Scientific Journal of Finance and Financial Law Studies

RESEARCH ARTICLE

e-ISSN : 2822- 3179
2025, Vol. 5 (1), 14 - 27
Date Submitted : 18.02.2025
Date Revised : 23.02.2025
Date Accepted : 25.02.2025

The Relationship Between Economic Growth, Health Expenditure and Environmental Pollution: The Case of G8 Countries

Esra CEBECİ MAZLUM *(ORCID: 0000-0001-5563-0681), Dr. Öğr. Üyesi,*
Selçuk Üniversitesi, ***Silifke-Taşucu Meslek Yüksekokulu***
Dış Ticaret, Mersin, Türkiye; esracebeci@selcuk.edu.tr

Ekonomik Büyüme, Sağlık Harcaması ve Çevre Kirliliği İlişkisi: G8 Ülkeleri Örneği

Özet

Sağlık, beşeri sermayenin kalitesinin belirlenmesinde rol oynamaktadır. Toplumların gelişmişlik düzeyleri ile sağlık göstergeleri arasında yakın bir ilişki vardır. Çevre kirliliğinin insan sağlığı üzerinde pek çok etkisi vardır. Ülkelerin sürdürülebilir kalkınma amaçları çerçevesinde sağlık, ekonomik büyüme ve çevre konuları giderek önem kazanmıştır. G8 ülkeleri dünya ekonomisinde önemli rol oynamaktadır. G8 ülkelerinin gelişmiş ülke ekonomileri arasında olması nedeniyle sağlık harcamaları diğer ülkelere kıyasla öncü rol olabilmesine imkan sağlamaktadır. Bu çalışmada 2000 ile 2020 tarihlerinde sağlık harcamaları, çevre kirliliği ve ekonomik büyüme ilişkisi G8 ülkeleri (Fransa, Almanya, İtalya, Japonya, İngiltere, Amerika, Kanada, Rusya) özelinde incelenmiştir. Bu ilişkinin tespitinde panel veri analizi uygulanmıştır. Değişkenler arasındaki ilişkinin tespitinde nedensellik analizi sonuçları sağlık harcaması ile ekonomik büyüme arasında ve sağlık harcaması ile çevre kirliliği arasında karşılıklı nedensellik ilişkisi olduğunu göstermektedir.

Anahtar Kelimeler: Sağlık harcamaları, ekonomik büyüme, çevre kirliliği
JEL Kodları: I15, O40, Q50.

Abstract

Health plays a role in determining the quality of human capital. There is a close relationship between the development levels of societies and health indicators. Environmental pollution has many effects on human health. Within the framework of sustainable development goals of countries, health, economic growth and environmental issues have become increasingly important. G8 countries play an important role in the world economy. Since G8 countries are among the developed economies, health expenditures allow them to play a leading role compared to other countries. In this study, the relationship between health expenditures, environmental pollution and economic growth between 2000 and 2020 was examined for G8 countries (France, Germany, Italy, Japan, England, America, Canada, Russia). Panel data analysis was applied to determine this relationship. In determining the relationship between variables, the results of causality analysis show that there is a mutual causality relationship between health expenditure and economic growth and between health expenditure and environmental pollution.

Keywords: Health expenditures, economic growth, environmental pollution
JEL Codes: I15, O40, Q50.

Introduction

The relationship between health expenditure, the environment and economic growth is multifaceted. A healthy population can stimulate economic growth. On the other hand, environmental pollution negatively affects human health, and environmentally friendly health practices can enable the reduction of health expenditures. Additionally, environmental pollution can negatively affect economic growth.

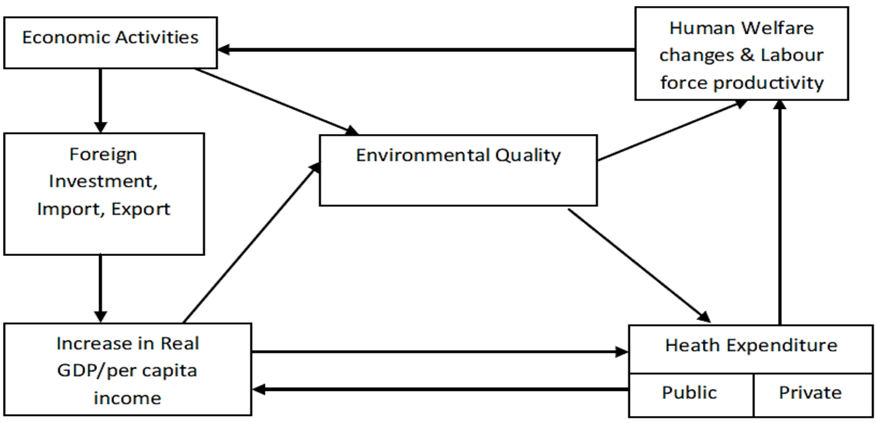
Health expenditures are an important element in the development and protection of human capital, one of the dynamics of economic growth. It is thought that healthy individuals have a high production contribution and will facilitate the economic growth process through increased income (Yaburgan and Kostekci, 2022: 109). Health expenditures, which vary from country to country, are basically capital expenditures. It develops in parallel with the social demands of large segments of society with its accumulation dynamics. Health expenditures, which are examined in the economic literature, especially within the growth theory, are the subject of many studies in terms of their relationship with labor productivity and economic growth (Celik, 2020: 4).

Environmental pollution can be expressed as the deterioration of ecological balance as a result of human activities and the accumulation of certain substances in some layers of the earth. As a matter of fact, people's aim is not to pollute the environment or disrupt the ecological balance; However, it is inevitable that the world balance will be disrupted as a result of human effects such as excessive production and consumption. (Akdur, 2005:13).

