <0.01 | -3.525 | <0.01 |

**Note:** The Akaike criterion for optimal latency has been taken into account. Its symbol refers to the difference of the variable. CIPS statistics critical table values are obtained from Table B (-2.25) for constant and trendy table C (-2.76) for constant and trendy within the scope of 5% signiability levels in Pesaran (2007) in accordance with T and N conditions.

When the results in Table 3 are examined at the 5% importance level, it is seen that both Gini and GDPPC variables are stable at the level by rejecting $H_0$ because the calculated table values are greater than the critical value and because the probability values are less than 0.05. But since the unemp argument is not stationary at the level, it is stationary by taking the difference. Therefore, after it was understood that all variables were stationary at the level, the panel performed an LS analysis and decoded whether there was a short-term relationship between the variables.

### 3.4. Panel LS Model Estimation

There are a number of tests to be performed for the selection of the model. These tests are F (Chow) test, Breusch-Pagan test and Hausman test. First of all, F test is applied to the data in order to determine which model is suitable between the pooled model and the fixed effects model. The basic hypotheses of the F test are as follows:

$H_0$: The Pooled Effects.

$H_1$: The Fixed Effects.

If the probability value is less than 0.05, the $H_0$ hypothesis is rejected and the existence of a fixed effects model is accepted.

**Table 4.** F Test Results

| | **Statistics** | **Probability** |
|---|---|---|
| **F** | 8.45 | 0.000 |
| **Chi-square** | 16.12 | 0.000 |

According to Table 4, since the probability values of fixed and random effect are less than 0.05, the empty hypothesis was rejected in both models and the model of fixed effects, which is the alternative hypothesis, was determined to be valid.

When choosing panel data models, it is determined by the help of the Hausman test which of the constant or random assumptions of the

coefficients makes sense. The Hausman (1978) specification test is used to choose between a model of fixed and random effects. The fixed effects model is based on the assumption that there is a correlation between arguments and the term error. The random effects model assumes that the arguments and the error term are unrelated (Hausman, 1978:1258). In this context, the hypotheses of the test are as follows:

$H_0$: The Random Effects.

$H_1$: The Fixed Effects.

**Table 5.** Hausman Test Results

| | **Statistics** | **Probability** |
|---|---|---|
| $\boldsymbol{GINI_{it}}$ | 11.83 | 0.002 |

Since the probability value of the model is less than 0.05, the empty hypothesis is rejected and the alternative "The Fixed Effects" hypothesis is accepted.

Another test, the Breusch-Pagan LM test, determines whether there is a random and pooled effect model, but the test's hypotheses are as follows:

$H_0$: The Pooled Effects.

$H_1$: The Random Effects.

**Table 6.** LM Test Results

| | Statistics | Probability |
|---|---|---|
| **Breusch-Pagan** | 4562.52 | 0.000 |

In line with the results in Table 6, the empty hypothesis was rejected because the probability value was less than 0.05. Therefore, it has been determined that the random effects model is valid.

As a result of the tests applied, it was understood that the fixed effects model should be accepted in order to continue the study in line with the F and Hausman analyses. Accordingly, the analysis results for the model are included in Table 7.

**Table 7.** Fixed Effects Model Result

| Variables | Coefficient | Standard Error | t-Statistics | Probability |
|---|---|---|---|---|
| **GDPPC** | -0.00105 | 0.00054 | -1.92 | 0.055 |
| **ΔUNEMP** | -0.00432 | 0.00105 | -4.09 | 0.000 |
| **C** | 0.46414 | 0.00126 | 367.30 | 0.000 |

**Note:** F statistical probability value: 0.0003

$$\mathbf{GINI = 0{,}464 - 0{,}001\ GDPPC - 0{,}004\ \Delta UNEMP}$$

According to the intragroup forecaster results that allow the above fixed unit effects, while the arguments are constant, the average income inequality is 0.464 units. While GDP growth per capita is steady,

income inequality decreases by an average of 0.004 units when unemployment increases by 1 unit.

While unemployment is stable, income inequality decreases by an average of 0.001 units when GDP per capita increases by 1 unit. The F statistical value indicates that the model is meaningful as a panel. In addition, unemployment rates of 5% make sense to explain income inequality, while GDP growth per capita makes sense at 10% to explain income inequality.

### 3.5. Panel Causality Test

Panel sized causality analysis allows for systematic combining of significant and more observations compared to time series. The most commonly used Dumitrescu and Hurlin (2012) causality tests in this plane are the active sides of the causality test compared to other causality tests; to be able to simultaneously evaluate cross sectional dependence and heterogeneity between the countries that make up the panel, to apply it in both conditions such as T>N and T<N, and to achieve accurate findings in unstable panel data sets (Dumitrescu and Hurlin, 2012). Another feature of the test in question is that it can analyze both when the co-ordination is found and when it is not. For this reason, Dumitrescu-Hurlin panel causality test was applied within the scope of causality analysis in this model where there is no cointegration relationship.

In the Dumitrescu and Hurlin (2012) panel causality test, when X and Y refer to the static series detected during the T period for the number of units N, the following linear heterogeneous model is considered for each unit (i) at t time (Dumitrescu and Hurlin, 2012:1457):

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{k} Y_i^{(k)} Y_{i,t-k} + \sum_{k=1}^{k} \beta_i^{(k)} X_{i,t-k} + e_{i,t}$$

In the model K; when expressing the optimum delay length, $\alpha_i$ Is fixed, $Y_i$and $\beta_i$ the assumption that there are variables between units applies. Therefore, a model of fixed effects is established in causality analysis. According to the above model, the test hypotheses are as follows:

$H_0$: $\beta_i = 0\ \forall i = 1, \dots, N$ (There is no causality for all units)

$H_1$: $\beta_i = 0\ \forall i = 1, \dots, N_1$(Some units have causality)

$$\beta_i \neq 0\ \forall i = N_1 + 1, \dots, N$$

In the $H_1$ equation above $0 \leq N_1/N < 1$ and the test statistic used to test the null hypothesis is the average of individual Wald statistics.

$$W_{N,T}^{Hnc} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T}$$

According to the equation seen above, asymptotic test statistics and semi-asymptotic test statistics where T and N are constant should be based on the condition that T and N go forever. Under the N>T

condition, the following statistics with semi-asymptotic distribution are used (Bozoklu and Yılancı, 2013:177-178).

$$Z_{N,T}^{Hnc} = \sqrt{\frac{N}{2K}}(W_{N,T}^{Hnc} - K)$$

$$Z_{N,T}^{Hnc} = \frac{\sqrt{N}[W_{N,T}^{Hnc} - N^{-1}\sum_{i=1}^{N} E(W_{i,T})]}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(W_{i,T})}}$$

$$Z_{N,T}^{Hnc} = \frac{\sqrt{N}[W_{N,T}^{Hnc} - N^{-1}\sum_{i=1}^{N} K_i x \frac{(T_i - 2K_i - 1)}{(T_i - 2K_i - 3)}]}{\sqrt{N^{-1}\sum_{i=1}^{N} 2K_i \, x \frac{(T_i - 2K_i - 1)^2 x (T_i - K_i - 3)}{(T_i - 2K_i - 3)^2 x (T_i - 2K_i - 5)}}}$$

Accordingly, the results of the Dumitrescu-Hurlin Causality Test used in the research are given in Table 8.

**Table 8.** Dumitrescu And Hurlin Panel Causality Test Results

| Null Hypothesis | W-Statistics | Zbar-Statistics | Probability | Decision |
|---|---|---|---|---|
| **GK → GDPPC** | 1.836 | 2.290 | 0.022 | Reject |
| **GDPPC → GK** | 1.120 | 0.331 | 0.740 | Accept |
| **GK → ΔUNEMP** | 1.687 | 1.883 | 0.059 | Accept |
| **ΔUNEMP → GK** | 1.177 | 0.486 | 0.626 | Accept |

| | | | | |
|---|---|---|---|---|
| **GDPPC → ΔUNEMP** | 0.862 | -0.375 | 0.707 | Accept |
| **ΔUNEMP→ GDPPC** | 4.162 | 8.661 | 0.000 | Reject |

According to the result of the causality test, there is a one-way causality relationship from the Gini coefficient at the 5% significance level to GDP growth per capita. Accordingly, income inequality within the framework of the data set used in the analysis is the reason for GDP growth per capita. In addition, according to Table 8, there is no causality from GDP per capita to unemployment, while there is a one-way causality connection from the unemployment rate to GDP growth per capita. On the other hand, there was no causality relationship between the GINI coefficient and unemployment.

### 3.6. Varying Variance Test

One of the most important assumptions of the panel Least Square (LS) method is the fixed variance assumption. The panel LS method states that the dependent variable variance will remain constant while the unit values of descriptive variables are dynamic, and this assumption is called constant variance in the literature. In the varying variance test, the empty hypothesis refers to the validity of the fixed assumption, while the alternative hypothesis indicates that the varying variance assumption is valid.

**Table 9.** Varying Variance Test Results

| | |
|---|---|
| **F-Statistic** | 10.593 |
| **Probability (F-Statistic)** | 0.000 |
| **R-Squared** | 0.046 |

According to Table 9, since the probability value F is less than 0.05, the empty hypothesis is rejected and it is concluded that the varying variance status is valid.

### 3.7. Multiple Linear Connection Test

Multiple linear connectivity is the case that in multiple regression models, some or all of the arguments are related to each other. The correlation matrix between descriptive variables is used to determine the existence of multiple linear connections. If the absolute value of the correlation coefficient between variables is close to 1, it is concluded that there is a multiple linear connection between those arguments. In addition, each value above 0.5 leads to multiple linear connectivity problems.

**Table 10.** Multiple Linear Connection Test Correlation Coefficient Results

| Variables | GK | GDPPC | ΔUNEMP |
|---|---|---|---|
| **GK** | 1.000 | 0.117 | -0.013 |
| **GDPPC** | 0.117 | 1.000 | -0.527 |
| **ΔUNEMP** | -0.013 | -0.527 | 1.000 |

In this study it was concluded that there is no problem of multiple linear connections in the established model, since the calculated correlation coefficients of all other variables except the relationship between the unemployment rate and GDP growth per capita are less than 0.5.

### 3.8. Normality Test

Parametric methods acknowledge that the data is distributed normally. Whether this assumption is valid or not is tested by some tests. The Jarque-Bera test is one of the analyses used as publication to determine the suitability of error terms to normal distribution and their hypothesis is as follows:

$H_0$:The error term is normally distributed.

$H_1$:The error terms do not normally distributed.

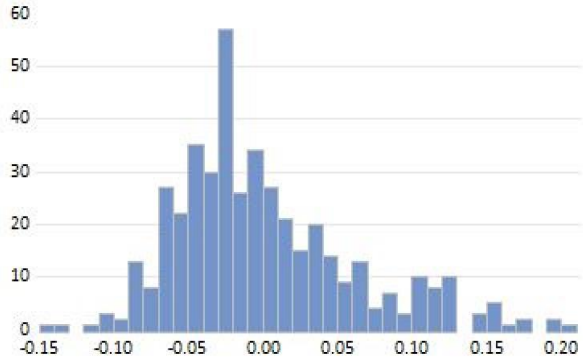



**Figure 2. Distribution of Error Terms**

Table 11 as well as Figure 2 should be evaluated in order to comment on the distribution of error terms.

**Table 11.** Statistical Results Of Error Terms

| | |
|---|---|
| **Mean** | 1.16e-16 |
| **Median** | -0.013 |
| **Maximum** | 0.202 |
| **Minimum** | -0.141 |
| **Std. Dev.** | 0.060 |
| **Skewness** | 0.893 |
| **Kurtosis** | 3.622 |
| **Jarque-Bera** | 64.845 |
| **Probability** | 0.000 |

According to the normality analysis, the probability value of Jarque-Bera was calculated as 0.000. Since it is 0.000<0.05, the empty hypothesis is rejected and the error terms are not distributed normally. On the other hand, the oblique is greater than 0 with a value of 0.893, and the pressure value is as it should be, with a value greater than 3.622 and 3.

## IV. CONCLUSION AND RECOMMENDATIONS

In this study, the connection between economic growth and income distribution injustice of selected OECD countries was investigated with short-term analysis of 5% significance using annual data from 1990 to 2019. In the first step of the study, it was determined that cross sectional dependence exists between variables and that the slope coefficients have a heterogeneous structure. Then, as a result of the Pesaran (2007)

CADF unit root test applied to understand the level at which the series is stable, it was found that the GINI coefficient and GDP per capita were stable at the level, but the unemployment rates became stable in the first difference. On top of this, the difference of the unemployment variable was taken and made stable in order to investigate the existence of a short-term relationship with panel LS analysis of the variables. In line with the findings of the fixed effects model, it was concluded that while unemployment was stable, income distribution injustice decreased by an estimated 0.001 units when GDP per capita increased by 1 unit, meaning that GDP growth per capita positively affected income inequality.

According to the findings of the Dumitrescu-Hurlin (2012) causality test applied to determine the causality relationship and direction between the variables, it was observed that there was a causality relationship between some variables. In this context, while there is a one-way causality connection from the GINI coefficient to GDP growth per capita, it was determined that unemployment had no effect on income inequality. In line with this result, it is understood that income inequality within the framework of selected OECD countries is a reason for per capita income growth.

As a result, the selected variables influence the unfairness of income distribution at different levels and directions. Compared to other studies, the results obtained by Persson-Tanbellini (1991), Deininger-Squire (1996) and Erkisi-Ceyhan (2020) support this study. On the other hand, the results of the Barro (2000) and Majeed (2010) research,

which concluded that income inequality and economic growth increased and decreased in the same direction, are in contrast with this study. Under the policy proposal, OECD countries will have a fairer standard of living if they increase the GDP per capita rate to ensure income distribution fairness. In achieving this, it is a prerequisite for countries to decrease imports and increase exports and investments.

## REFERENCES

Alesina, A. and Perotti R. (1996). Income Distribution, Political Instability and Investment, European Economic Review, Vol. 40, No. 6 (June, 1996), pp 1203-1228.

Atkinson, A.B. and Bourguignon, F. (2014). Handbook of Income Distribution, Vol. 2 (December, 2014).

Baltagi, B.H. (2008). Econometric Analysis of Panel Data (Fourth Edition), (June, 2008), West Sussex: Wiley, John & Sons.

Barro, R. (2000). Inequality and Growth In A Panel of Countries, Journal of Economic Growth, Vol.5, No.1 (March,2000), pp 5-32.

Bozoklu, Ş. and Yılancı, V. (2013). Finansal Gelişme ve İktisadi Büyüme Arasındaki Nedensellik İlişki: Gelişmekte Olan Ekonomiler İçin Analiz, Journal of DEU Faculty of Economics and Administrative Sciences, Vol. 28, No. 2 (December, 2013), pp 161-187.

Campos, A. (2017). How Does Inequality Affect Economic Growth?, Caixa Bank Research, (January, 2017), "https://www.caixabankresearch.com/en/economics-markets/activity-growth/how-does-inequality-affect-economic-growth" https://www.caixabankresearch.com/en/economics-markets/activity-growth/how-does-inequality-affect-economic-growth, 12.06.2021

Cantarero, D., Pascual M. and Sarabia J.M. (2005). Effects of Income Inequality on Population Health: New Evidence From The European Community Household Panel, Applied Economics, Vol. 37, No. 1 (Feb, 2005), pp 87–91.

Clarke, G.R. (1995). More Evidence on Income Distribution and Growth, Journal of Development Economics, Vol. 47, No. 2 (August, 1995), pp 403-427.

Deininger, K. and L. Squire (1996). A New Data Set Measuring Income Inequality, World Bank Economic Review, Vol. 10, No. 3 (September, 1996), pp 565-591.

Dumitrescu, E. I. and Hurlin, C. (2012). Testing for Granger Non-Causality in Heterogeneous Panels, Economic Modelling, Vol. 29, No. 4 (July, 2012), pp 1450-1460.

Erkişi, K. and Ceyhan, T. (2020). İktisadi Büyüme ve Gelir Dağılımı Adaleti İlişkisi: Bir Panel Veri Analizi, Journal of Socioeconomics, Vol. 28, No. 43 (January, 2020), pp 195-212

Hausman, J. A. (1978). Specification Tests in Econometrics, Econometrica, Vol. 46, No. 6 (November, 1978), pp 1251-1271.

Herzer, D. and Vollmer S. (2012). Inequality and Growth: Evidence From Panel Cointegration, Journal of Economic Inequality, Vol. 10, No. 4 (October, 2012), pp 489-503

Keeley, B. (2015). Income Inequality: The Gap Between Rich and Poor, OECD Insights, OECD Publishing, (December, 2015), Paris.

Lahouij, H. (2017). The Effects of Income Inequality on Economic Growth Evidence from MENA Countries, 2017 Awards for Excellence in Student Research and Creative Activity, Eastern Illinois University.

Majeed, M.T. (2010). Inequality, Trade Openness and Economic Growth in Asia, Applied Econometrics and International Development, Vol. 10, No. 2 (January, 2010), pp 201-212.

Persson, T. and Tabellini, G. (1991). Is Inequality Harmful for Growth? Theory and Evidence, National Bureau of Economic Research, (January, 1991), Working Paper No: 91-155.

Pesaran, H.M. (2004). General Diagnostic Tests for Cross Section Dependence in Panels, University of Cambridge Working Paper, 1-39, Faculty of Economics, University of Cambridge.

Pesaran, M. H. and Yamagata, T. (2008). Testing Slope Homogeneity in Large Panels, Journal of Econometrics, Vol. 142, No. 1 (January, 2008), pp 50-93.

Pesaran, M. H. Ullah, A., and Yamagata, T. (2008). A Bias-Adjusted LM Test of Error Cross Section Independence, The Econometrics Journal, Vol. 11, No. 1 (January, 2008), pp 105–127.

Pesaran, M.H. (2007). A Simple Panel Unit Root Test in the Presence of Cross Section Dependence, Journal of Applied Econometrics, Vol. 22, No. 2 (April, 2007), pp 365-312.

Rosser, J.B., Rosser, M.V. and Ahmed, E. (2000). Income Inequality and the Informal Economy in Transition Economies, Journal of Comparative Economics, Vol. 28, No.1 (March, 200), pp 156–171.

