PANOECONOMICUS, 2024, Vol. 71, Issue 3, pp. 373-393
Received: 11 April 2021; Accepted: 29 August 2021.

UDC 330.342:159.938.363.6(560)"1960/2014"
https://doi.org/10.2298/PAN210411005A
Original scientific paper

Halim Can Avcı
Corresponding Author
Independent Researcher
Ankara,
Turkey
✉ hcavci@gmail.com

Zafer Çalışkan
Hacettepe University,
Department of Economics,
Ankara,
Turkey
✉ caliskan@hacettepe.edu.tr

The Effect of Health on Economic Growth: A Production Function Approach for Turkey

Summary: Until the Augmented Neo-Classical Growth Model developed by Mankiw, Romer and Weil, growth theories have ignored the human capital factor. This study aims to investigate the impact of health on economic growth in Turkey between 1960-2014 through a production function that includes human capital. Health and education are included in the production function as the two main components of human capital. The Multivariate Auto-Regressive Distributed Lag (ARDL) Bounds Test was conducted for empirical analysis. As a result, a significant long-term cointegration relationship was found between the variables. The results also indicate that a 1% increase in life expectancy at birth leads to a 0.67% increase in GDP, a 1% increase in the number of students per teacher in vocational and technical secondary education leads to a 0.21% decrease in GDP, and a 1% increase in the number of students per teacher in tertiary education leads to a 0.21% increase in GDP.

Keywords: Economic growth, Health, ARDL bounds test, Production function, Turkey.

JEL: C32, I10, I20, O40.

Most economic theorists have embraced the role of non-economic dimensions of economic growth (such as education and health). As stated by Robert E. Lucas (1988), economic growth is a summary measure of all activities of a society and therefore depends on everything that goes on within that society. Any improvement in societal conditions, which thereby increase the level of health and education, improves a country's individual welfare and economy. Therefore, a large number of recently published studies have focused on analyzing the interesting link between human capital and economic growth to verify the hypothesis of a causal relationship.

Health is a crucial aspect of human capital, and thus a critical ingredient of economic growth. This study aims to make a unique contribution to the investigation of the impact of health on economic growth in Turkey using a production function approach which includes health and education variables simultaneously and using a multivariate ARDL Bounds Test approach.

This paper is organized as follows. First, the link between human capital and economic growth is explained, followed by a brief literature review. Then, the production function is defined and the data set is introduced. Subsequent to that, a step-by-step explanation of the econometric method used is provided and the paper concludes with a summary of the estimation results.

1. Human Capital and Economic Growth

Human capital has been defined by the Organisation for Economic Co-operation and Development (OECD) as the knowledge, skills, competencies, and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being (Brian Keeley 2007). Human capital and economic growth are two things that are always interrelated and inseparable as a higher stock of human capital tends to affect economic growth positively. Therefore, there is a need to look at economic growth from a wider perspective. One of the main indicators of economic welfare is income *per capita*. The positive correlation between health and income *per capita* makes it one of the best-known relations between human capital and economic level. This correlation has commonly been thought to reflect a causal link running from income to health; however, this link has recently been thought to run in reverse, from health to income. It has been observed that average real income is higher in countries with higher living standards and welfare. Disparities in real income between countries are typically associated with large differences in nutrition, education, health, and other welfare variables (David Romer 1996). The seminal study extending this Neo-Classical growth theory to human capital was published by N. Gregory Mankiw, Romer, and David N. Weil (1992).

The five main elements of human capital have been defined by the Nobel Prize-winning economist Theodore W. Schultz, who played a major role in human capital studies, as health, on-the-job training, schooling, adult education, and migration (Pedro Teixeira 2014). Although these five elements have been partially or fully adopted in the literature, empirical studies generally tend to use education and health in terms of ease of measurement and access to data, completely ignoring migration. Accordingly, like other similar studies, this study uses education and health as components of human capital.

Great importance has recently been placed on education within human capital literature as a result of the widespread consensus on the impact of education on productivity, economic growth, and development. Education has many positive effects on the individual and is considered beneficial to society and the economy as a whole. Through education, individuals can improve their communication and coordination skills as well as their productivity. In addition, education contributes to an individual's ability to assess and adapt to changing conditions. As the educated individual is not bound to the *status quo*, it is much easier for them to adapt to technological innovations and new applications. In addition, a high level of education aids in bringing about innovation in production technology (Lawrence J. Lau, Dean T. Jamison, and Frederic F. Louat 1991). A more educated and qualified workforce not only increases its productivity but also contributes to the productivity of individuals within the same working environment and increases total productivity (Başak Karşıyakalı 2008). All these considerations can be summarized by saying that higher rates of education in an economy increase labor productivity and total output through the human capital channel (Eric A. Hanushek and Ludger Wössmann 2007).

Another critical aspect of human capital is health, thereby making it a critical component of economic growth as well. Countries with higher levels of health tend to be wealthier than countries with lower health conditions. Unhealthy workers cannot effectively contribute to the economy and also become a burden on their families and the social welfare infrastructure. Healthy workers are more energetic and robust both physically and mentally and tend to be more productive as they are less likely to be absent from work due to health-related conditions (David E. Bloom, David Canning, and Jaypee Sevilla 2004; Teixeira 2007). According to Michael Grossman (1999), health determines the total amount of time that a laborer can spend to produce money earnings and commodities. One unhealthy laborer decreases that particular laborer's productivity, whereas an unhealthy society in general reduces both the individual and total labor productivity of that society. In a society struggling with epidemics or malnutrition, even if the individual is healthy, there will be little opportunity to work productively. From this perspective, health becomes one of the prerequisites of economic growth through efficiency (İbrahim Hakan Yetkiner 2006). In addition to productivity, societal health levels also have indirect effects on economic growth. A healthy society has a larger total workforce as life expectancy and incidents of disability within the workforce decrease. A society with longer life expectancy prevents the early loss of scientists, politicians, artists, and inventors who can benefit that society in the future (Selma J. Mushkin 1962). A further indirect benefit of health on economic growth in an increase in the savings and investments made by individuals who are able to postpone retirement to later ages (Dilek Temiz and Suna Korkmaz 2007). Bloom and Canning (2003) also indicated that improvements in public health can lead to lower fertility rates and smaller families, thereby increasing the participation of women in the labor force.

In light of this information and the fact that the OECD defines human capital as the knowledge, skills, competencies, and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being, it is clear that health is a key element of human capital. Nevertheless, there are three unclear issues: (i) the nature of the relationship between health and economic growth is unclear, both because of bidirectional causality between these two variables and confounding factors; (ii) the relationship between health and economic growth varies depending on the dimension of health examined (e.g., morbidity vs. mortality) in addition to age, gender, and socioeconomic status; and (iii) a crucial difference exists between the economic effects of health interventions in less developed *versus* developed countries (Bloom, Michael Kuhn, and Klaus Prettner 2018).

2. Literature Review

It has been established above that health as an aspect related to human capital is critical to economic growth. The aim of this section is to introduce economic growth literature that includes the health factor, with a specific focus on recent studies related to the Turkish economy. The studies discussed in this section that include health as a determinant of economic growth, along with their results and methods used, are sequentially present in further detail in Appendix Table A1.

Most research into the relationship between health and economic growth has been carried out using cross-sectional and panel data. Jeffrey D. Sachs and Andrew M. Warner (1997), Bloom et al. (1998), Bloom and Pia N. Manaley (1998), Bloom and Jeffrey G. Williamson (1998) and John L. Gallup and Sachs (2000) utilized cross-sectional data to investigate the effect of life expectancy at birth on GDP *per capita* using the Ordinary Least Squares (OLS) method. Their results show that an increase in life expectancy at birth increases the economic growth rate. Amar A. Hamoudi and Sachs (1999) found a remarkably robust correlation between economic and health indicators by using the same type of data and the same method.

