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Health Expenditures and Gross Domestic Product An Empirical Analysis for Member-Countries of European Union with Cointegration Analysis

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Abstract: This study investigates the relationship between health expenditures and GDP for 15 member - countries of European Union. Initially, the unit root test is examined for all used variables and then the Engel - Granger and Johansen and Juselious cointegration tests are applied. In order to examine the short - run and long - run relationships of the above variables an error correction model methodology is used. The results of this analysis suggest that there is a long - run relationship between health expenditures and GDP in most member-countries of European Union.

Key words: Health Expenditures, Gross Domestic Product, European Union, Cointegration

INTRODUCTION

In many countries world wide, the health economics sector becomes more important as it appears from the increasing shares that this sector absorbs in relation to GDP. This is the reason why health economics has started to consist an important section of economic science. As a result, this fact has appointed an important course of health economics in education, which started to consist an individual schedule studies in many universities to consist an individual schedule studies, independent and dynamic by itself.

The obligation of those factors that have taken on the disposal of health sector services is the rational allocation resources for health, so that the real needs of the population are satisfied and the social inequalities are avoided.

The demand on health sector services and medical care doesn't consist an end itself for any consumer of these services, but a necessary precondition in order to ensure the human health as the most desired good [1,2]. The most important thing is the double role, which the demand achieves clearly at a consumption level, since all people want to be and feel healthy. It is obvious that the demand on health services sector can't be faced as the demand for any other good. The magnitude of health sector services is regarded more as pharmaceutical rather than preventive.

The major factors that possibly affect the increase of health expenditures are the following:

- The demographic population growth. It is known that the cost of expenditures of health sector services is increased by the population senility rate, which implies degenerative diseases and other illnesses, which are mentioned by some medical studies [3].
- The technology. Undoubtedly, the rapid technological progress, which is noteworthy nowadays and its frantic course has affected every expression of economic activity of modern human, would be impossible if it did not affect the provision of health sector services [4]. The technological progress is basically defined by the total expenditures on research and development sector and by the modulation of total expenditures of health sector services from supply - leading.
- The economic development. Many studies focused on the relationship between GDP and health sector services [5,6,7]. In the results of these studies there was a variety as it is ascertained by some of them that health is a sumptuous good with elasticity demand larger than 1 [8,9]. However, there are studies that insist on the exclusive importance of GDP in the modulation of health expenditures [10,11].
- Health sector infrastructure. The correlation between the infrastructure, which a society has modulated and the health expenditures is many times weaker than it is believed [12].
- Health system planning. Health systems in Europe are classified in two main categories, the Bismarck and the Beveridge health systems. European Union's member-countries had adopted the first system in 1998 and had spent 8.6% of their GDP for the health sector, 12% larger than the countries that adopted the second health system, which provide 7.6% of their GDP according to WHO data, (Regional Report for Europe 2001. Health for all databases-version January 2001. WHO Regional Office for Europe, Copenhagen).

  The European Union's population senility rate is expected to increase rapidly in accordance to earlier predictions. The population of upper 65

years old age has already started to increase relatively with the total population rate but also in absolute numbers, confirming the initial estimation of the senility of European population in different countries. It is expected to be more intense in East and South European Union countries [13].

By these estimations the population of upper 65 years old age will increase averagely by 15.4% in 1995 to 17.9% in 2010 for 15 member-countries of European Union, namely with annual growth rate 1.25%. This annual rate is expected to be 1.4% after 2010 and for the next 15 years, namely 50% population growth by 1995.

The population rate of upper 80 years old is expected to increase more rapidly around 36% for many European countries and 50% approximately for countries such as Belgium, Luxemburg, France, Great Britain. It is important for us to take into account these estimations in any oncoming planning of health sector and particularly the insurance organizations, which are expected to face many crucial problems due to this evolution.

OECD worked out three possible scenarios for the growth of the health expenditures cost relatively with GDP growth (Ageing in OECD countries-a critical policy challenge. Social policy studies no. 20, OECD Paris,1996) The first scenario predicts that there will be an increase of expenditures at least 1% than real GDP growth, the second one predicts an increase equal to real GDP growth and the third scenario is referred to an increase of expenditures at 1% greater than real GDP growth. If the health expenditures cost remains constant the prediction of health expenditures growth in European Union's member-countries will reach at 30% during the period 1995-2030.

To the question whether health care is a luxury or a necessity, the better answer is that health care fulfills both meanings, since the income elasticity differs in each of the different level analysis, [14]. By insurance the elasticity of private incomes is closer to 0, while the elasticity of national health expenditures is larger than 1.