Theyson, K.C. and Heller, L.R. (2015). Development and Income Inequality: A New Specification of the Kuznets Hypothesis, The Journal of Developing Areas, Tennessee State University, College of Business, Vol. 49, No. 3 (July, 2015), pp 103-118.

Todaro, M.P. and Smith, S.C. (2012). Economic Development (11th Ed.). London: Pearson Education Limited.

Turgut, E. and Uçan, O. (2019). Yolsuzluğun Vergi Oranları İle Olan İlişkisinin OECD Ülkeleri Örnekleminde İncelenmesi, Journal of Nigde Omer Halisdemir University Institute of Social Sciences, Vol. 1, No. 3, pp 1-17.

# CHAPTER 6

# IMPACT OF HEALTH AND EDUCATION EXPENDITURES ON ECONOMIC GROWTH: PANEL DATA ANALYSIS ON G8 COUNTRIES

Rukiye AYKOÇ[1]

[1] Graduate Student, Niğde Ömer Halisdemir University, Department of Economics, rukiyeaykoc@hotmail.com, https://orcid.org/0000-0001-5232-2026

## 1.Introduction and Theoretical Structure

When we look at economic growth, health and education expenditures, we can say that it is among the most important and invested places among the countries.

The two main factors in the formation of human capital in economies are expenditures on education and health. Education expenditures enable individuals to develop their knowledge, skills and abilities, while health expenditures facilitate and increase motivation for individuals to participate in production more efficiently and effectively.

Considering that human capital is an important factor for economic growth, it can be said that improvements in the average life expectancy of individuals are of great importance for economies. In other words, improvements in the life expectancy and health conditions of individuals make it easier for individuals to get a better education and increase the economic well-being of the country.Investments in education and health expenditures play an important role in improving the quality of life of individuals and also contribute to the economic growth of countries.Looking at it as a whole, education and health are two main factors that increase human productivity.Therefore, the allocation of more resources to education and health services and the increase of these services benefit the accumulation of human capital, that is, economic growth.It is seen that education and health levels are also high in countries with high levels of economic development.Education and health care directly and indirectly affect

economic growth in many ways, but at the same time they are affected by the economic growth.Education and health levels alsoappear to have an impact on each other and investments in these areas are known to be much more effective.Education and health expenditures contribute to the increase of the education and health level of the society and economic growth.It improves the quality of service in the fields of education and health.

In this study, the aim is to examine the relationship between health and education expenditures and economic growth in human capital in G8 countries using the data between 2000 and 2018. Panel data analysis is used in the study as it has a more advantageous structure compared to other analysing methods. The G8 countries examined in the study made large investments in human capital.

## 2.Literature Review

Hansen and King (1996) in their paper, analyzed the relationship between per capita health expenditures and GDP in 20 OECD countries in the period 1960-1987 with the help of unit root testing. As a result of the study, it was determined that the series was not fixed and it was concluded that GDP had a significant impact on determining the level of total health expenditures.

Dregere and Reimers (2005) in their study, examined data on economic growth and health expenditures of OECD countries between 1975 and 2001. Panel co-integration test has been applied. They concluded that

there is a long-term relationship between health expenditures and economic and economic growth.

Çalışkan (2009) in his study, based on panel data analysis method, covers the period 1984-2005. As a result of the study, the changes between GDP per capita and health expenditure per capita were strongly explained. It has shown that the health services of the OECD countries are not technically luxury but need.

Çetin and Ecevit (2010) in articles, used data from 15 OECD member states between 1990 and 2006 to investigate the impact of health on economic growth. The relationship between the share of annual public health expenditures in total health and economic growth are tested by panel data analysis. They found a weak and positive relationship between health expenditures and economic growth, and concluded that this relationship was not statistically significant.

Elmi and Sadeghi (2012) in this study, examined data on per capita national product and per capita health expenditures of developing countries between 1990 and 2009.Panel co-integration and vector error correction analysis were used. It has been found that there is a one-way causality from economic growth to health expenditure in the short term, and in the long termthere is a two-way causality from economic growth to health expenditure

Yardımcıoğlu(2012) in his study, between 1975 and 2008, He investigated the relationship between health and economic growth for 25 OECD countries. According to the results of the study conducted

within the framework of co-integration analysis and causality analyses, a positive and meaningful relationship between health and economic growth variables was detected in the long term and it was determined that there was a two-way causality.

Selim, Uysal and Eryiğit (2014) in their panel data analysis, they investigated the relationship between economic growth and health expenditure of human capital. The study worked with a model of co-integration and error correction between per capita health expenditures and economic growth of 27 EU member states and Turkey between 2001 and 2011. According to the results obtained in the study, they found a positive relationship between per capita health expenditure and economic growth in both the short and long term.

Lacheheb and others (2014) in their papers, examined the relationship between health expenditure, education expenditure and economic growth with data from 1995 to 2010 for 20 MENA (Middle East and North African region) countries. Panel pooled smallest squares method, fixed effects model and random effects model were examined. As a result, it shows a positive relationship between health expenditures and economic growth.

Öztürk and Topçu (2014) , investigated the relationship between health expenditures and economic growth. They investigated health-based growth in G8 countries and conducted panel data analysis. As a result of the study, it was found that there is a one-way causality between health expenditures and economic growth, and that health expenditures

affect economic growth in the short term, but economic growth affects health expenditures in the long term.

Hayaloğlu and Bal (2015) In this articles, examined the relationship between health expenditures and economic growth and studied data from 2000 to 2013.It was surveyed for 54 upper middle-income countries. In this respect, the effect of public and private health expenditures on economic growth in addition to total health expenditures are tested using panel data analysis method. In line with the results obtained, the increase in both total health expenditures and public and private sector health expenditures has positively affected economic growth in upper middle income countries.

Şahbudak and Şahin(2015) in articles, they study was conducted between 1995 and 2013, analyzed the relationship between health indicators and economic growth in BRIC countries with panel data analysis. In the study, unit root tests were performed and it was understood that it are stationary and co-integration test was performed. As a result, they found a positive relationship between the share of health expenditures in GDP, life expectancy at birth and economic growth. There was a negative correration between economic growth and child mortality rates.

Saraçoğlu and Songur (2017) In this study, the relationship between per capita health expenditures and national income per capita was investigated in 10 Eurasian countries, including Turkey, for the period 1995-2014.Peseran (2008) cross sectional dependency test was used.

Hadri&Kurozumi (2012) panel unit root test, Westerlund & Edgerton (2007) panel co-integration test and Dumitrescu & Hurlin (2012) panel causality test were then performed. As a result, they found a two-way causality relationship between per capita health expenditures and per capita national income.

Karasaç and Sağın (2018) In this study, they worked with 34 OECD countries including Turkey. The main purpose of the study was to analyze the effects of health expenditures on growth in economies, which are important factors in the formation of human capital in the OECD country. First, panel unit root tests and panel co-integration were performed, and then the Smallest Frames Prediction and Vector Error Correction model were used. In line with these results, it was concluded that there is a linear relationship between health expenditures and GDP for OECD countries.According to the vector error correction model results, a two-way causality relationship was found between the variables received.

Dinçer and Yüksel (2019) in this study,examined the data from 1996 to 2016 on the causality relationship between health expenditures and economic growth in E7 countries.Panel data analysis method was used in the study.As a result of the analysis, they concluded that there is a long-term relationship between economic growth and health expenditures, but there is no causality relationship between health expenditures and economic growth.

Özkan and Zengin (2018) in this study, examined the relationship between GDP per capita, total drug sales and per capita health expenditures of 21 OECD countries between 2000 and 2015.In the analysis, unit root test was used for stasis test. Pedroni and Kao conjunction analysis concluded that the relationship between the variables used was long-term. As a result of the Granger causality test, there was a two-way causality relationship was obtained from GDP per capita to health expenditures per capita and there was aone-way causality from per capita health expenditures to the total amount of drug sales.

Kılıç and Özbek (2018) In their panel data analysis, examined data on health expenditure, education expenditure and economic growth in OECD countries between 1995 and 2013.Levin Lin Chu, Hadri, Breitung, Im Peseran Shin, Fisher ADF and Fisher PP unit root tests were performed for stasis analysis. Since the unit is not stable at the level as a result of the root, its differences are taken and it has become stable in the first degree. Cointegration tests were carried out and Dumitrescu-Hurlin panel causality tests were examined for causality. They found that there was a %5 severity-level two-way causality relationship.

As a result of the literature research, although studies establishing a two-way causality relationship between education, health and economic growth are predominant, there are also studies that establish a one-way relationship. When conducting the research, groups of countries with different income levels were generally examined.If we consider the

literature summary in general, we can say that there is a positive relationship between education, health and economic growth.

## 3. Data set, Methods and findings

In this study, the G8 countries and the impact of economic growth on health expenditures and education expenditures in these countries were examined by panel data analysis method. The data used in the study were obtained by the World Bank for 2000-2018. Estimating the models used in the analysis used stata and gauss package programs were used. The variables used in the study are shown in Table 1.

**Table 1:** Working Data Set

| Variables | Variable Name | Code | source |
|---|---|---|---|
| Dependent Variable | Per Person GDP (US Dollars) | RGDP | World Bank |
| IndependentVariable | Education Expenditures(US Dollars) | EDUCATION | World Bank |
| | Health Expenditures(US Dollars) | HEALTH | World Bank |

The study will examine whether health care spending, education expenditure and economic growth are co-integration in the long term. Therefore, the variables should not be stable, the first differences should

include unit roots. Unit root test should be performed before the co-integration test. Panel unit root tests should first be investigated whether there is a relationship between the cross sections that make up the panel. Panel data unit root tests are divided into first and second generation unit root tests. While there is no relationship between cross section units in first generation tests, second generation tests are assumed to have a relationship between cross sections. For this reason, cross section dependency and homogeneity test will be performed first, and then unit root tests will be performed based on the results of this test and conjunction test will be performed from here. Finally, we will have finished our analysis with panel causality.

### 3.1. Cross Section Dependency Test

Cross section dependency is meant to refer to the existence of a correlation relationship between the units that make up the series. Cross section dependency tests are used to determine which group panel unit root tests will be suitable for research.

Cross sectional dependency tests are the following three tests. The first one is Lagrange Multiplier (LM) tests developed by Breusch and Pagan (1980).The second is the Peseran (2004) CD test, and finally the Peseran, Ullah & Yamagato (2008) set LM test. When testing cross section dependency, these three tests will be interpreted according to the review.In the testing of cross section dependency, both time (T) and cross section size (N) of the series should be taken into account.Breusch and Pagan (1980) test is applied if the time dimension of the series is greater than the cross section size (T>N), if it is smaller than the cross

section (T<N) or if the time and cross section size is equal (T=N) Peseran (2004), the CD LM test is applied, if the time is less than the cross section size (T<N) or vice versa Peseran (2004) CD test is applied and the Pesaran,Ullah & Yamagato test is applied when the time dimension is greater than the cross section size (T>N) (Gençoğlu, S. Kuşkaya, S. Büyüknalbant, T. 2020: 1292).

| Test | Statistical Values | Probability Values | Result |
|---|---|---|---|
| LM | 145.4 | 0.0000 | ($H_0$ Red) Cross Section Dependent |
| LM adj | 29.12 | 0.0000 | ($H_0$ Red) Cross Section Dependent |
| LM CD | 9.607 | 0.0000 | ($H_0$ Red) Cross Section Dependent |

Table 2 provides cross section results of G8 counties for 19 years.

**Table.2:** Cross Section Dependency Test

Cross-section hypotheses

$H_0$:No cross section dependency

$H_1$: There is a cross section dependency.

$H_0$ if the hypothesis is accepted, the first generation panel unit root tests are performed. If the H0 hypothesis is rejected, second generation unit root tests are performed.

When looking at the results of LM, LM adj, LM CD tests, the H0 hypothesis is rejected at a level of %5 significance. Rejection of the H0 hypothesis indicates cross-sectional dependence in the series.

### 3.2. Homegeneity Test

Homogeneity testing of slope coefficients was used in the standard delta and corrected delta method developed by Pesaran and Yamagata (2008). Zero hypothesis in homogeneity test H0:Slope coefficients are homogeneous and alternative hypothesis H1:Slope coefficients are heterogeneous (Kar, Ağır and Türkmen, 2018: 312).

**Table.3:** Homogeneity Test Results

| | Delta | Probability |
|---|---|---|
| | 15.242 | 0.0000 |
| Adj. | 17.154 | 0.0000 |

Based on the results of the analysis, the H0: hypothesis was rejected at the level of % 5 significance and it was decided that the coefficients were heterogeneous.

### 3.3. Panel Unit Root Analysis

Panel data analysis, which is formed by combining cross-section and time series, brings with it time series features and problems encountered in time series with itself. As with time series data, whether variables contain unit roots and whether there is conjunction between variables with the same degree of unit root will be examined (Kubar,2016:72).

Whether the series provides the static condition is important for the reliability of the estimates made.Whether the series is static or not strongly affects the characteristics and behavior of the series(Kılıç, Bayar ve Özekicioğlu,2014:123).

Hypotheses of the Test;

H0:Series has Unit root

H1:No Volume root in series

CADF test results developed by Peseran (2007) are shown in Table 4. It is seen that all variables are not stable at the level but are stable after the first difference is taken. Therefore, the result is I(1) for all variables. This situation shows that a shock to the country's economies does not immediately lose its effect, so the shocks are permanent. Since the series are not stable at the level, cointegration tests are performed (Kar, Ağır and Türkmen, 2019:43).

**Table 4:** CIPS Panel Unit Root Test Results

| | CIPS Test Statistics | CIPS table %5 |
|---|---|---|
| GDP | **-0.952** | **-2.47** |
| HEALTH | **-1.533** | **-2.47** |
| EDUCATION | **-1.511** | **-2.47** |
| $\Delta GDP$ | **-4.210** | **-2.47** |
| $\Delta HEALTH$ | **-4.676** | **-2.47** |
| $\Delta EDUCATION$ | **-5.265** | **-2.47** |

In the study, the test statistic values obtained as a result of the application of the CIPS estimator can be compared with the critical table values in Peseran (2006), to test whether the panel data is stable as a whole. Here, the level was first examined and cips test statistical values were found to be smaller than CIPS table values. The H0 hypothesis was not rejected and the differences of the variables were taken. When we looked at the CIPS values and CIPS table value after the difference of the variables, it was concluded that H0 was rejected at a critical value of 5% and that it was I(1) but also stable. Therefore, our analysis will continue with the co-integration test.

### 3.4. Panel Cointegration Analysis

The variable results of the co-integration analysis developed by Westerlund are given in table 5. The H0 hypothesis are as "no co-integration". Ecm boot co-integration test developed by Joakim Westerlund was used. Gt, Ga and bootstrap tests were examined if there was cross-sectional dependence and heterogeneous results were found. The results are shown in Table 5.

**Table 5:** Westerlund Panel Co-integration Test

| | **Statistics** | **bootstrap** |
|---|---|---|
| **Gt** | **-0.567** | **0.780** |
| **Ga** | **3.797** | **0.897** |

H0:No peer integration

H1:Co-integration exists

In the results obtained, it was concluded that it was not rejected at the level of 5% signification and that there was no co-integration.Therefore, it has emerged that there is a short-term relationship between health expenditure, education expenditure and economic growth variables but there is no long-term relationship.Before looking at the short-term relationship, the difference of the variables is taken and the level is stabilized.The variables whose differences are taken are also tested for the smallest squares method.

### 3.4.1. LM Test

In the LM test, Breusch-Pagan, King-Wu and Honda results are usually given together. This test examines whether there arerandom effects and pooled effects model**.** If the probability value is less than 0.05, we accept the H0 hypothesis, that is, the pooled effects are rejected, the model of random effects is considered.However, if the probability value is greater than 0.05, the H0 hypothesis, that is, pooled effects model, is considered.

**Table 6:** LM Test Results

| | **Test** Hypothesis | | |
|---|---|---|---|
| | Cross Section | Time | Both of them |
| Breusch-Pagan | 26.24987 (0.0000) | 1.150325 (0.2835) | 27.40020 **(0.0000)** |
| Honda | 5.123463 (0.0000) | 1.072532 (0.1417) | 4.381230 (0.0000) |
| King-Wu | 5.123463 (0.0000) | 1.072532 (0.1417) | 4.891270 (0.0000) |

According to Breusch-Pagan, the probability value is less than 0.05, which is considered a random effect model.

### 3.4.2. Hausman Test

In the Haussman model, the random effects and constant effects model are tested. The hypotheses are as follows: H0: Random Effects Model H1: Fixed Effects Model. If the probability value is less than %5, the H0 hypothesis is rejected. Otherwise, the H0 hypothesis is not rejected and the fixed effects model is accepted if the probability value is more than 5% (Uçan, 2018:371).

**Table7:** Hausmann Test Results

| Test Summary | Ki-square statistics | Ki-Sg d.f | Probability |
|---|---|---|---|
| Random cross section | 42.944566 | 2 | 0.00000 |

Because the probability value is less than 0.05, the H0 hypothesis is rejected and the fixed effects model is accepted.

### 3.4.3. F Test (Chow Test)

In this part of the study, pooled effects and fixed effects model are tested. If the probability value is less than 0.05, the H0 hypothesis is rejected and the model of fixed effects is considered. The hypotheses

are as follows; H0: Pooled effects model H1: fixed effects model. If the probability value is greater than 0.05, the H0 hypothesis is accepted and the pooled effects model is involved.

**Table 8:** F Test(chow test) Results

| | statistics | s.d | probability |
|---|---|---|---|
| Cross Section F | 6.251872 | (7.134) | 0.0000 |
| Cross Section Ki- Square | 40.696128 | 7 | 0.0000 |

The probability value is less than 0.052 and the H0 hypothesis is rejected, meaning that the fixed effects model is accepted.

As a result of the 3 tests, the fixed effects model was accepted.

