Determinants of EU-28 Healthcare Expenditure

Viorela-Ligia Văidean

***Abstract*—The development level of a country is reflected by their healthcare expenditures, as investments in the health status of the population further bring several economic benefits along. European governments have focused on continuous improvement of member states' healthcare systems through various complex strategies. The purpose of this paper is to explicate the per capita healthcare expenditures of EU-28 member states over a ten year time interval by the per capita gross domestic product and the share of the population aged 65 and above in the total population. A dummy variable is also used for the predominant financing method of European healthcare systems.**

***Index Terms*—Econometric modeling, gross domestic product, healthcare expenditure, healthcare systems.**

I. Introduction

Health and healthcare have become top priorities throughout all European Union member states' strategies. Investigations in the field of interactions between the health and economic sectors have been considered as a major concern of European governments in the light of the last decades, specialists dealing with the effects of healthcare financing on national economies. Without doubt, health economics will benefit in the future by reinforcing its ties with general economic theory [1].

It is considered that the very same factors that contribute to the flourishing of the society influence the health status of the population as well. Decent living and working conditions, education and income sustain a maintained health status. On turn, the health status contributes towards an increased work productivity and efficiency, the healthy ageing of population and less expenditures on sick leaves and social benefits, thus less lost fiscal incomes. Moreover, the best way to ensure the population's health and wealth is for governments to work on the social and individual determinants of health, as a good health state of the population may sustain economic recovery and development [2]. The Regional Office for Europe of the World Health Organization (WHO) also believes that health performance and economic performance are interrelated, and optimizing resource usage in the health sector in order to reduce costs is essential. None the less, The Moscow Declaration emphasizes the need for multi-sectoral action on the behavioral, environmental, social and economic factors that determine health, sustaining a combined strategy for health governing [3].

Many interesting reports have been written on European healthcare systems' performance. The seventh and last Euro Health Consumer Index findings emphasize the continuous improvements of European healthcare performance from one year to another on the one hand and the increase in healthcare gaps as crisis hit poorer parts of Europe, placing Romania and Bulgaria at the very bottom, on the other hand. New categories have been recently added in computing the index, i.e. eHealth and Prevention, pointing out the trends in healthcare systems' development [4].

The study of healthcare expenditure may come with important conclusions on the health state of a population, as countries that registered high levels of health expenditure per capita also have the strongest healthcare systems and the best health outcomes, lower mortality rates and higher life expectancies. Investing in health pays off, findings suggesting that there is a direct relationship between per capita health expenditures and under-5 (child) mortality rate for several countries [5].

The paper is organized as follows: Section II shortly reviews the specialized literature in the field of healthcare expenditure modeling, Section III describes the data and the models' specifications and Section IV discusses the estimation results, few conclusions and suggestions for future research.

II. Literature Review

Health economists have always been interested in analyzing the drivers of personal health care expenditure through empirical studies [6]. The most important single determinant of cross-sectional variation in health care expenditures is the national income or per capita Gross Domestic Product (GDP). Besides income, other previously validated determinant factors of healthcare expenditure focus on institutional arrangements in the field, such as primary care physicians or physicians paid on a capitation basis [7]. Furthermore, factors such as population aging, increased coverage of health insurance, growth in the number of health professionals and hospital capacity and a lower productivity growth in the service sector than in other sectors partly explain health care expenditure growth [6]. Some studies have validated the number of doctors per 100,000 inhabitants or several indicators referring to hospital activity as explanatory for the level of total healthcare expenditures.

An interesting approach is that of considering technological change in medicine as a determinant of expenditures in the field, accounting for the major part of healthcare expenditures' increase. Reference [8] has included newly developed types of medical devices, technologies and pharmaceuticals into technological change in medicine, and

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this view has become widely accepted by health economists. Nevertheless, it is ultimately considered that the value of life increases twice as fast as income [9], so predictions state a continuous increase of spending on health care for the decades to follow.