The contradiction whether health sector services are a sumptuous good, arises mainly from the failure of the level analysis to be determined clearly, so that the proprieties of different social groups are differentiated. These differentiates are appeared by a horizontal structure which enable the limits among them indistinguishable. This contradiction sustained undiminished during all the decade through continuous publications, which tried to give a satisfactory answer relatively to this question [15,16,17,6,8,18].

The confusion and the inability of these empirical results come from the determination failure of a specific set of notes [9]. The estimations of the income elasticity for each case or for every national health system will differ exactly as the prices elasticity differs for individual firms and households.

Consequently, the answer to our question has very much importance in relation to the modulation of health sector policy and for this reason the consideration of this question play a decisive role. We can define the necessity as a percentage increase of GDP. In contrary, we could define the luxury character of health sector as an increase of annual health expenditures at a greater rate than the respective GDP growth rate.

In the empirical analysis of this paper we used annual data for all variables and for all member-countries of European Union.

MATERIALS AND METHODS

For the analysis of health expenditures for 15 member-countries of European Union the following function is used

$$HCE = f(GDP) \qquad (1)$$

where, HCE expresses the real health care expenditures in each of the examined country. Specifications of the international health expenditures models are regarded as ad hoc [19]. Prior work also established the more meaningful determinants to include such as Gross Domestic Product (GDP) and the relative prices of HCE (RELP) defined as the ratio of health services prices index to the GDP prices index. The a priori expectations from received theory are

$$\frac{\partial HCE}{\partial GDP} > 0 \quad \text{and} \quad \frac{\partial HCE}{\partial RELP} > 0$$

The data that we used for 15 European Union member-countries are obtained from CD-ROM of OECD (OECD Health Data 2000, CD ROM, Paris, France, The OECD), which contains health database of these countries. The familiar problem of the international exchange rate conversions was faced in the basis of the constant exchange rates theory. All data are expressed by logarithms in order to include the proliferative effect of time series and are symbolized with the letter L preceding each variable name. The data processing was made by using the econometric package [20].

At this point it should be noted that the time series data in many countries are inadequate, so there is a short relative diversification in some countries to the examined period. In some cases the available data are very limited (case of Portugal), this doesn't reduce the results value at all, while for the rest countries the available data are satisfactory.

RESULTS AND DISCUSSION

Most macroeconomic time series contain unit roots that are characterized by the existence of stochastic trends in accordance to [21]. The unit root test is significant in

Table 1: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test Results

Country	LHCE*	LGDP*	LRELP*	LHCE**	LGDP**	LRELP**	Sample
Austria	I(2)	I(2)	I(1)	I(1)	I(1)	I(1)	1960 - 1998
Belgium	I(2)	I(2)	I(2)	I(1)	I(1)	I(1)	1960 - 1996
Denmark	I(2)	I(1)	I(1)	I(2)	I(1)	I(1)	1980-1998
Finland	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1997
France	I(2)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1997
Germany	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1996
Greece	I(2)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1992
Ireland	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1997
Italy	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960-1997
Luxembourg	I(2)	I(1)	I(1)	I(2)	I(1)	I(1)	1970 - 1996
Netherlands	I(2)	I(1)	I(1)	I(2)	I(1)	I(1)	1972 - 1996
Portugal	I(2)	I(2)	I(1)	I(2)	I(1)	I(1)	1989 - 1996
Spain	I(2)	I(2)	I(2)	I(2)	I(2)	I(1)	1960 - 1996
Sweden	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960 - 1996
U.K	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	1960 - 1996

Notes: *MacKinnon critical value for rejection of hypothesis of a unit root test (ADF) at 5% significance level are –2.9422 (with intercept) and –3.5348 (with intercept and trend).
**MacKinnon critical value for rejection of hypothesis of a unit root test (Phillips-Perron) at 5% significance level are –2.9350 (with intercept) and –3.5236 (with intercept and trend).

order to examine the stationary of a time trend because the non- stationary regressor rejects many empirical results. The existence of the stochastic trend is determined by the unit root test of time series data. In this empirical analysis unit root is tested by using the Augmented [22] and [23]. For the ADF test, the regression is first estimated for the variable X in the form:

$$X_t = + _{t-1} + _t \quad (2)$$

where the test hypothesis is

$$_0: = 0 \quad X_t \sim I(d) \quad \text{where } d > 0$$
$$H_1: < 0 \quad X_t \sim I(0)$$

and I(0) implies data stationarity around a constant. Most time series are integrated of order d or I(d). This means that they must be differenced d times to induce stationarity. One of the differences between the alternative unit root test by Phillips and Perron is the ADF test without lagged difference terms.