### 3.4.4 Fixed Effects Model

**Table9:** Fixed Effects Model Results

| Variables | Coefficient | Std.error | t-statistics | probability |
|---|---|---|---|---|
| **DHEALTH** | 6.12E+08 | 53832739 | 11.36251 | 0.0000 |
| **DEDUCATION** | 5.175514 | 1.082593 | 4.780666 | 0.0000 |
| **C** | 1.19E+10 | 1.38E+10 | 0.864022 | 0.3891 |

F-statistical probability Value :0.0000

**DRGDP=1.19+538DHEALTH+1.08EDUCATION**

According to the fixed effects model, all coefficients are fixed between time and countries. While the arguments are constant, the economic growth dependent variable averages 1.19 units. While health spending is stable, economic growth increases by an average of 1.08 units when education spending increases by one unit. While education spending is steady, economic growth increases by an average of 538 units when health spending increases by one unit. The F-statistical value indicates that the model as a whole makes sense(Uçan,2018:372).

### 3.5 Panel Granger Causality Causality Causality Test

It was put forward by Granger, and the main effect in terms of causality is that a cause will not occur after the effect. If variable X affects variable Y, variable X helps to advance assessments of the Y variable at the same time. No information about the length of delay was specified when analyzing the Granger causality test. Therefore, Var analysis has been tested. No information about the length of delay is specified when analyzing. Therefore, the length ofdelay was calculated with Var analysis and used as 2 (Özkan and Zengin,2018:376).

**Table 10:** Granger Causality Causality Causality Analysis Results

| Zero hypothesis ($H_0$ hypothesis) | Observation Number | f-statistics | probability |
|---|---|---|---|
| No causality from DHEALTH to DGDP | 128 | 3.26307 | 0.0416 |
| No causality from DGDP to DHEALTH | | 1.14723 | 0.3209 |
| No causality from DEDUCATION to DGDP | 128 | 0.11911 | 0.8878 |
| No causality from DGDP to DEDUCATION | | 7.62252 | 0.0008 |
| No causality from DEDUCATION to DHEALTH | 128 | 0.92354 | 0.3998 |
| No causality from DHEALTH to DEDUCATION | | 1.81217 | 0.1676 |

When looking at the results of granger causality, the H0 hypothesis was determined as having causality and in the H1 hypothesis having no causality. In the study, %5 was interpreted according to the level of signability. There is causality from health expenditures to economic growth, there is no causality from economic growth to health expenditures, and there is a one-way causality.In the same table, there is a causality from education expenditures to economic growth, but

there is no causality from economic growth to health expenditures.Finally, there is no causality from education expenditures to health expenditures, and there is no causality from health expenditures to education expenditure.

## RESULT

In the relationship between health, education and economic growth, health and economic growth are both the cause and the result. A good level of human capital improves the quality of life of working people. Investments in education and health will also increase the country's prosperity in the long run. The educated and healthy population produces more, which means it generates more income per capita. In the literature, education is often said to be positive in studies that address health and economic growth. Due to the increasing budget opportunities, the separation of resources for education and health expenditures should be investigated and the opportunity of more positive use should be provided.

In this study, panel data analysis for G8 countries (Germany, Japan, United Kingdom, Canada, France, Russia, USA countries) was investigated using annual data from 2000-2018 on education expenditures, health expenditures and economic growth relationship. In the study, unit root analysis was performed on the variables to see if the series would be used in a paremetric study, i.e. to avoid the problem of false regression. With the CADF table developed by Peseran (2007), the unit root operation was performed based on cips statistical results and it was concluded that the unit was root at the level, that it was stable

at 5% when the first difference was taken, that is, all variables were stagnant in the first degree.

As a second stage, westerlunt co-integration test is performed to investigate whether there is a long-term relationship between variables. The peer integration test rejected the co-integration hypothesis between variables at a %5 severity level and accepted the alternative hypothesis that there is peer integration between variables. From here, health expenditure, education expenditure and economic growth variables move in the short term. As the third phase of the study, the differences of the variables were taken and the smallest squares were processed and the fixed, random and pooled effects model was examined and the fixed effects model was reached. As the fourth stage, the differences in the existence of the causality relationship between the variables were made based on the variables taken and granger causality panel was investigated by causality test. A one-way cagial relationship has been detected between the variables. As a fifth stage, control tests of the variables have been carried out, which we can say as follows. When we look at the results of normality, when the Jarqua-Bera probe value is %5, it is said that the variables do not dissipate normally, and in the opposite case, inthe case where it is above %5, it dissipates normally. As a result of our normality test, our probability value is below 0.05 and we say that it is distributed normally. As a result of test, it is concluded that there is no autocorelation because the probability values are above 0.05. As a result of the variance test, the ki-square values were 0.85 and it was concluded that there was no changing variance with a fixed

variance because this value was greater than 0.05. As a result, it was concluded that health, education and economic growth are integral parts of one, and that the change in one variable significantly affects the other variable. Increased spending on health care and education and increased contribution to the economy. National education and health policies should be developed and the quality of health and education services should be improved. These improvements will lead to a healthier and more educated society. Countries also need to pay attention to health and education expenditures for their continuous growth and development.

## REFERENCES

Çetin, M. & Ecevit, E.(2010). "Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: OECD Ülkeleri Üzerine Bir Panel Regresyon Analizi", Doğuş Üniversitesi Dergisi, 11(2), 166-182.

Dinçer, H.& Yüksel, S. (2019). "Sağlık Harcamaları ve Ekonomik Büyüme arasındaki nedensellik ilişkisinin belirlenmesi:E7 ülkeleri üzerine bir uygulama", İstanbul Medipol Üniversitesi Journal of Health Systems and Policies, cilt:1,ss.5-23.

Drege C, Reimers, Hans, (2005), Health Care Expenditures in OECD Countries: A Panel Unit Root and Cointegration Analysis, IZA Discussion Paper No. 1469.

Elmi, Z. M. Sadeghi S, (2012), "Health Care Expenditures and Economic Growth in Developing Countries: Panel Co-Integration and Causality", Middle-East Journal of Scientific Research, 12 (1), 88-91.

Gençoğlu, P., Kuşkaya, S., & Büyüknalbant, T.(2020). "Seçilmiş OECD Ülkelerinde Sağlık Harcamalrının Sürdürülebilirliğin Panel Birim Kök Testleri İle Değerlendirilmesi". Ankara Üniversitesi Sosyal Bilimler Fakültesi Dergisi, Cilt 75, ss. 1283-1297.

Granger, C.W. (1969). "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods".Econometrica: Journal of the Econometric Society, 424-438.

Hansen, P. & King, A.(1996). "The Determinants of Health Care Expenditure: A Cointegration Approach," Journal of Health Economics, Cilt:15, Sayı:1, ss.127-137.

Hayaloğlu, P. & Bal, H.(2015). "Üst Orta Gelirli Ülkelerde Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi", İşletme ve İktisat Çalışmaları Dergisi, 3(2), 35-44.

Kar, M,. Ağır, H. & Türkmen, S.(2018). "Gelişmekte Olan Ülkelerde Elektrik Tüketimi İle Ekonomik Büyüme İlişkisinin Ekonometrik tahmini", 5. Uluslararası Politik Ekonomik ve Sosyal Araştırmalar Kongresi(ICPESS)'de sunulan bildiri. Politik, Ekonomik ve Sosyal Araştırmalar Merkezi, Niğde, Türkiye,26-29 Ekim.

Kılıç, R., & Özbek, R. İ. (2018). "Sağlık ve Eğitim Hizmetleri ile Ekonomik Büyüme İlişkisi: OECD Ülkeleri Uygulaması". Ordu Üniversitesi Sosyal Bilimler Araştırmaları Dergisi, 8(2),369-391

Kubar, Y.(2016). "Az Gelişmiş ve Gelişmekte Olan Ülkelerin Kalkınma Göstergeleri ile Ekonomik Büyüme Arasındaki İlişki: Bir Panel Veri Analizi 1995-2010".Ardahan Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, sayı.4 ss.65-99.

Lacheheb, M., Med Nor, N., Baloch, I. (2014). Health Expenditure, education and Economic Growth in MENA Countries, *Munich Personal RePEc Archive*, Paper No: 60388, http://mpra.ub.uni-muenchen.de/60388/, (08.02.2016).

Özcan, G. & Zengin, G.(2018). "Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi: OECD Ülkeleri Üzerine Panel Veri Analizi". Sosyal Bilimler Dergisi, Cilt:8, Sayı:16

Özkan, G. & Zengin, G. (2018). "Sağlık Harcamaları Ekonomik Büyüme İlişkisi: OECD Ülkeleri Üzerine Panel Veri Analizi(200-2015). Sosyal Bilimler Dergisi, Cilt:8, Sayı:16

Öztürk, S., & Topçu, E. (2014). "Health Expenditures and Economic Growth: Evidence from G8". International Journal of Economics and Empirical Research,2(7), 262-267.

Sağın, A. & Karasaç, F .(2018). "Impact of Health Expenditures on Economic Growth in OECD Economies", Kırklareli Journal of University Faculty of Economics and Administrative Sciences, 7(1), 72-86.

Saraçoğlu, S. & Songur, M. (2017). ”Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi: Avrasya Ülkeleri Örneği”, Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi, Cilt:8, Sayı:16.

Selim, S., Uysal, D., Eryiğit, P. (2014). “Türkiye’de Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisinin Ekonometrik Analizi”, Niğde Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 7(3),13-24.

Şahbudak, E. & Şahin, D.(2015). “Sağlık ve Ekonomik Büyüme Arasındaki İlişkinin Analizi: BRIC Ülkeleri Üzerine Bir Panel Regresyon Analizi”, İşletme ve İktisat Çalışmaları Dergisi, Cilt 3, Sayı 4, ss.154-160

Uçan, O.(2018). “Enerji ve Büyüme İlişkisi: Brezilya, Türkiye ve Çin Örneklemi”, 5. Uluslar arası Politik Ekonomik ve Sosyal Araştırmalar Kongresi (ICPESS)”, ss:365-373.

Westerlund, J. & Edgerton, D. L. (2007). A panel bootstrap cointegration test. Economics Letters, 97(3), 185-190.

Yardımcıoğlu, F. (2012). “OECD Ülkelerinin Sağlık ve Ekonomik Büyüme İlişkisinin Ekonometrik Bir İncelemesi”,Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi, Cilt 13, Sayı:2, ss:27-47.

# CHAPTER 7

# THE VALIDITY OF THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS IN E7 COUNTRIES: A PANEL DATA ANALYSIS

Emine Dilara AKTEKİN[1]
Hilal BUDAK [2]

[1]Res.Assistant., Niğde Omer Halisdemir University, Department of Economics, dilaraaktekin@ohu.edu.tr https://orcid.org/0000-0002-4112-2456
[2]Res.Assistant., Niğde Omer Halisdemir University, Department of Economics, hilalbudak@ohu.edu.tr https://orcid.org/0000-0003-2599-8586

## 1. INTRODUCTION

The rapid increase in industrial production after the industrial revolution has brought environmental degradation as well. Since the main problem of the countries is economic growth, environmental problems were not taken into account at the beginning. However, the emergence of problems such as climate change, desertification and global warming has become clearer after 1960 has led to the testing of the relationship between environmental pollution and economic growth. Environmental pollution caused by economic growth has made it a necessity for countries to prefer cleaner technologies in the production process. In this context, since 1990, developed countries have started to transition to environmentally sensitive production processes. However, developing countries have continued their production by taking into account environmental degradation due to the high cost of clean Technologies (Artan et al., 2015: 309).

Testing the relationship between economic growth and environmental pollution is based on the Environmental Kuznets Curve hypothesis. The environmental Kuznets Curve hypothesis is deduced from the Kuznets Curve hypothesis developed by Simon Kuznets (1955), which investigates the relationship between inequality in income distribution and economic growth. Kuznets (1955) argues that while inequality in income distribution increases in the early stages of economic growth, inequality in income distribution will decrease after a certain income level, despite the continuous increase in growth (Örnek and Türkmen, 2019:111). The relationship between these variables is also called to as

the "inverted-U hypothesis" (Dinda, 2004: 432; Song et al., 2008: 381). The Kuznets Curve was adapted to the environment by Grossman and Krueger (1991) and the environmental pollution variable was used instead of the inequality variable in income distribution (Dinda, 2004:432). In other words; The Environmental Kuznets Curve hypothesis states that environmental pollution increases depending on the increase in income level, but after the income reaches a certain level, environmental pollution will decrease (Apergis and Payne, 2010:650). The Environmental Kuznets Curve is shown in Figure 1.

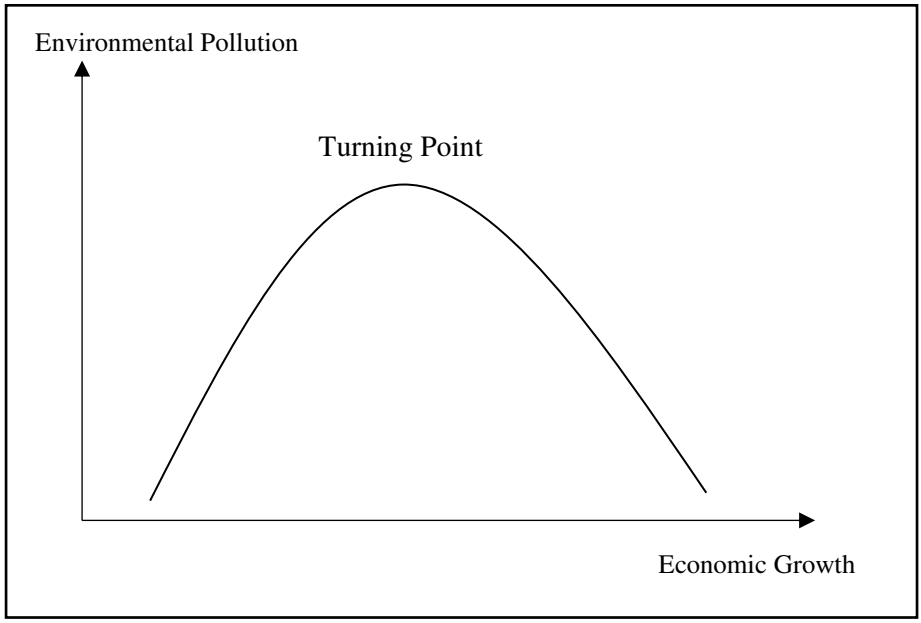



**Figure 1:** The Environmental Kuznets Curve (Yandle et al., 2004:3)

The inverted U shape of the relationship between environmental pollution and economic growth is based on three different effects: scale, composition and technology (Grosmann and Krueger, 1991:7; Shi,

2004: 7; Ang, 2007: 4773). The scale effect means that increases in the production process have an increasing effect on waste and emission rates. This situation causes environmental degradation (Yandle et al., 2004: 3; Başar and Temurlenk, 2007: 2). After reaching a certain income level, the composition effect emerges. With the composition effect and the increase in income level, service and information sectors gain importance in the economy. Accordingly, environmental awareness increases and environmentally sensitive activities gain importance (Dinda, 2004: 434-436; Song et al., 2008: 383). The technology effect, on the other hand, expresses the increase in research and development expenditures within the total expenditures depending on the income level. Therefore, while environmental pollution increases due to the scale effect in the first stage of economic growth, environmental pollution decreases as a result of the composition and technology effect in the later stages of economic growth (Grosmann and Krueger, 1991:7).

According to the Environmental Kuznets Curve hypothesis, in the early stages of industrialization and economic growth, the primary goal is to increase income. Accordingly, countries consume natural resources rapidly, increase their production and use non-clean technologies. All these negative effects cause a significant increase in environmental pollution. However, reaching a certain income level causes people to become conscious and increase environmental awareness. Accordingly, the use of clean technology is becoming widespread and the use of renewable resources is increasing. This situation also causes a decrease

in greenhouse gas emissions that cause environmental pollution (Arı and Zeren, 2011: 38-39).

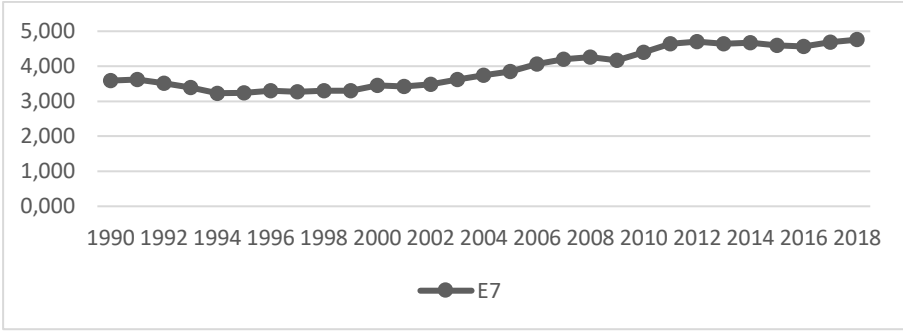



**Figure 2:** Per Capita $CO_2$ Emission Average of E7 Countries Between 1990-2018

Figure 2 shows the course of per capita carbon dioxide emissions of the E7 countries included in the study between 1990 and 2018. The figure was created by compiling the World Bank statistical data and taking the carbon dioxide emission averages per capita of the E7 countries. It is observed that carbon dioxide emissions in E7 countries followed a decreasing course until 2001. However, as of 2001, it is seen that carbon dioxide emissions in E7 countries tend to increase again.

Although the number of studies examining the relationship between environmental pollution and economic growth is quite high, the number of studies examining E7 countries within the scope of the Environmental Kuznets Curve (EKC) hypothesis is quite limited. In this study, starting from the mentioned deficiency in the literature, the relationship between environmental pollution and economic growth in E7 countries was examined within the scope of Environmental Kuznets

Curve (EKC) hypothesis. In the second part of the study investigating the validity of the Environmental Kuznets Curve hypothesis in E7 countries, the relevant literature is presented. The third section consists of the empirical framework of the findings, with explanations of the dataset, research model and analysis procedure. The study is completed with the fourth section, where the results and evaluations are presented.

## 2. LITERATURE REVIEW

In the globalizing world, there has been a significant increase in the number of studies conducted to determine the relationship between environmental problems and economic growth and the environment in recent years (Dinda, 2004:432). The common point of these studies is the thought that environmental pollution increases in the first stages of economic growth and decreases after a certain income level (Apergis and Payne, 2010:650). Although there are many studies in the literature to test the validity of the Environmental Kuznets Curve hypothesis, a common consensus could not be reached in the results obtained from the studies. In this case, in addition to the different economic structures of the countries, the different perspectives in the studies, the methods used, the sample selection and the analysis tools are also effective.

