NON-LINEAR PANEL DATA ANALYSIS BETWEEN ECONOMIC GROWTH AND HEALTH EXPENDITURES

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ABSTRACT

In the 1960s, endogenous growth theories revealed that human capital as much effect as physical capital in economic growth. Then, it was focused on how to increase human capital accumulation, and it was determined that first of all, education and then health were two main components. There are a lot of studies in the literature trying to assess the relationship between health expenditures and economic growth. In the studies on the relationship between economic growth and health expenditures, which is the subject of this study, it has been observed that economic growth is increased by health expenditures generally, but there are some studies that show that it does not affect economic growth even decrease. In this study, the relationship between health expenditures and economic growth has been examined for OECD countries, including Turkey, with two different methods: dynamic panel data analysis and non-linear panel data analysis. In these methods, firstly, the relationship between health expenditures and economic growth is examined, then the other components of economic growth that are generally accepted in the literature, such as capital accumulation, total factor productivity and the democracy index, whose effects on economic growth are discussed, are included in the model to determine the effect of health expenditures on economic growth has been studied.

Key words: Economic Growth, Health Expenditures, Non-Linear Panel Data Analysis

EKONOMİK BÜYÜME VE SAĞLIK HARCAMALARI ARASINDA LİNEER OLMAYAN PANEL VERİ ANALİZİ

ÖZ

Beşerî sermaye birikiminin ekonomik büyüme üzerinde en az fiziki sermaye birikimi kadar önemli olduğu 1960'larda içsel büyüme teorileri ile ortaya konmuştur. Ardından beşerî sermaye birikiminin nasıl arttırılacağı üzerine odaklanılmış, öcelikle eğitim ardından da sağlığın iki ana bileşen olduğu tespit edilmiştir. Literatürde ekonomik büyüme ile sağlık harcamalarının ilişkisi üzerine birçok çalışma mevcuttur. Bu tezin konusu olan sağlık harcamaları ile ekonomik büyüme arasındaki ilişki üzerine yapılan çalışmalarda genellikle sağlık harcamalarının ekonomik büyümeyi artırdığı görülmüş olsa da hiç etkilemediği ya da ekonomik büyümeyi düşürdüğüne dair çalışmalar da mevcuttur. Bu çalışmada sağlık harcamaları ve ekonomik büyüme ilişkisi Türkiye'nin de içinde bulunduğu OECD ülkeleri için dinamik panel veri analizi ve non lineer panel veri analizi olmak üzere iki ayrı yöntemle incelenmiştir. Bu yöntemlerde öncelikle ekonomik büyüme ve sağlık harcamaları arasındaki ikişki incelenirken, ardından ekonomik büyümenin literatürde genel kabul gören diğer bileşenleri olan sermaye birikimi, toplam faktör verimliliği ve ekonomik büyüme üzerinde etkisi tartışılan demokrasi endeksi gibi bileşenler de modele dahil edilerek sağlık harcamalarının ekonomik büyüme üzrindeki etkisi tespit edilmeye çalışılmıştır.

Anahtar Kelimeler: Sağlık Harcamaları, Ekonomik Büyüme, Lineer Olmayan Panel Veri Analizi

INTRODUCTION

In this study the relation between health expenditures and economic growth has been examined for OECD countries, including Turkey, with five different methods: panel data analysis, structural break panel data analysis, panel causality test, dynamic panel data analysis and non-linear panel data analysis. In these methods, firstly, the relation between health expenditures and economic growth is examined, then the other components of economic growth that are generally accepted in the literature, such as total factor productivity, capital accumulation and the democracy index, whose effects on economic growth are discussed, are included in the model to determine the effect of health expenditures on economic growth. has been studied.

In addition, although there are studies on the optimal level of public expenditures in the literature, it has been observed that there is no study on the optimal level of health expenditures in OECD countries, and it has been tried to calculate at which health expenditure level the economic growth will be maximum. In addition, while it is almost agreed in the literature that physical capital accumulation, total factor productivity positively affects economic growth.

It is thought that democracy's effect and health expenditures increase growth by increasing human capital accumulation and reducing income inequality, as well as increasing the ratio of public consumption expenditures to GDP and preventing physical capital accumulation and reducing growth.

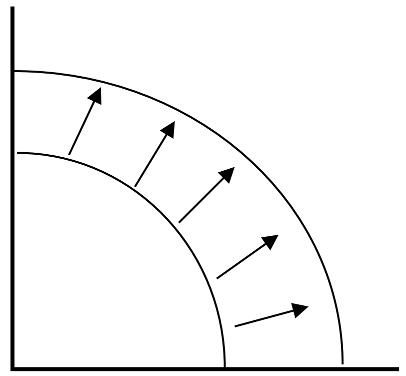
Therefore, in this study, although their effect on economic growth is controversial in the literature, these two variables, which are thought to increase economic growth by increasing human capital, will be added to the model and how much they contribute to economic growth besides total factor productivity and accumulation of physical capital which are agreed as the main elements of economic growth, are analyzed.

1. ECONOMIC GROWTH CONCEPT

According to another definition, economic growth is defined as the increase in real output per capita (Economic, 2005: 55, Karluk, 2005: 55), as the economy grows and the production capacity of the economy increases, more goods and services are produced.

Economic growth can be explained as the expansion of goods and services production capacity. In other words, if the production possibilities of the country are shifted to the right in a production possibility frontier, it can be said in economic growth, as seen in Figure 1.

Figure 1: Production Opportunities Curve



2. HEALTH EXPENDITURES AND ECONOMIC GROWTH RELATION

Most of the economists have a common view that the high level of health of countries affects the development of the country positively (Karagül, 2002: 72). There is a direct impact of health, income and prosperity of the countries, labor productivity, demographic and human capital factors (Taban, 2006: 33).

Developed countries can allocate more from the Gross Domestic Product (GDP) for the protection, development and treatment of human health that is the main element of economic growth. In a sense, health investments are considered as "productive investment" (Tokgöz, 1981: 503).

Developments in health and education services affect the production function and raise the level of labor services. When the workforce is healthy, less time is wasted and more effective efforts are made. It is also a fact that healthy labor power will make a significant contribution to a rapid economic growth (Talas, 1972: 80).