Increasing environmental pollution is one of the important factors affecting the increase in health expenditures. The increase in carbon dioxide emissions and other harmful gases in the atmosphere can have negative effects on environmental pollution and public health. Direct exposure to environmental pollution can harm individuals' health, increase mortality rates, impair people's quality of life, and therefore lead to increased health expenditures (Karasoy and Demirtas, 2018: 1921).

Graph 1 presents the conceptual framework of health expenditure and environmental pollution. The graph shows that the increase in health expenditures is due to environmental pollution. It also shows the increase in income as a result of economic activities, driven by unlimited sources of foreign investment and earnings from exports rather than imports. One of the problems that arise as a result of income generation is environmental degradation caused by the production of toxic substances and chemicals and greenhouse gas (GHG) emissions from industrial facilities. The impact of all these environmental pollutions on public health can be severe, acute and chronic (Elimi et al., 2020: 5108).

Graph 1. Healthcare expenditure and environmental quality nexus



Source: Elimi et al. (2020): 5108.

There is very limited research in the literature on the relationship between health expenditures, economic growth and environmental pollution. This subject attracted the interest of researchers. Current study examples from literature are concentrated on. These studies in the literature appear to have been applied to different periods, different methods and different countries and country groups.

Many studies have followed the pioneering work of Mushkin (1962), who explained that health expenditures are an important source of economic growth and that their role in promoting economic growth is important. Grossman (1972) explained that health capital, expressed as a durable capital stock, is different from other forms of human capital and that the demand for medical care should be more basic for good health. Grossman stated that if an education that increases its effectiveness with investments in health is provided, the more educated will demand a wider optimal health stock, and that there is a negative correlation between medical expenditures and education.

With regard to OECD countries, Govdeli (2019) examined health expenditures, economic growth and carbon dioxide (CO_2) emissions and applied panel cointegration and causality analysis to determine the relationship between these variables. According to the results of Granger causality analysis, economic growth is the cause of health expenditures, CO_2 emissions are the cause of health expenditures, and economic growth is the cause of CO_2 emissions. Wang et al. (2019) applied the bootstrap autoregressive distributed lag cointegration model to investigate the long-term relationship between health expenditures, CO_2 emissions and gross domestic product per capita. According to the findings, there is a short-term relationship between the three variables. It was determined that there is a bidirectional causality between health expenditures and GDP growth for Germany and the United States, between CO_2 emissions and GDP growth for Canada, Germany and the United States, and between health expenditures and CO_2 emissions for New Zealand and Norway. In another study, Sahin and Durmus (2019) found a one-way causality relationship from CO_2 emissions to health expenditures in Finland, Spain, Sweden, Portugal and Greece. It has been observed that there is a causality relationship from economic growth to health expenditures in Finland, Sweden, Switzerland, Italy, the Netherlands, Poland, Greece, Australia, Spain, Canada and Norway.

Chaabouni and Saidi (2017) examined the relationship between CO_2 emissions, health spending and GDP growth for 51 countries over the period 1995-2013 using dynamic simultaneous-equations models and generalized method of moments (GMM) in their study. There is a bidirectional causality between CO_2 emissions and GDP per capita, between health spending and economic growth for the three groups of estimates. Additionally, there is unidirectional causality from CO_2 emissions to health spending, except low-income group countries.

Ghorashi and Rod (2017) investigate the relationship between the environment, health expenditures and economic growth. In this work, dynamic simultaneous equation models are used for Iran from 1972-2012. The findings demonstrate there is a bidirectional relationship of causality between CO_2 emissions and economic growth. There is also a unidirectional relationship of causality from health expenditures to economic growth.

Khosnevis Yazdi and Khanalizadeh (2017) analyze the linkage among air pollution, economic growth and health care expenditure in the Middle East and North Africa region (MENA) countries for the period 1995-2014 using autoregressive distribute lag method. As a result of the work, health expenditure, income, CO_2 and PM_{10} emissions are a cointegrated panel. In addition, long-run elasticities show that income and CO_2 and PM_{10} emissions have statistically significant positive effects on health expenditures.

Zaidi and Saidi (2018) studied the health expenditure, environmental pollution and economic growth in the Sub-Saharan African countries using data from 1990 to 2015. The ARDL results showed that economic growth has a positive impact on the health expenditure while emissions and NOE (nitrous oxide emissions) have negative impact on the health expenditure (HE) in the long run. The results show that a 1% increase in per capita GDP will lead to a 0.332% increase in health expenditure, but an increase in CO_2 emissions and NOE of 1% will decrease the HE by 0.066% and 0.577%, respectively. In a study carried out on 47 African Ibukun and Osinubi (2020) investigated the relationship among environmental quality, economic growth and health expenditure using both static and dynamic estimation methods on data covering the period from 2000 to 2018. According to the study results, economic growth has a positive and significant effect on health expenditures. Additionally, a significant positive relationship was found between environmental quality and health expenditures.

Atuahene et al. (2020) focused on the period of 1960-2019 on China and India countries using a dynamic panel data model estimated employing GMM. A significant positive impact of CO_2 emissions on health expenditure while economic growth has a negative impact on health expenditure for both countries for the period under study. The population growth rate has transposed effect on India's health spending; on the other hand, its impact on China's health spending is significantly positive.

Zeeshan et al. (2021) explained the household health expenditure, CO_2 emissions and environmental pollution in China for the period 1990 to 2019 by applying the nonlinear autoregressive distributed lag and Granger causality. The results demonstrated that in the short-run and long-run positive shocks of CO_2 emissions and environmental pollution positively affecting health expenditure, while negative shocks reduce health spendings. Also, there is bi-directional causality among household spendings, CO_2 emissions and environmental pollution.

Bilgili et al. (2021) period of the study covers the years 1991-2017 for 36 Asian countries. FMOLS, GMM and quantile regression analysis confirm the EKC hypothesis in Asia. FMOLS and quantile regressions have reached the reducing effects of government and private health expenditures on CO_2 emissions. Findings of quantile regression show a significant impact of both public and private health expenditures in reducing CO_2 at the 50th and 75th quantiles but results are insignificant for the 25th quantile.