Recent European studies targeted the pattern variations of government healthcare spending, by evaluating political, economical and health system determinants of recent changes to healthcare expenditure. The statistical model includes annual changes in GDP and per capita tax revenue, public debt as percentage of GDP in previous year, implemented austerity, left or right government party and International Monetary Fund (IMF) bailout active in current year as macro explanatory variables. Much of the burden of budget cuts is being concentrated in the healthcare sector, particularly in countries exposed to IMF lending agreements and regardless of the governing parties [10].

Individual lifestyle risk factors related to healthcare expenditures range from the unhealthy body weight measured through the Body Mass Index (BMI) to ageing and vices such as current or past smoking and excessive alcohol intake. These health risks were associated with healthcare expenditure and chronic diseases by performing a cross-sectional analysis of health survey and medical claims, proving that obesity and tobacco use are associated with significant increases of healthcare expenditures [11]. Several previous studies have assessed the impact of ageing upon healthcare expenditures and some validated the shares of population aged 15 and under and that of the population aged 65 and above to the total population as proxies for the need for healthcare, based on the assumption that younger and older people do need more medical attention due to their more fragile health status [12]. Actually working with age groups as explanatory variables has also been validated for other independent variables. Reference [13] benchmarks rescue departments' efficiency of the Austrian Red Cross, using the share of the population aged 64 and above to the total population in data envelopment analysis and fractional regression models.

The share of healthcare expenditures in a nation's GDP has also been explicated by its per capita GDP, the share of public healthcare expenditures in total healthcare expenditures, the share of elderly people in total population and a new morbidity variable. The morbidity variable has been considered a better proxy than the other measures for estimating the need for healthcare, being computed based on the self-assessed health status, as the ratio of the population who answered his/her health status was good, very good or excellent to the total number of interviewed individuals from Finland, Netherlands, Sweden, the United States of America (USA) and the United Kingdom of Great Britain and Northern Ireland (UK). Estimations support the idea that healthy people who feel they are healthy are generally healthier than individuals who do not feel they are healthy, thus lowering healthcare expenditures [14].

Regarding the financing mechanisms of the European healthcare systems, studies report Bismarck systems to have exceeded Beveridge systems in terms of efficiency. The resources collected through compulsory social insurance contributions are put to better use that those collected through taxes. Although there have been intense debates over the relative merits of the two types of system, Bismarck healthcare systems, where there is a multitude of insurance organizations that are organizationally independent of healthcare providers, have outrun Beveridge systems. Looking at the results of the Euro Health Consumer Index 2013, the top operational healthcare systems with good results consist of dedicated Bismarck countries, for the main majority of years [4].

Having reviewed some papers on the topic of healthcare expenditure drivers, it may be concluded that, despite previous efforts and depending on the availability of data, future research still has to validate the potential exogenous variables that would determine the healthcare expenditures of nations as an endogenous variable.

III. Data and Methodology

A. Data

This study uses Eurostat available data for the 28 member states of the European Union (EU). The data cover the 2004-2013 time interval. The total number of observations is of 280 (the 28 member states over the ten year time period), with 10.48% missing values of total data values, so modeling is applied to an unbalanced panel.

Table I presents the summary statistics for the per capita healthcare expenditures of EU-28 member states as the dependent variable and the two independent variables used in this study, while Table II computes their correlation coefficients.

TABLE I: Summary Statistics

	Per capita Healthcare Expenditures	Per capita Gross Domestic Product	65 + Population Share
Mean	2008.9	22706	16.264
Median	1611.2	19700	16.60
Minimum	130.0	2600	10.80
Maximum	5508.9	83400	21.20

Source: Author's processing in Gretl.

TABLE II: Correlation Coefficients

	Per capita Healthcare Expenditures	Per capita Gross Domestic Product	65 + Population Share
Per capita Healthcare Expenditures	1.0000	0.9528	0.2163
Per capita Gross Domestic Product		1.0000	-0.0864
65 + Population Share			1.0000

Source: Author's processing in Gretl.