It should not be forgotten, however, that the level of health is also important for the person to be able to receive education and economic activities. In this direction, health and education should be evaluated together in the human capital stock (Karagül, 2002: 70)

Theoretical discussions on economic growth literature focus on the role of human capital in the economic growth process (Çetin and Ecevit, 2010: 166). Because human capital is a source of economic growth and health is the most important economic component of human capital, a cause of health and economic growth is also considered as a reason for health (European Commission, 2005: 20).

In the literature, causality relation between health expenditures and GDP is explained by four different hypotheses. Among these are the hypothesis that health spending positively affects GDP (Mushkin, 1962: 129, Hansen and King 1996: 135, Bloom and Canning 2000: 1209, Groosman 1972: 223, Newhouse 1977: 5, Foo Tang 2011: 199). In this hypothesis, there is a one-way causality from health expenditures to GDP. The second is the hypothesis that health spending affects not only the positive growth of growth but also the growth of the health sector (Elmi and Sadeghi, 2012: 88, Mehrara and Musai, 2011: 103). Here, two-way causality from health expenditure to GDP and from GDP to health spending is discussed. The third hypothesis is that health expenditures do not affect GDP. In other words, there is no causal relationship between two variables in this hypothesis. The last hypothesis assumes that health expenditures negatively affect GDP (Akar, S., 2014: 312). There is a causal relationship between health and income. Rural health expenditures of the countries, health expenditure of the society and health of the society can affect the productivity of the country. This relationship can be bi-directional as well as health-conscious or health-conscious. Although these divergent forms differ between countries, the causality relation can be observed in both countries in different income groups (Erdil and Yetkiner, 2004: 702).

The province of these studies, Groosman (1972) did not work is done. According to this study, the health service expressed as fixed capital stock positively affects output growth. Spending on the health sector encourages economic growth as a type of investment. Newhouse (1977) suggests that GDP at national level is a positive influence on medical care.

Mushkin (1962) pioneered the study of health as an important catalyst for economic growth and economic growth, followed by a number of studies investigating the relationship between health spending and income in the literature. A large part of these studies [Newhouse (1977), Parkin et al. (1987), Wang and Rettenmaier (2007) and Hartwig (2008) show that both variables have a positive correlation (Tang and Ch'ng, 2011: 6814).

Jones (1990) dealt with public expenditure in the United States between 1964 and 1984 by means of a model of imbalance between public expenditure and economic growth variables. Other expenditures, which health and transfer spending reduce by economic growth, have reached the result, in particular expenditures incurred by local governments, to encourage growth.

Kelly (1997) reached the conclusion that between 1970 and 1980, 73 countries' health spending did not make a meaningful contribution to economic growth.

Base and Snow (2003), from 1971 to 2000 for the period between annual data using in Turkey in the distribution of public spending (education, health, social security and infrastructure spending) was investigated using the co-integration approach, the effects of economic growth. Econometric results of the analyzes showed that the effect of infrastructural expenditures is statistically insignificant and the effect of growth of health expenditures is negative, while the effect of education and social security expenditures on economic growth is positive.

Tan et al. (2010) representing a correct relationship Keynes public expenditure to national income from their work in order to test the hypothesis for Turkey's economy in 1969-2003 period; has identified the existence of a causality relationship from infrastructure spending to gross domestic product.

Nelson and Phelps (1966) and Romer (1990) defined the interdependence between per capita income and health expenditure in models of internal growth. Health spending contributes to economic growth by developing human capital, and at the same time, the growth of economic growth can be led to human capital investments to achieve a chain growth.

Ak’s (2012) study that was done with health expenditure in Turkey showed there was not a short-term relationship between economic growth, but has determined that a relationship in the long term.

Uçan and Atay (2016), the study covers the period 2006Q1-2014Q4 they analyze the relationship between the growth of health expenditures in Turkey and have determined that the run relationship between variables.

Kıymaz et al. (2006), the relationship between health spending and economic growth in Turkey 1984-1998 period for their study addressed using the Johansen cointegration analysis, private health spending and Gross National Product (GNP) to include that of a cointegration relationship and per capita GDP than medical expenses one-sided relationship.

The impact of health expenditure on economic growth, which is one of the important indicators of health, is multifaceted and long-lasting (Taban, 2006: 35). Recent studies have also proved that the positive impact of investments on health in the economic development process. The macroeconomic and health commission (2001) and the comprehensive report published by the European Commission (2005), set up by the World Health Organization, point out that for both developed and developing countries, health spending is an incentive for GDP growth and that health spending should be done. (Karabulut, 1999: 139).

Sorkin (1977) has concluded that in developed countries, the society has made little positive contribution to economic growth despite improvements in health conditions.

Strauss and Thomas (1998) have shown an empirical study of the relationship between health and productivity. According to the study result, there is a relationship between some health indicators (disease types and nutrition habits) and physical efficiency.

Reinhart (1999) deals with the effects of government spending on economic growth with a life expectancy at birth. In Bloom et al. (2001) empirical analyzes, they used the human capital Solow model.

For most of the empirical studies on the effect of health on economic growth, the main problem is that as a health indicator it is often necessary to take life expectancy at birth. For example, Bloom and Canning (2000) found that birth expectancy had a positive and significant effect on the economic growth process. In this study, health was measured as a life expectancy at birth; other dimensions of health did not join the account.

Erdil and Yetkiner (2004) assessed a causality relationship was found that worked towards economic growth from health in low- and middle-income countries and health expenditure in high-income countries.

When human capital on economic growth in the private economy of Turkey is examined as a factor in human capital is seen that most of the studies used in training again. However, the health issue, which is basic component of human capital, has attracted the attention of researchers and they have started to take a lead in this field. Examples of studies done in this area are Kar and Ağır (2003), Taban (2005), Temiz and Korkmaz (2007).

On the other hand, according to Bloom and Canning (2000), health spending has positive effects on economic prosperity and growth. The reasons for this positive effect are summarized as follows; Healthy individuals (employees) are more efficient and healthy individuals have a positive effect on human capital. The fact that the average life span is too high encourages an increase in physical investments. However, increased health spending supports the longer average life span and, in this case, increases long term growth.