Sancar and Atay-Polat (2021) analyzed the data of Türkiye, Brazil, Mexico, China, India and South Africa for the period 2000-2016. According to the analysis results, a bidirectional causality relationship was found between health expenditures and economic growth, a bidirectional causality relationship between health expenditures and CO_2 emissions, and a bidirectional causality relationship between economic growth and CO_2 emissions.

Boztosun and Adlı (2022) examined the effects of environmental pollution and economic growth on health expenditures in Turkey for the period 2000-2018. According to the results of long-term parameter estimation, in the model in which health expenditures are dependent, a 1% increase in economic growth increases health expenditures by 1.355%. A 1% change in CO_2 emissions causes a 3.598% decrease in health expenditures. According to the CUSUM test, the coefficients do not contain structural breaks. In another study conducted specifically in Türkiye Atay Polat and Ergun (2018) analyzed the period 1980-2016, used the Zivot-Andrews test with additional structural breaks, the Gregory-Hansen cointegration test and the Toda-Yamamoto test. Their findings showed that there is no long-run relationship between health expenditures, economic growth and CO_2 emissions. The results also include a one-way causality relationship from health expenditures to economic growth and CO_2 emissions and from economic growth to CO_2 emissions.

In the literature, there is no consensus expressed in the studies explaining the relationship between the variables. As a summary of this section, it can be stated that most studies cover multi-country analyses and apply panel data methods.

The contribution of the study to the literature is to examine the subject with up-to-date data, especially for G8 countries. G8 countries have a significant share in the world economy and the fact that no studies have been found in this country group in the literature has encouraged studies on this subject. The reason why the data range was chosen as 2000-2020 was that data other than economic growth could be found for these dates. The remaining sections are presented focusing on areas such as economic growth, health sector development and environmental indicators in G8 Countries and the literature review is made in Section 2. Section 3 presents the findings. Section 4 provides the conclusions.

2. Health Sector Development, Environmental Indicators and Economic Growth in G8 Countries

The second part of research has focused on the economic growth, health sector development and environmental indicators in G8 countries.

2.1. Health Sector Development in G8 Countries

A number of indicators are used to determine the levels of countries in the health sector. These indicators can be used to interpret the health services of countries. In this section, where health indicators in G8 countries are discussed, data on sociodemographic indicators and health indicators of the countries are presented.

According to the data obtained from the World Bank, in our research, the country with the highest population growth rate among the G8 countries in 2022 is Germany (0.72 %) and the country with the lowest is Japan (-0.44 %). When we evaluate the G8 countries according to age groups in 2022; when we examine the population of the 0-14 age group, the G8 country with the lowest share in the total population is Japan with 11%. The share of the 0-14 age group in the total population is around 17 % in France, England, America and Russia, while this rate is 13.9 % in Germany and 15.5 % in Canada. The country with the highest share of the 15-64 age group in the total population is Russia (66.4 %) and the country with the lowest is Japan (58.4 %). It is observed that the share of the population aged 65 and above in the total population is around 61 % in all G8 countries.

Table 1. Socio Demographic Indicators of G8 Countries (2022)

Variables	France	Germany	Italy	Japan	United Kingdom	USA	Canada	Russian Federation
Population growth rate (Annual %)	0,305015	0,720875	-0,32649	-0,44385	-0,08194	0,377565	1,82337	0,07383
Population ages 0-14 (% of total population)	17,199	13,95818	12,43025	11,62273	17,46672	17,95944	15,57709	17,70425
Population ages 15-64 (% of total population)	61,14258	63,6286	63,51617	58,45271	63,3634	64,91244	65,38859	66,49782
Population ages 65 and above (% of total population)	61,14258	61,14258	61,14258	61,14258	61,14258	61,14258	61,14258	61,14258

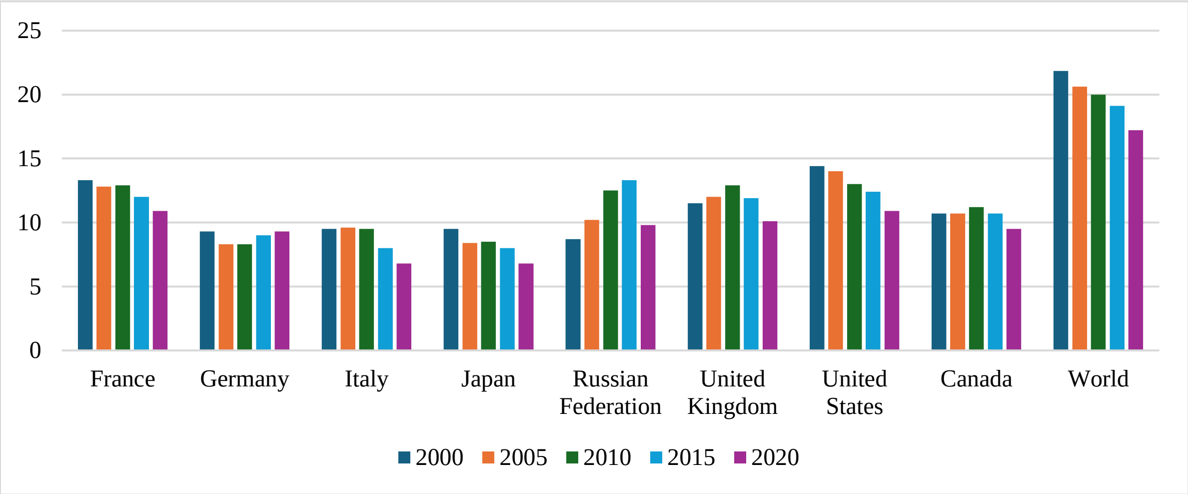
Source: World Bank

Crude birth rate is the number of live births occurring in a population in a given year, expressed as a ratio to the total population in the mid-term of the same year, usually multiplied by 1,000 (WHO, 2024). Graph 2 shows the crude birth rate for G8 countries and the world for 2000, 2005, 2010, 2015 and 2020 years. In Graph 2, 2000 up to 2020, the down-surging trend in crude birth rate in the World is seen. Among the G8 countries, the highest crude birth rate in 2000 was in the United States (14.4). This country is followed by France (13.3), England (11.5), and Canada (10.7). In addition, crude birth rates in Germany, Italy, Canada, and Japan were around 8-9.