The validity of the Environmental Kuznets Curve Hypothesis was first examined by Grossman and Krueger (1991). In the study, the relationship between air quality and economic growth for NAFTA countries was analyzed by panel data method. SO2, PM and smoke emissions were used as air quality indicators. An N-shaped Environmental Kuznets Curve relationship was determined in the

analysis results. In addition, a decreasing relationship was found between PM and income.

Shafik and Bandyopadhyay (1992), in their study, examined the relationship between environmental pollution and income for 149 selected countries using panel data analysis method. The lack of urban health protection, lack of clean water, changes in forest area, annual deforestation rate, litter per capita, undissolved oxygen in rivers, amount of sulfur dioxide and carbon dioxide emissions per capita were used as indicators of environmental pollution. The results of the analysis revealed findings supporting the EKC hypothesis between income and deforestation, amount of sulfur dioxide and carbon dioxide.

Panayotou (1993), in the study, examined the relationship between per capita income and environmental pollution with the cross-sectional data analysis method. The results of the analysis revealed the findings supporting the EKC hypothesis between per capita income and environmental pollution. In addition, the reduction in forest areas was examined in the study.

Selden and Song (1994), in their study covering 3 periods, 1973-1975, 1979-1981 and 1982-1984, examined the relationship between air pollution and income for 30 selected countries classified as high, middle and low income, using panel data analysis method. SO2, PM, nitrous oxide (NOX) and carbon monoxide (CO) were used as air pollution indicators. The results of the analysis revealed the findings supporting the EKC hypothesis between the air pollution indicators and the per capita income level variable.

Moomaw and Unruh (1997), in their study covering the period 1950-1992, investigated the relationship between environmental pollution and per capita income for 16 selected countries using panel data method. $CO_2$ emission was used as an environmental pollution indicator. In the analysis results, it was determined that there is a N-shaped relationship between $CO_2$ emissions and per capita income.

Vincent (1997), in the study covering the period 1970-1990, tested the EKC for Malaysia with the panel data method. The results of the analysis showed that the EKC hypothesis was not valid for the research period in Malaysia.

Hamilton and Turton (2002) investigated the relationship between economic growth, greenhouse gas emissions and energy intensity for OECD countries in their study covering the 1982-1997 period. The results of the analysis showed that the opportunities to reduce greenhouse gas emissions are greater in the USA, Canada, the Netherlands and Australia, but more limited in Germany, England and Japan.

Bertinelli and Strobl (2005), in their study covering the 1950-1990 period, examined the relationship between sulfur and carbon dioxide emissions and income for 122 selected countries. Within the scope of the study, the validity of the EKC was tested. The results of the analysis showed that the EKC hypothesis was not valid for the research period in 122 selected countries.

Ang (2007) , in this study covering the period 1960-2000, investigated the relationship between $CO_2$ emissions, income and energy use for France using cointegration and causality methods. The results of the analysis revealed findings supporting the EKC relationship between $CO_2$ and income. In addition, it was emphasized that a more precise EKC relationship was determined by including energy data in the analysis.

Apergis and Payne (2010), in their study covering the period 1992-2004, investigated the causal relationship between carbon dioxide emissions, energy consumption and real output for 11 countries in the Commonwealth of Independent States. The results of the analysis showed that there is a bidirectional causality relationship between energy consumption and $CO_2$ emissions in the long run. In addition, findings supporting the EKC hypothesis were obtained.

Iwata et al. (2010), in the study covering the period 1960-2003, he examined the relationship between carbon dioxide emissions, energy consumption and real output for France with the ARDL method. The results of the analysis showed that there is an inverted-U relationship between the mentioned variables. In other words, findings supporting the EKC hypothesis were found in the study.

Jaunky (2011), in this study covering the 1980-2005 period, tested the EKC hypothesis for 36 high-income countries with panel data analysis method. As a result of the analysis, findings supporting the EKC hypothesis were obtained in Greece, England, Portugal, Oman and Malta. In addition, it was found that a 1% increase in economic growth

for 36 selected countries in the long term increased environmental pollution by 0.22%.

Saatçi and Dumrul (2011), examined the relationship between environmental pollution and economic growth for Turkey in their study covering the period 1950-2007, using unit root and cointegration tests that include structural breaks. The results of the analysis showed that there is a long-term relationship between environmental pollution and economic growth. In addition, findings supporting the EKC hypothesis were obtained in the study.

Farhani and Rejeb (2012), tested the validity of the EKC hypothesis for 15 MENA countries in their study covering the 1973-2008 period. In the study, the relationship between energy consumption, carbon dioxide emissions and economic growth was examined by panel data analysis method. The results of the analysis showed that there is a unidirectional causality relationship from economic growth and carbon dioxide emissions to energy consumption in the long run.

Sarısoy and Yıldız (2013), in their study covering the period 1992-2009, examined the relationship between economic growth, $CO_2$ and population for 30 countries (15 developed and 15 developing) with panel data analysis and Granger causality method. The results of the analysis showed that the EKC hypothesis was not valid for the research period in 30 countries, 15 of which were developed and 15 of which were developing.

Erataş and Uysal (2014), in their study covering the period 1992-2010, examined the relationship between environmental pollution and income level for BRICT countries with dynamic panel data method. The results of the analysis showed that the EKC hypothesis is valid in BRICT countries.

Zambrano-Monserrate et al. (2016), in their study covering the period 1960-2010, examined the relationship between environmental degradation, economic growth, energy consumption and trade liberalization in Iceland using ARDL model and Granger causality test within the scope of EKC. Analysis results showed that the EKC hypothesis is valid.

Uddin et al. (2016), in this study covering the period 1961-2011; The validity of the Environmental Kuznets Curve Hypothesis for 22 selected countries was tested with the Johansen cointegration and vector error correction model. The results of the analysis showed that the EKC Hypothesis was valid for 10 countries.

Ergün and Polat (2017), in their study covering the 1980-2010 period, examined the relationship between economic growth, carbon dioxide emissions and electricity consumption for G7 countries with panel data analysis method. The results of the analysis showed that there is a bidirectional causality relationship between carbon dioxide emissions and economic growth, and between electricity consumption and economic growth, and a unidirectional causality from electricity consumption to carbon dioxide emissions.

Liu et al. (2017), in his study covering the period 1970-2013, examined the relationship between carbon dioxide emissions, per capita renewable energy consumption and agricultural value added variables for ASEAN-4 using panel data method. The results of the analysis showed that the EKC hypothesis was not valid for the research period.

As it can be understood from the literature summary, studies examining the relationship between environmental pollution and economic growth within the scope of the EKC Hypothesis have not reached a common consensus. Despite these studies, which are increasing in number, the number of studies examining the relationship between environmental pollution and economic growth in E7 countries with the dynamic panel data method within the scope of the EKC Hypothesis is relatively few. Based on this gap in the literature, this study aims to contribute to the empirical literature with current data sets and analysis techniques.

## 3. DATASET AND METHODOLOGY

In the study, the annual data set for the period 1990-2018 was used, the per capita Gross Domestic Product (GDP), the square of the Gross Domestic Product per capita ($GDP^2$) and Carbon Dioxide Emission ($CO_2$) values per capita were arranged in accordance with the panel data set. In the created model; Carbon Dioxide Emission (C) per capita was used as the dependent variable.

In the study, it was tried to measure how independent variables affect carbon dioxide emission. Table 1 shows the variables used in the

analysis and their sources. It was included in the analysis by taking the logarithm of the dependent and independent variables.

**Table 1:** Description of the Variables Used in the Analysis

| Time Series | Variable | Description | Source |
|---|---|---|---|
| Environmental Pollution | $LCO_2$ | Carbon Dioxide ($CO_2$) Emissions Per Capita (metric tons) | WB-WDI, 2021 |
| Economic Growth | LGDP | Real GDP Per Capita | WB-WDI, 2021 |
| Square of Economic Growth | $LGDP^2$ | Squared Real GDP Per Capita | WB-WDI, 2021 |

Since the model used in the research was based on the studies of Selden and Song (1994), one of the main studies of the EKC hypothesis, a quadratic model was established in the study. The theoretical model of this study was formed as follows:

$$Y= f\,(GDP, GDP^2\ )$$

In the study, the long-term linear panel regression model, which was created with a holistic approach, to examine in which direction and to what extent independent variables affect the dependent variable, is as follows:

$$LCO_{2it}= \beta_0+\beta_1 LGDP_{it}+\beta_2\, LGDP^2_{it}+ u_{it}$$

(i=1,2,3,,……..,7; t=1990,1991,…….2018)

Here; all variables are in logarithmic form as described in the table above, while i represents the country, t the year, $\beta_0$ a constant and uit the error term. The possible results of the model created in line with the theoretical explanations and the findings obtained in previous studies are as follows (Dinda, 2004: 440-441):

- $\beta_1 = \beta_2 = 0$ in case, there is no relationship between x and y.
- $\beta_1 > 0$ ve $\beta_2 = 0$ in case, there is a linear relationship between x and y.
- $\beta_1 < 0$ ve $\beta_2 = 0$ in case, there is an inverse relationship between x and y.
- $\beta_1 > 0$, $\beta_2 < 0$ in case, there is an inverted-U-shaped relationship between x and y. This relationship shows the existence of the EKC hypothesis.
- $\beta_1 < 0$, $\beta_2 > 0$ in case, there is a U-shaped EKC relationship between x and y.

In order to test the validity of the EKC hypothesis, the homogeneity of the coefficient of the independent variable in the model is examined before analyzing the relationship between environmental pollution and economic growth. For the homogeneity test, the Slope Homogeneity Test developed by Pesaran and Yamagata (2008) is used. In order to determine whether there is dependency between sections in the model, LM (Breusch and Pagan,1980) test, $CD_{LM}$ (Pesaran, 2004) test, CD test (Pesaran, 2004) and $LM_{adj}$ (PUY, 2008) tests are applied. As a result of these analyzes, Hadri ve Kuruzomi (2012) Unit Root Test, which is one of the second generation panel unit root tests, takes into account inter-

sectional dependence is used. Whether there is a cointegration relationship between the variables is analyzed using cointegration test developed by Westerlund and Edgerton (2007). The long-term coefficients of the variables are estimated with the CCE (Common Corelated Effects) estimator developed by Pesaran (2006), which takes into account the inter-sectional dependence.

In the analysis, the results of econometric analysis were tried to be revealed by using the panel data analysis method in order to examine whether the EKC hypothesis is valid in E7 countries.

## 3.1. Empirical Findings

### 3.1.1. Coefficient Homogeneity Test

In the study, the Slope Homogeneity Test developed by Pesaran and Yamagata (2008) was applied to test the homogeneity of the coefficients. In the homogeneity test, the null hypothesis shows that the coefficients are homogeneous, while the alternative hypothesis shows that the coefficients are heterogeneous. The homogeneity test shows the relationship between countries. Accordingly, countries with similar economic structures are expected to be homogeneous, and countries with different economic structures are expected to be heterogeneous. In Table 2, homogeneity test results of the series belonging to E7 countries are given.

**Table 2:** Homogeneity Test Results

| E7 | Homogeneity | |
|---|---|---|
| SERIES | $\Delta$ | $\Delta_{adj}$ |
| $LCO_2$ | 1.410 (0.079)* | 1.685 (0.046)** |
| LGDP | 6.445 (0.000)*** | 6.807 (0.000)*** |
| $LGDP^2$ | 6.328 (0.000)*** | 6.683 (0.000)*** |

**, **, *** shows statistical significance at the 10%, 5% and 1% levels, respectively.*

When the homogeneity test results are examined, it is concluded that the slope parameters are heterogeneous. Accordingly, it is concluded that the results differ from each other in terms of E7 countries.

### 3.1.2. Cross-Section Dependence Test

Cross-section dependence shows the existence of correlation between the units forming the series. However, cross-section dependency tests determine which of the panel unit root tests is suitable for the study. In the study, LM test developed by Breusch and Pagan (1980), $CD_{LM}$ and CD tests developed by Pesaran (2004) and Pesaran et al. (2008) developed by $LM_{adj}$ test was used. Table 3 shows the cross-section dependency test results.

**Tablo 3:** Cross-Section Dependence Test Results

| E7 | Cross-Sectional Dependence | | | |
|---|---|---|---|---|
| SERIES | LM | $CD_{LM}$ | CD test | $LM_{adj}$ |
| $LCO_2$ | 31.719 (0.062)* | 1.654 (0.049)** | -3.029 (0.001)*** | 5.223 (0.000)*** |
| LGDP | 31.241 (0.070)* | 1.580 (0.057)* | -3.106 (0.001)*** | 1.751 (0.040)** |
| $LGDP^2$ | 30.956 (0.074)* | 1.536 (0.062)* | -3.194 (0.001)*** | 1.677 (0.047)** |

**, **, *** shows statistical significance at the 10%, 5% and 1% levels, respectively.*

According to the results of the cross-section dependency test in Table 3, the $H_0$ hypothesis was rejected and it was concluded that there was a cross-section dependency. Accordingly, it has been determined that second-generation panel unit root tests should be applied, which takes into account cross-sectional dependence (Nazlıoğlu, 2010: 142).

### 3.1.3. Panel Unit Root Test

The existence of unit root for panel data is checked by cross-section dependency tests. The appropriate panel unit root test is applied according to the cross-sectional dependency status. Second-generation panel unit root tests should be used in the analysis of the stationarity of the series, due to the cross-sectional dependence between the series. Therefore, the Hadri-Kurozumi unit root test developed by Hadri-Kurozumi (2012), one of the second generation unit root tests, was used in the analysis. The Hadri-Kurozumi unit root test results are shown in Table 4.

**Tablo 4:** Panel Unit Root Test Results

| Hadri-Kurozumi (2012) | | |
|---|---|---|
| E7 | At Level | 1 st Diff. |
| | Constant + Trend | Constant + Trend |
| $LCO_2$ | 2.803 (0.003) | 0.211 (0.416) |
| LGDP | 1.963 (0.025) | 0.911 (0.181) |
| $LGDP^2$ | 1.961 (0.025) | 1.160 (0.123) |

It is concluded that for E7 countries, carbon dioxide emissions $LCO_2$, economic growth LGDP, and $LGDP^2$, which is the square of economic growth, contain unit root at the level.

### 3.1.4. Panel Cointegration Test

Considering the existence of unit root for panel data is very important to obtain cointegration test results to be applied. For this reason, considering that the series in the panel contain unit roots at the level, the panel cointegration test, which can be used in heterogeneous and cross-sectional dependence conditions, was applied by Westerlund and Edgerton (2007). Panel cointegration test results are given in Table 5.

**Tablo 5:** Westerlund ve Edgerton Panel Cointegration Test Results

| Constant + Trend | | |
|---|---|---|
| E7 | LM statistics | Bootstrap p-value |
| $LCO_2$-LGDP | 17.922 | 0.391 |
| $LCO_2$-$LGDP^2$ | 17.918 | 0.403 |

*Note: The number of bootstrap iterations is 1000.*

According to the cointegration test results applied, it has been determined that there is a long-term relationship between the variables of carbon dioxide emission $LCO_2$, economic growth LGDP, and $LGDP^2$, which is the square of economic growth, for E7 countries.

### 3.1.5. Panel Cointegration Coefficient Estimation

After the cointegration relationship was determined, the cointegration coefficients were estimated using the CCE (Common Corelated Effects) method developed by Pesaran (2006) (Örnek ve Türkmen,2019:124). The CCE model can be applied both in case of N>T and when T>N (Pesaran et al., 2008: 50). Cointegration is estimated by CCE and the estimation results of the co-integration coefficients of the variables are given in Table 6.

**Table 6:** Panel Cointegration Coefficient Estimation Results (CCE)

| | $CO_2$= f(GDP) | | | $CO_2$= f($GDP^2$) | | |
|---|---|---|---|---|---|---|
| | Coefficient | Std. Error | p-value | Coefficient | Std. Error | p-value |
| CCE | 0.461** | 0.187 | 0.014 | 0.008** | 0.003 | 0.012 |
| **Country Results** | | | | | | |
| Brazil | 1.247** | 0.532 | 0.019 | 0.022** | 0.009 | 0.021 |
| China | -0.249 | 0.165 | 0.129 | -0.005 | 0.003 | 0.122 |
| Indonesia | 0.207 | 0.253 | 0.413 | 0.004 | 0.005 | 0.364 |
| India | 0.109 | 0.234 | 0.641 | 0.002 | 0.004 | 0.564 |
| Mexico | 0.833*** | 0.167 | 0.000 | 0.015*** | 0.003 | 0.000 |
| Russia | 0.618*** | 0.036 | 0.000 | 0.011*** | 0.001 | 0.000 |
| Turkey | 0.460*** | 0.176 | 0.009 | 0.008*** | 0.003 | 0.009 |

**, **, *** shows statistical significance at the 10%, 5% and 1% levels, respectively.*

According to the cointegration coefficient estimation results in Table 6, a 1% increase in per capita income in E7 countries increases carbon dioxide emissions per capita by 0.461%; A 1% increase in per capita income squared increases carbon dioxide emissions per capita by 0.008%. Therefore, it is seen that the EKC approach is not valid in E7 countries, that is, the inverse "U" relationship is not valid.

## 4. CONCLUSION

Policy makers in industrializing countries do not care about the environmental degradation caused by industrialization in order to generate high income. Economic growth destroys nature by causing environmental degradation. This situation both increases the cost of economic development and causes social problems. It is aimed to minimize environmental degradation through international agreements. Therefore, policy makers need to take into account the problems that may cause environmental degradation while guiding economic growth. In this study, the relationship between environmental pollution and economic growth for E7 countries between 1990 and 2018 was examined with the help of the Environmental Kuznets Curve hypothesis. The environmental pollution-economic growth relationship revealed by the EKC hypothesis was tested with the panel data method.

In line with the results obtained from E7 countries, it is seen that the turning point in the EKC hypothesis could not be achieved and economic growth increased environmental pollution. It has been determined that E7 countries do not take environmental problems into account in order to generate high income. Accordingly, it is seen that

the E7 countries could not achieve a growth in harmony with the environment and harm the environmental quality. However, it is foreseen that the E7 countries will be able to reduce their carbon dioxide emissions with the taxes and environmental policies to be implemented in the future. In this context, policy makers in E7 countries should increase environmental incentives and provide technological investments.