In studies dealing with countries of the Organization for Economic Co-operation and Development (OECD), a positive relationship was found between health spending and economic growth. Hansen and King (1996) conducted a unit root analysis of health spending and GDP variables in OECD countries and found that these series are not static. Nevertheless, it emphasized the importance of GDP in determining the level of total health expenditure.

Beraldo, Montolio and Turati (2009) assessed 1 percent increase in total health spending increases the per capita GDP by between 0,06 and 0,10 percent. The increase of 0.04 percent to 0.07 percent is due to public expenditures.

McCoskey and Selden (1998) used panel data differently from Hansen and King (1996) when examining GDP and per capita health expenditure in OECD countries, and this panel provided a unit root test. According to this study, the series contain unit root and the null hypothesis is rejected. However, the results of the study show that national health expenditures reduce the likelihood of misdetection in panel data analysis and misleading health policies.

According to Dormont et al. (2008), the potential impacts of public health spending in the US, Europe, and Japan are positively affecting potential growth and productivity. The reasons for this are shown in the developed economies to meet the health services from the public budget. The study also found that health expenditures tend to increase in the same direction as per capita income (unit income elasticity).

Akram (2009) investigated the impact of health indicators on economic growth in Pakistan between 1972-2006. The study shows that per capita GDP is positively affected by long-term health indicators. However, short-term health indicators do not have a significant impact on GDP per capita.

Mehrara and Musai (2011) examined the causality between health spending and economic growth in oil-exporting countries. According to this study, economic growth and health expenditures are related in both ways.

Wang (2011) assessed; growth in low- and high-income countries is due to the different characteristics of health spending, as it occurs at different levels. Nevertheless, in countries with similar economic conditions and moderate economic development, economic growth is positively affected, although the level of health expenditure varies.

Elmi and Sadeghi (2012), unlike Wang (2011), analyzed co-integrated relationship and causality between economic growth and health expenditures in developing countries between 1990 and 2009. According to the study, there is a two-way causality between long term GDP and health expenditure variables. For this reason, it is suggested that the hypothesis of growth based on health is valid in developing countries.

Gerdtham and Jönsson (1991) in their study of twenty-two OECD countries; Contrary to Groosman (1972) and Newhouse (1977) studies, the relative price of health spending is not related to national income. The supply of health expenditures is increasing due to the national gender. Moreover, the relative price of health spending close to price elasticity -1 creates a rationing effect 1 in the amount of health spending. Hence, the level of health expenditure is not large in countries with higher price levels. However, the difference in the amount of health spending and the amount of health expenditures among countries also changes the definition of health expenditures from country to country. Gerdtham and Jönsson (2000) analyzed the relationship between international health spending and GDP for twenty-one OECD countries during the period 1960-1997. The results of this study show that, unlike the results of Gerdtham and Jönsson (1991), both variables are not static and that health expenditures and GDP are cointegrated.

Hitiris and Posnett (1992) found that health expenditures, which are close to 1 in income and price elasticities, are an important determinant of GDP.

Okunade and Karakus (2001) investigated whether health spending, the relative price of health spending and the GDP variables for the OECD countries during the period 1960-1997 were cointegrated. Study; In the UK, Ireland and Greece, health spending has been claimed to be regarded as luxury goods in the long run, since the price and income elasticity of the health expenditure is greater than 1. However, health spending, the relative price of health spending and the GDP variables coexist. For this reason, implementation of national health spending policies in OECD countries can be beneficial for growth.

According to Milne and Molana (1991), neglecting the relative price of health spending leads to income elasticity greater than 1. The fact that a relative unit of increase in income does not increase real health spending due to the compensatory role of relative price. According to the study results, the relative price of health expenditures and the GDP tend to increase together. Besides this increase tendency, health spending also increases in the same direction.

The analysis of health expenditure and GDP in Turkey generally have focused on the analysis of cointegration between public spending and GDP. For this reason, studies addressing health expenditures in public spending are relatively few. Studies that analyze the causality between health expenditures and GDP have different results using different samples.

3. DYNAMIC PANEL DATA ANALYSIS

In the study, the effect of health expenditures on economic growth was investigated with balanced panel analysis, using data from 23 OECD countries for the period 1990-2021

Dynamic panel data analysis method is used in the study. Dynamic panel data analysis has advantages such as a greater number of observations and more homogeneous structure, increasing the degree of freedom and reducing the problem of connection between explanatory variables.

In addition, dynamic panel data analysis can give more effective results in cases such as autocorrelation, changing variance, and internality problems. Two-stage system generalized moments (two-step System-GMM) method also gives stronger results in dynamic panel data analysis. (Hayaloğlu and Topal, 2017: 199). Because the lagged value of the dependent variable is included in the model as an independent variable, and the internality problem that may occur can be eliminated from the beginning.

In the differential GMM developed by Arellano and Bond (1991), the problems that may occur in the dynamic panel estimation can be eliminated by using the previous period values of the dependent variable as the instrument variable and by taking the first-order differences of the variables and including them in the model. System GMM panel data analysis is used when the time dimension (T) is smaller than the unit size (N), and the efficiency of the model is increased by including more instrumental variables in the model (Hayaloğlu and Topal, 2017: 199).

3.1. MODEL AND DATASET

Below is the econometric model created to analyze the relationship between health expenditures and economic growth and other components of economic growth with dynamic panel data:

$$GSHit = \alpha + \beta_1\, GSHit\text{-}1 + \beta_2 HEit + \beta_3 DEMit + \beta_4 TFVit + \beta_5 FSit + uit \qquad \textbf{(1)}$$

In the model, time t is country i; α constant term; β's are slope coefficients; μ is the unit effect and u are the error term. GSH, which shows the economic growth rate, is the dependent variable. SH is the main independent variable and expresses the ratio of health expenditures to national income, while other variables are control variables that have an effect on economic growth. TVF Total Factor Productivity is the ratio of FS physical capital stock to national income. In Equation the growth rate of national income per capita, the ratio of health expenditures to national income and the ratio of physical capital stock to national income, which are the main components of economic growth, are modeled over total factor productivity and democracy index. In this study, the relationship between health expenditures and economic growth (the rate of increase in national income) was determined by 23 OECD countries (Canada, England, Australia, Belgium, New Zealand, Austria, Denmark, Finland, Ireland, Greece, Germany, Hungary, Iceland, Japan, Korea, Netherlands, Switzerland, Norway, Italy, Spain, Sweden, USA and Turkey) were analyzed using annual data for the period 1990-2021. The data are taken from Penn World Table 9.1, OECD Stat and Polity IV, the series expressed in million USD based on 2011. Data analyzes were carried out using Stata 15 and Gauss 20 computer programs. In order to provide balanced panel analysis, the condition of having an equal number of data from 23 countries was taken into account, and 736 observation values were obtained from 23 countries with 32 years of data for the period 1990-2021.