Robert J. Barro (1996), Bloom, Canning, and Sevilla (2004), Daron Acemoğlu and Simon Johnson (2006), Murat Çetin and Eyyup Ecevit (2010) and Ramazan Kılıç and Rabia İ. Özbek (2018) conducted panel data analysis by using variants of OLS. Barro (1996) found that a 1% increase in life expectancy at birth increased the growth rate by 0.0423 points, while a 1% increase in the fertility rate decreased the growth rate by 0.0161 points. Bloom, Canning, and Sevilla (2004) estimate that a 1-year increase in life expectancy would increase GDP by 1.3%. Acemoğlu and Johnson (2006) suggest that the initial impact of an increase in life expectancy on GDP is positive but small and added that it has not yet been determined whether an increase in life expectancy at birth results in faster *per capita* growth. Çetin and Ecevit (2010) and Kılıç and Özbek (2018) used health expenditures in their analyses. While Çetin and Ecevit (2010) did not find a statistically significant relationship between health expenditures and economic growth, Kılıç and Özbek (2018) determined that an increase in health expenditures increases GDP.

Francesco Caselli, Gerardo Esquiandl, and Fernando Lefort (1996) and Barış Yıldız and Gizem Yıldız (2018) used the Generalized Method of Moments in their analyses. While Yıldız and Yıldız (2018) estimated that a 1% increase in *per capita* health expenditures increases *per capita* GDP by 0.29%, Caselli, Esquiandl, and Lefort (1996) found the coefficient of life expectancy at birth insignificant.

Erkan Erdil and Yetkiner (2004) investigated Granger Causality in their panel data analysis for 75 countries. Bi-directional causality was determined in 46 countries; in cases where causality was unidirectional, the direction of causality flowed from health to GDP in high-income countries, and from GDP to health in other country groups. Nazife Ö. Kılıç and Murat Beşer (2018) determined bi-directional causality between health expenditures and GDP in their study by using the Toda-Yamamoto Causality method for 8 countries.

Alok Bhargava et al. (2001) conducted a panel data analysis with the help of the Dynamic Random Effects method and found that an increase in adult survival rate increases economic growth while an increase in fertility rate decreases economic growth. Also, Sibel Selim, Doğan Uysal, and Pınar Eryiğit (2014) estimated that a 1% increase in *per capita* health expenditures increases GDP by 0.9% in their Panel Error Correction Model.

So'nia Maria Aniceto Morgado (2014) investigated the causality between growth and some health indicators such as life expectancy at birth and infant mortality rate for Portugal and found that growth is the cause of health. Alper Aslan, Angeliki N. Menegaki, and Can T. Tuğcu (2016) used the ARDL Bounds Test approach in their time series analysis for 7 countries and determined that a 1% increase in health expenditures increases GDP by approximately 0.40% only in France. Other countries had insignificant positive parameters.

As indicated in the research listed above, the relationship between health and economic growth has mostly been studied using cross-sectional and panel data. Very rarely is the production function approach used. In fact, the only studies to include production functions in the above literature reviews were only Bloom, Canning, and Sevilla (2004), Morgado (2014) and Aslan, Menegaki, and Tuğcu (2016).

On the other hand, studies related to Turkey have generally focused on analyzing the causality between GDP and several health or education indicators. Research conducted by Sami Taban (2006), Temiz and Korkmaz (2007), Şadan Çalışkan, Mustafa Karabacak, and Oytun Meçik (2013), Cahit Aydemir and Seniha Baylan (2015), Adil Akıncı and Güner Tuncer (2016), İbrahim Doğan (2016) and Ali Şen and Nergis Bingöl (2018) can be referenced as examples. Some studies have created coefficient estimations with methods such as the ARDL Bounds Test or the Generalized Moments method without considering production factors. Seyfettin Erdoğan and Hilal Bozkurt (2008) found that Gross National Product (GNP) and life expectancy at birth are cointegrated, but the coefficients are insignificant. Sibel Bali Eryiğit, Kadir Y. Eryiğit, and Ufuk Selen (2012) estimated that a 1% increase in GNP increases health expenditures by 0.52%, and a 1% increase in health expenditures increases GNP by 0.91%. Ahmet Ay, Oktay Kızılkaya, and Emrah Koçak (2013) used a different proxy for health variable and suggested that a 1% increase in the number of inpatient health institutions increases the GDP by 13.21%, a 1% increase in the number of outpatient health institutions increases the GDP by 0.79%, and a 1% increase in the number of people per medical officer increases the GDP by 5.60%. Selim Başar, Serkan Künü, and Gürkan Bozma (2016), Emre Atılgan, Dilek Kılıç, and Hasan M. Ertuğrul (2017), Bünyamin Demirgil, Fatih Şantaş, and Gülcan Şantaş (2017) and Cüneyt Y. Kesbiç and Gökhan Salman (2018) focused on the effect of health expenditures on GDP. While Başar, Künü, and Bozma (2016) found a 1% increase in health expenditures increases GDP by 1.13%, Atılgan, Kılıç, and Ertuğrul (2017) and Demirgil, Şantaş, and Şantaş (2017) estimated increase of GDP as 0.43% and 0.55%, respectively. Kesbiç and Salman (2018) suggested that the effect of public health expenditures on economic growth is positive but the effect of private health expenditures on economic growth is negative.

The research conducted in this present study differs from previous contributions in the field. The first element that distinguishes this paper from most of the reviewed literature is that it adopts the production function approach. As mentioned above, very few papers have adopted this approach in the past. Nevertheless, none have used a production function that includes health and education together in studies on Turkey. Secondly, the present research used the relatively new multivariate ARDL Bounds Test. Several studies have used the ARDL Bounds Test such as Erdoğan and Bozkurt (2008), Aslan, Menegaki, and Tuğcu (2016), Başar, Künü, and Bozma (2016), Atılgan, Kılıç, and Ertuğrul (2017), and Demirgil, Şantaş, and Şantaş (2017); however, only Aslan, Menegaki, and Tuğcu (2016) conducted a multivariate analysis focusing on the effect of health expenditures rather than life expectancy at birth on growth. Additionally, their study excluded Turkey. Thirdly, this study offers contributions in terms of the data set. For total factor productivity (TFP), the use of proxies as frequently seen in the literature was avoided and the TFP series published by Penn World Table (PWT) was used directly. For the education series, this study also followed a different approach and used the number of students per teacher at different levels because of some content and measurement problems which will be discussed in the following sections.

Through these differences, this study aims to provide a unique contribution to the investigation of the impact of health on economic growth in Turkey through the use of the production function approach including health and education variables simultaneously, and the use of the multivariate ARDL Bounds Test approach.

3. Model and Data

This study used the Cobb-Douglas production function as indicated below:

$$Y = CA^{\delta}K^{\alpha}L^{\beta}E_1^{\gamma}E_2^{\phi}H^{\lambda}, \tag{1}$$

where *Y* is output, *C* is constant, *A* represents TFP, *K* is capital stock, and *L* is labor force. The human capital components are education (*E*) and health (*H*).

For the ease of estimation and interpretation, the production function (1) will be used in the natural logarithmic form as follows:

$$lnY = lnC + \delta lnA + \alpha lnK + \beta lnL + \gamma lnE_1 + \phi lnE_2 + \lambda lnH. \tag{2}$$

Output, TFP, capital stock, and labor force data were obtained from PWT 9.0. For output data, expenditure-side real GDP at current purchasing power parities (PPP) in million 2011 United States dollars (USD) was used. The TFP series consists of real TFP at constant national prices. This series is an index that accepts the 2011 TFP level 1 for all countries and is ideal for observing a country's TFP change according to PWT 9.0. For capital stock, the series real capital stock at current PPPs (in million 2011 USD) was selected. The workforce series is expressed as the number of employees in millions.