## REFERENCES

Ang, J. B. (2007). $CO_2$ Emissions, Energy Consumption and Output in France. *Energy policy*, *35*(10), 4772-4778.

Apergis, N. and Payne, J. E. (2010). The Emissions, Energy Consumption, and Growth Nexus: Evidence from the Commonwealth of Independent States. *Energy Policy, 38*(1), 650-655.

Artan, S., Hayaloğlu, P. and Seyhan, B. (2015). Türkiye'de Çevre Kirliliği, Dışa Açıklık ve Ekonomik Büyüme İlişkisi. *Yönetim ve Ekonomi Araştırmaları Dergisi, 13*(1), 308-325.

Ayşe, Arı and Zeren, F. (2011). $CO_2$ Emisyonu ve Ekonomik Büyüme: Panel Veri Analizi. *Yönetim ve Ekonomi: Celal Bayar Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *18*(2), 37-47.

Başar, S. and Temurlenk, M. S. (2007). Çevreye Uyarlanmiş Kuznets Eğrisi: Türkiye Üzerine Bir Uygulama. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *21*(1), 1-12.

Bertinelli, T. and Strobl, E. (2005). The Environmental Kuznets Curve Semi-Parametrically Revisited. *Economics Letters*, *88*(3), 350–357.

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics, 49*(4), 431–455.

Erataş, F. and Uysal, D. (2014). Çevresel Kuznets Eğrisi Yaklaşımının "BRICT" Ülkeleri Kapsamında Değerlendirilmesi. *İstanbul Üniversitesi İktisat Fakültesi Mecmuası*, *64*(1), 1-25.

Ergün, S. and Polat, M. A. (2017). G7 Ülkelerinde $CO_2$ Emisyonu, Elektrik Tüketimi ve Büyüme İlişkisi. *Siyaset, Ekonomi ve Yönetim Araştırmaları Dergisi*, *5*(2), 257-272.

Farhani, S. and Ben Rejeb, J. (2012). Energy Consumption, Economic Growth and $CO_2$ Emissions: Evidence from Panel Data for MENA Region. *International Journal of Energy Economics and Policy (IJEEP), 2*(2), 71-81.

Grossman, G. M. and Krueger, A. B. (1991). Environmental Impacts of a North American Free Trade Agreement. *NBER Working Paper,* No. 3914.

Hamilton, C. and Turton, H. (2002). Determinants of Emissions Growth in OECD Countries. *Energy Policy, 30*(1), 63-71.

Iwata, H., Okada, K. and Samreth, S. (2010). Empirical Study on the Environmental Kuznets Curve for $CO_2$ in France: The Role of Nuclear Energy. *Energy Policy, 38*(8), 4057-4063.

Jaunky, V.C. (2011). The $CO_2$ Emissions-Income Nexus: Evidence from Rich Countries. *Energy Policy, 39*(3),1228-1240.

Liu, X., Zhang, S. and Bae, J. (2017). The Impact of Renewable Energy and Agriculture on Carbon Dioxide Emissions: Investigating the Environmental Kuznets Curve in Four Selected ASEAN Countries. *Journal of Cleaner Production*, 164, 1239-1247.

Moomaw, W. R. and Unruh, G. C. (1997). Are Environmental Kuznets Curves Misleading Us? The Case of $CO_2$ Emissions. *Environment and Development Economics*, *2*(4), 451-463.

Nazlıoğlu, Ş. (2010). Makro İktisat Politikalarının Tarım Sektörü Üzerindeki Etkileri: Gelişmiş Ve Gelişmekte Olan Ülkeler İçin Bir Karşılaştırma. *Yayınlanmamış Doktora Tezi, TC Erciyes Üniversitesi Sosyal Bilimler Enstitüsü, Kayseri*.

Örnek, İ. and Türkmen, S. (2019). Gelişmiş ve Yükselen Piyasa Ekonomilerinde Sürdürülebilir Enerji: Çevresel Kuznets Eğrisi Yaklaşımı. *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *28*(3), 109-129.

Panayotou, T. (1993). Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. *ILO Technology and Employment Programme Working Paper,* WP238.

Pesaran, M. H., Ullah, A. and Yamagata, T. (2008). A Bias-Adjusted LM Test of Error Cross- Section Independence. *The Econometrics Journal, 11*(1), 105-127.

Saatçi, M. and Dumrul, Y. (2011). Çevre Kirliliği ve Ekonomik Büyüme İlişkisi: Çevresel Kuznets Eğrisinin Türk Ekonomisi için Yapısal Kırılmalı Eş-Bütünleşme Yöntemiyle Tahmini. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* (37), 65- 86.

Sarısoy, S. and Yıldız, F. (2013). Karbondioksit ($CO_2$) Emisyonu ve Ekonomik Büyüme İlişkisi: Gelişmiş ve Gelişmekte Olan Ülkeler için Panel Veri Analizi. *Sosyal Bilimler Metinleri*, *2013*(1), 1-19.

Selden, T. M. and Song, D. (1994). Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions?. *Journal of Environmental Economics and Management, 27*(2), 147-162.

Shafik, N. and Bandyopadhyay, S. (1992). *Economic Growth and Environmental Quality: Time-Series and Cross-Country Evidence* (904). World Bank Publications.

Shi, J. (2004). Tests of the EKC Hypothesis Using $CO_2$ Panel Data. *Resource Economics and Policy Analysis (REPA) Research Group Working Paper 2004-03*, 1-42.

Song, T., Zheng, T. and Tong, L. (2008). An Empirical Test of the Environmental Kuznets Curve in China: A Panel Cointegration Approach. *China Economic Review, 19*(3), 381-392.

Uddin, G. A., Alam, K. and Gow, J. (2016). Does Ecologıcal Footprınt Impede Economic Growth? An Empirical Analysis Based on the Environmental Kuznets Curve Hypothesis. *Australian Economic Papers*, *55*(3), 301-316.

Vincent, J. R. (1997). Testing for Environmental Kuznets Curves within a Developing Country. *Environment and Development Economics*, *2*(4), 417-431.

Yandle, B., Bhattarai, M., and Vijayaraghavan, M. (2004). Environmental Kuznets Curves: A Review of Findings, Methods, and Policy Implications. *PERC Research Study,* 1-38.

Zambrano-Monserrate, M. A., Troccoly-Quiroz, A. and Pacheco-Borja, M. J. (2016). Testing the Environmental Kuznets Curve Hypothesis in Iceland: 1960-2010. *Revista de Economía del Rosario,19*(1), 1-28.

# CHAPTER 8

# EFFECT OF R&D ACTIVITIES ON ECONOMIC GROWTH FOR G20 SELECTED COUNTRIES: PANEL DATA ANALYSIS

Kübra UZBOYALI[1]

[1] Graduate Student. Niğde Ömer Halisdemir University. Department of Economics. kubrauzboyalii@gmail.com. https://orcid.org/0000-0001-5598-7162

## INTRODUCTION

Companies that focus on profit maximization in economic growth models; R&D are based on technological development with their activities. They also focus on continuous growth. If globalizing world and integrated economies are taken into account; can be seen that R&D expenditures and new technologies don't only affect the country where they are made. Production capacity will also be positively affected in other countries with which that country interacts. In addition, R&D investments; prevention of economic instability and international provide a competitive advantage.

Technological innovations are seen as the driving force of economic growth and recovery. This is a topic that has been studied from the past to the present. There are many theoretical and empirical studies on this subject in the literature.

The aim of this study is to ensure that R&D activities for 8 selected G-20 countries analyze its effect on growth. In the first chapter, the theoretical and conceptual framework are discussed. In the second part, based on the theoretical background, empirical studies in the literature study results are shared. In the third part, the data set and the study methodology are given in order. In the fourth section, the findings obtained as a result of the application of the methodology are given. This study is different from other studies because the applied test are giving more accurate results. In addition, the selected countries present more data.

## 1. THEORETICAL AND CONCEPTUAL FRAMEWORK

Long time before modern theories of growth were developed, technological changes (new machines) had an important place for Adam Smith, David Ricardo and Karl Marx. Although these thinkers were aware of the power of technology, they were unable to develop a growth theory that would examine the long-term economic relationship in a healthy way (Özcan and Özer, 2017:17).

The traditional growth models of Solow-Swan (1956), Ramsey (1928), Cass (1965) and Koopmans (1965) are the basis of economic growth models. However, within these considerations, it was insufficient to explain the effect of technology for economic growth (Yıldız, 2018: 43). The first economist to emphasize technological innovations within the framework of economic growth is Joseph Alois Schumpeter. While he has an important place for economic growth in theories from classical economists to the present day, technological innovations have been seen as the engine of economic development, especially for Joseph Alois Schumpeter. So much that even today Schumpeter is one of the most cited thinkers on this subject. According to Schumpeter, new technologies must be channeled into the economy in order for the economy to come out of crisis and recession, and to achieve prosperity (İçke, 2014: 19).

Fritsch referred to Schumpeter's views on innovations in a book review he published in 2017. Accordingly, for Schumpeter, innovation is a commercial application of ideas and inventions. It also highlights

critical issues in research methodology that social scientists struggle with even today.

In the neo-classical model, it has been argued that growth will follow a stagnant course in the long run. Generally population growth rate, savings rate and technological innovations are considered to be exogenous (Yıldız, 2018: 43). While the neoclassical growth model examines technology and innovation as an external factor, on the other hand, endogenous growth models endogenoudly them to have been put forward (Güneş, 2019: 162).

Following the Second World War, the Harrod-Domar Growth model was developed. So much so that these two studies of carried out independently in 1939-46, were an extended version of John Maynard Keynes macroeconomic model. In this model, the contribution of new technology to economic growth is not directly examined. It has been indirectly endogenoused into the model with the belief that it will affect the capital-output ratio. In 1957, the Harrod-Domar model was expanded by Roberth Solow and technological development was included in the growth model. In addition, the Harrod-Domar model has been subject to inadequate empirical findings, while the Solow growth model has improved by improving the robustness of the assumptions (Özcan and Özer, 2017: 17).

Parallel to this, we come across the works of Romer and Lucas. While these thinkers accept technology and innovations as endogenous in their work, they also point to growth with R&D. According to Romer's study

in 1994, it is not an exogenous technological development outside the control of the market mechanism adopted in the Neo-classical model; It is argued that the accepted view is endogenously determined by the economic forces that operate freely within a decentralized market structure. Romer, like Schumpeter, defends the view that innovative technology is the driving force for the economy, but draws attention to the strong correlation between R&D activities and economic growth (Güneş, 2019: 162).

Also with Lucas' concept of "Learning by Doing", explains the productivity increase provided by human capital to labor force and physical capital. The human capital increase used in the model is similar to Arrow's approach. This model: it allows the development of a new product that cannot be competed or excluded. Production increases are realized with the spillover effect in the economy. Here, R&D stands out as an important element (Güneş, 2019: 162-163). In an article Lucas wrote in 1988, Lucas explained the economic growth process with an example and included human capital in the model. The increase in productivity will contribute to economic growth if a job previously done by two workers can be done with one worker using technology. Therefore, according to Lucas, technological innovations, capital goods and human capital are directly related to economic growth (Yıldırım and Kantarcı, 2018: 667).

The Barro Growth Model was developed in 1990, the Aghion and Howitt Growth Model in 1992, and the Grossman and Helpman Growth Model in these years. In all of them, technology has been studied as an

endogenous factor in economic growth (Yıldırım and Kantarcı, 2018: 667).

## EMPIRICAL LITERATURE

Dağlı and Ezanoğlu (2021) conducted a study, the effects of R&D, patent and advanced technology exports on economic growth were examined by panel data analysis method for OECD countries. As a result of the study, it was concluded that the effect of the mentioned R&D and patent variables on economic growth was positive and statistically significant. The variable of advanced technology exports was not found significant. In addition, the effect of R&D expenditures on economic growth is much higher than the patent effect.

A time series analysis was conducted in the study titled "The Contribution of R&D and Innovation to Economic Growth" conducted by Kaygısız and Yegül (2020). The analysis was made for South Korea and covers the years 1996-2016. As a result of the study, it has been concluded that R&D expenditures and patent applications have positive effect on economic growth. In addition, it was observed that the number of researchers affected economic growth negatively. R&D and patent coefficients are consistent with expectations and are statistically significant.

In the study conducted by Oğuz in 2020, a panel data analysis was conducted for the G8 countries covering the years 1997-2017. In 2016, Dam and Yıldız conducted a study on whether R&D and innovation affect economic growth in BRICS-TM Countries between 2000-2012.

As a result of both studies, it was observed that there is a significant and positive relationship between R&D expenditures and economic growth.

In the study conducted by İğdeli in 2019, the effects of R&D and education expenditures on economic growth in Turkey were examined. The study covering the years 1990-2016, ARDL test and Granger causality tests were used as methods. A long-term positive correlation has been detected on the impact of R&D and education expenditures on the economy. There is also a unidirectional correlation from R&D expenditures to education expenditures. Another study examining 32 OECD countries was conducted by Güneş. The test result is congruent, but the one-way correlation is from economic growth to R&D. The results of both studies are in agreement with each other. However, the one-way correlation is from economic growth to R&D.

A panel data analysis was conducted by Yılgör et al. in 2019. The analysis was made for 20 OECD countries between 2009 and 2016. The correlation between R&D expenditures, foreign trade and economic growth has been tested. As a result of the analysis, it has been determined that the change in R&D expenditures has a positive effect on economic growth in the long run. There is a causality running from R&D expenditures to economic growth.

Baykul also conducted a panel data analysis in 2018. The analysis covers the years 2010-2014. The effects of R&D expenditures and employment on regional economic growth were tested. As a result of

the study, the effect of R&D expenditures and employment on regional economic growth was found to be positive and statistically significant.

Yıldırım and Kantarcı (2018) studied for 15 developing countries. Their study is a panel data analysis covering the years 1998-2013. As a result, the effect of R&D expenditures on economic growth is not statistically significant. This is a result contrary to the general literature.

Altıntaş and Mercan conducted a study in 2015. In the study, panel cointegration analysis was performed on OECD countries with cross-section dependency. As a result, it was concluded that the increase in R&D expenditures strongly affected economic growth.

In the study conducted by Gülmez and Akpolat in 2014, the GMM approach developed by Arellano and Bond was used. This was a study covering Turkey and 15 EU countries for the period 2000-2010. As a result of the analysis, it has been seen that GDP per capita, R&D expenditures and patents have a positive effect on economic growth. But according to the data, R&D expenditures are 4 times more effective than patents.

Gülmez and Yardımcılıoğlu (2012) conducted panel data analysis for 21 OECD countries between 1990-2010. Arı and Özcan also conducted a similar study in 2014. According to the results of panel data analysis covering the years 1990-2011 in 15 OECD countries, it has been concluded that R&D expenditures have a positive effect on growth.

In the study conducted by Korkmaz in 2010 tested the relationship between R&D expenditures and economic growth in Turkey. For this, Johansen cointegration method was used. As a result of the study covering the years 1990-2008, it was observed that there is a long-term cointegration relationship between both variables. For the short term, it was determined that R&D expenditures affect GDP with the Granger causality test performed using the error correction model.

Özer and Çiftçi studied in 2009. A panel data analysis was conducted for OECD countries covering the years 1990-2005. As a result of the study, it has been determined that R&D expenditures, a number of patents and a number of researchers have a positive and high rate relationship on GDP.

Within the framework of literature research, the general indicators used in studies are variables such as R&D expenditures, number of patents and number of employees. In general, these variables appear to have a positive effect on economic growth.

## DATA AND EMPIRICAL METHODOLOGY

### 1.1. DATA SET

In this study, the effects of R&D expenditures, R&D employees (researchers) and state employees on economic growth for 8 selected G-20 countries were analyzed for the period between 2000-2017. In order to increase the robustness factor for parameter estimation, the time interval was determined as 18 years, while 8 countries with more

complete data were preferred. Data were included in the analysis on an annual basis and panel data analysis method was used.

GDP data is used as an indicator of economic growth. For R&D expenses, similar to other studies in the literature, data on R&D expenditures made in the specified years were used. While this data is taken in millions of dollars, the number of R&D employees and, sowewhat different from the literature, the number of R&D state employees are also included in the analysis. All data in the study were taken from the OECD Database.

The countries considered in the econometric analysis are France, Germany, Italy, Japan, Korea, Mexico, Turkey and the United Kingdom.

Information about the variables and data sources are explained in Table 1 below.

**Table 1:** Data, Definitions and Sources Used in the Study

| Variable | Abbreviation | Definition | Source |
|---|---|---|---|
| **Gross Domestic Product -The Dependent Variable-** | GDP | Gross domestic product (GDP) is the standard measure of the value added created through the production of goods and services in a country during a certain period. As such, it also measures the income earned from that production, or the total | OECD |

| | | | |
|---|---|---|---|
| | | amount spent on final goods and services. | |
| **Gross Domestic Spending on R&D -Independent Variable-** | R&D | Gross domestic spending on R&D is defined as the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc., in a country. It includes R&D funded from abroad, but excludes domestic funds for R&D performed outside the domestic economy. | OECD |
| **R&D Number of Researchers -Independent Variable-** | STAFF | Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of the projects concerned. This indicator is measured in per 1 000 people employed and in number of researchers. | OECD |
| **Government Researchers -Independent Variable-** | GSTAFF | Government researchers are professionals working for government institutions engaged in | OECD |

| | | | |
|---|---|---|---|
| | | the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned. This indicator is measured in per 1000 people employed and in number of researchers. | |

## ECONOMETRIC METHOD

### Cross-Section Dependency Test for Panel Data Model

The first point to start the analysis is the analysis of the cross-sectional dependence of the countries related to the panel. That the horizontal section independence refers to not being affected by a shock to any of the units that make up the panel; means that the cross-section dependence is affected by shocks. Today, due the extent of globalization, the increase in the level of international trade and integration, the probability of seeing cross-section independence is low. As seen in the global financial crisis in 2008, an economic shock in any country affected other countries in different ways (Pesaran et al. 2004: 4; Altıntaş, Koçbulut, 2016: 152).

