6. BÖLÜM / CHAPTER 6

ON THE RELATIONSHIP BETWEEN HEALTH EXPENDITURES, GDP, AIR POLLUTION AND POPULATION AGEING: EVIDENCE FROM TURKEY

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ABSTRACT

This paper investigates the long-term relationship between health expenditures, GDP, CO2 emissions as an indicator of air pollution, and population aging in Turkey over the period of 1975 through 2018. For this purpose, we apply the Carrion-i Silvestre et al. (2009) unit root test and the Maki (2012) cointegration test by taking into account the effects of structural breaks. These techniques have an advantage of allowing up to five multiple structural breaks. As the first step of our analysis, we used traditional unit root tests by neglecting the existence of possible structural breaks and found that all the series were nonstationary in level but stationary after first differencing. Then, the same results were obtained based on the Carrion-i Silvestre et al. (2009) unit root tests. These results led us to use the Maki(2012) cointegration test with multiple structural breaks in the long-term relationship between health expenditures, GDP, CO2 emissions, and the aging population. According to the results of three different cointegration model specifications (A, B, and C), the evidence of a long-term relationship was found between health expenditures and GDP and also between health expenditures, GDP, and CO2 emissions. However, there is no evidence of a long-term relationship between health expenditures, GDP, CO2 emissions, and the aging population.

Keywords: Health expenditures, GDP, CO2 emissions, Population ageing, Structural breaks

1. Introduction

Over the past two decades, it has been revealed that there is a very close relationship between health expenditures and economic development level. In societies that have achieved a certain level of economic development, more resources are allocated to improve the quality of health services in order to invest in the labor force (World Health Organisation, 2005). This development in health level increases economic growth by increasing productivity. The treatment of diseases and the protection and improvement of human health are essential elements of economic development. However, although the development levels, socio-cultural values, and health policies of countries are different, the reasons for the increase in health expenditures are generally similar. Many factors affect healthcare spending such as an increase in personal income, technological developments in the medical field, changes in the demographic structure, increases in global health risks, increases in chronic diseases, urbanization, environmental factors, increases in education level and health awareness, easier access to health services, changes in social value judgments, the prolongation of life, changes in the social order, and personal lifestyles (Hansen and King, 1996). The most important of these factors affecting health expenditures is the increase in per capita income. Individuals tend towards goods and services that will enable them to live more comfortably as their income increases. Those who want to improve their living conditions will increase the demand for health services. Since the seminal paper by Newhouse (1977), there has been wide empirical literature on the relationship between health expenditures and income [Baltagi and Moscone, 2010; Baltagi et al., 2017; Boachie and Ramu, 2016; Chaabouni and Abednnadher, 2014; Erdil and Yetkiner, 2009; Feldstein, 1988; Hitiris and Posnett, 1992; Mehrara et al., 2012; Samadi and Rad, 2013; Odubunmi et al., 2012; Wang, 2011].

On the other hand, the increase in the economic welfare of countries has triggered the consumption of global fossil fuel-based energy resources and increased global greenhouse gas emissions. The effects of environmental problems, such as carbon dioxide emission, global warming, increased use of natural resources and air pollution, have been felt more intensely, especially since the 1990s. With the deterioration of global environmental quality, the health conditions of individuals have deteriorated, and this situation has made environmental pollution a global problem, which is another important cause of the increase in health expenditures. The inverted U-shaped relationship between economic growth and environmental pollution indicators was defined by Kuznets (1955) with the Environmental Kuznets Curve Hypothesis. With the growth in income level, there is an increase in consumption. Since this increase is at the expense of environmental quality, environmental pollution is increasing. On the other