The majority of studies involving the education variable use enrollment rates at different levels of education as a proxy. However, this study, contrary to the general literature, uses the number of students per teacher at different levels as a proxy for the education variable. Previous studies on Turkey have also used enrollment rates by following international literature. However, at least for Turkey, there are issues in using enrollment rate as there is controversy as to whether these rates in fact reflect the quality of education or not. Enrollment rates are simply a percentage or ratio and do not measure what quality of education is being received.

In Education at a Glance 2017, the OECD focuses on all levels of education, including tertiary, and states that the number of students per teacher affects the working conditions of the teacher and that the working conditions in turn affect the teacher's ability and willingness to build relationships and interact attentively with the student (Organisation for Economic Co-operation and Development - OECD 2017). In the same publication, it was stated that a low number of students per teacher allows the teacher to focus on the individual needs of the students and facilitates the provision of classroom order (OECD 2017). The QS Intelligence Unit, one of the institutions that publishes global university rankings, defines the student faculty ratio as the only available and comparable data in evaluating the quality of education. The organization further states that while this series does not fully demonstrate the quality of education, it is a strong candidate for the measurement of quality of education (QS World University Rankings 2018)[1]. The University and College Union of the United Kingdom states that the number of students per faculty member is one of the key indicators of the learning experience (Stephen Court 2012). In publication No. 2014/2, the Council of Higher Education of Turkey states that increasing the number of students per faculty member will decrease the time allocated to research by increasing the workload of the faculty members and will adversely affect the quality of education and research capacity (Gökhan Çetinsaya 2014). Due to these reasons, school enrollment rates were not used in the present study as the number of students per teacher rates better measure quality of education.

Since the focus of our study is on economic growth, education that increases the quality and productivity of labor gains importance. Therefore, the education component of human capital is represented in this study by the number of students per teacher in both secondary and tertiary education. Based on the literature, not all secondary education institutions are included, only vocational and technical secondary education institutions were included in the secondary education series of this study (Theodore W. Schultz 1961; Edward F. Denison 1974; OECD 2008). Data for the years 1960 through to 2011 were obtained from the Statistical Indicators 1923-2011 of the Turkish Statistical Institute (TurkStat 2018)[2]. Vocational and technical secondary education data for the years 2012 to 2014 were retrieved from the Republic of Turkey's Ministry of National Education National Education Statistics Formal Education publication of the related years (T.C. Millî Eğitim Bakanlığı 2013, 2014, 2015). The number of students per teacher in tertiary education for the same period was compiled from the Republic of Turkey's Ministry of National Education National Education Statistics Formal Education 2016/'17 (T.C. Millî Eğitim Bakanlığı 2017).

Similar to other related research, life expectancy at birth was used to represent the health component of human capital as it is one of the most important indicators of the general health status of the population and welfare of the society. The World Health Organization (WHO) defines life expectancy at birth as the average number of years that a newborn is expected to live if current mortality rates continue to apply (World Health Organization 2006). Simply, life expectancy at birth indicates how many years the person born in a given year will live on average. In the literature, there are studies using infant mortality rates, various disease indices, fertility rates, number of health workers, number of health institutions, and health expenditures to represent the health variable as an alternative to the life expectancy at birth. However, life expectancy at birth reflects infant mortality, morbidity rates, and quality of health institutions (Sachs and Warner 1997), making it a preferred option. It would not be appropriate to interpret fertility rates as indicators of public health alone. As well, there is controversy as to whether health expenditures, which are preferred due to the ease of accessing data, are in fact a measure of good public health. Thus, life expectancy at birth was the preferred

[1] **QS World University Rankings.** 2018. QS Intelligence Unit. http://www.iu.qs.com/university-rankings/indicator-faculty-student/ (accessed June 12, 2018).
[2] **TurkStat.** 2018. https://www.tuik.gov.tr/Home/Index (accessed June 10, 2018).

series in this study and the data were obtained from the OECD Statistical Database (OECD 2018)[3].

4. Methodology

Empirical analysis within this study was conducted using the ARDL Bounds Test, which was developed by M. Hashem Pesaran, Yongcheol Shin, and Richard J. Smith (2001). This test is a relatively new method of testing the relationship between variables in levels (Pesaran, Shin, and Smith 2001). The ARDL Bounds Test has several advantages over conventional cointegration methods. The most important of these is that there is no prerequisite for the stationarity of the variables. In addition, the ARDL Bounds Test has the following advantages. It is relatively more efficient in finite or small samples and that is not a complex method meaning that after determining the optimal number of lags, the cointegration relationship can be estimated with OLS (Joseph M. Frimpong and Eric F. Oteng-Abayie 2006). In addition, this test is dynamic in that it includes the past values of the variables and allows for the selection of different optimal lag lengths for variables (Do Thi Thao and Zhang Jian Hua 2016). Unbiased estimates of the long-run model can be obtained (Mounir Belloumi 2014).

The most important advantage of the ARDL Bounds Test is that it can be applied irrespective of whether the variables are integrated of order zero I(0), order one I(1), or mutually cointegrated (Pesaran, Shin, and Smith 2001). Unlike other conventional time series and cointegration analyses, the ARDL Bounds Test does not require prerequisites for the variables to be I(0) or I(1) or to be integrated of the same order. However, the use of the procedure becomes problematic if the series are integrated of order two or higher (Bazoumana Ouattara 2004). Therefore, the preliminary step of the ARDL Bounds Test should be to apply a stationary test to the data under analysis.

After determining stationarity of the data, the ARDL Bounds Test can be used to test whether there is a long-term cointegration relationship between the variables. For testing, the unrestricted error correction model (UECM) of the production function (2) under analysis should be defined. The UECM specification of the ARDL model for Equation (2) is presented in Equation (3):

$$\Delta lnY_t = a_0 + \sum_{i=1}^{p} a_{1i}\Delta lnY_{t-i} + \sum_{i=0}^{p} a_{2i}\Delta lnA_{t-i} + \sum_{i=0}^{p} a_{3i}\Delta lnK_{t-i} + \sum_{i=0}^{p} a_{4i}\Delta lnL_{t-i} + \sum_{i=0}^{p} a_{5i}\Delta lnE1_{t-i} + \sum_{i=0}^{p} a_{6i}\Delta lnE2_{t-i} + \sum_{i=0}^{p} a_{7i}\Delta lnH_{t-i} + \theta_1 lnY_{t-1} + \theta_2 lnA_{t-1} + \theta_3 lnK_{t-1} + \theta_4 lnL_{t-1} + \theta_5 lnE1_{t-1} + \theta_6 lnE2_{t-1} + \theta_7 lnH_{t-1} + u_t. \quad (3)$$

In UECM (3), α represents the short-term coefficients, θ is the long-term coefficient, p is the number of lags, t is the period, and u represents the error term. An OLS regression is estimated for the first differences part of the model (3). Then, the joint significance of the parameters of the lagged level variables is tested after adding them to the first regression (Frimpong and Oteng-Abayie 2006). This test is carried out by the bound F-test. If the calculated F-statistic is above the upper bound, the hypothesis H_0, which states that there is no long-term cointegration relationship, is rejected. If the

[3] **Organisation for Economic Co-operation and Development.** 2018. OECD Statistical Database. https://stats.oecd.org/ (accessed June 08, 2018).

F-statistic is below the lower bound, the H_0 hypothesis cannot be rejected, indicating that there is no cointegration relationship. If the F-statistic is between two bound values, no inference can be made.