The equation (2) is estimated by using the OLS method with an option to include a constant and time trend, while t-statistic of the coefficient is also corrected for serial correlation.

Table 1 presents the results of ADF and Phillips-Perron tests. The order of integration is tested at the 0.05% significance level and the critical values obtained from [24] tables. The results are robust regardless the lag length.

Cointegration Test: If time series (variables) are non-stationary in their levels, they can be integrated with integration of order 1, when their first differences are stationary. These variables can be cointegrated as well, if there are one or more linear combinations among the variables that are stationary. If these variables are being cointegrated, then there is a constant long-run linear relationship among them.

Since it has been determined that the variables under examination are integrated for European Union member-countries, then the cointegration test is performed. The testing hypothesis is the null of non-cointegration against the alternative that is the existence of cointegration.

Firstly, we examine the cointegration relationship between the two variables LHCE and LGDP. Table 2 presents the [25] cointegration test results between LHCE and LGDP.

The two examined variables were conducted with and without the inclusion of a time trend in the estimated regressions, indicate that there is a significant cointegration relationship among 4 member-countries of EU (Finland, France, Spain and United Kingdom). This could imply that health policies of EU member-countries, especially these four countries are considered to be of vital importance.

Table 2: Engle-Granger Cointegration Test Results Between LHCE and LGDP

Country	E-G (no trend)	E-G (with trend)
Austria	-2.58	-2.87
Belgium	-2.35	-2.65
Denmark	-1.83	-1.98
Finland	-2.99*	-3.76*
France	-3.27*	-3.82*
Germany	-2.84	-3.24
Greece	-1.12	-1.43
Ireland	-2.31	-2.44
Italy	-2.67	-2.81
Luxembourg	-1.98	-2.24
Netherlands	-1.67	-1.79
Portugal	-1.07	-1.24
Spain	-2.96*	-3.62*
Sweden	-2.65	-2.83
U.K	-3.14*	-3.54*

Notes: *MacKinnon critical value for rejection of hypothesis of a unit root test at 5% significance level are –2.9422 (with intercept) and –3.5348 (with intercept and trend).

Table 3: Long-run LGDP Elasticity

Country	Income elasticity	t-test (from the mean)
Austria	1.23	-1.56
Belgium	1.41	1.71**
Denmark	1.27	- 0.94
Finland	1.34	- 1.77**
France	1.39	0.54
Germany	1.42	0.83
Greece	1.25	-1.04
Ireland	1.21	-1.17
Italy	1.29	0.47
Luxembourg	1.43	2.17*
Netherlands	1.33	0.76
Portugal	1.15	- 0.46
Spain	1.48	2.14*
Sweden	1.22	-1.47
U.K	1.26	-1.83**
Average E.U	1.31	

Notes: *Significant at 5% level, **Significant at 10% level.

In Table 3 the long-run elasticities of GDP are presented for all member-countries with elasticity of mean 1.31.

From Table 3 we can infer that in all member-countries of European Union the income elasticity is larger than 1. This means that health care is regarded as luxury in European Union countries following the earlier studies of [17,8,9] since the average rate of annual health expenditures is larger than the relative rate of GDP.

Then we apply the [26] maximum likelihood approach process, [27, 28] for three variables (LHCE, LGDP,LRELP). An autoregressive model coefficient is used for the modelling of each variable (which regarded endogenous) as one function of all endogenous lagged variables of model.

Table 4: Johansen Cointegration Test Results (Likelihood Rations)

Country	Rank = 0	Rank ≤ 1	Rank ≤ 2
Austria	32.35*	14.72	2.83
Belgium	33.65*	11.30	3.19
Denmark	38.33*	10.97	2.53
Finland	56.85*	17.51*	2.45
France	47.18*	23.06*	2.57
Germany	30.17*	13.87	2.01
Greece	35.42*	11.24	3.37
Ireland	35.12*	13.22	1.85
Italy	33.92*	14.72	0.58
Luxembourg	38.15*	12.98	2.79
Netherlands	47.31*	13.97	1.39
Portugal	42.11*	18.96*	2.46
Spain	36.18*	19.14*	1.62
Sweden	39.34*	14.08*	2.87
U.K	39.94*	12.62	1.66
Critical val.	29.68	15.41	3.76

Note: Critical values at 5% level. Trace test statistics is compared with the critical values from Johansen and Juselious (1990). * indicate rejection of the null hypothesis at 95 percent critical value

Given the fact that in order to apply the Johansen technique a sufficient number of time lags is required, we have followed the relative procedure, which is based on the calculation LR (Likelihood Ratio) test statistic [29]. The results showed that the value =3 is the appropriate specification for the above relationship. Further on we determine the cointegration vectors of the model, under the condition that table 4 has an order r<n (n=3). The procedure of calculating order r is related to the estimation of the characteristic roots (eigenvalues), which are the following:

$$\hat{\lambda}_1 = 0.37930 \qquad \hat{\lambda}_2 = 0.12954 \quad \hat{\lambda}_3 = 0.0556971$$

Table 4 suggest that the number of statistically significant normalized cointegration vectors is equal to 1 for (Austria, Belgium, Denmark, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, United Kingdom) and equal to 2 for (Finland, France, Portugal, Spain and Sweden).