hand, as income increases, along with the desire to increase environmental quality, sacrifices are made in consumption. This effect was investigated by Grossman and Krueger (1996) in three ways: the scale effect, the composition effect, and the technology effect. The scale effect measures pollution that occurs as a result of the increase in production and manufactured goods. As industrialization increases, it has been seen that environmental pollution is increasing due to the use of more natural resources, more pollutant emissions, less efficient and relatively dirty technologies, and the high priority and negligence toward increases in material production. The composition effect covers the change in the share of polluting goods in the national income. With the increase in income, the service and informatics sector begins to gain an important place in the economy. Later, in the post-industrial phase, the transition to cleaner technologies and knowledge- and service-based activities are combined with the increased ability and willingness to improve environmental quality. This is shown as the decreasing part of the curve and is known as the technology effect (Dinda, 2004). Although there are many studies on the Environmental Kuznets Curve Hypothesis, much less attention is paid to the relationship between environmental pollution and health expenditures [Apergis et al., 2018; Beatty and Shimshack, 2014; Brunekreef and Holgate, 2002; Janke et al., 2009; Mead and Brajer, 2005; Narayan and Narayan, 2008; Qureshi et al., 2015; Remoundou and Koundouri, 2009; Wordley et al., 1997; Yazdi et al., 2014].

Another factor that increases health expenditures is the increase in the elderly population because with the continuous increase in average life expectancy, the aging of the population, the emergence of new diseases as age progresses, the increase in chronic diseases, the increase in the need for health services, the prolongation of care periods in diseases, and the obligation to stay in health institutions for more time than necessary increase health expenditures significantly (Zweifel et al., 1999). When health expenditures are examined in many countries, the lowest expenditures are made for children. Health expenditures increase due to increasing age and increase exponentially specifically after the age of 50 years old. The share transferred by the elderly population to health expenditures is higher than the young population. Personal health expenditures increase significantly specifically among the population over 65 years of age. According to a study conducted for the United States, the population over the age of 85 demands 3 times more health services than the population aged 65-74 and 2 times more than the population aged 75-84 (Alemayehu and Warner, 2004). Despite the importance of an aging population on health expenditures, there is little literature on the relationship between aging populations and health expenditures [De Meijer et al., 2013; Payne et al., 2007; Pammolli et al., 2012; Zweifel et al. 1999]. However, there are some studies that use the aging population

as an explanatory [Bloom et al., 2015; Chaabouni and Abednnadher, 2014; Di Matteo and Di Matteo, 1998; Murthy and Okunade, 2009; Novignon et al., 2015; Rahman, 2008].

This paper investigates the long-term relationship between health expenditures, GDP, carbon dioxide emissions (CO₂) (as an indicator for air pollution), and the aging population in Turkey over the period of 1975 to 2018. The contribution of the paper to the literature is that this paper takes into account health expenditures, GDP, carbon dioxide emissions, and the aging population together in the same analysis for Turkey and applies the Carrion-i Silvestre et al. (2009) unit root test and the Maki (2012) cointegration test by considering the effects of structural breaks in the relationship. These techniques have an advantage of allowing up to five multiple structural breaks. This allows placing greater confidence in the results.

The paper is arranged as follows: Section 2 outlines the methodologies of the Carrion-i Silvestre et al. (2009) unit root test and the Maki (2012) cointegration test while Section 3 describes the data and reports the results. Finally, Section 4 concludes.

2. Methodology

This paper examines the long-term relationship between health expenditures, GDP, CO₂ emissions, and the aging population in Turkey by using the Carrion-i Silvestre et al. (2009) unit root tests and the Maki (2012) cointegration test. As the first step, the Carrion-i Silvestre et al. (2009) unit root tests was carried out for unit root properties of the series. Second, the Maki (2012) cointegration test was applied for long-term relationships. Details of the test methodologies are explained as follows.

2.1. Carrion-i Silvestre et al. (2009) unit root test with multiple structural breaks

The unit root tests developed by Carrion-i Silvestre et al. (2009) take up to five structural breaks with the following features: (i) the tests allow an arbitrary number of changes in both level and slope of the trend function; (ii) when defining structural breaks, they use the algorithm of Bai and Perron (2003) through the quasi-generalized least squares (quasi-GLS) method and dynamic programming process which minimizes the residual sum of squares; (iii) the tests include the feasible point optimal statistics (Elliott et al., 1996) and M class unit root tests presented in Stock (1999) and analyzed in Ng and Perron (2001). The Data Generating Process (DGP) of the test can be written as follows:

$$y_t = d_t + u_t \tag{1}$$

$$u_t = \alpha u_{t-1} + v_t, \quad t = 0, 1, \dots, T \tag{2}$$

where u_t is an unobserved mean-zero process. The null hypothesis of the unit root under multiple structural breaks is tested by using five different statistics. One of them is the feasible point optimal statistic given by:

$$P_T^{GLS}(\lambda^0) = \frac{\{S(\bar{\alpha}, \lambda^0) - \bar{\alpha}S(1, \lambda^0)\}}{s^2(\lambda^0)} \quad (3)$$