If a long-term cointegration relationship is detected, the analysis continues. Long-term coefficients are obtained by estimating Equation (3), after selecting the optimal lag length for each variable. The final step of the ARDL Bounds Test is to estimate the error correction model (ECM) to obtain short-term dynamic coefficients and error correction term. ECM specification is presented in Equation (4):

$$\Delta lnY_t = a_0 + \sum_{i=1}^{p} a_{1i}\Delta lnY_{t-i} + \sum_{i=0}^{p} a_{2i}\Delta lnA_{t-i} + \sum_{i=0}^{p} a_{3i}\Delta lnK_{t-i} + \sum_{i=0}^{p} a_{4i}\Delta lnL_{t-i} + \sum_{i=0}^{p} a_{5i}\Delta lnE1_{t-i} + \sum_{i=0}^{p} a_{6i}\Delta lnE2_{t-i} + \sum_{i=0}^{p} a_{7i}\Delta lnH_{t-i} + \psi ECM_{t-1} + u_t. \quad (4)$$

In Equation (4), ψ denotes the speed of the adjustment parameter or error correction term (ECT). ECT expresses how much of the short-run disequilibrium is being corrected in the long-run (Atılgan, Kılıç, and Ertuğrul 2017). A positive ECT indicates divergence, while a negative ECT refers to convergence. An ECT of 1 indicates that the adjustment will take place within the period and a 0 indicates that it will not (Emeka Nkoro and Aham K. Uko 2016).

5. Results

Since the estimated production function (2) is in the natural logarithmic form, the seven time series subject to the analysis were measured in natural logarithms. First, the augmented Dickey-Fuller (ADF), the Kwiatkowski-Phillips-Schmidt-Shin (KPSS), and the Phillips-Perron (PP) unit root tests were performed on the series. Table 1 summarizes the stationary test results of the series and indicates that none of the series were found to be integrated of order two or higher. Therefore, there are no issues applying the ARDL Bounds Test.

Table 1 Conventional Unit Root Test Results

Variables (ln)	ADF		PP		KPSS	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
Y	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
A	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)
K	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
L	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)
E1	I(0)	I(0)	I(1)	I(1)	I(0)	I(0)
E2	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
H	I(1)*	I(1)	I(1)	I(1)	I(1)	I(1)

Notes: Unless otherwise specified, tests were performed at a 5% significance level. * denotes a 10% significance level.

Source: Authors' calculations.

Although all of the series subject to analysis were determined to be I(0) or I(1), conventional unit root tests do not take into account the effect of a possible structural break. Pierre Perron (1989) stated that structural changes in time series may affect the results of conventional unit root tests and suggested a unit root test that takes structural changes into consideration. Perron's (1989) approach, however, is based on the determination of break time exogenously and assumes it is known *ex ante* (Joseph P. Byrne and Roger Perman 2006). Eric Zivot and Donald W. K. Andrews (1992) criticized the exogenous determination of the break time in the Perron (1989) test and developed a unit root test in which the break time was determined endogenously (Veli Yılancı 2009). In light of these criticisms, Perron and Timothy J. Vogelsang (1992) and Perron (1997) further developed the Zivot-Andrews test to address two different types of structural breaks: additive outlier and innovational outlier. In the additive outlier, the effect of a structural break occurs at once and in total, whereas in the innovational outlier, the structural break occurs gradually in different periods (Veysel Karagöl and Meltem Erdoğan 2016). Following Perron and Vogelsang (1992) and Perron (1997), breakpoint unit root tests were also performed on the time series in the present study. As recommended by Perron (1997), the break time with the minimum Dickey-Fuller t-statistic was selected among all possible break times, and the lag length was determined by the F-test. As seen in Table 2, breakpoint unit root tests determined that all of the time series were I(0) or I(1) parallel to the conventional unit root tests, indicating once again that the ARDL Bounds Test could be applied without issue.

Table 2 Unit Root Tests with Structural Breaks

Variable (ln)	Innovational outlier	Additive outlier
Y	I(1)	I(1)
A	I(1)	I(1)
K	I(1)	I(1)
L	I(1)	I(0)
E1	I(0)	I(0)
E2	I(1)	I(1)
H	I(1)	I(1)

Notes: Tests were performed at a 5% significance level.

Source: Authors' calculations.

After the stationary tests, the presence of a long-term cointegration relationship was tested with the bound F-test for the UECM (3). As presented in Table 3, the calculated F-statistic is above the limit values at the 5% significance level. Therefore, hypothesis H_0, which states that there is no long-term cointegration relationship, is rejected and analysis proceeds to the next step.

Table 3 Bound F-test Results

F-bounds test		Null hypothesis: No levels relationship		
Test statistics	**Value**	**Signif.**	**I(0)**	**I(1)**
			Asymptotic: n = 1000	
F-statistic	16.51527	10%	2.12	3.23
k	6	5%	2.45	3.61
		2.5%	2.75	3.99
		1%	3.15	4.43
Actual sample size	51		Finite sample: n = 55	
		10%	2.27	3.486
		5%	2.676	3.999
		1%	3.636	5.169
			Finite sample: n = 50	
		10%	2.309	3.507
		5%	2.726	4.057
		1%	3.656	5.331

Source: Authors' calculations.

For the estimation of model (3), the optimal lag length for each variable should be determined. The optimal lag length was determined according to AIC by following Pesaran, Shin, and Smith (2001). Although low maximum lag lengths were selected for determining optimal lag length for studies using annual data in autoregressive models (Jeffrey M. Wooldridge 2013), a maximum lag number of 5 was used for this study. Among the 62,500 compared models, the ARDL (4, 3, 0, 0, 4, 2, 2) model with the smallest AIC was selected. The numbers in brackets refer to the lag length of the variables Y, A, K, L, E_1, E_2, and H, respectively.

Long-term coefficients were obtained by estimating model (3) with the optimal lag lengths for each variable. All of the long-term coefficients summarized in Table 4 are statistically significant at the 5% significance level.

Table 4 Long Term Coefficients

Variable (ln)	Coefficient	t-stat	p-value
A	0.8902	5.1204	0.0000
K	0.4000	8.0686	0.0000
L	0.5791	2.3719	0.0246
E1	-0.2122	-2.6200	0.0138
E2	0.2094	4.3974	0.0001
H	0.6657	2.7764	0.0095

Source: Authors' calculations.

According to estimation outputs, a 1% increase in life expectancy at birth leads to an approximate 0.67% increase in GDP. This result is generally parallel to the literature and points to the serious contribution of health to economic growth as Sachs and Warner (1997), Bloom, Canning, and Sevilla (2004), Selim, Uysal, and Eryiğit (2014), Aslan, Menegaki, and Tuğcu (2016), Başar, Künü, and Bozma (2016), Atılgan, Kılıç, and Ertuğrul (2017) and Demirgil, Şantaş, and Şantaş (2017) suggest. A 1% increase in the number of students per teacher in vocational and technical secondary education leads to an approximate 0.21% decrease in GDP. This result is again parallel to the expectation. The decrease in the quality of education in vocational and technical secondary education is expected to reduce the quality and productivity of skilled labor that come through these educational institutions. However, a 1% increase in the number of students per teacher in tertiary education leads to an approximate 0.21% increase in GDP. This finding is contrary to general expectation and can be interpreted to mean that the increase in the number of students per teacher in tertiary education has a positive effect on the GDP for Turkey.

A 1% increase in TFP, capital stock, and labor force increases the GDP by 0.89%, 0.40%, and 0.58%, respectively. These results indicate that the impact of TFP growth is substantial in Turkey. A significant increase in GDP can be achieved by increasing TFP. In addition, the effect of a 1% increase in the labor force is larger than the effect of a 1% increase in the capital stock, which can be interpreted to mean that production is based relatively on the human factor in Turkey.