The per capita healthcare expenditures span from a minimum value of 130 euro per inhabitant in Romania in 2003 to approximately 5509 euro per inhabitant in Luxembourg 2006, illustrating the disparities with regard to the healthcare domain among the EU countries. Romania and Bulgaria are countries that have spent very little for thehealthcare domain in the last ten years, while Luxembourg, Austria and Sweden have always occupied top positions of

per capita healthcare expenditure.

This trend is maintained for the per capita Gross Domestic Product (GDP) as well. Highly developed European countries also have high per capita healthcare expenditures. Regarding population dynamics, the proportion of European population aged 65 and above to the total population has shown an increasing trend, with an average of approximately 16.3 percent of elderly population, due to the decreases in birth and fertility rates, future projections emphasizing this trend.

Table II presents the correlation matrix for the considered dependent and independent variables. The single independent variable that achieves the best prediction of the per capita healthcare expenditures dependent measure is the per capita GDP. It's known that the higher the correlation coefficient, the stronger the relationship and the greater the predictive accuracy.

B. Research Methodology

The paper analyses the per capita total healthcare expenditure for the EU-28 member states with the help of a multiple linear econometric model, by considering the per capita healthcare expenditure of a country as an endogenous (dependent) variable. The estimations were carried out using the panel technique and the coefficients were at first estimated with the ordinary least squares (OLS) method for panel data, further on choosing a fixed effects model (FEM) and a random effects model (REM).

The estimated model is the following:

$$HCE_{it} = a_0 + a_1 GDP_{it} + a_2 P_{it} + a_3 D_i + \varepsilon_{it}$$

where

HCE_{it} = the predicted per capita healthcare expenditure of country i, year t;

GDP_{it} = the per capita GDP of country i, year t;

P_{it} = the share of population aged 65 and above to the total population of country i, year t;

D_i = dummy variable for country i

a_0 = constant per capita healthcare expenditures independent of per capita GDP and population;

a_1 = change in per capita healthcare expenditures associated with unit change in per capita GDP;

a_2 = change in per capita healthcare expenditures associated with unit change in elderly population share;

a_3 = difference for each country from the reference category

ε_{it} = the residual (the difference between the actual and predicted values of the dependent variable).

Collinearity is the association, measured as the correlation, between two independent variables. To maximize the prediction from a given number of independent variables, the researcher should look for independent variables that have low multicollinearity with the other independent variables but also have high correlations with the dependent variable, which is the case of Table II. None the less, the addition of more independent variables is based on trade-offs between increased predictive power versus overly complex and even potentially misleading regression models [15]. Based on these assumptions and the available data, the paper considers only two independent variables, GDP_{it} and P_{it}, for the multiple regression analysis of HCE_{it}.

The dummy variable D_i uses indicator coding in order to capture the effect of the typical Beveridge or Bismarck healthcare system of EU-28 countries. It's a dichotomous variable with a 0 value for mainly Beveridge healthcare systems and a value of 1 for traditionally Bismarck healthcare systems. The regression coefficient for the dummy variable represents differences on the dependent variable for each country from the reference category, i.e. the omitted group that received all zeros [15].

IV. Results and Conclusions

The Breusch-Pagan test statistic was applied and the p-value of 0.405781 higher that 0.05 favors the null hypothesis that the pooled OLS model is adequate, as opposed to the random effects model. The Hausman test had a p-value of 0.029981, this low p-value counting against the null hypothesis that the random effects model is consistent in favor of the fixed effects model.

The results for the OLS and FEM estimations are presented in Table III. Furthermore, the F test probability $P(F(9, 179) > 1.47374) = 0.160684$ is higher than 0.05, sustaining the adequacy of the OLS model (1st Model). A low p-value would have counted against the null hypothesis that the pooled OLS model is adequate, in favor of the FE alternative, but this wasn't the case.