Here, λ is the break fraction, $\bar{\alpha}$ equals $1 + \bar{c}/T$ with $\bar{c}$ as the noncentrality parameter and $s^2(\lambda^0)$ as an estimate of the spectral density at frequency zero of v_t . Following Perron and Rodriguez (2003), Carrion-i Silvestre et al. (2009) also use the M-class of tests analyzed in Ng and Perron (2001), allowing for multiple structural breaks, as follows:

$$MZ_{\alpha}^{GLS}(\lambda^0) = \left(T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2 \right) \left(2T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2 \right)^{-1} \quad (4)$$

$$MSB_T^{GLS}(\lambda^0) = \left(s(\lambda^0)^{-2} T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2 \right)^{1/2} \quad (5)$$

$$MZ_T^{GLS}(\lambda^0) = \left(T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2 \right) \left(4s(\lambda^0)^2 T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2 \right)^{-1/2} \quad (6)$$

with $y_t^2 = \tilde{y}_t - \hat{\psi}' z_t(\lambda^0)$ where $\hat{\psi}$ minimizes the objective function, and $s^2(\lambda^0)^2$ is an autoregressive estimation function. As a last statistic, Carrion-i Silvestre et al. (2009) use a modified feasible point optimal test following Ng and Perron (2001). This statistic can be defined as below:

$$MP_T^{GLS}(\lambda^0) = \frac{\left[\bar{c}^2 T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2 + (1 - \bar{c}) T^{-1} \tilde{y}_T^2 \right]}{s(\lambda^0)^2}. \quad (7)$$

The $MP_T^{GLS}(\lambda^0)$ statistic is important since its limiting distribution coincides with the feasible point optimal test. The asymptotic critical values of the tests are calculated through a bootstrap approach. If the test statistics are smaller than the corresponding critical values, the null hypothesis is rejected, giving stationarity.

2.2. Maki (2012) cointegration test with multiple structural breaks

The cointegration test suggested by Maki (2012) allows for an unknown number of breaks based on the test of Bai and Perron (1998) for multiple structural breaks and the Kapetanios (2005) unit root test with m-structural breaks. Maki (2012) uses four different models to test for cointegration, allowing for multiple breaks, as follows:

Model 1, with a break in the intercept and without trend:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \beta x_t + v_t$$

Model 2, with a break in the intercept and coefficients and without trend:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t$$

Model 3, with a break in the intercept and coefficients and with trend:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \gamma t + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t$$

Model 4, with a break in the intercept, coefficient, and trend:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \gamma t + \sum_{i=1}^k \gamma_i t K_{i,t} + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t$$

In these models, K_i stands for dummy variables constructed as follows:

$$K_i = \begin{cases} 1 & \text{when } t > T_B \\ 0 & \text{otherwise} \end{cases}$$

where T_B is the time of the break point. In order to test the null hypothesis of no cointegration under structural breaks, critical values are computed by using Monte - Carlo simulations as can be found in Maki (2012).

3. Data and empirical results

In this paper, we used annual per capita health expenditures, per capita GDP, per capita CO₂ emissions, and the population aged 65 and over (thousands of people) for Turkey in the period of 1975-2018. The data source, except per capita CO₂ emissions, came from the OECD statistics database. We obtained per capita CO₂ emissions data from the World Development

Based on the results in the table, it is clear that the unit root null hypothesis cannot be rejected for the series, which was consistent with the ADF and PP unit root tests. These results led us to use cointegration tests in the long-term relationship between LHEALTH, LGDP, LCO₂, and LPOPULATION for Turkey. Since conventional cointegration tests are biased towards accepting the null of no cointegration if there are structural breaks in the relationship and produce spurious cointegration results, we used the Maki (2012) cointegration test with multiple structural breaks. Here, we considered three different cointegration models by adding variables step by step. As a first model, we examined the long-term relationship between LHEALTH and LGDP (Cointegration Model A). Then, we included LCO₂ to the cointegration model and tested the long-term relationship between LHEALTH, LGDP, and LCO₂ (Cointegration Model B). As a last model, the long-term relationship between LHEALTH, LGDP, LCO₂, and LPOPULATION was investigated (Cointegration Model C). The cointegration test results of these three models are tabulated in Table 3 under three structural breaks.