The final step of the ARDL Bounds Test is to estimate the ECM (4) to obtain the ECT. As presented in Table 5, the ECT is approximately -0.67 and is statistically significant indicating that 67% of disequilibrium from the previous year's shock is eliminated in the current year. In other words, the model converges to the equilibrium.

Table 5 Error Correction Term

Error correction term	-0.671768			
	Value	Signif.	I(0)	I(1)
t-statistic	-11.81209	10%	-2.57	-4.04
		5%	-2.86	-4.38
		2.5%	-3.13	-4.66
		1%	-3.43	-4.99

Source: Authors' calculations.

The cornerstone of the ARDL Bounds Test approach is the OLS. Therefore, the estimated model naturally needs to meet the basic assumptions of the OLS (Aslan, Menegaki, and Tuğcu 2016). The model checked for serial correlation, heteroscedasticity, non-normality, regression specification error, and stability. As summarized in Table 6, the model has not violated any assumptions of the OLS.

Table 6 Diagnostic and Stability Checks

Breusch-Godfrey serial correlation LM test:				
F-statistic	0.686200		p-value	0.5121
Heteroscedasticity test: Breusch-Pagan-Godfrey				
F-statistic	0.908353		p-value	0.5841
Normality test: Jarque-Bera				
JB-statistic	0.2837		p-value	0.8677
Ramsey RESET test				
F-statistic	0.174941	df (2, 27)	p-value	0.8405
Cusum test	Stable at 5% level			
Cusum square test	Stable at 5% level			

Source: Authors' calculations.

6. Conclusions

According to economic theory, the stock of human capital in an economy can be seen as an important potential factor in economic growth. In order to test this hypothesis, human capital was considered to have an important role in economic growth. The results obtained within this present study support this argument. A significant long-term cointegration relationship was found in the analysis, where the dependent variable was GDP and the independent variables were TFP, capital stock, labor force, the number of students per teacher in vocational and technical secondary education, the number of students per teacher in tertiary education, and the expected life expectancy at birth. Estimation results show that a 1% increase in life expectancy at birth leads to an approximate 0.67% increase in GDP. This result is generally parallel to the literature and points to the significant contribution of health to economic growth. At first glance, this coefficient estimate seems to be quite high. However, as life expectancy at birth is measured in years, a 1% increase in this rate corresponds to a high increase in years. Moreover, there are debates, especially in the developed world, about whether life expectancy at birth has reached a plateau or its increase has slowed down (Denis Campbell 2017; Elisabetta Barbi et al. 2018; Thomas R. Frieden 2018; Independent Staff 2018). The average annual rate of increase in life expectancy at birth in Turkey is approximately 0.29% for the last 10 years[4]. Therefore, the fact that a 1% increase in life expectancy at birth leads to a 0.67% increase in GDP is a reasonable estimate of the importance of health.

A 1% increase in the number of students per teacher in vocational and technical secondary education indicates a decrease of approximately 0.21% in GDP. This result is parallel to the expectation that the decrease in the quality of education in vocational and technical secondary education will reduce the quality and productivity of skilled labor that come through these educational institutions. However, a 1% increase in the number of students per teacher in tertiary education indicates an increase of approximately 0.21% in GDP. This finding is contrary to general expectation and can be interpreted to mean that the increase in the number of students per teacher in tertiary education has a positive effect on GDP for Turkey.

The results of this research emphasize the importance of human capital in the economic growth process. Policies that increase the health of both society and the individual can increase the welfare level of the country. Considering that the main labor source of small and medium enterprises in Turkey is vocational and technical education institutions, the importance given to these institutions in educational policies should be increased. Practices that encourage enrollment in these types of institutions should be developed. The number of available institutions of these types should also be increased and special attention should be paid to prevent an increase in the number of students per teacher. Policies should also be adopted that encourage successful secondary school graduates to continue on to tertiary education, increase the quality of secondary school education and enhance the successful transition to tertiary institutions. The results of this research also indicate the substantial impact of an increase in TFP, pointing to a need to formulate policies for the development of technology and the efficient use of resources.

Although this study contains similar results with the literature, it has some important limitations. As mentioned above, life expectancy seems to have plateaued. Since quality of life is as important as life span in health economics literature, it is necessary to reflect the change in the quality of life to the models. In particular, the increasing prevalence and burden of noncommunicable diseases (NCDs) affect both health expenditures and economic development. Therefore, new models are needed to link the aspects of NCDs that take into account their impact on quality of life to economic growth. The present study can be improved in this aspect. The second important limitation of this study is the sectoral structure. Turkey's growth dynamic in recent years is moving away from productive sectors. This is therefore thought to be one reason why the impact of change in health and education levels is relatively low. This study can be developed in such a way that the return on health and education investments can be better seen and the change in the production structure is taken into account. The final limitation is that the change in the fertility structure is not considered. The fact that the fertility rate, which is an important determinant of *per capita* income, is not included in the present study, is a limitation, although it has a very long-term effect.

[4] Calculated by the authors from OECD data. 2012 was excluded due to an exceptional increase.

It is also important to emphasize the limitations arising from the dataset. The limitation of the data set caused the period under investigation to be relatively short. Again, because of the data availability, this study portrayed human capital through the variables of health and education in parallel to literature, although the five main elements of the concept of human capital are defined as health, on-the-job training, schooling, adult education, and migration (Teixeira 2014). Nevertheless, this paper may be a starting point for future studies. The belief is that this study can be repeated by generating a health index for Turkey and including other health variables. Additionally, with a more comprehensive framework, the effects of preventive and curative health can be distinguished and it may be possible to extend human capital to include on-the-job training, adult education, and migration alongside formal education and health.

References

Acemoğlu, Daron, and Simon Johnson. 2006. "Disease and Development: The Effect of Life Expectancy on Economic Growth." National Bureau of Economic Research Working Paper 12269.

Akıncı, Adil, and Güner Tuncer. 2016. "Türkiye'de Sağlık Harcamaları ile Ekonomik Büyüme Arasındaki İlişki." *Sayıştay Dergisi*, 102: 47-61.

Aslan, Alper, Angeliki N. Menegaki, and Can T. Tuğcu. 2016. "Health and Economic Growth in High-Income Countries Revisited: Evidence from an Augmented Production Function for the Period 1980-2009." *Quality and Quantity*, 50(2): 937-953. http://dx.doi.org/10.1007/s11135-015-0184-2

Atılgan, Emre, Dilek Kılıç, and Hasan M. Ertuğrul. 2017. "The Dynamic Relationship between Health Expenditure and Economic Growth: Is the Health-Led Growth Hypothesis Valid for Turkey?" *European Journal of Health Economics*, 18(5): 567-574. http://dx.doi.org/10.1007/s10198-016-0810-5

Ay, Ahmet, Oktay Kızılkaya, and Emrah Koçak. 2013. "Sağlık Göstergeleri ile Ekonomik Büyüme Arasındaki İlişki: Türkiye Örneği." *Niğde Üniversitesi İİBF Dergisi*, 6(1): 163-172.

Aydemir, Cahit, and Seniha Baylan. 2015. "Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi: Türkiye Üzerine Bir Uygulama." *Dicle Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 7(13): 417-435.

Barbi, Elisabetta, Francesco Lagona, Marco Marsili, James W. Vaupel, and Kenneth W. Wachter. 2018. "The Plateau of Human Mortality: Demography of Longevity Pioneers." *Science*, 360(6396): 1459-1461. http://dx.doi.org/10.1126/science.aat3119

Barro, Robert J. 1996. *Health and Economic Growth*. Cambridge, M. A.: World Health Organization.