TABLE III: The Estimation of Healthcare Expenditure

HCE	OLS (1st Model)	FEM (2nd Model)
Constant term	-1834.99*** (0.00)	-1638.78*** (0.00)
GDP	0.09319*** (0.00)	0.09341*** (0.00)
P	102.661*** (0.00)	90.6878*** (0.00)
D	117.85*** (0.00)	108.42*** (0.00)
R^2	0.926602	0.931665
Adjusted R^2	**0.925431**	0.927084

Source: Authors' processing in Gretl.

Note: Within parentheses there are the p-values and *** designates the 1% significant coefficients.

The estimations reveal the dependency relationship between the per capita healthcare expenditures of EU-28 member states and certain macroeconomic aggregates that may be their approximation, according to the data synthesized in Table III, through the least squares method for panel data, and the fixed effects model, previous tests supporting the first. The default robust estimator is that suggested by Arellano, handling both heteroskedasticity and autocorrelation (the HAC approach).

The regression estimation method uses a confirmatory approach, having previously specified the perceptual measures to be included in the model as independent

variables, directly entered into the regression equation at one time. Specialists also call this technique a simultaneous regression.

The predictive accuracy of the model is given by its coefficient of determination (R^2), representing the amount of variance in the dependent variable HCE explained by the independent variables. This overall predictive fit is the most common standard used and it ranges from 1.0 (perfect prediction) to 0.0 (no prediction). A value of 0.925431 points towards a strong prediction accuracy, and the use of the Adjusted R^2 as the measure of overall model predictive accuracy is often preferred, being particularly useful in comparing across regression equations involving different numbers of independent variables or different sample sizes because it makes allowance for the degrees of freedom for each model [15].

The most direct interpretation of the regression variate is a determination of the relative importance of each independent variable in the prediction of the dependent measure, i.e. per capita healthcare expenditures. Regression analysis provides a means of objectively assessing the magnitude and direction (positive or negative) of each independent variable's relationship. The signs of the GDP and P coefficients from Table no.3 denote whether the relationship is positive or negative, and the value of the coefficients indicate the change in the HCE value each time the independent variable changes by 1 unit [15]. There is a direct positive relationship between the both independent variables and healthcare expenditures, so the higher the per capita GDP and the share of population aged 65 and above in the total population, the higher the per capita healthcare expenditures of country *i* in year *t*. All other things equal, at a 1 euro increase in per capita gross domestic product, per capita healthcare expenditures are higher on average by 0.09261 euro.

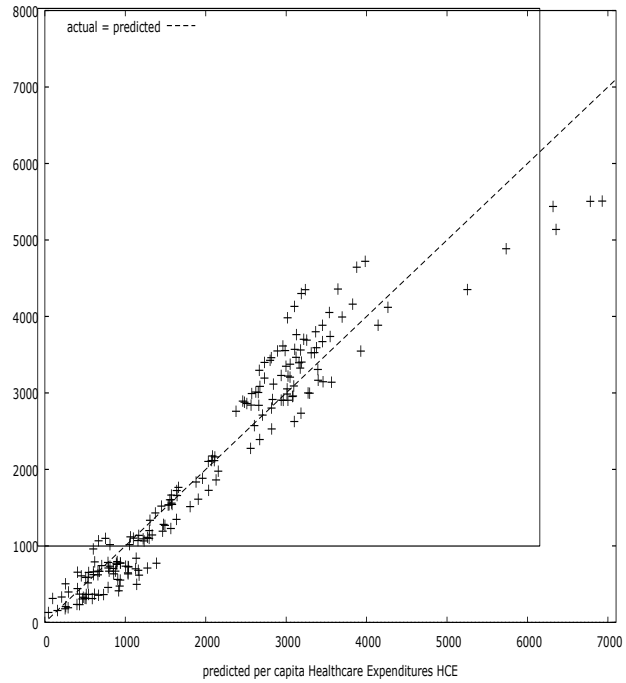

Fig. 1. Actual versus predicted per capita healthcare expenditures for EU-28 countries, estimated through the 1st Model (OLS technique).