Table 3

The results of Maki (2012) cointegration tests under three structural breaks

Test Models	Statistics	Break years
Cointegration Model A: $LHEALTH = f(LGDP)$		
Model 1	-4.054	1978; 1981; 1985
Model 2	-4.274	1998; 1995; 2006
Model 3	-4.951	1978; 1981; 1984
Model 4	-7.680 ^a	1982; 1997; 2009
Cointegration Model B: $LHEALTH = f(LGDP, LCO_2)$		
Model 1	-5.167 ^c	1989; 1998; 2006
Model 2	-4.848	1980; 1999; 2007
Model 3	-4.827	1977; 2010; 2015
Model 4	-6.591	1981; 1995; 2002
Cointegration Model C: $LHEALTH = f(LGDP, LCO_2, LPOPULATION)$		
Model 1	-4.609	1990; 1996; 1998
Model 2	-5.288	1990; 1996; 1998
Model 3	-6.215	1982; 1988; 1997
Model 4	-6.564	1991; 1997; 2008
Notes: ^a and ^c denote the rejection of the null hypothesis of “no cointegration” at the 1% and 10% significance levels, respectively. Critical values can be found in Table 1 of Maki(2012).		

The results in the table show that there is evidence of a long-term relationship between LHEALTH and LGDP for Turkey, according to test model 4, when we take into account cointegration model A. The results of cointegration model B give evidence of a long-term

relationship between LHEALTH, LGDP, and LCO₂ based on test model 1. However, no evidence of a long-term relationship was found between LHEALTH, LGDP, LCO₂, and LPOPULATION when cointegration model C is considered. When we give our attention to the structural break dates for the cases with cointegration, it is seen that the first, second, and third breaks occur in 1982, 1997, and 2009 for the relationship between LHEALTH – LGDP, and also in 1989, 1998, and 2006 for the relationship between LHEALTH – LGDP – LCO₂, respectively. These identified breaks correspond to important periods in terms of the health system of Turkey. After 1980, private health services were supported instead of the public health services in Turkey, as in other countries. For this purpose, significant changes were made in both the legal and institutional structure. With article 56 of the 1982 Constitution, health services were removed from being a service that the state was obliged to provide, and the state was tasked with “planning and regulating the provision of health institutions from one source.” In the 1990’s, climate change, global warming, and environmental degradation topics had become important. Increased carbon dioxide emissions and the relation to income level had been questioned. In these years, regulations were made under the name of “health reforms” in Turkey. With the “Social Insurance and General Health Insurance Law,” which is enacted in 2006 and entered into force in 2008, the financing of health and health service provision were definitively separated from each other. The model of receiving services from the “Social Security Institution” was created with this law by collecting health financing. Due to these regulations in the health system of Turkey, changes occurred in the long-term relationships between health expenditures and other determinants.

4. Conclusions

This paper examined the long-term relationship between health expenditures, GDP, CO₂ emissions as an indicator of air pollution, and the population aged 65 and over in Turkey for the period of 1975-2018. To achieve this goal, we used the Carrion-i Silvestre et al. (2009) unit root test and the Maki (2012) cointegration test by considering the effects of structural breaks in the relationships. Taking into account these structural breaks permitted confidence in the results. Depending on the length of the data, these tests were applied for three structural breaks. Since the results of the Carrion-i Silvestre et al. (2009) unit root test indicated that all the series were nonstationary in level but stationary after first differencing, these results led us to use the Maki (2012) cointegration test for the long-term relationship between LHEALTH, LGDP, LCO₂, and LPOPULATION. Based on the results of three different cointegration models (A, B, and C), the evidence of a long-term relationship was found between LHEALTH and LGDP and also between LHEALTH, LGDP, and LCO₂. However, there was no evidence

of a long-term relationship between LHEALTH, LGDP, LCO₂, and LPOPULATION. When attention was given to the identified structural breaks for the cointegration cases, it was seen that these breaks corresponded to important periods and regulations of the health system of Turkey.

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