Başar, Selim, Serkan Künü, and Gürkan Bozma. 2016. "Eğitim ve Sağlık Harcamalarının Ekonomik Büyüme Üzerine Etkisi: Türkiye Üzerine Bir Uygulama." *Iğdır Üniversitesi Sosyal Bilimler Dergisi*, 10: 189-204.

Belloumi, Mounir. 2014. "The Relationship between Trade, FDI and Economic Growth in Tunisia: An Application of the Autoregressive Distributed Lag Model." *Economic Systems*, 38(2): 269-287. http://dx.doi.org/10.1016/j.ecosys.2013.09.002

Bhargava, Alok, Dean T. Jamison, Lawrence J. Lau, and Christopher J. L. Murray. 2001. "Modeling the Effects of Health on Economic Growth." *Journal of Health Economics*, 20(3): 423-440. http://dx.doi.org/10.1016/S0167-6296(01)00073-X

Bloom, David E., and Pia N. Malaney. 1998. "Macroeconomic Consequences of the Russian Mortality Crisis." *World Development*, 26(11): 2073-2085. http://dx.doi.org/10.1016/S0305-750X(98)00098-9

Bloom, David E., Jeffrey D. Sachs, Paul Collier, and Christopher Udry. 1998. "Geography, Demography, and Economic Growth in Africa." In *Brookings Papers on Economic Activity*, 207-295. Washington, D. C.: Brookings Institution Press. http://dx.doi.org/10.2307/2534695

Bloom, David E., and Jeffrey G. Williamson. 1998. "Demographic Transitions and Economic Miracles in Emerging Asia." *The World Bank Economic Review*, 12(3): 419-455. http://dx.doi.org/10.1093/wber/12.3.419

Bloom, David E., and David Canning. 2003. "The Health and Poverty of Nations: From Theory to Practice." *Journal of Human Development*, 4(1): 47-71. http://dx.doi.org/10.1080/14649880032000051487

Bloom, David E., David Canning, and Jaypee Sevilla. 2004. "The Effect of Health on Economic Growth: A Production Function Approach." *World Development*, 31(1): 1-13. http://dx.doi.org/10.1016/j.worlddev.2003.07.002

Bloom, David E., Michael Kuhn, and Klaus Prettner. 2018. "Health and Economic Growth." Institute of Labor Economics Discussion Paper 11939.

Byrne, Joseph P., and Roger Perman. 2006. "Unit Roots and Structural Breaks: A Survey of the Literature." University of Glasgow Working Paper 2006-10.

Campbell, Denis. 2017. "Rise in Life Expectancy Has Stalled since 2010, Research Shows." *The Guardian*, July 18. https://www.theguardian.com/society/2017/jul/18/rise-in-life-expectancy-has-stalled-since-2010-research-shows.

Çalışkan, Şadan, Mustafa Karabacak, and Oytun Meçik. 2013. "Türkiye'de Sağlık-Ekonomik Büyüme İlişkisi." *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi*, 37: 123-130.

Caselli, Francesco, Gerardo Esquivel, and Fernando Lefort. 1996. "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics." *Journal of Economic Growth*, 1(3): 363-389. http://dx.doi.org/10.1007/BF00141044

Çetin, Murat, and Eyyup Ecevit. 2010. "Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: OECD Ülkeleri Üzerine Bir Panel Regresyon Analizi." *Doğuş Üniversitesi Dergisi*, 11(2): 166-182. http://dx.doi.org/10.31671/dogus.2019.160

Çetinsaya, Gökhan. 2014. *Büyüme, Kalite, Uluslararasılaşma Türkiye Yükseköğretimi İçin Bir Yol Haritası*. Eskişehir: Yükseköğretim Kurulu.

Court, Stephen. 2012. "An Analysis of Student: Staff Ratios and Academics' Use of Time, and Potential Links with Student Satisfaction." https://www.ucu.org.uk/media/5566/An-analysis-of-studentstaff-ratios-and-academics-use-of-time-and-potential-links-with-student-satisfaction-Dec-12/pdf/ucu_ssranalysis_dec12.pdf.

Demirgil, Bünyamin, Fatih Şantaş, and Gülcan Şantaş. 2017. "Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: Uygulamalı Bir Çalışma [özet]." In *Uluslararası Politik, Ekonomik ve Sosyal Araştırmalar Kongresi Bildiri Özetleri Kitabı*. Ankara: Center for Political, Economic and Social Research.

Denison, Edward F. 1974. *Accounting for United States Economic Growth, 1929-1969*. Washington, D. C.: Brookings Institution.

Doğan, İbrahim. 2016. "Verimlilik, Ekonomik Büyüme ve Sağlık İlişkisi; Türkiye için Doğrusal Olmayan Nedensellik Testi." *Ekonomi ve Yönetim Araştırmaları Dergisi*, 5(2): 21-48.

Erdil, Erkan, and İbrahim Hakan Yetkiner. 2004. "A Panel Data Approach for Income-Health Causality." Hamburg University Research Unit Sustainability and Global Change Working Paper FNU-47.

Erdoğan, Seyfettin, and Hilal Bozkurt. 2008. "Türkiye'de Yaşam Beklentisi - Ekonomik Büyüme İlişkisi: Ardl Modeli ile Bir Analiz." *Bilgi Ekonomisi ve Yönetimi Dergisi*, 3(1): 25-38.

Eryiğit, Sibel Bali, Kadir Y. Eryiğit, and Ufuk Selen. 2012. "The Long-Run Linkages between Education, Health and Defence Expenditures and Economic Growth:

Evidence from Turkey." *Defence and Peace Economics*, 23(6): 559-574. http://dx.doi.org/10.1080/10242694.2012.663577

Frieden, Thomas R. 2018. "U.S. Life Expectancy Is Dropping: Here's how to Fix It." *The Washington Post*, January 11. https://www.washingtonpost.com/opinions/us-life-expectancy-is-dropping-heres-how-to-fix-it/2018/01/11/c6aa6420-f3b4-11e7-beb6-c8d48830c54d_story.html?noredirect=on&utm_term=.b6688dd03f72.

Frimpong, Joseph M., and Eric F. Oteng-Abayie. 2006. "Bounds Testing Approach: An Examination of Foreign Direct Investment, Trade, and Growth Relationships." Munich Personal RePEc Archive Paper 352.

Gallup, John L., and Jeffrey D. Sachs. 2000. "The Economic Burden of Malaria." Center for International Development at Harvard University Working Paper 52.

Grossman, Michael. 1999. "The Human Capital Model of the Demand for Health." National Bureau of Economic Research Working Paper 7078.

Hamoudi, Amar A., and Jeffrey D. Sachs. 1999. "Economic Consequences of Health Status: A Review of the Evidence." Center for International Development at Harvard University Working Paper 30.

Hanushek, Eric A., and Ludger Wössmann. 2007. *Education Quality and Economic Growth*. Washington, D. C.: World Bank.

Independent Staff. 2018. "Rise in Life Expectancy Slowing Down in the UK, Figures Show." *Independent*, August 07. https://www.independent.co.uk/news/uk/home-news/life-expectancy-uk-rise-slowing-down-world-richest-countries-statistics-a8481416.html.

Karagöl, Veysel, and Meltem Erdoğan. 2016. "Cari Açığın Belirleyicilerine Yönelik Bir Zaman Serisi Analizi: Türkiye Örneği." *Sakarya İktisat Dergisi*, 5(2): 31-56.

Karşıyakalı, Başak. 2008. "Türkiye'de Ekonomik Büyümenin Kaynaklarının Analizi." PhD diss. Dokuz Eylül Üniversitesi.