Graph 3 presents crude death rate (per thousand) in G8 countries and World for 2000-2020 years. According to data from the World Bank, the crude death rate in 2000 was higher in the G8 countries (except Japan and Canada) than in the world. The crude death rate in the world in 2000 was 8.4. In the 2000-2022 period, Russia is the country with a crude death rate well above the world rate among the G8 countries. The crude death rate in the G8 countries in 2022 is as follows: France (9.9), Germany (11.9), Italy (12.5), Japan (11.1), Russia (14.4), England (10.1), America (10.3), Canada (8.1).

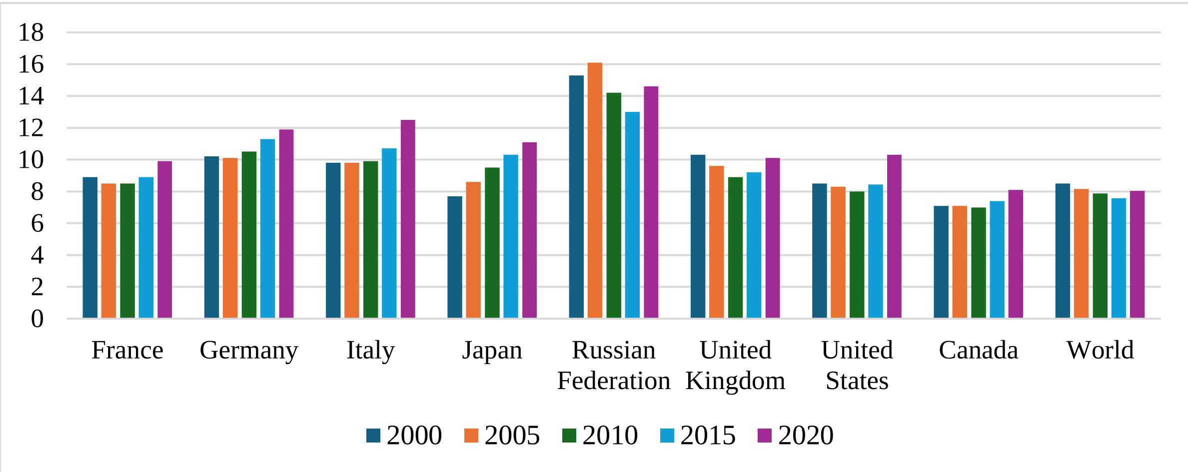
Infant mortality rates express the number of babies who do not survive to the age of one per thousand births (Mwale, 2004, p. 123). Graph 4 shows the infant mortality rates per 1000 births. We see that the infant mortality rate has decreased in all G8 countries and in the world in the period 2000-2022. The infant mortality rate in the world was well above the G8 countries. While 53 out of every 1000 live infants died in G8 countries in 2000, this figure decreased to 28 in 2020. The country with the highest infant mortality rate in G8 countries in 2000 was Russia, where 15 out of every 1000 live infants died.

Graph 2. Crude Birth Rate (Per Thousand) in G8 Countries and the World



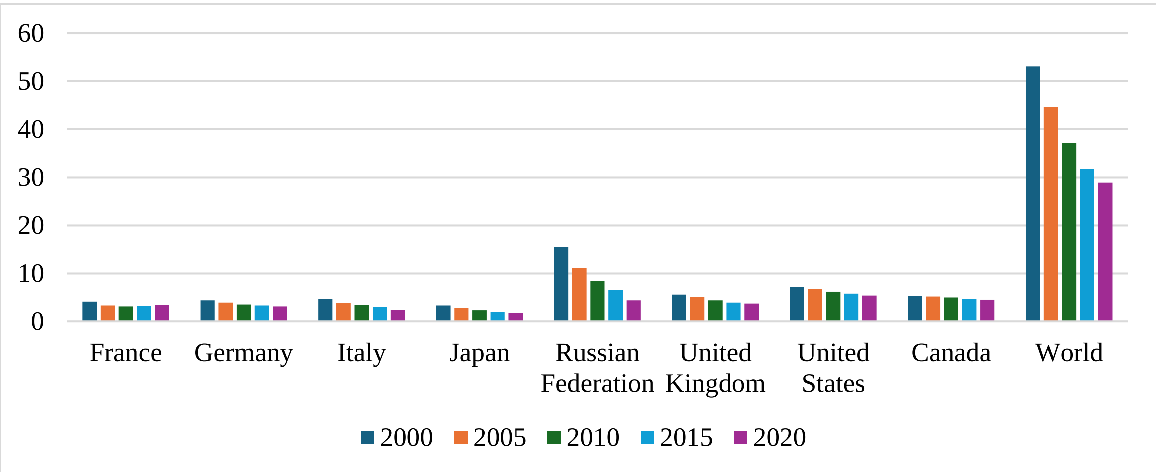
Source: World Bank

Graph 3. Crude Death Rate in G8 Countries and the World (Per Thousand)



Source: World Bank

Graph 4. Mortality Rate, Infant in G8 Countries and the World (Per Thousand)



Source: World Bank

Life expectancy at birth refers to the average number of years a person born in a certain year will live (Chang et al., 2011). Life expectancy at birth provides an idea about the development of the health systems and welfare levels of countries. This indicator is considered as an important indicator of health and welfare (Coban, 2020, p. 1396). When we examine Table 2, life expectancy at birth in the world was 67 years in 2000 and increased to 72 years in 2020. In the G8 countries, the country with the lowest life expectancy at birth in the years 2000-2022 is Russia (65 years) and the country with the highest is Japan (81 years). We can say that life expectancy at birth increased in years in all G8 countries.