Fig. 1 plots the actual versus the predicted per capita healthcare expenditures. The estimated model adjusts the actual data well. The residuals are normally distributed, closely following the diagonal line, according to Fig. 2.

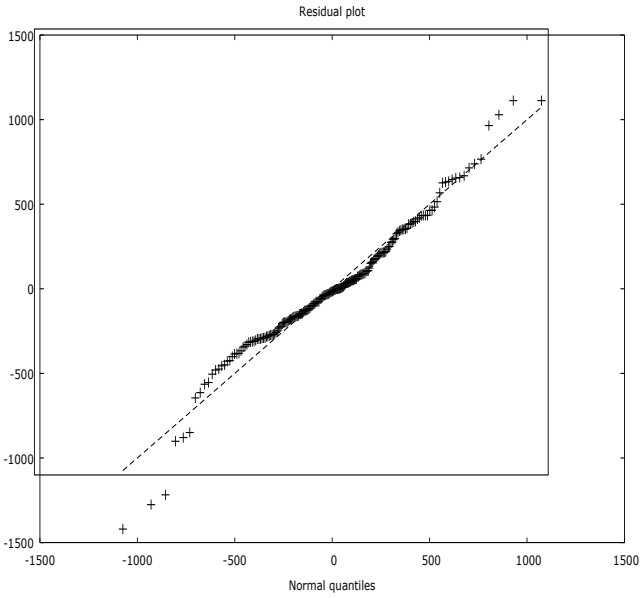

Fig. 2. Residuals' plot, closely following the diagonal.

There's a positive and 1% significant coefficient of the dummy variable D_i. The a_3 regression coefficient is interpreted as the value for Bismarck systems compared to Beveridge systems. Its positive value indicates that Bismarck countries have higher per capita healthcare expenditures compared to Beveridge countries. The amount of 117.85 represents the difference in HCE between the means of the two country groups, controlling for all other variables in the model. Out of the 28 European Union member states, 16 were categorized as typically having a decentralized Bismarck healthcare system, where patients pay insurance premiums to a sick fund through a local/regional social insurance model. Among these, the highest per capita total healthcare expenditures are registered in Austria, The Netherlands, Belgium, France, and Luxemburg. Indeed, these confirm previous studies, which found the total and public per capita healthcare expenditures, as well as the life expectancy, to be higher on average for Bismarck 'all-payer' models than Beveridge 'socialized medicine' models [16].

Regarding the generalization and transferability of these results, one has to consider the previous partially validated results on the same topic, and some other empirical approaches to model validation, such as additional or split samples. The paper restricted the observations' sample based on the dummy variable, keeping only the sixteen Bismarck healthcare model countries, and reapplied the OLS technique, with heteroskedasticity-robust standard errors, obtaining similar results to the original population. All estimated coefficients were significant at a 1% threshold and their values were really close to the original model. R^2 was 0.921520 and the Adjusted R^2 was of 0.920303. Similar results were obtained on different subsamples, such as by dropping all observations with missing values and random subsamples, validating the results and supporting forecasting based on it. Still, future research might consider several other independent variables, like the share of female population to the total population, another age group and/or the degree of

urbanization.

The development level of a European country is, to a certain extent, mirrored by their healthcare expenditures, so the healthcare expenditure of a country seems to highlight the development level of that country even more. Some of the least developed European countries are Romania and Bulgaria, which find themselves at the lowest levels of per capita healthcare expenditures and health status indicators in the EU. Furthermore, the healthcare expenditures ´challenges EU-28 governments are facing are huge, because the increase rate of healthcare costs is higher than that of GDPs. Reference [2] also argues that this increased healthcare expenditures ´trend is due to an increased demand on behalf of patients for new treatments and technologies and of the population for being protected against health risks and accessing high quality medical services. There ś a strong need for an effective strategy that would attain real healthcare benefits at an acceptable cost.

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