3.1. DATA SOURCES AND DESCRIPTIVE STATISTICS

Table 1: Data Sources

Variable	Explanation	Data source
GSH	Real gross domestic product per capita, adjusted for purchasing power parity	Penn World Table 9,1
HE	Real health expenditure per capita adjusted for purchasing power parity	OECD Stat
FS	Physical Capital Stock	Penn World Table 9,1
FV	Total Factor Efficiency	Penn World Table 9,1
DEM	Democracy Index	Polity IV

Table 2: Descriptive Statistics

Variables	Mean	Stand. Dev.	Min.	Max.
GSH	2.138	2.893	5.438	11.893
FS	24.703	4.571	12.643	37.765
TFV	0.997	0.073	0.7542	1.3325
DEM	9.92	0.577	8	10
HE	8.993	2.57	3.99	17.117

4. METHOD

The existence of horizontal cross-section dependency between the countries forming the panel before the study; investigated by the Bias-corrected scaled (LMBC) test. Stability of series; from the second-generation unit root tests, taking into consideration the horizontal section dependency and the structural breaks in the series, Carrion-i-Silvestre et al. (Panel Kwiatkowski-Phillips-Schmidt-Shin) method developed by the Ministry of Education, Culture, Sports, Science and Technology (2005). Homogeneity of cointegration coefficients; Pesaran and Yamagata (2008). Cointegration coefficients; It was estimated by the Augmented Mean Group (AMG) method developed by Eberhardt and Bond (2009), which considers the horizontal section dependency.

4.1. TESTING HORIZONTAL CROSS - SECTION DEPENDENCE

In panel data analysis, it is of utmost importance to determine whether there is horizontal section dependency between the panellist countries and, if such dependency exists, to use the methods that take this into account in the analyzes to be done. Regardless of this situation, tests and coefficient estimates can produce misleading or even inconsistent parameters, if panel horizontal dependency exists (Chudik and Pesaran, 2015). For this reason, it is very important to test the existence of horizontal section dependency in series and model in panel data analysis.

Horizontal section dependency tests; a shock coming from one of the panellist countries tests whether it influences the others. Horizontal cross-section dependence is particularly likely among countries that interact with each other. Since the countries that make up the panel in this study are members of the OECD and generally have active co-operation among them, an economic shock from one of these countries is likely to affect other countries as well.

Breusch and Pagan (1980) LM test, which was followed by Pesaran (2004) LMs test and Pesaran (2004) CD test, and lastly Baltagi, Feng and Kao (2012) corrected the deviation of the previous tests to test the horizontal section dependency He developed the LMBC test. These tests can be examined as

$$y_{it} = \beta'_{it} x_{it} + u_{it} \qquad (2)$$

Here, β_i the cross-sectional feature vectors corresponding to the predicted parameters; u_{it} mean is zero, variance is constant series of error terms. The hypotheses of these tests are:

H_0: There is no horizontal section dependency between countries

H_1: There is horizontal section dependency between countries

To test these hypotheses, the following test statistics were developed:

Breusch and Pagan (1980) LM test statistic:

$$LM = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_i \hat{\rho}_{ij}^2 \sim \chi^2_{\frac{N(N-1)}{2}} \quad (3)$$

Pesaran (2004) extended the equation (3) for the case where the number of horizontal cross sections is very large in the scale LM test as follows:

$$LM_S = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T_i \hat{\rho}_{ij}^2 - 1) \sim N(0,1) \quad (4)$$

He also solved the problem of possible size deformation in Pesaran (2004) and his tests and improved the CD test statistic to be used when the time dimension is greater than or equal to the horizontal section size:

$$CD = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_i \hat{\rho}_{ij}^2 \sim N(0,1) \quad (5)$$

$$LM_{BC} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T_i \hat{\rho}_{ij}^2 - 1) - \frac{1}{2(T-1)} \sim N(0,1) \quad (6)$$

Horizontal section dependency tests results seen in Table 3

Table 3: Horizontal Cross Section Dependency Test Results

	LM Test Statistics	***LM_S Test Statistics***	***CD Test Statistics***	***LM_{BC} Test Statistics***
GDPC	8289.75 (0.00)	373.90 (0.00)	90.85 (0.00)	373.62 (0.00)
HEXPC	8200.65 (0.00)	369.75 (0.00)	90.34 (0.00)	369.47 (0.00)
Model	1746.19 (0.00)	69.46 (0.00)	10.16 (0.00)	-

Note: Parentheses are the likelihood values. ****; indicates the presence of horizontal section dependency between countries at the relevant sera level of significance of 1%. LMBC test statistic can not be produced for models.

In Table 3, the H0 hypothesis was rejected for the output of probability less than 0.05 in the tests for the series and the model, and it was decided that there was horizontal cross-section dependency among the panellist countries. In this case, an economic shock from one country can also affect others. For this reason, it is beneficial for countries to closely follow developments in other countries involved in the analysis while developing their policies. In addition, second-generation (dynamic) panel data analysis methods that take horizontal section dependency into consideration should be used in the following stages of the study.

4.2. STRUCTURAL BREAKING PANEL UNIT ROOT TEST

In econometric analyzes, the stationarity ratings of the series must be determined before proceeding to regression analysis. Because the test methods to be used in the later stages of the analysis are determined according to the stationarity ratings of the series. If the series are not stable at the level values, analysis with the level values of these series may have a false regression problem (Engle and Granger, 1987).