The first of the cross-section dependency tests was developed by Breush and Pagan (1980). This test is the Langrange Multiplier test and

is assumed to be used when T > N (Pesaran et al. 2004: 4; Altıntaş and Koçbulut, 2016: 152).

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \quad (1)$$

The CD-LM test developed by Pesaran (2004) after the Breusch Pagan test seen in equation (1) can be used in cases where both N and T are large (Altıntaş and Koçbulut, 2016: 152).

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{\rho}_{ij}^2 - 1) \quad (2)$$

This test seen in equation (2) is an improved version of the Breush Pagan test. However, in cases where N > T, serious deterioration is observed in the CD-LM test, as N increases, the deviations increase. Therefore, to be used in cases where N > T, Pesaran (2004); He developed the CD test. This test (3) can be used when N > T (Pesaran, 2004: 9; Altıntaş and Koçbulut, 2016: 153).

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \quad (3)$$

Pesaran (2004) CD test shows standard normal distribution under the Ho hypothesis, which shows that there isn't relationship between cross-sections. Another test is the LM-Adj test developed by Pesaran etc. (2008) seen in equation (4) (Pesaran et al., 2008: 108; Altıntaş and Koçbulut, 2016: 153).

$$LM_{adj} = \sqrt{\left(\frac{2}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T\hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\sqrt{v_{Tij}^2}} \quad (4)$$

The hypotheses created for the aforementioned cross-section dependency tests are as follows:

$H_0$ : No cross section dependency. (independency) $H_1$ : Cross section dependency

If the Ho hypothesis is accepted after the test results are taken, it means that there is no cross-sectional dependence. Otherwise, it is concluded that there is a cross-section dependency. If the cross section is dependent, the second generation unit root tests are used in the analysis; If the cross section is independent, first generation unit root tests should be continued (Baltagi, 2008: 284; Altıntaş and Koçbulut, 2016: 153).

**Homogeneity/Heterogeneity Test**

After the cross-section dependency test, homogeneity/heterogeneity test should be done. Using Pesaran and Yamagata (2008) delta tests, it can be observed whether the constant term and slope coefficients have a homogeneous or heterogeneous structure for the horizontal section (Yılgör et al. 2019: 121). The hypotheses for this test are as follows:

$H_0$ : $\beta i = \beta$ Slopes are homogenity. $H_1$ : $\beta i \neq \beta$ Slopes are heterogenity

## Unit Root Test

The long-term characteristics of a data series can be revealed by determining how the value of the variable in the previous period affects this period. For this reason, if it is desired to understand what kind of process a series comes from; The regression of the value of the series in each period with the values in the previous period should be found, and it should be ensured to determine the stationary level of the series with unit root tests (Uçan et al. 2021: 150).

Unit root tests are divided into two, according to whether the horizontal sections that make up the panel are interdependent or not. Unit root tests based on dependency assumption are called second generation unit root tests while tests to be performed under the assumption of independence (there is no correlation between the units that make up the panel) first generation unit root tests. Levin, Lin and Chu (2002), Breitung (2005), Hadri (2000), Maddala and Wu (1999), Im, Pesaran and Shin (IPS, 2003), Choi (2001) while the known ones from the second generation unit root tests are as follows: Bai and Ng (2004), Taylor and Sarno (MADF, 1998), Breuer, Mcknown and Wallace (SURADF, 2002), Pesaran (CADF, 2006, 2007) and Varrion-i Silvestre etc. (PANKPSS, 2005, Altıntaş and Koçbulut, 2016: 154).

In this study, since the cross-section dependence for the countries was determined and it was determined that the data had heterogeneous slope coefficients, the unit root tests that should be done after this stage are the second generation unit root tests. For this study, the CADF test

developed by Pesaran (2007) will be applied. Unit root test can be done with CADF for each country, that is, for each cross-sectional unit. Therefore, the stationarity in the series can be calculated for the whole panel as well as for the sections separately. Under the assumption that each country is affected differently by time effects and taking into account spatial autocorrelation, this test can be used in cases T > N and N > T (Altıntaş and Mercan, 2015: 361).

**Panel ARDL Test**

The panel ARDL test is applied when the series are both I(0) and I(1), as in this study.It provides estimation of the relationship for both the short and long term.ARDL test has some advantages such as being more unbiased and effective than other cointegration tests. However, it gives more consistent results in studies with small samples.

Finally, it can be said that short and long-term predictions of the model can be made by eliminating the problems related to the variables excluded from the model and autocorrelation. For this reason, Panel ARDL model was created with the result of unit root tests and the effect of technological innovation on economic growth has been examined (Yıldız, 2018: 49).

When it comes to cross-section, the first estimator for cointegration coefficients is Pesaran (2006) CCE (Common Correlated Effects) method. In this method, the individual cointegration coefficients are estimated first. Then, the cointegration coefficient belonging to the overall panel was calculated using the CCMGE (Common Correlated

Mean Group Effects) method; calculated by taking individual arithmetic averages. However, there will be differences when looking at the overall size of the countries. Depending on these, it is predicted that the effect of all of them on the panel in general will differ. Therefore, in this study, the Panel AMG model developed by Eberhardt and Bond in 2009 is preferred. This method, like the other, considers the cross-section dependency. In addition, the average effect is calculated by weighting the results of the panel and the individual coefficients. In this respect, this test gives more reliable results than CCMGE (Göçer, 2013: 233).

**Panel Causality Test**

In this study, the Dumitrrescu & Hurlin test, which takes into account the cross-sectional dependence and heterogeneity between the countries that make up the panel, was used. The test is the Granger causality test developed by Dumitrescu and Hurlin in 2012 (Çelik and Ünsür, 2020: 206). The hypotheses are as follows:

$H_0$ : There isn't causality. $H_1$ : There is causality.

**RESULTS**

The analysis of the study first started with the cross-section dependency test. These tests were performed using Eviews 12 package program and StataMp 14. The results obtained with Eviews are given in Table 2.

**Table 2.** Cross-Section Dependency Test Results

| | ***RGDP*** | | ***R&D*** | |
|---|---|---|---|---|
| | *Statistic* | *Prob.* | *Statistic* | *Prob.* |
| **Breusch-Pagan LM** | 483.3914 | 0.0000 | 231.3489 | 0.0000 |
| **Pesaran scaled LM** | 60.85423 | 0.0000 | 27.17364 | 0.0000 |
| **Bias-corrected scaled LM** | 60.61894 | 0.0000 | 26.93835 | 0.0000 |
| **Pesaran CD** | 21.98412 | 0.0000 | 14.25872 | 0.0000 |
| | ***STAFF*** | | ***GSTAFF*** | |
| | *Statistic* | *Prob.* | *Statistic* | *Prob.* |
| **Breusch-Pagan LM** | 211.6539 | 0.0000 | 208.3795 | 0.0000 |
| **Pesaran scaled LM** | 24.54178 | 0.0000 | 24.10422 | 0.0000 |
| **Bias-corrected scaled LM** | 24.30649 | 0.0000 | 23.86893 | 0.0000 |
| **Pesaran CD** | 13.53759 | 0.0000 | 6.431056 | 0.0000 |

Looking at the results in the table, it is concluded that there is a cross-sectional dependence between countries. In other words, another country may be affected by a shock that occurs in any country. For this reason, these countries should act by taking other countries into account while developing policies. In addition, due to the cross-section dependency, second generation unit root tests will be performed in the later part of the analysis.

As a result of the homogeneity/heterogeneity test performed in the second step of the study, consistent results were obtained in both programs. The results obtained with StataMP 14 are given in Table 3. However, the series contains random effects.

**Table 3.** Homogeneity/Heterogeneity Test Results

| | Delta | P-value |
|---|---|---|
| Testing for slope heterogeneity (Pesaran, Yamagata. 2008. Journal of Econometrics) | 12.090 | 0.000 |
| | Adj. 14.226 | 0.000 |
| H0: slope coefficients are homogenous | | |

As can be seen in the table, it has been concluded that all slope coefficients have heterogeneous, that is, different values from each other.

The second generation unit root test findings are given in Table 4 below.

**Table 4.** Pesaran CIPS Test Results for RGDP

| H0 (homogeneous non-stationary): bi = 0 for all i | | | | | |
|---|---|---|---|---|---|
| CIPS = | -2.180 | N,T = (8,18) | 10% | 5% | 1% |
| | | Critical values at | -2.21 | -2.34 | -2.6 |

As seen in the table, the Cips value is 2,180 at the 5% significance level; The cadf table value was found to be 2.93.Since 2.180 < 2.93, Ho could not be rejected, and it was concluded that it was not stationary, that is, I(1).This result shows that the shock to a country's economy does not lose its effect immediately.

Cips for R&D variant 2,169 < 2.96 = Ho could not be rejected and it was concluded that it was not stationary, that is, I(1). STAFF (number of researchers) chips for variable that 3.475 > 2.96 = By rejecting Ho, the stationary result is reached, that is, the variable is I(0).GSTAFF

(number of government researchers) since chips are 3.332 > 2.93 for variable that, Ho is rejected and stationary result is reached, that is, the variable is I(0).

**Panel ARDL**

Panel ARDL results obtained with Stata are given in the table below.

According to the table 5, the coefficient of R&D expenditures is statistically significant for Japan and Korea at 5% and 10% significance levels. The direction of its relationship with economic growth is positive in Japan and negative in Korea.For Mexico, R&D expenditures are significant at the 10% significance level and the direction of the relationship was found to be negative. The number of R&D sector employees was significant for Italy and Korea at the 5% and 10% significance levels.In addition, the direction of the relationship with economic growth is positive for both countries. The number of government employees in the R&D sector was statistically significant for Germany, Italy, Turkey and the United Kingdom at the 5% and 10% significance levels. At the same time, the direction of the relationship was found to be negative in line with each other in all four countries.

**Table 5.** Panel ARDL Augment Mean Group Estimator

| **FRANCE** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
|---|---|---|---|---|---|---|
| R&D | 175052.7 | 167705.6 | 1.04 | 0.297 | -153644.3 | -153644.3 |
| STAFF | -.8146256 | 1.18502 | -0.69 | 0.492 | -3.137221 | 1.50797 |
| GSTAFF | 5.436411 | 5.389439 | 1.01 | 0.313 | -5.126695 | 15.99952 |
| **GERMANY** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | 183265 | 166025.5 | 1.10 | 0.270 | -142138.9 | 508668.9 |
| STAFF | -.0035907 | .0479543 | -0.07 | 0.940 | -.0975794 | .0903979 |
| GSTAFF | -2.774957 | .8665431 | -3.20 | 0.001 | -4.47335 | -1.076563 |
| **ITALY** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | -160337.6 | 315688.1 | -0.51 | 0.612 | -779074.9 | 458399.7 |
| STAFF | 6.63671 | 2.259294 | 2.94 | 0.003 | 2.208575 | 11.06485 |
| GSTAFF | -18.16437 | 7.038716 | -2.58 | 0.010 | -31.96 | -4.368743 |
| **JAPAN** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | 898387 | 304430.7 | 2.95 | 0.003 | 301713.8 | 1495060 |
| STAFF | -1.132642 | 1.954812 | -0.58 | 0.562 | -4.964003 | 2.698719 |
| GSTAFF | 23.11497 | 41.95071 | 0.55 | 0.582 | -59.10691 | 105.3368 |
| **COREA** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | -246773.2 | 54749 | -4.51 | 0.000 | -354079.3 | -139467.1 |
| STAFF | 3.16782 | .8207545 | 3.86 | 0.000 | 1.559171 | 4.776469 |
| GSTAFF | -7.471057 | 4.875309 | -1.53 | 0.125 | -17.02649 | 2.084372 |
| **MEXİCO** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | -395965.5 | 206327.9 | -1.92 | 0.055 | -800360.7 | 8429.637 |
| STAFF | -1.525208 | 1.771368 | -0.86 | 0.389 | -4.997026 | 1.94661 |
| GSTAFF | 14.30592 | 10.25254 | 1.40 | 0.163 | -5.788687 | 34.40052 |
| **TURKEY** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | 407880.6 | 411479.6 | 0.99 | 0.322 | -398604.7 | 1214366 |
| STAFF | .2700787 | .5170562 | 0.52 | 0.601 | -.7433328 | 1.28349 |
| GSTAFF | -113.4869 | 36.46478 | -3.11 | 0.002 | -184.9565 | -42.01723 |
| **UNITED KİNGDOM** | Coef. | Std. Error | Z | Prob.(95%) | Conf. | Interval |
| R&D | -425409.2 | 435743.7 | -0.98 | 0.329 | -1279451 | 428632.7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| STAFF | -.0989529 | .10832 | -0.91 | 0.361 | -.3112563 | .1133504 |
| GSTAFF | -70.72523 | 12.27466 | -5.76 | 0.000 | -94.78313 | -46.66734 |

## Dumitrescu & Hurlin Causality Test

Dumitrescu & Hurlin (2012) causality test was performed through Stata/MP 14.1 program and the results in Table 6 were obtained.

**Table 6.** Dumitres & Hurlin (2012) Causality Test Results

| | |
|---|---|
| ***R&D→ GDP***<br>W-bar = 4.4701<br>Z-bar = 6.9402 (p-value = 0.0000)<br>Z-bar tilde = 4.9668 (p-value = 0.0000) | ***GDP → R&D***<br>W-bar = 0.9906<br>Z-bar = -0.0188 (p-value = 0.9850)<br>Z-bar tilde = -0.2647 (p-value = 0.7912) |
| ***STAFF → GDP***<br>W-bar = 16.4872<br>Z-bar = 30.9743 (p-value = 0.0000)<br>Z-bar tilde = 23.0348 (p-value = 0.0000) | ***GDP → STAFF***<br>W-bar = 3.7904<br>Z-bar = 5.5808 (p-value = 0.0000)<br>Z-bar tilde = 3.9448 (p-value = 0.0001) |
| ***GSTAFF → GDP***<br>W-bar = 13.4227<br>Z-bar = 24.8454 (p-value = 0.0000)<br>Z-bar tilde = 18.4273 (p-value = 0.0000) | ***GDP → GSTAFF***<br>W-bar = 4.5154<br>Z-bar = 7.0307 (p-value = 0.0000)<br>Z-bar tilde = 5.0349 (p-value = 0.0000) |

As a result of the causality test, one-way causality was observed from R&D expenditures to economic growth.; bidirectional causality was determined from the number of researchers and the number of government researchers to economic growth. In addition, bidirectional causality has been determined from economic growth to the number of

researchers and the number of government researchers. The results are as in Table 6.

## CONCLUSION

A panel data analysis was conducted to observe the impact of R&D activities on economic growth in 8 countries selected from the G-20 countries. The variables used in the analysis are: R&D expenditures, the number of R&D researchers, and the number of R&D government researchers. The analysis covers the years 2000-2017.It consists of 8 countries, 18 years and 144 observations in total.

First of all, the existence of cross-sectional dependence between the countries forming the panel was determined. Then, the homogeneous test was performed using the Pesaran and Yamagata (2008) delta tests. As a result of this test, it was concluded that the coefficients were heterogeneous. Therefore, cointegration comments will not be valid for the panel as a whole.

Then, the CADF test developed by Pesaran (2007), which takes into account heterogeneity and cross-sectional dependence, was applied. At this stage, Ho could not be rejected for the RGDP and R&D expenditures variable, and it was concluded that they were not stationary, that is, they were I(1). This result shows that the shock to a country's economy does not lose its effect immediately. For STAFF (number of researchers) and GSTAFF (number of government researchers) variable, Ho was rejected and the stationary result, I(0), was reached.

From this point of view, we continued to work with the Panel AMG model developed by Eberhardt and Bond in 2009, which gives more reliable results compared to the CCE test.As a result of this test, the coefficient of R&D expenditures was statistically significant at 5% and 10% significance levels for Japan and Korea. The direction of the relationship with economic growth was positive in Japan and negative in Korea. For Mexico, R&D expenditures are significant at the 10% significance level and the direction of the relationship is negative. The number of R&D sector researcher was significant for Italy and Korea at the 5% and 10% significance levels. The direction of the relationship between this variable and economic growth is positive for both countries. The number of government researchers in the R&D sector was statistically significant for Germany, Italy, Turkey and the United Kingdom at the 5% and 10% significance levels. the direction of the relationship in each is correspondingly negative.

According to the Dumitrescu & Hurlin causality test performed at the next stage, one-way causality was determined from R&D expenditures to economic growth; Bidirectional causality was determined from the number of researchers and government researchers to economic growth, and from economic growth to the number of researchers and government researchers.

If we refer to the policy recommendations according to the results; recommendations will be made for horizontal sections, not for the overall panel.

i. R&D expenditures should be increased in order to ensure economic growth and development for Japan from the 8 countries included in the analysis. Support should be provided to the private sector and the public for R&D expenditures. Because a positive relationship has been determined between R&D expenditures and economic growth.

ii. The number of R&D researchers specified as qualified workforce should be increased in Italy and Korea.In order to achieve this, training programs and courses should be provided on information technologies and algorithms. Because as a result of the analysis, it has been reached that the number of researchers positively affects the economic growth in these two countries.

iii. The ratio of researchers to national income should be increased and employment policies should be developed for this purpose.

iv. In countries where the relationship between R&D expenditures and economic growth is positive, tax relief and transfers can be provided to this sector in order to encourage investment in R&D.

## REFERENCES

Altıntaş, H. and Koçbulut, Ö. (2016). İkiz Açıklar ve Feldstein-Horioka Hipotezi: OECD Ülkeleri Üzerine Yatay Kesit Bağımlılığı Altında Yapısal Kırılmalı Panel Eşbütünleşme Analizi. ***Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,*** (48), pp. 145-174. Web: https://app.trdizin.gov.tr/makale/TWpBMk9UZzJOZz09/ikiz-aciklar-ve-feldstein-horioka-hipotezi-oecd-ulkeleri-uzerine-yatay-kesit-bagimliligi-altinda-yapisal-kirilmali-panel-esbutunlesme-analizi retrieved from this address on April 6, 2021.

Altıntaş, H. and Mercan, M. (2015). Ar-Ge Harcamaları ve Ekonomik Büyüme İlişkisi: OECD Ülkeleri Üzerine Yatay Kesit Bağımlılığı Altında Panel Eşbütünleşme Analizi. ***Ankara Üniversitesi Sosyal Bilimler Fakültesi Dergisi.*** 70(2), pp. 345-376. Web: https://dergipark.org.tr/tr/pub/ausbf/issue/3242/45262 retrieved from this address on May 29, 2021.