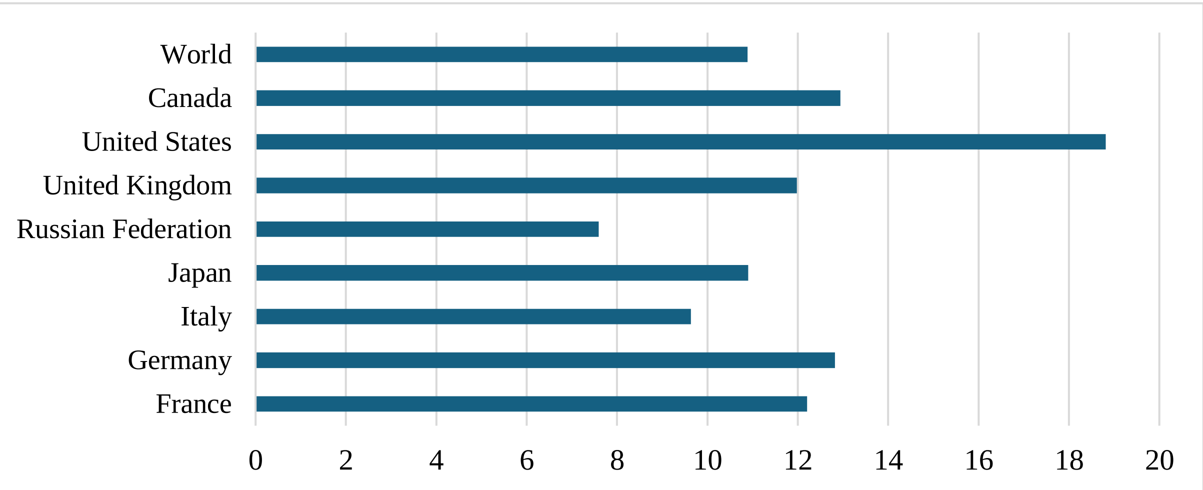
Table 2. Life Expectancy at Birth, total (years) in G8 Countries and the World

Years/ Countries	France	Germany	Italy	Japan	Russian Federation	United Kingdom	United States	Canada	World
2000	79,0561	77,92683	79,77805	81,0761	65,48365854	77,74146341	76,63658537	79,16683	67,7004
2005	80,16341	78,93171	80,78293	81,95512	65,5297561	79,04878049	77,48780488	80,11268	69,19874
2010	81,66341	79,9878	82,03659	82,84268	68,84121951	80,40243902	78,54146341	81,3222	70,6712
2015	82,32195	80,64146	82,5439	83,7939	71,18341463	80,95609756	78,6902439	81,81561	72,09434
2020	82,17561	81,04146	82,19512	84,56	71,33878049	80,35121951	76,9804878	81,67049	72,24347

Source: World Bank

Today, governments are giving more importance to health expenditures. Health expenditures play an important role in ensuring economic development and vary according to the development levels of countries. Especially in developed countries, the share allocated to health expenditures is higher compared to developing countries (Akar, 2014, p. 311). Figure 5 shows health expenditures in G8 countries, and the world based on data obtained from the World Bank. Accordingly, the country with the highest share of health expenditures in GDP is the United States with 18%. The countries following the United States are Canada (12.9%), Germany (12.8%), France (12.2%), England (11.9%), Japan (10.9%), Italy (9.6%), and Russia (7.5%). The rate of health expenditures in the world in GDP is 10.8%. The countries whose health expenditures in G8 countries are below the world health expenditures are Italy and Russia.

Graph 5. Current health expenditure in G8 Countries and the World (% of GDP) (2020)

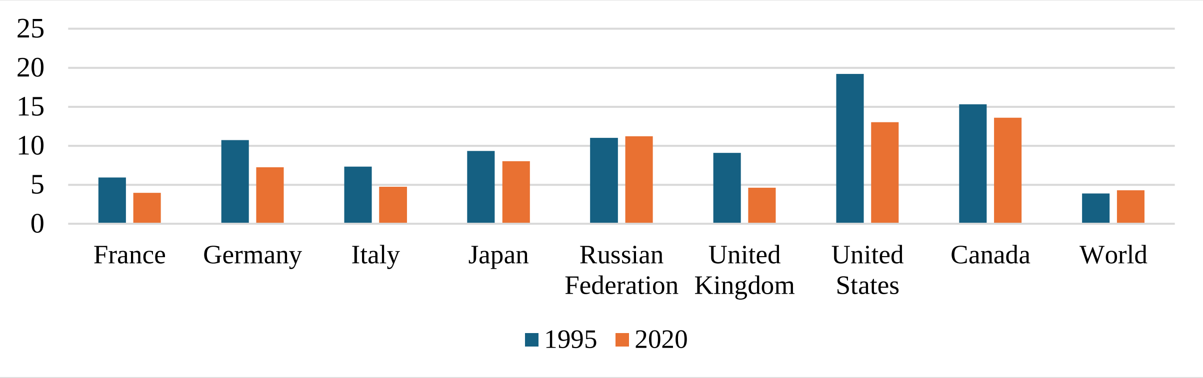


Source: World Bank

2.2. Environmental Indicators in G8 Countries

In the graph 6, carbon dioxide emission data of G8 Countries and the World between 1995 and 2020 are shown in the light of data obtained from the World Bank. Carbon dioxide emissions in G8 countries exceeded world data. Among the G8 countries, the country with the highest CO_2 emissions in 1995 was America (19.2) and the country with the lowest CO_2 emissions was France (5.9). In 2020, the country with the highest CO2 emissions was Canada (13.5) and the country with the lowest CO_2 emissions was France (3.9). In G8 countries, except Russia, there was a decrease in CO_2 emissions from 1995 to 2020.