Since horizontal cross-section dependency is identified among countries in the study, second generation unit root test is required. However, these tests do not consider the structural breaks in the series, taking into account the horizontal section dependency between the panellist countries. However, when there are structural breaks in the sera, tests made without considering this situation may yield deviations (Charemza and Deadman, 1997). During the period covered by this study, numerous economic crises, political and economic integration, war, terrorist attacks, etc., the use of methods that take into account structural wrinkles in the work becomes necessary. For this reason, the stability of the series in the study was evaluated by Carrion-i-Silvestre et al. (2005) developed by the PANKPSS test. In addition to taking into account the horizontal section dependency between the panellist countries, this test permits structural breaks of up to five in each series of panellular horizontal sections and can determine the structural break dates for each country separately and the stability of the series under the existence of these structural breaks (Gocer and Akin, 2016). Carrion-i-Silvestre et al. (2005), the PANKPSS test is based on the following models:

$$y_{i,t} = \alpha_{i,t} + \beta_{it} t + \varepsilon_{i,t} \tag{7}$$

$$\alpha_{i,t} = \sum_{k=1}^{m} \theta_{i,k} D(T_{b,k}^{i})_t + \sum_{k=1}^{m} \gamma_{i,k} DU_{i,k,t} + \alpha_{i,t-1} + v_{i,t} \tag{8}$$

$v_{i,t}$ denotes zero mean, constant variance error terms series, α denotes constant terms, *t denotes* time trend. $i = 1, \dots, N$ and $t = 1, \dots, T$. $D(T^i_{b,k})_t$ and $DU_{i,k,t}$ are dummy variables and defined below:

$$D(T^i_{b,k})_t = \begin{cases} 1, & t = T^i_{b,k} + 1 \\ 0, & \text{other situations} \end{cases} \tag{9}$$

$$DU_{i,k,t} = \begin{cases} 1, & t > T^i_{b,k} \\ 0, & \text{other situations} \end{cases} \tag{10}$$

$T^i_{b,k}$; *i* refers to the history of structural break of the ith horizontal section. Carrion-i-Silvestre, et al. (2005) hypothesis tests are below:

H_0: *Series are stationary under structural breaks*

H_1: *Series are not stationary under structural breaks*

The PANKPSS multi-structure fractured panel unit root test and the resulting test statistics and critical values are presented in Table 4. At this stage of the work, Gauss 9.0 program and Carrion-i-Silvestre, et al. (2005) have been used.

Table 4: Carrion-i-Silvestre et al. (2005) PANKPSS Panel Unit Root Test Results

Countries	***GDPPC***		***HEXPC***		***ΔGDPPC***	***ΔHEXPC***
	Test Statistics	***Structural Break Dates***	***Test Statistics***	***Structural Break Dates***	***Test Statistics***	***Structural Break Dates***
Australia	0.095 [0.094]	1980; 1987; 1994; 2000; 2005	0.115 [0.091]	1984; 1992; 1998; 2003; 2008	0.033*** [0.069]	0.093*** [0.160]
Austria	0.102 [0.086]	1980; 1988; 1994; 1999; 2005	0.211 [0.142]	1989; 1996; 2002; 2007	0.039*** [0.086]	0.111** [0.116]
Belgium	0.095 [0.089]	1980; 1987; 1993; 1999; 2005	0.109** [0.116]	1981; 1990; 1998; 2002; 2007	0.040*** [0.116]	0.089*** [0.192]
Canada	0.093 [0.083]	1980; 1986; 1993; 1998; 2004	0.122 [0.114]	1981; 1989; 1999; 2004; 2008	0.037*** [0.060]	0.092*** [0.180]
Denmark	0.098 [0.082]	1981; 1988; 1994; 1999; 2005	0.095 [0.173]	1981; 1990; 1998; 2003; 2007	0.040*** [0.081]	0.089*** [0.157]
Finland	0.098 [0.097]	1980; 1987; 1996; 1999; 2005	0.098 [0.128]	1982; 1989; 1999; 2003; 2007	0.036*** [0.063]	0.082*** [0.190]
Germany	0.121 [0.098]	1980; 1988; 1998; 2005; 2009	0.098* [0.127]	1980; 1987; 1994; 2002; 2007	0.024*** [0.065]	0.098*** [0.147]
Iceland	0.116 [0.091]	1979; 1986; 1996; 2003; 2006	0.152 [0.110]	1980; 1986; 1997; 2001	0.046*** [0.065]	0.135*** [0.158]

Table 4 (continued): Carrion-i-Silvestre et al. (2005) PANKPSS Panel Unit Root Test Results

Countries	***GDPPC***		***HEXPC***		***ΔGDPPC***	***ΔHEXPC***
	Test Statistics	***Structural Break Dates***	***Test Statistics***	***Structural Break Dates***	***Test Statistics***	***Structural Break Dates***
Ireland	0.098 [0.091]	1981; 1989; 1996; 2000; 2004	0.217 [0.181]	1989; 1996; 2000; 2003; 2006	0.058*** [0.073]	0.163*** [0.176]
Israel	0.095 [0.086]	1980; 1987; 1993; 1999; 2006	0.086* [0.148]	1979; 1988; 1993; 1999; 2009	0.033*** [0.065]	0.070*** [0.144]
Japan	0.117 [0.083]	1981; 1988; 1995; 2003	0.122 [0.088]	1981; 1991; 1999; 2004; 2009	0.052*** [0.066]	0.146*** [0.187]
Korea	0.131 [0.102]	1986; 1993; 1999; 2003; 2006	0.136 [0.176]	1988; 1995; 2000; 2005; 2009	0.055*** [0.061]	0.165** [0.183]
Holland	0.099 [0.088]	1980; 1988; 1995; 1999; 2005	0.105 [0.255]	1981; 1990; 1999; 2004; 2007	0.043*** [0.082]	0.123** [0.131]
New Zeland	0.100 [0.082]	1980; 1985; 1993; 1999; 2005	0.150 [0.112]	1987; 1994; 2000; 2005; 2008	0.042*** [0.072]	0.140*** [0.162]
Norway	0.120 [0.084]	1983; 1993; 1999; 2005	0.190 [0.138]	1989; 1996; 2001; 2004; 2007	0.020*** [0.080]	0.120** [0.129]
Portugal	0.096 [0.080]	1980; 1988; 1994; 1999; 2005	0.139 [0.094]	1986; 1994; 1999; 2004; 2007	0.060*** [0.079]	0.124*** [0.194]
Spain	0.104 [0.088]	1981; 1988; 1996; 2000; 2005	0.148 [0.145]	1987; 1991; 1997; 2002; 2006	0.074*** [0.082]	0.133*** [0.158]
Switzerland	0.131 [0.070]	1980; 1988; 1999; 2006	0.094* [0.154]	1980; 1988; 1995; 2001; 2007	0.024*** [0.069]	0.094*** [0.163]
England	0.095 [0.090]	1981; 1987; 1995; 1999; 2003	0.122 [0.114]	1982; 1991; 1999; 2002; 2005	0.045*** [0.091]	0.127*** [0.281]
USA	0.093 [0.085]	1980; 1987; 1993; 1998; 2004	0.099 [0.112]	1982; 1989; 1996; 2001; 2006	0.047*** [0.076]	0.099*** [0.193]
Turkey	0.140 [0.107]	1985; 1994; 2003; 2006; 2009	0.150 [0.146]	1989; 1995; 1998; 2003; 2006	0.087*** [0.135]	0.138** [0.144]
Panel	27.94 [10.53]	-	26.27 [17.37]	-	3.79*** [9.64]	20.265*** [24.67]