Baykuıl, A. (2018). Bölgesel Ekonomik Büyüme Üzerinde Ar-Ge Faaliyetlerinin Etkileri: Türkiye'de Düzel 1 Bölgelerinde Ampirik Bir İnceleme. ***Manas Sosyal Araştırmalar Dergisi.***7(2), pp. https://dergipark.org.tr/tr/pub/mjss/issue/40519/485924 retrieved from this address on 11 June 2021.

Çelik, M. and Ünsür Z. (2020). Küreselleşme ve Büyüme İlişkisinin Dumitrescu-Hurlin Panel Nedensellik Testi İle Belirlenmesi. ***İzmir İktisat Dergisi.*** 35(1), pp. 201-210. Web: https://atif.sobiad.com/index.jsp?modul=makale-detay&Alan=sosyal&Id=BuB6DXUBu-adCBSEt2T2 retrieved from this address on 16 June 2021.

Dağlı, İ. and Ezanoğlu, Z. (2021). Ar-Ge, Patent ve İleri Teknoloji İhracatının Ekonomik Büyümeye Etkileri: OECD Ülkeleri İçin Dinamik Panel Veri Analizi. ***İnsan ve Toplum Bilimleri Araştırmları Dergisi.*** 10(1), pp. 438-460. Web: http://www.itobiad.com/tr/pub/issue/60435/780229 retrieved from this address on May 28, 2021.

Fritsch, M. (2017). The Theory of Economic Development – An Inquiry Into Profits, Capital, Credit, Interest, and The Business Cycle. Regional Studies, 51(4), 654–655. doi:10.1080/00343404.2017.1278975 retrieved with this doi on August 1, 2021

Göçer, İ. (2013). Ar-Ge Harcamalarının Yüksek Teknolojili Ürün İhracatı, Dış Ticaret Dengesi ve Ekonomik Büyüme Üzerindeki Etkileri. ***Maliye Dergisi.*** (165) pp. 215-240. Web: https://kutuphane.dogus.edu.tr/mvt/pdf.php?pdf=0015414&lng=0 retrieved from this address on June 5, 2021.

Gülmez, A. Akpolat, A. (2014). Ar-Ge & İnovasyon ve Ekonomik Büyüme: Türkiye ve AB Örneği İçin Dinamik Panel Veri Analizi. ***Abant İzzet Baysal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi.*** 14(14), pp. 1-17. Web: https://docplayer.biz.tr/18458845-Ar-ge-inovasyon-ve-ekonomik-buyume-turkiye-ve-ab-ornegi-icin-dinamik-panel-veri-analizi.html retrieved from this address on 11 June 2021..

Gülmez, A. and Yardımcılıoğlu F. (2012). OECD Ülkelerinde Ar-Ge Harcamaları ve Ekonomik Büyüme İlişkisi: Panel Eşbütünleşme ve Panel Nedensellik Analizi (1990-2010). ***Maliye Dergisi.*** 163(1), pp. 335-353. Web: https://app.trdizin.gov.tr/makale/TVRReE5qYzBOQT09/oecd-ulkelerinde-ar-ge-harcamalari-ve-ekonomik-buyume-iliskisi-panel-esbutunlesme-ve-panel-nedensellik-analizi-1990-2010- retrieved from this address on June 15, 2021.

Güneş, H. (2019). Ar-Ge Harcamaları İle Ekonomik Büyüme İlişkisi: OECD Ülkeleri İçin Panel Veri Analizi. ***Sakarya İktisat Dergisi.*** 8(2), pp. 160-176. Web: https://dergipark.org.tr/tr/pub/sid/issue/45684/576221 retrieved from this address on 12 June 2021.

İçke, M. (2014). Schumpeter ve Yeniliklerin Finansmanı. ***Kahramanmaraş Sütçü İmam Üniversitesi Sosyal Bilimler Dergisi.***11(1), pp. 17-38. Web:

https://dergipark.org.tr/tr/pub/ksusbd/issue/10272/126026 retrieved from this address on May 30, 2021.

İğdeli, A. (2019). Ar-Ge ve Eğitim Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: Türkiye Örneği. ***Manas Sosyal Araştırmalar Dergisi.*** 8(3), pp. 2517-2538. Web: https://dergipark.org.tr/tr/pub/mjss/issue/47096/520848 retrieved from this address on 11 June 2021.

Kaygısız, A. and Yegül, S. (2020). Ekonomik Büyümeye Arge ve Yeniliğin Katkısı: Güney Kore Üzerine Ampirik Bir Analiz. ***Isparta Uygulamalı Sosyal Bilimler ve Güzel Sanatlar Dergisi.*** 2(Özel), pp. 30-42. Web: https://dergipark.org.tr/tr/pub/sosguz/issue/57566/752921 retrieved from this address on 14 June 2021.

Korkmaz, S. (2010). Türkiye'de Ar-Ge Yatırımları ve Ekonomik Büyüme Arasındaki İlişkinin Var Modeli İle Analizi. ***Yaşar Üniversitesi E-Dergisi.*** 5(20), pp. 3320-3330. Web: https://dergipark.org.tr/tr/pub/jyasar/issue/19132/203021 retrieved from this address on May 25, 2021.

Oğuz, S. (2020). G8 Ülkelerinde Ar-Ge Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: Bir Panel Veri Analizi. ***Manisa Celal Bayar Üniversitesi Sosyal Bilimler Dergisi.*** 18(4), pp. 127-138. Web: https://dergipark.org.tr/tr/pub/cbayarsos/issue/58743/786505 retrieved from this address on 12 June 2021.

Özcan, S. and Özer P. (2017). Ar-Ge Harcamaları ve Patent Başvuru Sayısının Ekonomik Büyüme Üzerindeki Etkileri: OECD Ülkeleri Üzerine Bir Uygulama. ***Anadolu Üniversitesi Sosyal Bilimler Dergisi.*** 18(1), pp. 15-28. Web: https://dergipark.org.tr/tr/pub/ausbd/issue/44441/550617 retrieved from this address on 14 June 2021.

Özer, M. and Çiftçi N. (2009). Ar-Ge Tabanlı İçsel Büyüme Modelleri ve Ar-Ge Harcamalarının Ekonomik Büyüme Üzerine Etkisi: OECD Ülkeleri Panel Veri Analizi. ***Sosyal Ekonomik Araştırmalar Dergisi.*** 8(16), pp. 219-240. Web:

https://dergipark.org.tr/tr/pub/susead/issue/28423/302688 retrieved from this address on 11 June 2021.

Uçan, O. et al. (2021). Turizm Sektörünün Türkiye Ekonomisine Etkisi: ARDL Sınır Testi Yaklaşımı. ***Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi.*** (45), pp. 144-159. Web: https://www.researchgate.net/publication/351218855_Turizm_Sektorunun_Turkiye_Ekonomisine_Etkisi_ARDL_Sinir_Testi_Yaklasimi retrieved from this address on May 27, 2021.

Yıldırım, D. and Kantarcı T. (2018). Araştırma Geliştirme Harcamaları ve Ekonomik Büyüme İlişkisi Üzerine Bir Panel Veri Analizi. ***Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi.*** 6(5), pp. 661-670. Web: https://dergipark.org.tr/tr/pub/anemon/issue/36491/396601 retrieved from this address on 12 June 2021.

Yıldız, G. (2018). Teknolojik İnovasyonun Ekonomik Büyüme Üzerindeki Etkisi: Türkiye – AB(15) Ülkeleri Örneği. ***Uluslar arası İktisadi ve İdari İncelemeler Dergisi.***Prof Dr. Harun Terzi Özel Sayısı, pp. 41-58. Web: https://dergipark.org.tr/tr/pub/ulikidince/issue/37268/380899 retrieved from this address on May 28, 2021.

Yılgör, M. and Aytan D. (2019). Savunma Harcamaları ve Ar-Ge Harcamalarının Ekonomik Büyüme Üzerine Etkileri: Panel Veri Analizi. ***ICOAEF VI Uluslararası Uygulamalı Ekonomi ve Finans Konferansı.*** pp. 100-115. Web: https://www.academia.edu/download/61707464/ICOAEF-VI.-Full-paper-proceeding-with-ISBN-1.1.20-120200107-122390-18e251y.pdf#page=112 retrieved from this address on 12 June 2021.

Yılgör, M et al. (2019). OECD Ülkelerinde Ar-Ge Harcamaları, Dış Ticaret ve Ekonomik Büyüme İlişkisi: Panel Veri Analizi. ***Anadolu Üniversitesi Sosyal Bilimler Dergisi.*** 20(3), pp. 193-208. Web: https://dergipark.org.tr/tr/pub/ausbd/issue/56965/801751 retrieved from this address on June 10, 2021.

# CHAPTER 9

# THE RELATIONSHIP BETWEEN ENERGY CONSUMPTION AND ECONOMIC GROWTH IN BRICS COUNTRIES AND TURKEY: PANEL COINTEGRATION ANALYSIS

Ayşegül DAVAL[1]

Zerife YILDIRIM[2]

[1] Master Student, Niğde Ömer Halisdemir University, Department of Finance, ayseguldaval63@gmail.com, Orcid: 0000 0003 4276 2516

[2] Assistant Professor, Harran University, Department of Econometrics, zerifeyildirim@gmail.com, Orcid: 0000 0002 2478 2823

## INTRODUCTION

Energy, which has an increasing importance from past to present, has an important place in our lives and is an integral part of increasing the welfare of the country, is an indispensable part of human life. Research on the importance of energy need, which has an important role in economic growth and sustainable development, has increased considerably in recent years. With the economic growth, energy production and consumption are increasing day by day in response to the increasing population and therefore the need.

With the increase in production in the globalizing world with industrialization, the need for energy, which is an important input among economic activities, has also increased. Especially the 1973 oil crisis and the developments after it revealed the importance of energy again and again. In this context, the relationship between economic growth and energy within the framework of sustainable development is researched, analyzed and interpreted by researchers. After the 20th century, there has been a change from fossil fuels, which are the primary energy source and harmful, to electrical energy. As a matter of fact, electrical energy has become an increasingly preferred choice due to the ease of production from other energy sources and the fact that it is not harmful to the environment.

The fact that energy resources are not evenly distributed and scarce in the world is an indication that energy is an indispensable resource. BRICS (Brazil, Russia, India, China and South Africa) countries,

which emerged as a strong alternative to the world economy, aimed to create a more egalitarian structure in the world economy and aimed to provide a global common benefit by spreading it regardless of its political-cultural-commercial characteristics.

In this study, it is aimed to analyze the effect of electricity consumption on economic growth between 1990-2019 for BRICS countries and Turkey according to panel data method and cointegration tests. For this purpose, the information obtained about the effect of per capita electrical energy consumption and inflation rate on economic growth has been tried to be supported by analyzing with numerical data. Stata 16 and Eviews 12 econometric packages were used in the analysis.

## 1. THEORETICAL PART

Although the BRICS countries are not close to each other geographically and have different social and cultural structures within themselves, they are important countries that have an economic and political say in their region (Açma, 2020).

Electricity, which has an important role in economic development, and energy, which is accepted as the basic input of production on a global scale, have been the subject of research by economists and researchers. According to Koç, Yağlı, Koç and Uğurlu (2018), “with the developments in industrialization and the transformation process, the need for energy has emerged with the addition of the increase in the world's population.” According to Aydın (2021), the fact that

energy was seen as an intermediate input, cheap and abundant before the 1970s caused neoclassical economists to interpret the view that energy had no effect on economic growth. In the 1970s, with the occurrence of energy shocks, energy prices increased and the economic growth rate decreased. With the 1973 Oil Crisis, the importance of the place of energy in the production factor began to be better understood and after the crisis, it was determined that the relationship between energy and economic growth was significantly related and started to be the subject of research in the literature.

According to the study of Ameyaw, Oppong, Aba Abruquah, and Ashalley (2017), causality between electricity consumption and economic growth can be in three ways: one-way, two-way or no relationship.

Payne (2010); The causality relationship between two variables can be synthesized with 4 hypotheses. First, the growth hypothesis assumes a unidirectional causality running from electricity consumption to the economy. If this is the case, the reduction in electricity consumption due to policies to conserve electricity could have a negative impact on economic growth. Second, the retention hypothesis suggests unidirectional causality running from economic growth to electricity consumption. In this case, electricity conservation policies designed to reduce electricity consumption and waste will have little or no impact on economic growth. Third, the neutrality hypothesis assumes that there is no causal relationship between electricity consumption and economic growth. The meaning of the neutrality hypothesis is that

electricity saving policies will have no effect on economic growth. Fourth, the feedback hypothesis emphasizes the interdependent relationship between electricity consumption and economic growth, in which causality runs both ways. Therefore, under the feedback hypothesis, an energy policy towards improvements in electricity consumption efficiency may not adversely affect economic growth.

It cannot be said that there is a general consensus in the causality researches between energy consumption and economic growth.

According to Robledo and Sarmiento(2013), different studies have been conducted on energy consumption and economic growth and different results have been reached. The first study, Kraft and Kraft(1978), found a unidirectional causality relationship from GDP to energy consumption in the USA for the 1947-1974 period. Abosedra and Baghestani(1991) proved the claim made by Kraft and Kraft(1978) using the standard Granger causality test. On the other hand, Akarca and Uzun(1980) claimed that the results of Kraft and Kraft(1978) were wrong because no evidence of causality could be found when the time period was limited to 2-year intervals. Although Yu and Hwang(1984) and Yu and Choi(1985) used many different methods, they could not find a causal relationship between energy consumption and GDP.

Within the scope of the research, cross-section dependency and homogeneity tests were applied between the countries included in the panel data set. After reaching the conclusion that it is cross-section

dependent, the stationarity of the series was tested with the 2nd generation unit root test, MADF, and GUW (Gengenbach, Urbain, Westerlund) cointegration analysis was performed, and the analyzes were terminated with DOLSMG, one of the heterogeneous estimators, as a long-term relationship estimator parameter.

The study proceeds as follows: in the second part, the literature review, in the third part, the methods and findings were analyzed, and in the last part, the results and recommendations were discussed.

## 2. LITERATURE REVIEW

Study: Fatai (2014)
Countries/Years: 18 Sub-Saharan African Countries/ 1980-2011
Method: Panel Co-Integration
Results: According to the panel cointegration test results, there is a stable long-term balance between energy consumption and economic growth. There is a unidirectional relationship from energy consumption to economic growth in Eastern and Southern Africa, which supports the growth hypothesis. The neutrality hypothesis for energy consumption and economic growth in the Central and West African region is supportive. No causal relationship was found between the two variables.

Study: Adhikari and Chen (2013)
Countries/Years: 80 developing countries/ 1990-2009
Method: Panel Co-Integration Panel DOLS
Results: The income levels of the countries in the panel were divided into 3 groups. A long-term cointegration relationship was found between energy consumption and economic growth in all three groups. A strong relationship from energy consumption to economic growth was found for upper middle-income and lower middle-income countries, and a strong relationship from economic growth to energy consumption for low-income countries. The findings explained that energy consumption has a positive and statistically significant effect on economic growth for these countries in the long run.

Study: Çağıl, Türkmen, Çakır (2013)
Countries/Years: Turkey/ 22 years
Method: VAR analysis, Granger causality test
Results: Electrical energy consumption and macroeconomic variables were examined and it was concluded that there was a one-way causality relationship

between these variables. In the study, it was concluded that there is a bidirectional but weak causality relationship between the electricity consumption per capita and the growth rate of the industrial sector.

Study: Belke, Dreger and Dobnik (2010)
Countries/Years: 25 OECD Countries/ 1981-2007
Method: Causality Test
Results: A strong causal relationship was found between real GDP, energy consumption and energy price index in the long and short run. According to this result, an increase in energy consumption causes economic growth and vice versa. Economic growth and energy consumption had an impact on energy prices. According to this result, an increase in energy consumption causes economic growth and vice versa. Economic growth and energy consumption have an impact on energy prices.

Study: Lee ve Chang (2008)
Countries/Years: 16 Asian countries/ 1971-2002
Method: Causality Test
Results: The relationship between energy consumption and real GDP was investigated. Although no causality can be found in both variables in the short run, a one-way causality relationship has been found in the long run from energy consumption to economic growth. What this means is the fact that although reducing energy consumption does not negatively affect GDP in the short run, it will negatively affect it in the long run. Therefore, these countries should adopt a stronger energy policy.

Study: Yapraklı and Yurttançıkmaz (2012)
Countries/Years: Turkey/ 1970-2010
Method: Granger Causality, Cointegration Test
Results: Bidirectional causality was found between electricity consumption and economic growth in Turkey.

## 3. METHOD, EMPIRICAL FINDINGS

In the study, the long-term causality relationship between the variables will be analyzed. For this purpose, firstly, in order to determine the stationarity of the series of the variables, the horizontal section dependence and the homogeneity test of the slope parameters will be investigated. According to the analyzes made, the appropriate panel unit root test will be applied, and in order to determine the long-term

relationship between the variables, the panel cointegration test and long-term coefficient estimates will be determined and interpreted. In the analyzes, the dependent variable is per capita national product and the independent variables are electricity consumption per capita and inflation.

The time dimension of the panel data is T, and the cross section dimension is N. Depending on the relationship between T and N, the cross-section dependence is examined. Accordingly, in cases where T>N, the CDLM1 test developed by Breush-Pagan (1980) is applied. In cases where T<N, the CDLM test developed by Pesaran and Yamagata (2008) is applied, and in cases where both T and N are large, the CDLM2 test developed by Pesaran (2004) is applied.

Since there is T>N in the relationship between 30 years (T) covering the period between 1990-2019 in the data set and 6 countries (N) in the context of BRICS-T countries, it is appropriate to use the CDLM1 test developed by Breush-Pagan (1980) in the cross-sectional dependence analysis.

### 3.1. Sample

In the data set, data belonging to the variables of National Product (GDP), Electricity Consumption Per Capita (ELKTK) and Inflation (INF) were used for the time dimension between 1990-2019. In the horizontal section, there are BRICS-T (Brazil, Russia, India, China, South Africa and Turkey) countries. The data sets of the study were

obtained from the official websites of the World Bank, IndexMundi, OECD, IMF. Explanations about the variables are shown in Table 1.