Graph 6. CO_2 Emissions in G8 Countries and the World (metric tons per capita)



Source: World Bank

2.3. Economic Growth Outlook in G8 Countries

Although more than three years have passed since the global economy experienced the biggest shock of the last 75 years, the wounds are still healing in an environment where inter-regional growth differences are increasing. After a strong initial recovery from the depths of the COVID-19 pandemic, the pace of recovery has slowed (IMF, 2023, p. 1). One of the important indicators of social welfare is high GDP per capita. GDP per capita figures for G8 countries are shown in Table 3. In 1995, the country with the lowest GDP per capita among the G8 countries was Russia, and the country with the highest was Japan. By 2022, Russia will once again be the country with the lowest GDP per capita among the G8 countries, while the country with the highest will be America.

Table 3. GDP per capita in G8 Countries (1995-2022, current US $)

Countries/ Years	1995	2000	2005	2010	2015	2022
France	26889,43	22416,43	34768,18	40676,06	36652,92	40886,25
Germany	31658,35	23694,76	34520,24	41572,46	41103,26	48717,99
Italy	20664,55	20137,59	32055,09	36035,64	30242,39	34776,42
Japan	44197,62	39169,36	37812,9	44968,16	34960,64	34017,27
United Kingdom	23168,95	28280,93	42104,79	39598,96	44964,39	46125,26
United States	28690,88	36329,96	44123,41	48650,64	56762,73	76329,58
Canada	20679,63	24271	36382,51	47562,08	43596,14	55522,45
Russian Federation	2665,78	1771,594	5323,455	10674,99	9313,021	15270,71

Source: World Bank

3. Data, Methodology and Findıngs

3.1. Data Sources and Description

This study covers G8 Countries (France, Germany, Italy, Japan, England, USA, Canada, Russia) between 2000-2020 and the model was estimated with panel data analysis. The analysis of the data set used in the study was carried out with the STATA package program. Accessibility to the data set for G8 countries constitutes the limitation of the study. Information about the data set is included in Table 4. In the model, the dependent variable is health expenditures, and the independent variables are defined as economic growth and carbon dioxide emissions, respectively. The variables used in the study were obtained from the World Bank database. The definitions for the variables in model (1) are listed in Table 4. The selection of variables in the model was inspired by the studies of Govdeli (2009) and Wang et al. (2019).

Table 4. Measurement and Source of Data

Variables	Symbol	Measure	Data Source
Health expenditures	HE	per capita health expenditures	World Bank
Economic growth	GDP	per capita GDP	World Bank
Environmental pollution	CO	per capita CO_2 emission	World Bank

The model used in the study is as in equation (1):

$$LHE_{it} = \alpha_{it} + \beta_1 LGDP_{it} + \beta_2 LCO_{it} + u_{it} \quad (1)$$

In Equation 1, α is the constant value, β is the slope parameter, i is the unit size of the panel, t is the time dimension of the panel, and u is the error term. In the model considered, the GDP criterion is GDP per capita (GDP); per capita health expenditures (HE) were used as the health expenditure measure and per capita CO_2 emission variable (CO) was used as the environmental pollution measure. All the variables are expressed in natural logarithm.

In the study, the number of observations, mean, standard deviation, minimum and maximum values containing descriptive statistical information about the variables in the G8 countries are reported. Table 5 presents the descriptive statistics of the variables from 2000 to 2020. When Table 5 was examined, it was concluded that the lowest HE value was 3.95 and the highest HE value was 20.46. The HE is found to have a mean of 10.31. The GDP is found to have a mean of 36135.23. The CO is found to have a mean of 3893.72.

Table 5. Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
HE	168	10.31	4.20	3.95	20.46
GDP	168	36135.23	13206.58	1771.59	65120.39
CO	168	3893.72	2174.1	95.12	11702.41

Panel data analysis was used in the study investigating the relationship between health expenditures, economic growth and environmental pollution. The methodological sequence to be applied in the study is as follows: Breusch-Pagan (1980) CD_{lm1} Pesaran and Yamagata (2008) delta test was used to test homogeneity.Causality analysis was carried out with Dumitrescu-Hurlin (2012) test.

3.2. Methodology and Findings

In the study, firstly, the cross-sectional dependency was tested. The Breusch-Pagan LM test highlights that it is valid for small N and T, this test is based on the average of the squared pair-wise sample correlation coefficients of the residuals and is applicable when N is fixed and T → ∞. This test can be calculated as follows (Breusch and Pagan, 1980):

$$\mathbf{LM} = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} T_{ij} \hat{p}_{ij}^2 \sim X^2_{\frac{N(N-1)}{2}} \quad (2)$$

According to the results in Table 6, since the probability values of the test statistics were less than 5%, the H_0 hypothesis was rejected, and it was determined that there was cross-sectional dependence in the series.

Table 6. Inter-Unit Correlation Test Results

Test	Statistic	p-value
Breusch Pagan (1980) LM	85.96	0.000

In this study, the homogeneity of the series was examined by using the Delta test developed by Pesaran and Yamagata (2008) was used to determine the homogeneity and heterogeneity of slope coefficients. The hypotheses of the delta test are as follows:

H_0: Slope coefficients are homogenous

H_1: Slope coefficients are heterogeneous

Two different test statistics were developed by Pesaran & Yamagata (2008). Delta ($\tilde{\Delta}$) test statistic is used for large samples, while $\tilde{\Delta}adj$ test statistic is used for small samples.