Note: The figures in parentheses are the critical values produced by 1000 repetitive bootstrap. *, **, and ****; the corresponding series are stable at the level of significance of 10%, 5% and 1%, respectively. In order to reveal the actual structural break dates in the series, only the structural break dates from the test with the level values of the series are taken here.

According to the results in Table 4; it is seen that the series are generally not stationary in level values but become stationary when the first differences are received, that is, they are I (1). In this case, there is a risk of encountering false regression problems in analyzes to be made with the level values of these series. For this reason, the cointegration test has to be performed before the regression analysis. When the structural breakage dates determined by the test method are examined; East and West Germany united as 1989, made from aircraft into the World Trade Organization in the United States September 11, 2001 terror attacks in 2008, the effects of the global economic crisis, the 1994 crisis in terms of Turkey and the effects of single party governmentperiod starting in November 2002 are seen.

4.3. PANEL CAUSALITY TEST

A causality test should be performed to determine whether there is an interaction between the variables used together in the analyzes. Otherwise, the misuse of unrelated variables in regression models comes to the foreground. The main advantages of this method are; (Dumitrescu and Hurlin, 2012). It is also possible to identify cross-sectional dependence among the panellist countries and to identify causality relations between some of the panellist countries. Dumitrescu and Hurlin (2012) panel causality test are performed using the following equations.

$$Y_{i,t} = \alpha_i + \sum_{k=1}^{P} \gamma_i^k Y_{i,t-k} \sum_{k=1}^{P} \beta_i^k X_{i,t-k} + \varepsilon_{i,t} \qquad (11)$$

$$X_{i,t} = \theta_i + \sum_{k=1}^{P} \delta_i^k X_{i,t-k} \sum_{k=1}^{P} \aleph_i^k Y_{i,t-k} + \epsilon_{i,t} \qquad (12)$$

P denotes optimum delay length. Hypothesis of these tests;

$H_0: \beta_i = 0$ For all i values

$$H_1: \begin{cases} \beta_i = 0, & i = 1, 2, \ldots, N_1 \\ \beta_i \neq 0, & i = N_1 + 1,\ N_1 + 2, \ldots, N \end{cases}$$

In the study Dumitrescu and Hurlin (2012) panel causality test were conducted and the obtained results are presented in Table 5. This analysis was performed using the Eviews 9.0 program.

Table 5: Dumitrescu and Hurlin (2012) Panel Causality Test Results

	***W* Statistics**	**$\bar{Z}$ Statistics**	***Probability Value***
GDPPC ↛ HEXPC	19.75***	20.25***	0.00
HEXPC ↛ GDPPC	11.19***	9.00***	0.00

Note: ***; At the level of significance of 1%, the existence of causality relation is expressed.

According to the results in Table 5; the hypothesis was strongly rejected because the probability values were smaller than 0.01 and it was decided that there was a two-way causality relationship between per capita health expenditure and per capita national income. So, these two variables affect one, and it would be sensible to use them together in the same regression. In addition, moving from this result, it is estimated that the health expenditure per capita increases the national income by affecting the health and productivity of the workforce positively in accordance with the Effective Wage Theory (Yıldırım, Karaman and Taşdemir, 2009) and on the other hand the increased national income increases the amount of resources allocated to health expenditures.

4.4. STRUCTURED FRACTURED PANEL COINTEGRATION TEST

In this study, the existence of a cointegration relationship between the series was tested by the method developed by Basher and Westerlund (2009). This test; besides to considering horizontal section dependence, it also permits structural fracture up to five in the cointegration equation and can internally determine the structural fracture histories. Another advantage of the test method is that it can take into account the presence of structural breaks in the fixed term and / or trend separately. In this respect, the panel is superior to the cointegration tests. The test statistic developed by Basher and Westerlund (2009: 508) is below

$$Z(M) = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{M_i+1}\sum_{t=T_{ij-1}+1}^{T_{ij}} \frac{S_{it}^2}{(T_{ij}-T_{ij-1})^2\hat{\sigma}_i^2} \qquad (13)$$

$S_{it} = \sum_{s=T_{ij-1}+1}^{t} \hat{W}_{st}$. $\hat{W}_{it}$; is a vector of error terms obtained from an efficient estimator of the type of fully modified least squares. When Z (M) is regulated it becomes:

$$Z(M) = \sum_{t=T_{ij-1}+1}^{T_{ij}} \frac{S_{it}^2}{(T_{ij}-T_{ij-1})^2\hat{\sigma}_i^2} \sim N(0,1) \qquad (14)$$

Test's hypothesis:

H_0: *The series are co-integrated under structural breaks*

H_0: H_1: *The series are not co-integrated under structural breaks*

In the study Basher and Westerlund (2009) cointegration test was conducted and the results are presented in Table 6. At this stage of the work, the Gauss 9.0 program and the codes written by Basher and Westerlund (2009) are used for this program.

Table 6: Basher and Westerlund (2009) Panel Cointegration Test Results

	Test Statistics	***Probability value***
Non-Breaking and Trendless Model in Fixed Terms	3.827***	0.288
Unbreakable and Trendy Model in Fixed Terms	7.626	0.043
Fixed Term Break Model	3.827***	0.328
Constant Term and Trend Break Model	7.626***	0.300

Note: Probability values in parentheses are obtained with 1000 repetitive bootstrap. ***; It is stated that there is cointegration at the level of 1% significance.