**Table 1.** Variables Used in the Study and Their Explanations

| **Variables** | **Abbreviation** | **Explanation** | **Data Source** | **Period** |
|---|---|---|---|---|
| National Income per Capita | GDP | Current US Dollar | World Bank | 1990-2019 |
| Electricity Consumption per Person | ELKTK | Electric Power Consumption (kWh per Person) | World Bank, IndexMundi | 1990-2019 |
| Inflation | INF | Consumer Prices (% per annum) | World Bank, OECD, IMF | 1990-2019 |

Descriptive statistics of the variables to be used in the analyzes are given in Table 2. In order to make the calculations easily and to prevent deviations from the assumptions, the analysis was started after the natural logarithms of the data sets of the variables were taken.

**Table 2.** Descriptive Statistics

| Variable | Observation | Mean | Std. Dev. | Min. | Max |
|---|---|---|---|---|---|
| LGDP | 180 | 3,5071 | 0,4595 | 2,4788 | 4,2034 |
| LELKTK | 180 | 3,3567 | 0,5726 | 2,41 | 8,8089 |
| LINF | 180 | 1,0236 | 0,6925 | -0,4587 | 3,4695 |

The standard panel data model can be represented as in equation 1. (Alev and Erdemli, 2019: 73):

$$Y_{i,t} = a_i + \beta_{i,t} X_{i,t} + \beta_{i,t} X_{i,t} + \mu_{i,t}$$

(1)

In this representation, Y is the dependent variable, i=1.2,….,N is the cross-section size, t=1.2,…,T is the time dimension, while X is k independent (explanatory) variables. In addition, $a_i$ represents the time-independent individual parameter, and $\mu_{i,t}$ represents the error term coefficient.

The econometric model used according to the variables in the study is as given in equation 2.

$$LGDP = \hat{b}_0 + \hat{b}_1 LELKTK + \hat{b}_2 LINF \quad (2)$$

### 3.2. Cross Section Dependency

In the study, first of all, the cross-sectional dependence of the data sets is investigated. Since the relationship between cross-section and time dimension in the data set is T>N, it is appropriate to use the CDLM1 test developed by Breush-Pagan (1980) in the analysis of cross-sectional dependence. The cross-section dependency test results obtained within the scope of the study are given in Table 3.

**Table 3.** Cross Section Dependency Test Results

| **Cross Section Dependency Test** | | | | | | |
|---|---|---|---|---|---|---|
| | **LGDP** | | **LELKTK** | | **LINF** | |
| | Statistics | Probability | Statistics | Probability | Statistics | Probability |
| $CDLM_1$ (BP, 1980) | 369.583 | 0.000*** | 218.371 | 0.000*** | 130.248 | 0.000*** |
| $CDLM_2$ (Pesaran, 2004) | 19.211 | 0.000*** | 9.995 | 0.000*** | 10.739 | 0.000*** |
| CDLM(Pesaran, vd.2004) | 63.642 | 0.000*** | 36.034 | 0.000*** | 19.945 | 0.000*** |
| Bias- Corrected scaled LM | 63.539 | 0.000*** | 35.931 | 0.000*** | 19.842 | 0.000*** |

Note: The "***" "**" "*" signs on the probability values indicate statistical significance at 1%, 5% and 10%, respectively.

Horizontal Section Dependency Hypothesis:

$H_0$: No Cross Section Dependence (no cross-section dependency)

$H_1$: Cross Section Dependence (has a cross-section dependency)

According to the test results for the cross-section dependence in Table 3. the probability values were significant in all tests, and the $H_0$ hypothesis was rejected throughout the panel. According to this result, there is a cross-sectional dependence between the units. For this reason, second generation unit root tests should be applied in stationarity research.

### 3.3. Homogenity Test

The homogeneity test is to test whether a change in one of the countries covered in the panel data analysis is affected at the same level in other countries. For this reason, the economic situation of the countries is important. Whether the variables are homogeneous or not changes the form of the unit root tests to be applied. In this context, homogeneity/heterogeneity research is carried out with the Delta test developed by Pesaran and Yamataga (2008). The hypothesis is as follows:

$H_0$: Variables are Homogeneous

$H_1$: Variables are Heterogeneous

**Table 4**: Homogenity Test (Delta Test)

| Delta Test | Cofficient | P-Value |
|---|---|---|
| $\Delta$ | 18.602 | 0.000*** |
| $\Delta_{adj}$ | 19.982 | 0.000*** |

Note: The "***" "**" "*" signs on the probability values indicate statistical significance at 1%, 5% and 10%, respectively.

The p-value is 0.000, indicating significance at 1%. $H_0$ is rejected because the coefficient is found to be significant. According to this result, the variables are heterogeneous and the slope coefficients are different from each other.

### 3.4. Panel Unit Root

After the cross-sectional dependence and homogeneity research were done between the coefficients, it was found appropriate to use the Multivariate Augmented Dickey-Fuller (MADF) unit root test as the second generation unit root test in the stationarity research.

Taylor and Sarno (1998) proposed the multivariate extended Dickey Fuller (MADF) unit root test, which is similar to the standard single equation ADF test (Tatoğlu, 2017: 79).

$$y_{it} = \mu_i + \sum_{j=1}^{k} \rho_{ij}\, y_{it-j} + u_{it} \qquad i = 1,...,N \;\; ve \;\; t = 1,...,T$$

(3)

In the estimation of the N equations in Equation 3. as a system, the correlation between the residues is taken into account and a test process covering the entire system is applied. The MADF test statistic has a $\chi^2$ distribution with N degrees of freedom.

In the MADF test, the error term is assumed to be independent normally distributed.

$$u_{it} \approx IN(0, \Lambda) \quad (4)$$

**Table 5**: Multivariate Extended Dickey Fuller (MADF) Panel Unit Root Test

| | Obs | Lags | MADF | Approx 5% CV |
|---|---|---|---|---|
| LOGGDP | 29 | 1 | 61.689 | 27.491 |
| LOGELKTK | 29 | 1 | 16951.808 | 27.491 |
| LOGINF | 29 | 1 | 38.115 | 27.491 |

$H_0$: all 6 timeseries in the panel are I(1) processes

Table 5 above shows the MADF test results. The test with the condition T>N is suitable for this example. The lag length is set to 1. When the result is examined, it is seen that the MADF test statistic and the 5% critical value are given. The main hypothesis of the test is that all 6 time series of the panel are I(1). According to the results, H0 hypothesis is rejected at 95% confidence level, since the MADF test statistic is greater than the given critical value, the panel data series is stationary.

### 3.5. Gengenbach, Urbain ve Westerlund (GUW) Panel Cointegration Test

An error correction-based panel cointegration test was developed by Gengenbach, Urbain, and Westerlund (2016) using the common factor structure. In this test, the following (in vector form) error correction model was used (Tatoğlu, 2017: 205):

$$\Delta y_i = d\delta_{y.xi} + \alpha_{yi}\, y_{i,-1} + \omega_{i,-1}\gamma_i + \nu_i\pi_i + \varepsilon_{y.xi} = \alpha_{yi}\, y_{i,-1} + g_i^d \lambda_i + \varepsilon_{y.xi} \quad (5)$$

In this test, which is based on the error correction model, heterogeneity and inter-unit correlation are allowed.

**Table 6:** Panel Cointegration Test (Gengenbech, Urbain, Westerlund)

Panel EC-test:

| **d. y** | **Coefficient** | **t-statistics** | **P-val*** ** |
|---|---|---|---|
| y (t-1) | -0.654 | -3.717 | < = 0.01 |

Long-run average coefficients:

| **loggdp** | **Coefficient** | **Std. Err.** | **z** | **P>\|z\|** | **[95% Interval]** |
|---|---|---|---|---|---|
| logelektk | .843894 | .1802824 | 4.68 | 0.000*** | .4905469<br>1.197241 |
| loginf | -.1784399 | .0437066 | -4.08 | 0.000*** | -.2641034<br>-.0927765 |

Pesaran (2015) CD-test:

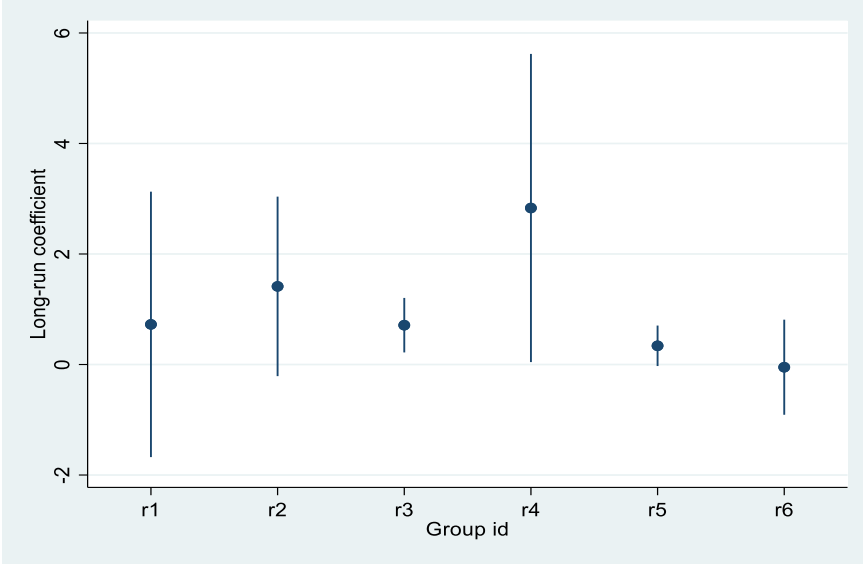
| **Variable** | **CD-test coefficient** | **P-value** |
|---|---|---|
| loggdp | 7.919 | 0.000*** |
| logelktk | 1.962 | 0.050** |
| loginf | 5.839 | 0.000*** |
| e | -2.723 | 0.006*** |

Root mean square error: 0.0261
Number of observations: 174
Number of groups: 6

The output above shows the results of the Gengenbach, Urbain and Westerlund panel cointegration tests, the estimation of long-term parameters, and the Pesaran CD test for inter-unit correlation. The lag length is chosen heterogeneously, it varies according to the units. When the $Y_{t-1}$ significance for the panel cointegration test is examined (since P-val < 0.1), it is understood that the $H_0$ hypothesis is rejected, therefore there is a cointegration relationship between GDP, ELKTK

and INF variables. The graphs of the estimated long-term parameters according to the units are given below.

**Graphic 1:** Graph of Long-Period Parameters




(Created by the authors)

### 3.6. Mean Group Dynamic Least Squares (DOLSMG) Estimator

The variables can be transformed by taking the difference from the cross-sectional averages and the model can be estimated for the whole panel with Pedroni's (2001) DOLSMG estimator.

**Table 7:** Mean Group Dynamic Least Squares (DOLSMG) Estimator

| **BRICS-T COUNTRIES** | | **DOLSMG** | |
|---|---|---|---|
| BRICS-T | Variables | Coefficient | t-statistics |
| BR1 | LOGELKTK | .9123 | 3.111** |
| BR2 | LOGINF | -.0207 | -.4259 |
| CHN1 | LOGELKTK | 1.345 | 8.937*** |
| CHN2 | LOGINF | -.264 | -2.763** |
| IND1 | LOGELKTK | -1.170 | -2.845** |
| IND2 | LOGINF | .0170 | .5141 |
| RUSS1 | LOGELKTK | .4768 | .6197 |
| RUSS2 | LOGINF | -.2813 | -.9835 |
| AFR1 | LOGELKTK | .8322 | 5.258*** |
| AFR2 | LOGINF | -.253 | -4.458*** |
| TR1 | LOGELKTK | -.188 | -2.606** |
| TR2 | LOGINF | .0803 | 2.576** |

Long Period Relationship (Mean Group)

| **Variables** | **Coefficient** | **t-statistics** |
|---|---|---|
| logelktk | .3680 | 5.093*** |
| loginf | -.1203 | -2.262** |

Not: statistics t-table values:
for $\alpha = 0.10$: 1.699 & for $\alpha = 0.05$ : 2.045 & for $\alpha = 0.01$: 2.756.

The output shows the estimation of the long-term relationship between loggdp, logelktk, loginf variables with DOLSMG, and the estimated (0.36 and -0.12, respectively) parameter is the long-term parameter. The t-statistic of the long-run parameter is significant. According to DOLSMG results, logelktk and loginf affect loggdp variable in the long run. A 1% increase in logelktk increases the loggdp rate by 0.36%. A 1% increase in loginf reduces the loggdp rate by 0.12%.

## 4. CONCLUSION AND RECOMMENDATIONS

With the increase in energy consumption in the world, the need for energy has emerged and it has been the subject of research in the history of the literature due to the determination of its relationship with economic growth. According to the results of the literature, causality was found between the relationship between economic growth and energy in general. In this study, the relationship between energy consumption and economic growth was tested in the context of BRICS-T countries. In this sense, the relationship between economic growth and energy consumption for the period 1990-2019 was investigated with the GUW cointegration method. In the study, the cross-section dependency was found and the second generation unit root test was used in the stationarity research of the series. According to the homogeneity test result, it was concluded that it is heterogeneous. The long-term relationship between the series was examined with the GUW cointegration test and it was concluded that there was cointegration. According to the panel DOLSMG test result, the t-statistic of the long-term parameter estimation in the 1rd, 2rd, 3rd, 5rd and 6th countries for LOGELKTK among the LOGGDP, LOGELKTK and LOGINF variables on the basis of units in the output is significant. For LOGINF, the t-statistic of long-term parameter estimation is significant in countries 2rd, 5rd ve 6rd.

With the possibility of Turkey, which has turned to alternative searches as a result of the problems with the EU and the BRICS countries, which are called developing countries, to become a member

of this group, the importance of the BRICS countries, which are thought to have a say in the 2050s, can be explained in this way and therefore constitutes the subject of the study.

As a result, the following can be said for the 3 variables in the study that mutually affect each other: Although being a member of the Kyoto Protocol, excessive increase in energy consumption can both negatively affect economic growth later on and cause environmental damage. In the case where economic growth and energy can mutually feed each other, it can lead to an increase in the use of fossil fuels. For this reason, countries should turn to renewable energy types in terms of their policy structures and operate in these areas.

In this study, other than the relationship between electricity consumption and inflation, other variables (e.g., the effects of other types of energy on the environment and related factors, control variables, other economic factors) were not analyzed. Further studies are needed to analyze these relationships.

## REFERENCES

Açma, B. (2020). Current Problems of the Economy. Eskişehir: Anatolian University.

Adhikari, D., and Chen, Y. (2013). Energy Consumption and Economic Growth: A Panel Cointegration Analysis for Developing Countries. Review of Economics & Finance,( Oct, 2012), pp 68-80.

Alev and Erdemli (2019). Electric Energy Consumption and Economic Growth Relationship: One For The Countries of The European Union and Turkey Analysis. ASSAM International Refereed Journal, Vol 6, No. 15 (Dec, 2019), pp 73.

Ameyaw, B., Oppong A., Abruquah, L. A., and Ashalley E. (2017). Causality Nexus of Electricity and Economic Growth: An Empiricial Evidence from Ghana. Open Journal of Business and Managemenent, 5(1-10) (Now, 2017).

Aydın, B. (2021). Energy-Growth Relationship Based on Development Literature. Journal of Finance, Economics and Social Studies, Vol. 6, No.5 (March, 2021), pp 2.

Belke, A. H., Dreger, C. and Dobnik, F. (2010). Energy Consumption and Economic Growth - New Insights into the Cointegration Relationship. Ruhr Economic Papers. Vol. 33, No. 5 (June, 2010), pp 3-22.

Çağıl, G., Türkmen, S. Y. and Çakır, Ö. (2013). The Relationship Between Energy and Macroeconomic Variables: An Application for Turkey. Journal of Accounting and Finance. (April, 2013), pp 161-174.

Economic Development and Cooperation Organization (2021). Web: https://www.oecd.org/ , accessed on 02.06.2021.

Fatai, B. O. (2014), "Energy Consumption and Economic Growth Nexus: Panel Co-Integration and Causality Tests For Sub-Saharan Africa", Journal of Energy in Southern Africa, Vol. 25, No. 4 (Now, 2014), pp 93.

IndexMundi (2021). Web: https://www.indexmundi.com/ accessed on 01.06.2021.

International Energy Agency, Electricity Consumption Per Capita. Web: https://www.iea.org/fuels-and-technologies/electricity accessed on 12.07.2021.

International Monetary Fund (2021). Web: https://www.imf.org/ accessed on 01.06.2021.

Karadaş, H. A., Koşaroğlu, Ş. M., and Salihoğlu, E. (2017). Energy Consumption and Economic Growth. Cumhuriyet University Journal of Economics and Administrative Sciences. Vol. 18, No. 1, pp 133-121.

Koç, A., Yağlı, H., Koç, Y., Uğurlu, İ. (2018). General Evaluation of Energy Outlook in the World and in Turkey. Engineer and Machinery (Review Article), Vol. 59, No. 692 (Sept, 2018), pp 86-114.

Lee, C. C., Chang, C. P. (2008). Energy consumption and economic growth in Asian economies: A more comprehensive analysis using panel data. Resource and Energy Economics. Vol. 30, No. 1 (May, 2007), pp 50-65.

Payne, J. E. (2010). A Survey of the Electricity Consumption-Growth Literatüre. Applied Energy.87(3), 723-731.

Robledo, J. C. and Sarmiento V. (2013). The Relationship Between Energy Consumption and GDP: Evidence From a Panel of 10 Latin American Countries. Latin American Journal of Economics, Vol. 50, No. 2 (Now, 2013), pp 233-255.

Tatoğlu, F. Y. (2017). Panel Time Series Analysis. Istanbul: Beta Publications.

Yapraklı, S. and Yurttançıkmaz, Z. Ç. (2012). Between Electricity Consumption and Economic Growth Causality: An Econometric Analysis On Turkey.

Cumhuriyet University Journal of Economics and Administrative Sciences. Vol. 13, No. 2 pp 195-215.

Worldbank (2021). Web: https://www.worldbank.org/ , accessed on 02.06.2021.


ISBN: 978-625-7562-38-6