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\ S-k}{\sqrt{2k}}\right) \tag{3}$$

$$\tilde{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\,S-E(Z_{it})}{\sqrt{var\,(Z_{\{it\}})}}\right) \tag{4}$$

According to the results, it was determined that the variables were heterogeneous because the probability of both tests was less than 1 % significance level (Table 7)

Table 7. Homogeneity Tests

Test Statistics	Statistic	p-value
Delta_tilde	15.198	0.000
Adj. Delta_tilde	16.891	0.000

In order to perform panel data analysis and obtain accurate results, it is necessary to ensure the stationarity of the time series of the variables (Gujarati, 2003). The first step is to determine whether the variables are stationary or not. Since there is cross-sectional dependence in the series, the CIPS test, one of the second-generation unit root tests, was applied. Table 8 shows the results of the CIPS unit root test. The equation for this test is as follows:

$$CIPS(N,T) = N^{-1}\sum_{i=1}^{N} t_i\,(N,T) \tag{5}$$

The hypotheses are as follows:

The null hypothesis (H_0): The series is non-stationary or the series has a unit root.

The alternative hypothesis (H_1): The series is stationary, or the series has no unit root.

As seen in Table 8, when the CIPS statistic values of all variables are compared with the critical values. Here, it shows that the variables contain unit roots with both constant and trend. The fact that the variables contain unit roots shows that the variables are not stationary.

Table 8. CIPS Unit Root Test Results by Levels

			Test Critical Values		
Variables	**Test Form**	**CIPS Statistics**	**1%**	**5%**	**10%**
LHE	Constant	-1.763	-2.21	-2.33	-2.57
	Constant& Trend	-2.064	-2.73	-2.86	-3.1
LGDP	Constant	-1.879	-2.21	-2.33	-2.57
	Constant& Trend	-2.242	-2.73	-2.86	-3.1
LCO	Constant	-1.601	-2.21	-2.33	-2.57
	Constant& Trend	-2.247	-2.73	-2.86	-3.1

Note: *, **, *** indicate 1%, 5%, 10% significance levels, respectively.

To ensure the stationarity of the series, the unit root test was performed by taking their first differences. The differenced unit root test results are given in Table 9. When the CIPS results obtained as a result of the application are evaluated, the values calculated for all variables examined are found to be lower than the critical values calculated for the CIPS test. The panel unit root test results indicate that all the variables used in the analysis are stationary in at least two tests. Therefore, all variables are first-order integrated I(1).

Table 9. CIPS Unit Root Test Results by Difference Levels

			Test Critical Values		
Variables	**Test Form**	**CIPS Statistics**	**1%**	**5%**	**10%**
LHE	Constant	-4.127	-2.21	-2.34	-2.6
	Constant& Trend	-4.172	-2.74	-2.88	-3.15
LGDP	Constant	-3.496	-2.21	-2.34	-2.6
	Constant& Trend	-3.336	-2.74	-2.88	-3.15
LCO	Constant	-3.025	-2.21	-2.34	-2.6
	Constant& Trend	-2.836	-2.74	-2.88	-3.15

The causal relationship between the variables is explored using the heterogeneous panel non-causality test developed by Dumitrescu and Hurlin (2012).

The advantages of this method are; It takes into account the cross-sectional dependency and heterogeneity among the countries that make up the panel and can be used in cases where the time dimension (T) is larger or smaller than the cross-sectional dimension (N). (Dumitrescu and Hurlin, 2012). In the Dumitrescu & Hurlin (2012) panel causality test, the main hypothesis, which shows that there is no homogeneous Granger causality relationship under the main hypothesis, is tested against the alternative hypothesis of homogeneous Granger causality (Bozoklu and Yılancı, 2013, p. 175).

In the Dumitrescu & Hurlin (2012) test, the hypotheses can be expressed as follows:

$H_0=\beta 1, \ldots\ldots, \beta_N=0$, there is no causal relationship.

$H_1=\beta_i \neq 0$ for at least one i, there is a causal relationship.

Table 10 explains that there is a causality relationship between economic growth to health expenditures. Additionally, there is a causality relationship between the health expenditure to economic growth. Hence, we say that there is mutual causality between these two variables. Similarly, there is a mutual causality relationship between carbon dioxide emissions and health expenditures.

Table 10. Dumitrescu-Hurlin Panel Causality Analysis Results

Direction of Relationship	W-bar	Z-bar	p-value	Casuality
LHE → LGDP	13.1145	7.2579	0.0000	there is causality
LGDP → LHE	8.9701	3.5509	0.0004	there is causality
LHE → LCO	13.5194	7.6200	0.0000	there is causality
LCO → LHE	9.4300	5.4300	0.0000	there is causality

Note: ** indicates 5% significance level.

Results

The increase in the world population and health expenditures after the Covid-19 global pandemic have become one of the most important topics in the literature. Countries trying to make their economic growth sustainable are trying to minimize the damage to the environment. Especially G8 countries are among the countries that attract attention in terms of health expenditures, environmental pollution and economic growth.

The aim of this study is to examine the relationship between health expenditures, environmental pollution and economic growth in G8 countries with annual data for the period 2000-2020. Panel data analysis was applied to determine the relationship between variables. Casuality analysis was used to determine the relationship between the variables. According to Dumitrescu Hurlin panel causality analysis, it was concluded that there is a mutual causality relationship from health expenditures to economic growth. Similarly, a mutual causality relationship was found between health expenditures and environmental pollution.

Health is an important component of human capital, and human capital is an important element for economic growth. Since investments in health will positively affect human capital and economic growth, more investments may be required in the field of health. In order for economic growth to be sustainable, otherwise, it may be encountered that human health will be negatively affected by the damage to the environment. Therefore, the environment should also be taken into consideration when trying to determine health policies. For this reason, renewable energy sources should be increased in order to reduce environmental damage, and the use of emission gases that harm the environment should be reduced.

In future studies, comparisons can be made with different country groups and Türkiye within the framework of different econometric methods and periods, the number of variables can be varied and dummy variables can be added.