Keeley, Brian. 2007. *OECD Insights: Human Capital: How what You Know Shapes Your Life*. Paris: OECD.

Kesbiç, Cüneyt Y., and Gökhan Salman. 2018. "Türkiye'de Sağlık Harcamaları ve Ekonomik Büyüme Arasındaki İlişkinin Tespiti: 1980-2014 VAR Model Analizi." *Finans Politik & Ekonomik Yorumlar*, 639: 163-180.

Kılıç, Nazife Ö., and Murat Beşer. 2018. "Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkileri: Merkezi ve Doğu Avrupa (CEEC) Ülkeleri Üzerine Panel Veri Analizi." *Süleyman Demirel Üniversitesi İİBF Dergisi*, 23(2): 373-382.

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

Lau, Lawrence J., Dean T. Jamison, and Frederic F. Louat. 1991. "Education and Productivity in Developing Countries: An Aggregate." Development Economics and Population and Human Resources Department Working Paper.

Lucas, Robert E. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics*, 22: 3-42. http://dx.doi.org/10.1016/0304-3932(88)90168-7

Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *The Quarterly Journal of Economics*, 107(2): 407-437. http://dx.doi.org/10.2307/2118477

Morgado, So'nia Maria Aniceto. 2014. "Does Health Promote Economic Growth? Portuguese Case Study: From Dictatorship to Full Democracy." *European Journal of Health Economics*, 15(6): 591-598. http://dx.doi.org/10.1007/s10198-013-0497-9

Mushkin, Selma J. 1962. "Health as an Investment." *The Journal of Political Economy*, 70(5): 129-157. http://dx.doi.org/10.1086/258730

Nkoro, Emeka, and Aham K. Uko. 2016. "Autoregressive Distributed Lag (ARDL) Cointegration Technique: Application and Interpretation." *Journal of Statistical and Econometric Methods*, 5(4): 63-91.

Organisation for Economic Co-operation and Development. 2008. *Education at a Glance 2008: OECD Indicators*. Paris: OECD Publications.

Organisation for Economic Co-operation and Development. 2017. *Education at a Glance 2017: OECD Indicators*. Paris: OECD Publishing.

Ouattara, Bazoumana. 2004. "The Impact of Project Aid and Programme Aid Inflows on Domestic Savings: A Case Study of Côte d'Ivoire." https://www.econstor.eu/obitstream/10419/39902/1/AEL_2008_31_ouattara.pdf.

Perron, Pierre. 1989. "The Great Crash, the Oil Price Shock and the Unit Root Hypothesis." *Econometrica*, 57(6): 1361-1401. http://dx.doi.org/10.2307/1913712

Perron, Pierre, and Timothy J. Vogelsang. 1992. "Nonstationarity and Level Shifts with an Application to Purchasing Power Parity." *Journal of Business and Economic*, 10(3): 301-320. http://dx.doi.org/10.2307/1391544

Perron, Pierre. 1997. "Further Evidence on Breaking Trend Functions in Macroeconomic Variables." *Journal of Econometrics*, 80(2): 355-385. http://dx.doi.org/10.1016/S0304-4076(97)00049-3

Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith. 2001. "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics*, 16(3): 289-326. http://dx.doi.org/10.1002/jae.616

Romer, David. 1996. *Advanced Macroeconomics*. Singapore: McGraw-Hill.

Sachs, Jeffrey D., and Andrew M. Warner. 1997. "Sources of Slow Growth in African Economies." *Journal of African Economies*, 6(3): 335-376. http://dx.doi.org/10.1093/oxfordjournals.jae.a020932

Schultz, Theodore W. 1961. "Investment in Human Capital." *The American Economic Review*, 51(1): 1-17.

Selim, Sibel, Doğan Uysal, and Pınar Eryiğit. 2014. "Türkiye'de Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisinin Ekonometrik Analizi." *Niğde Üniversitesi İİBF Dergisi*, 7(3): 13-24.

Şen, Ali, and Nergis Bingöl. 2018. "Sağlık Harcamaları ve Ekonomik Büyüme İlişkisi: Türkiye Örneği." *Akademik Yaklaşımlar Dergisi*, 9(1): 89-106.

Taban, Sami. 2006. "Türkiye'de Sağlık ve Ekonomik Büyüme Arasındaki Nedensellik İlişkisi." *Sosyoekonomi*, 2: 31-46.

T.C. Millî Eğitim Bakanlığı. 2013. *Millî Eğitim İstatistikleri Örgün Eğitim 2012-2013*. Ankara: Destek Hizmetleri Genel Müdürlüğü.

T.C. Millî Eğitim Bakanlığı. 2014. *Millî Eğitim İstatistikleri Örgün Eğitim 2013/'14*. Ankara: Destek Hizmetleri Genel Müdürlüğü.

T.C. Millî Eğitim Bakanlığı. 2015. *Millî Eğitim İstatistikleri Örgün Eğitim 2014/'15*. Ankara: Destek Hizmetleri Genel Müdürlüğü.

T.C. Millî Eğitim Bakanlığı. 2017. *Millî Eğitim İstatistikleri Örgün Eğitim 2016/'17*. Ankara: Destek Hizmetleri Genel Müdürlüğü.

Teixeira, Pedro. 2014. “Gary Becker’s Early Work on Human Capital - Collaborations and Distinctiveness.” *IZA Journal of Labor Economics*, 3(1): 1-20. http://dx.doi.org/10.1186/s40172-014-0012-2

Temiz, Dilek, and Suna Korkmaz. 2007. “Türkiye’de Sağlık ve Ekonomik Büyüme İlişkisi: 1965-2005 Dönemi.” In *16. İstatistik Araştırma Sempozyumu Bildiriler Kitabı “Sosyo-Ekonomik Gelişme ve İstatistik”*, 266-278. Ankara: TÜİK.

Thao, Do Thi, and Zhang Jian Hua. 2016. “ARDL Bounds Testing Approach to Cointegration: Relationship International Trade Policy Reform and Foreign Trade in Vietnam.” *International Journal of Economics and Finance*, 8(8): 84-94. http://dx.doi.org/10.5539/ijef.v8n8p84

Wooldridge, Jeffrey M. 2013. *Introductory Econometrics: A Modern Approach*. 5th ed. Mason: South-Western.

World Health Organization. 2006. “World Health Statistics 2006 Definitions and Metadata.” http://www.who.int/whosis/whostat2006DefinitionsAndMetadata.pdf.

Yetkiner, İbrahim Hakan. 2006. “Sağlık ile Büyüme.” *Ege Academic Review*, 6(2): 83-91.

Yılancı, Veli. 2009. “Yapısal Kırılmalar Altında Türkiye için İşsizlik Histerisinin Sınanması.” *Doğuş Üniversitesi Dergisi*, 10(2): 324-335.

Yıldız, Barış, and Gizem Yıldız. 2018. “Sağlık Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: Avrupa ve Merkez Asya Ülkeleri Örneği.” *Maliye Dergisi*, 174: 203-218.