When the results in Table 6 are examined, it is seen that there is a cointegration relation between the series. While no cointegration relationship was found in one of the tests that did not take structural breaks into account, the cointegration relation was determined in the tests considering structural breaks. This situation; once again reveals the superiority of structural fracture cointegration tests. Because of the cointegration relationship between the series, it has been decided that the series act together in the long run, that the long term analyzes to be made with the level values will not contain false regression problems and that the results to be obtained are reliable. Interestingly, no structural fracture occurred in this test. The test was repeated with different break numbers and different bootstrap cycles, but no structural break date was detected. It is useful to test whether the cointegration coefficients to be estimated are homogeneous without going through the regression analysis.

4.4. TESTING HOMOGENEITY OF COINTEGRATION COEFFICIENTS

Pesaran and Yamagata (2008) have developed the Swamy test, starting with Swamy (1970), to determine whether the slope coefficient is homogeneous in the regression model. In this test, it is tested whether the slope coefficients in the cointegration equation are the same for different countries. In other words;

$$Y_{it} = \alpha + \beta_i X_{it} + \varepsilon_{it} \qquad (15)$$

In this cointegration equation, if the β_i the slope coefficients are differentiated between horizontal sections are tested. Test hypotheses:

$H_0: \beta_i = \beta$ slope coefficients are homogeneous

$H_1: \beta_i \neq \beta$ slope coefficients are not homogeneous

Pesaran and Yamagata (2008), developed test statistics $\tilde{\Delta}$ for large samples and $\tilde{\Delta}_{adj}$ for little samples to test these hypothesis

$$\tilde{\Delta}= \sqrt{N}\left(\frac{N^{-1}S-k}{2k}\right)\sim\chi^2_k \quad (16)$$

$$\tilde{\Delta}_{adj}= \sqrt{N}\left(\frac{N^{-1}S-k}{v(T,k)}\right)\sim N(0,1) \quad (17)$$

At these statistics N; the number of horizontal cross-sections, S; Swamy test statistics, k; number of explanatory variables, ; standard error, ; the corresponding test statistic has a degree of freedom chi-square distribution, ; 0 means that the mean of the relevant test statistic has a constant normal distribution of variance. Pesaran and Yamagata (2008) were tested in order to examine whether the slope coefficient for equation (1) is homogeneous and the results obtained are presented in Table 7. At this stage of the work, the Gauss 9.0 program and codes written by Pesaran and Yamagata (2008) were used for this program.

4.4.8. ESTIMATION OF PANEL COINTEGRATION COEFFICIENTS

Regression analysis between stationary series in level values in panel data analysis; regression analysis between the series with non-stationary but cointegration relation at the level can be performed by using the Fully Modified Ordinary Least Squares (FMOLS) or Dynamic OLS (DOLS: DOLS) method, while the pooled least squares method can be performed with the random effects model or the fixed effect model.) methods. However, the FMOLS or DOLS methods do not consider the horizontal cross-section dependency of the model. For this reason, while estimating cointegration coefficients in panes with horizontal section dependency,

Pesaran obtained a simple arithmetic average of the cointegration coefficients obtained for countries using the CCE (Common Correlated Estimator) method when calculating the CCMGE(Common Correlated Mean Group Estimator) value of the panel as a whole. This method gives misleading results because it gives equal weight to each country in analysis. Eberhardt and Bond (2009) solved this problem by weighting individual results using variances, and developed the Panel Augmented Mean Group Estimator (AMG) method. The panel AMG method also includes; can take into account common factors in the series, produce effective results in unstable panellists, and can be used in the presence of the problem of internalisability (Eberhardt and Bond, 2009: 4). In addition, AMG produces robust estimates of autocorrelation and variance problems. In all these aspects, AMG is a stronger and more consistent predictor than other methods.

Table 8: Dynamic Panel Data Analysis Results

Variables	**Pooled LSM**	**Fixed Effect LSM**	**Differnece-2 GMM**	**System-2 GMM**
Gsh(-1)	0.212* (10.52) [0.000]	0.213* (7.13) [0.000]	0.288* (10.14) [0.000]	0.224* (4.62) [0.000]
HE	0.286* (4.28) [0.822]	0.173* (6.48) [0.955]	0.224* (8.88) [0.539]	0.210* (8.56) [0.001]
TVF	0.335* (5.66) [0.579]	0.322* (10.17) [0.299]	0.456* (5.48) [0.269]	0.271* (4.61) [0.077]
DEM	0.123* (6.63) [0.889]	0.085*** (1.18) [0.857]	0.182* (3.46) [0.542]	0.262** (3.21) [0.427]
Constant	14.436* (6.03)	12.536* (2.65)	11.365* (3.17)	14.305* (3.73)
Wald (χ2)	3688.92 [0.000]	8098.02 [0.000]	3992.27 [0.000]	1376.45 [0.000]
Sargan (χ2)	19.795 [0.833]	18.003 [0.905]	20.917 [0.794]	19.564 [0.848]
AR (1)	-3.339 [0.000]	-3.199 [0.001]	-3.305 [0.001]	-3.285 [0.001]
AR (2)	1.622 [0.102]	1.513 [0.125]	1.647 [0.100]	1.572 [0.115]
Hansen Test			9.12 [0.764]	6.18 [0.905]
Fark Hansen			0.19 [0.996]	1.35 [0.241]
R^2	0.94	0.98		
Country Number	23	23	23	23
Observation Number	690	690	690	690
Instrumental variable number			16	15

Note: () are t values, [] are standard deviation

Two-stage GMM models are preferred to correct the heteroscedasticity and autocorrelation problems of single-stage GMM estimators (Tatoğlu, 2018: 134). The difference GMM estimation results are shown in column 3 of the table. The autoregressive coefficient, which was not within the lower and upper limits shown in the 1st and 2nd columns, was found to be statistically significant at the 1% level. Other variables were not found to be statistically significant. In the 4th column, two-stage system GMM results are seen and the validity and significance of the Wald test statistic and the system GMM method were questioned. Sargan and Hansen test statistics are whether the instrument variables are valid; With AR (1) and AR (2) tests, it was questioned whether there was a first and second order autocorrelation in the model. The model was found to be statistically significant at the 1% level according to the Wald test statistic. There is no first-order or second-order autocorrelation problem in the model. It has been determined that the instrumental variables used in the Sargan and Hansen test are also valid. The difference Hansen test also showed that there was no internality problem. Therefore, the necessary assumptions are provided to use the system GMM. When the coefficients estimated using the system GMM are examined, it is seen that the most important factor of economic growth is total factor productivity. When the ratio of health expenditures to national income increases by 1%, the economic growth rate increases by % 0.286. This is in line with the Keynesian view in the literature and the endogenous economic growth model based on human capital. The effect of democracy index on economic growth remained as the lowest factor with 0.123.