From all cointegrating vectors we can infer that in the long-run period GDP and the ratio of health services prices index to the GDP prices index have a positive relationship with health expenditure in all examined member-countries of European Union. According to the signs of the vector cointegration components and based on the basis of economic theory the above relationships can be used as an error correction mechanism in a VAR model.

Table 5: Error Correction Model (ECM) Results

Country	$LGDP_t$	$LRELP_t$	ECT_{t-1}	R^2
Austria	0.2736[0.033]	0.0107[0.028]	-0.0087[0.165]	0.6317
Belgium	0.4515[0.001]	0.0410[0.073]	-0.0072[0.127]	0.4710
Denmark	0.2610[0.077]	0.0148[0.176]	-0.0126[0.237]	0.4511
Finland	0.5946[0.048]	0.0287[0.051]	-0.0056[0.065]	0.5855
France	0.6114[0.032]	0.0315[0.062]	-0.0047[0.098]	0.6008
Germany	0.4896[0.063]	0.0411[0.044]	-0.0207[0.342]	0.5319
Greece	0.5211[0.174]	0.0104[0.042]	0.0127[0.277]	0.4811
Ireland	0.3956[0.086]	0.0211[0.147]	-0.0156[0.101]	0.5014
Italy	0.4176[0.100]	0.0187[0.084]	-0.0090[0.086]	0.5319
Luxembourg	0.2849[0.057]	0.0054[0.000]	-0.0034[0.036]	0.6116
Netherlands	0.3542[0.074]	0.0098[0.072]	-0.0128[0.169]	0.5782
Portugal	0.6114[0.122]	0.0341[0.147]	0.0167[0.123]	0.4111
Spain	0.5345[0.084]	0.0178[0.088]	0.0087[0.044]	0.4677
Sweden	0.4715[0.037]	0.0252[0.098]	-0.0067[0.053]	0.4896
U.K	0.3142 [0.067]	0.0156 [0.127]	-0.0083[0.042]	0.5013

Note: Numbers in brackets indicate significant levels

VAR Model with an Error Correction Model: After determining that the logarithms of the model variables are cointegrated, we must estimate then a VAR model in which we shall include a mechanism of error correction model (MEC). The error-correction model arises from the long-run cointegration relationship and has the following form:

$$LHCE_t = \text{lagged}(\ LHCE_t,\ LGDP_t,\ LRELP_t\ ) + ECT_{t-1} + V_t \quad (3)$$

where . is reported to all variables first differences

ECT_{t-1} are the estimated residuals from the cointegrated regression (long-run relationship) and represents the deviation from the equilibrium in time period

-1< <0 short-run parameter, which represents the response of the dependent variable in each period started from equilibrium state.

V_t is a 3X1 vector of white noise errors.

In Table 5 the coefficient estimations of error correction models in all variables and in all member-countries of EU are appeared. The negative sign of error coefficient ECT_{t-1} (except for Greece, Portugal, Spain) is consistent with the hypothesis that this error term corrects the deviation from the long-run equilibrium relationship. Also in the same table the significance of the coefficients of error correction models in all variables is presented.

Table 5 suggests that the coefficients of error correction mechanisms are statistically significant in equations for the most member-countries of European Union of GDP and the ratio of prices index of health sector to prices index for GDP.

CONCLUSION

This present study employs with the relationship between health care expenditures of GDP and the ratio of health services prices index to the GDP prices index for the member-countries of European Union using annual data. The empirical analysis showed that the used variables present unit root. On this basis, the cointegration analysis, suggested by Engel-Granger and Johansen and Juselious, was applied in order to induce a long-run equilibrium relationship between the used variables. Our results suggest that there is a positive relationship not only between health care expenditures and GDP, but also between the ratio of health services prices index to the GDP prices index. Then the error correction model methodology was applied in order to estimate the short-run and the long-run relationships. The selected vectors gave the errors correction terms, which in most member-countries of EU proved to be statistically significant at 0.05% significance level during their importation in short-run dynamic equations. Finally, it was proved that health care must be regarded as a luxury in member-countries of EU.

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