Zivot, Eric, and Donald W. K. Andrews. 1992. “Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis.” *Journal of Business & Economic Statistics*, 10(3): 25-44. http://dx.doi.org/10.2307/1391541

Appendix

Table A1 Studies That Include Health as a Determinant of Economic Growth

Study	Data	Method	Dependent variable	Effect of health measure(s)
Barro (1996)	Panel 100 countries 1960-1990	3 stages least squares No production function (NPF)	Growth rate *per capita*	A 1% increase in life expectancy at birth (LE) increases the growth rate *per capita* by 0.0423 points. A 1% increase in fertility rate decreases the growth rate *per capita* by 0.0161 points.
Caselli , Esquiandl, and Lefort (1996)	Panel 97 countries 1960-1985	Generalized method of moments (GMM) NPF	GDP	LE: insignificant
Sachs and Warner (1997)	Cross-section 79 countries 1965-1990	Ordinary least squares (OLS) NPF	GDP *per capita*	An increase of one standard deviation in LE increases *per capita* economic growth rate by 0.70 points.
Bloom and Manaley (1998)	Cross-section 77 countries 1965-1991	OLS NPF	GDP *per capita*	A 5 unit increase in LE increases the economic growth rate by 0.21 points.
Bloom et al. (1998)	Cross-section 73 countries 1965-1990	OLS NPF	GDP *per capita*	A 5 unit increase in LE increases the economic growth rate by 0.29 points.
Bloom and Williamson (1998)	Cross-section 78 countries 1965-1990	OLS NPF	GDP *per capita*	A 5 unit increase in LE increases the economic growth rate by 0.32 points.
Hamoudi and Sachs (1999)	Cross-section 78 countries 1965-1990	OLS NPF	-	There is a remarkably robust correlation between economic and health indicators (LE, infant mortality rate, fertility rate, protein consumption, calorie intake, malaria index, vaccination coverage).
Gallup and Sachs (2000)	Cross-section 75 countries 1965-1990	OLS NPF	GDP *per capita* growth	Countries with intense malaria impact grow 1.3% less per year. A 1% increase in LE increases economic growth by 4%.
Bhargava et al. (2001)	Panel 92 countries 1965-1990	Dynamic random effects NPF	GDP *per capita*	An increase in adult survival rate increases economic growth and an increase in fertility rate decreases economic growth.
Bloom, Canning, and Sevilla (2004)	Panel 104 countries 1960-1990	Non-linear 2 stages least squares Production function exists	GDP	Under the assumption that total factor productivity is the same in all countries, a 1-year increase in LE increases GDP by 1.3%. When this assumption is abandoned, a 1-year increase in LE increases real GDP by 4%.
Erdil and Yetkiner (2004)	Panel 75 countries 1990-2000	Granger causality NPF	-	Bi-directional causality has been determined in 46 countries. In cases where causality is unidirectional; the direction of causality is from health to GDP in high-income countries, and from GDP to health in other country groups.
Acemoğlu and Johnson (2006)	Panel 120 countries 1960-2000	OLS and 2 stages least squares NPF	GDP and GDP *per capita*	The initial impact of LE growth on GDP is positive, but rather small. The increase in LE decreases *per capita* GDP in the first place. This negative effect decreases in the following 40 years. It has not been determined that the increase in LE results in faster *per capita* growth.
Taban (2006)	Time series Turkey 1968-2003	Johansen cointegration NPF	-	A bi-directional causality relationship between LE, the number of beds in healthcare institutions, and the number of people per healthcare personnel and growth has been determined. The causality relationship between the number of health institutions and economic growth has not been determined. It shows that the increase in LE and the increase in the number of beds in health institutions have a positive effect on growth, while the increase in the number of people per healthcare personnel has a growth-reducing effect. Health indicators are positively affected by the increase in GDP.
Temiz and Korkmaz (2007)	Time series Turkey 1965-2005	Johansen cointegration NPF	-	The increase in LE has a positive effect on Gross National Product (GNP), while the increase in infant mortality rates has a negative effect. In the long term; A bidirectional causality relationship between GNP and LE, and a unidirectional causality relationship between GNP and infant mortality rates from infant mortality rates to GNP has been determined.

Erdoğan and Bozkurt (2008)	Time series Turkey 1980-2005	ARDL bounds test NPF	-	GNP and LE series are cointegrated, but the coefficients are insignificant.
Çetin and Ecevit (2010)	Panel 15 countries 1960-2005	OLS NPF	GDP	Public health spending/total health spending: insignificant
Eryiğit, Eryiğit, and Selen (2012)	Time series Turkey 1950-2005	Johansen cointegration NPF	-	A 1% increase in GNP increases health expenditures by 0.52%, and a 1% increase in health expenditures increases GNP by 0.91%.
Ay, Kızılkaya, and Koçak (2013)	Time series Turkey 1968-2006	Johansen-Juselius cointegration NPF	GDP	A 1% increase in the number of inpatient health institutions increases the GDP by 13.21%. A 1% increase in the number of outpatient health institutions increases the GDP by 0.79%. A 1% increase in the number of people per medical officer increases the GDP by 5.60%.
Çalışkan, Karabacak, and Meçik (2013)	Time series Turkey 1967-2010	Granger causality NPF	-	A unidirectional causality from health variables (LE, the number of hospitals, the number of people per healthcare personnel, the number of beds) to GDP has been determined.
Morgado (2014)	Time series Portugal 1960-2005	VAR causality Production function exists	-	Growth is the cause of health (LE and infant mortality rate)
Selim, Uysal, and Eryiğit (2014)	Panel 28 countries 2001-2011	Panel error correction model NPF	GDP	A 1% increase in *per capita* health expenditures increases GDP by 0.9%.
Aydemir and Baylan (2015)	Time series Turkey 1998-2012	Granger causality NPF	-	Bi-directional causality has been determined between health expenditures and GDP.
Akıncı and Tuncer (2016)	Time series Turkey 2006-2016	Granger causality NPF	-	Bi-directional causality has been determined between health expenses in central government budget/GDP and GDP.
Aslan, Menegaki, and Tuğcu (2016)	Time series 7 countries 1980-2009	ARDL bounds test Production function exists	GDP	A 1% increase in health expenditures increases GDP by approximately 0.40% (only in France)
Başar, Künü, and Bozma (2016)	Time series Turkey 1998-2016	ARDL bounds test NPF	GDP	A 1% increase in health expenditures increases GDP by 1.13%.
Doğan (2016)	Time series Turkey 1960-2013	Non-linear Granger causality NPF	-	Bi-directional causality has been determined between health expenditures and GDP.
Atılgan, Kılıç, and Ertuğrul (2017)	Time series Turkey 1975-2013	ARDL bounds test NPF	GDP	A 1% increase in health expenditures increases GDP by approximately 0.43%.
Demirgil, Şantaş, and Şantaş (2017)	Time series Turkey 2010-2016	ARDL bounds test NPF	Growth	A 1% increase in health expenditures increases GDP by 0.55%.
Kesbiç and Salman (2018)	Time series Turkey 1980-2014	VAR analysis NPF	GDP *per capita*	While the effect of public health expenditures on economic growth is positive, the effect of private health expenditures on economic growth is negative.
Kılıç and Beşer (2018)	Panel 8 countries 1995-2016	Toda-Yamamoto causality NPF	GDP *per capita*	Bi-directional causality has been determined between health expenditures/GDP and GDP.
Kılıç and Özbek (2018)	Panel 32 countries 1995-2013	Fully Modified OLS and Dynamic OLS NPF	-	Fully Modified OLS: a 1% increase in health expenditures increases GDP by 0.45%, and a 1% increase in GDP increases health expenditures by 0.75%. Dynamic OLS: a 1% increase in health expenditures increases GDP by 0.38%, and a 1% increase in GDP increases health expenditures by 0.29%.
Şen and Bingöl (2018)	Time series Turkey 2006-2017	Toda-Yamamoto causality NPF	-	Bidirectional causality has been determined among all variables (GDP, medicine expenditures, transfers for health, general health treatment material expenses)
Yıldız and Yıldız (2018)	Panel 47 countries 1996-2014	2 stages GMM NPF	GDP *per capita*	A 1% increase in *per capita* health expenditures increases *per capita* GDP by 0.29%.

Source: Authors' compilation.

THIS PAGE INTENTIONALLY LEFT BLANK