5. ANALYSIS OF PANEL DATA USING THE NONLINEAR LEAST SQUARES METHOD USING THE GAUSS-NEWTON ALGORITHM (ITERATIVE SIMULATION) WITH THE CONVERGENCE HYPOTHESIS APPROACH

According to convergence hypothesis approach, undeveloped countries will have a higher growth rate, while developed countries will have a lower growth rate.

By using Cobb Douglas function, it is derived:

$$Ait / A_{it} = Yit^{\beta 1} HER^{\o}_{wit} A_{it}^{\o -1} - y \qquad \textbf{(2)}$$

then;

$$\ln yt=[\ln k(0)-\ln kg]-\beta 1(\Omega k+(n+\delta))e-\beta t+\ln Ag+([\ln y(0)-\{[\ln k(0)-\ln kg]-\beta 1(\Omega k+(n+\delta))+\ln Ag\}- \ln yg+\ln Ag]e-\beta t+\ln yg-\ln Ag)$$

then,

$$(\ln k/\ln A)=(\ln k(t)-\ln kg)e\lambda 1t(1(1-\alpha))+(\ln k(0)-\ln kg)e\lambda 2t(1-\beta 1(\Omega k+(n+\delta)))+(\ln kg\ln Ag)$$

$$Lny_{it} = (1 - e^{-\beta t})\ \alpha\ (1 - \theta)\ Lns_{it} + (1 - e^{-\beta t})\ \beta 1\ LnL_{it} + (1 - e^{-\beta t})\ \emptyset\ Ln\mathrm{HE}_{it} + (1 - e^{-\beta t})\ Ln\ (\gamma + (1 - \alpha)\ \beta 1 n_{it}) + (1 - e^{-\beta t})\ \alpha\ (1 - \theta)\ Ln\ [\delta + (1 - \alpha)\ (1 - \theta)\ nit + e^{-\beta t} Lny_{t-1} + \mu_{it} \qquad \textbf{(3)}$$

This is the reverse of the neoclassical approach, that is, output per worker is now proportional to Health Expenditure Labor Level and savings rate.

The higher the productivity of labor in economically free countries, the greater the positive effect of income savings per worker around balanced growth path values.

The results of the Pearson correlation matrix between the variables used in the analysis are below.

Table 6: Pearson Correlation Matrix

	HER	s	n
L	0.506	-0.121	-0.088
HER		-0.090	-0.262
s			0.082

When the correlation coefficients were examined, there was a positive and moderate (r=-0.121) negative and low-level, negative and low-level (r=-0.088) negative-oriented low-level relationship between the L variable and the HC, s and n variables, respectively. In addition, it is seen that there is a negative and low-level relationship (r=-0.090), (r=-0.262) between the HC variable and the s and n variables, respectively. Another finding is that there is a positive low-level relationship between the s variable and the n variable (r=0.082).

In general, no high level of negative or positive correlation was found. The nonlinear least squares estimation results of the dynamic econometric model are below.

Table 7: Nonlinear Least Squares Estimation Results

Parameter	Beta	SD	t	p
β	0.152	0.027	7.550***	**<0.001**
α	-10.342	11.270	-0.364	0.322
θ	1.047	0.022	37.023***	**<0.001**
β1	-0.053	0.019	-1.566	0.110
Ø	1.417	0.189	9.215***	**<0.001**

The coefficient of the θ parameter was found to be positive and statistically significant ($p<0.05$). In the light of this finding, when the productivity of the new technology stock increases by 1%, the per capita income increases by 1.047%.

The ratio (Ø) coefficient of per capita health expenditures to national income is positive and statistically significant ($p<0.05$). According to this finding, when the ratio of health expenditures per capita to national income increases by 1%, per capita income increases by 1.417 %.

The labor (β1) coefficient was negative and not statistically significant ($p>0.05$).

For the coefficient of convergence (β), the model converged at the point where the β coefficient was the smallest as a result of 5000 iterations with the NLS technique.

The coefficient of convergence is the initial value of the capital stock, which decreases exponentially at the rate β >0, with the weight of the capital value per worker and the weighted average of the initial and balanced growth path values. This ratio indicates that it converges to the balanced growth of physical productivity. It is seen that these coefficient results are statistically significant and the coefficient is low (0.152 per year, $p<0.05$). In light of this finding, GDP per capita growth for 23 countries is slow and will be effective in the long run. Life on a logarithmic scale of output per half worker is approximately;

Ln (2)/0.152 = 4,56 years

In other words, it takes 4,56 years to close half of the gap between countries' per capita income.

CONCLUSION

Based on the findings of the study; it can be said that countries that want to increase their per capita national income should increase their per capita health spending while doing so by calculating the optimum amount of health spending.

By dynamic panel data analysis, the relationship between health expenditures and democracy index and economic growth in the 1990-2021 period in 23 OECD countries was investigated with the system GMM technique, which has an important place in dynamic panel data methodology.

The results of the study determined the existence of a positive relationship between health expenditures, physical capital stock, total factor productivity and democracy index and GSH.

According to the panel Granger causality results, health expenditures, capital stock and total factor productivity are the Granger causes of GSH. No causality could be detected from democracy to GDP.

These results prove that health expenditures and democracy index are among the determinants of GDP in OECD countries in the long run.

In addition, the factors affecting economic growth have been sorted for OECD countries in a sense and it has been determined that total factor productivity, physical capital stock, health expenditures and democracy index increase the economic growth rate, respectively. In fact, it takes 4,56 years to close half of the gap between countries' per capita income.

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