References

Akar, S. (2014). Türkiye'de Sağlık Harcamaları, Sağlık Harcamalarının Nisbi Fiyatı ve Ekonomik Büyüme Arasındaki İlişkinin İncelenmesi, *Yönetim ve Ekonomi, XXI(*1), 311-322.

Akdur, R. (2005). Avrupa Birliği ve Türkiye'de Çevre Koruma Politikaları, Türkiye'nin Avrupa Birliği'ne Uyumu, Ankara Üniversitesi Avrupa Toplulukları Araştırma ve Uygulama Merkezi, Araştırma Dizisi: 23, Ankara.

Atay-Polat, M., & Ergun, S. (2018). Yapısal kırılma altında Türkiye'de ekonomik büyüme, CO_2 emisyonu ve sağlık harcamaları ilişkisi. *Business and Economics Research Journal, 9*(3), 481–498.

Atuahene, S.A., Yusheng, K., & Bentum-Micah, G. (2020). Health expenditure, CO_2 emissions, and economic growth: China vs. India. Preprints: 2020090384 (doi: 10.20944/preprints202009.0384.v1).

Bilgili, F., Kuşkaya, S., Khan, M., Awan, A., & Türker, O. (2021). The roles of economic growth and health expenditure on CO_2 emissions in selected Asian countries: A quantile regression model approach. *Environmental Science and Pollution Research, 30*, 1–24.

Bozoklu, Ş. & Yılancı, V. (2013). Finansal gelişme ve iktisadi büyüme arasındaki nedensellik ilişkisi: gelişmekte olan ekonomiler için analiz. *Dokuz Eylül Üniversitesi İktisadi İdari Bilimler Fakültesi Dergisi*, *28* (2), 161-187.

Boztosun, D., & Fatih, A. D. L. I. (2022). Sağlık harcamaları, çevre kirliliği ve ekonomik büyüme ilişkisi: Türkiye üzerine ampirik bir uygulama. *Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *15*(3), 538-549.

Çelik, A. (2020). G20 ülkelerinde sağlık harcamalarının ekonomik büyüme üzerindeki etkisinin analizi. *Yönetim ve Ekonomi Dergisi*, *27*(1), 1-20. DOI: 10.18657/yonveek.594695.

Chaabouni, S., & Saidi, K. (2017). The dynamic links between carbon dioxide (CO2) emissions, health spending and GDP growth: A case study for 51 countries. *Environmental research*, *158*, 137-144.

Chang CK, Hayes RD, Perera G, Broadbent MT, Fernandes AC, Lee WE (2011). Life expectancy at birth for people with serious mental ıllness and other major disorders from a secondary mental health care case register in London, *PloS one, 6*(5), e19590.

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

Ghorashi, N., & Rad, A. A. (2017). CO_2 emissions, health expenditures and economic growth in Iran: application of dynamic simultaneous equation models, *Journal of Community Health Research, 6*(2) 109-116.

Govdeli, T. (2019). Health expenditure, economic growth, and CO_2 emissions: Evidence from the OECD countries. *Adıyaman Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (31), 488–516.

Grossman, M. (1972). On the concept of health capital and the demand for health, *Journal of Political Economy*, 80(2), 223-255.

Gujarati, Damador (2003). Basic Econometrics, New York: McGraw Hill Book Co.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, 46(6), 1251-1271.

Ibukun, C. O., & Osinubi, T. T. (2020). Environmental quality, economic growth, and health expenditure: Empirical evidence from a panel of African countries. African Journal of Economic Review, 8(2), 119–140.

International Monetary Fund (2023). World Economic Outlook: Navigating Global Divergences. Washington, DC. October.

Karasoy, A. ve Demirtas, G., (2018). Sağlık Harcamalarının Belirleyicileri Üzerine Bir Uygulama: Çevre Kirliliği ve Yönetişimin Etkilerinin İncelenmesi, *İnsan ve Toplum Bilimleri Araştırmaları Dergisi, 7*(3), 1917-1939.

Khoshnevis Yazdi, S., & Khanalizadeh, B. (2017). Air pollution, economic growth and health care expenditure. *Economic research-Ekonomska istraživanja*, *30*(1), 1181-1190.

Mushkin, S. J. (1962). Health as an Investment. *Journal of political economy*, 70(5), 129-157.

Mwale, M. W. (2004). Infant and Child Mortality. Malawi Demographic and Health Survey, 8, 123-132.

Sancar, C., & Atay-Polat, M. (2021). CO_2 emisyonları, ekonomik büyüme ve sağlık harcamaları ilişkisi: Türkiye ve seçilmiş ülke örnekleri için ampirik bir uygulama. *Manas Sosyal Arastırmalar Dergisi, 10*(1), 236–252.

Şahin, D., & Durmus, S. (2019). OECD ülkelerinde ekonomik büyüme ve çevre kirliliğinin sağlık harcamaları üzerine etkisinin analizi. *Finans Politik & Ekonomik Yorumlar, 56*(647), 185–201.

WHO (2024). https://www.who.int/data/gho/indicator-metadata-registry/imr-details/1139

Yaburgan, G. & Kostekci, A. (2022). Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi: Türkiye'de İller Düzeyinde Panel Kanıtlar, *III. Uluslararası Farklı Boyutlarıyla Saglık Konferansı: Sağlık Turizminin Dünü, Bugünü ve Geleceği,* Çanakkale, Türkiye.

Wang, C. M., Hsueh, H. P., Li, F., & Wu, C. F. (2019). Bootstrap ARDL on health expenditure, CO_2 emissions, and GDP growth relationship for 18 OECD countries. *Frontiers in public health, 7*, 324.

Zaidi, S., & Saidi, K. (2018). Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. *Sustainable cities and society*, *41*, 833-840.

Zeeshan, M., Han, J., Alam Rehman, I. U., & Afridi, F. E. A. (2021). Exploring asymmetric nexus between CO_2 emissions, environmental pollution and household health expenditure in China. *Risk Management and Healthcare Policy, 14*, 527–539.