ECONOMETRIC MODELING OF ROMANIA'S PUBLIC HEALTHCARE EXPENSES – COUNTY PANEL STUDY

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ABSTRACT: The purpose of our paper is to analyze the per capita public healthcare expenditure of Romania in relation to different exogenous explanatory variables, through a panel study upon the forty one regions plus the capital city. The results of the four year panel study have been interpreted and commented. Our regional public healthcare expenditure is explicated to a great extent by the regional GDP. Other strong correlation variables were not found statistically significant.

Key words: public healthcare expenditure, panel data, correlation, fixed effects model.

JEL codes: H51, C23, C33

Introduction

The healthcare activity has a major influence upon the development of the national economy and Gross Domestic Product (GDP) increase. It assures the basic need of the man to be healthy and of the society to have a healthy population. At a macro economical level, it contributes to the work force reproduction and general welfare specifically. So, the healthcare sector of a country has a major importance and the purpose of our study is to study the under-financing of Romania's regions for this sector.

The connections between mass economic phenomena are characterized by the fact that one phenomenon or another may vary under the influence of a complex range of factors, some of which have a crucial influence and others are of a secondary importance. We've tried to identify the exogenous variables that would explain to a certain extent the regional public healthcare expenses of our country.

Literature review

The weight of the current healthcare expenditure within the GDP of a country has been growing rapidly in almost all developed countries. Although these represent a major public concern, little aspects are known about the factors that determine the rapid growth of these expenditures.

Thus, in 1994, Hoffmeyer and McCarthy (Hoffmeyer UK, McCarthy TR, 1994: 67) concluded their research by affirming that "there was only one clear and well-defined statistical factor that influenced the healthcare costs, namely their correlation with the GDP. Other robust and stable correlations had not been found yet". These statements were confirmed by Roberts (Roberts, 1999). After examining the origins of healthcare expenditure and its determinants by Newhouse in 1977 and the worldwide research that had followed in the field, Roberts concluded that "In the past twenty year period, there had been little progress in that research field, apart from the fact that changes in the national income per capita were closely correlated with changes in the healthcare spending per capita"(Roberts, 1999: 459).

In fact, researchers consider there are two periods in the evolution of the literature devoted to this field. At first, during the 1970 – 1990 period, Kleiman (1974), Newhouse (1977, 1978),

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Cullins and West (1979), Leu (1986), Parkin, McGuire and Yule (1987), Culyer (1990), Gerdtham and Jönsson (1991) and Hitiris and Posnett (1992) have shown evidence of a positive correlation between the volume of public healthcare spending and the GDP of most OECD[3] countries. This connection has proved to be robust over the years and even when studied by using conversion factors (such as deflators, exchange rates etc.). On the other hand, other intuitive exogenous variables could not be confirmed as being statistically significant.

The recent trend in research, which was originally established by Murthy and Ukpolo (1994) and Hansen and King (1996), has focused on the time series analysis of these variables[4]. Unit root and cointegration tests have been applied to the public healthcare expenditures and the GDP. The results have been somehow inconclusive and relatively less robust to the testing methodology. The latest research papers have continued to analyze the factors that influence healthcare expenditure, like Hartwig (2008), and have mostly relied on panel studies.

After reviewing the literature written on the field, it may be concluded that, despite the intensive research efforts, little is known about the potential exogenous variables that would explicit the healthcare expenses of a nation as an endogenous variable. Moreover, because the available time series data are relatively short, thus reducing the strength of the tests, and the fact that the number of tests is huge and it's growing, a certain degree of uncertainty persists over the properties of the time series analyzed in this research area.

Over the past thirty years research on the determinants of healthcare expenditure has focused on evaluating the strength of the relationship between the volume of public healthcare spending and the GDP. Attempts to determine other suitable exogenous variables have failed, as shown above, despite the fact that the correlation between public healthcare spending and GDP doesn't explain very much in terms of causal relationship. Even the apparent obvious weight of population aged 65 and above in the total population hasn't been proved to contribute and to explain the public healthcare spending in a certain extent, except for a very limited number of studies, such as Hitiris and Posnett (1992) and Di Matteo (1998, 2005).

Wilson (1999: 160) concluded that "economists haven't developed a formal theory that would explicit the health costs of a nation and that would predict the healthcare expenses per capita yet" and "without a strong theory, empirical research in this area have been based on ad-hoc thinking and they have depended on the availability of data". He further strengthened the importance of analyzing all these data and variables related to the population, i.e. per capita data. Indeed, both Roberts (1999) and Gerdtham and Jönsson (2000) militate for improving the theoretical foundations of healthcare expenditure macroeconomic analysis. According to Roberts (1999: 470), this should be "the main goal of future research".

Research methodology

For the above presented indicators we will verify the following hypothesis: does or doesn't there exist a dependency (correlation) between the public healthcare expenditures per capita and the real gross domestic product per capita, respectively the weight of the female population in the total population, and nevertheless for both factors, through econometric models using panel data[5]? For this purpose a database was constructed containing data corresponding to Romania's 41 counties - NUTS III plus Bucharest, i.e. the public healthcare expenditure per capita, the real gross domestic product per capita and the weight of female population within the total population, for the 2006-

[3] Organization for Economic Co-operation and Development

[4] The great majority of the studies published by that time were mainly cross-sectional analysis. Gerdtham (1992) was the first one to analyze time series data and panel data models.

[5] Panel data models consist of estimating regression equations that use data which are at the same time series data and cross-sectional data. Panel data models allow a single coefficient to summarize the impact of a variable upon a group of time series dependent variables (a group of companies, countries, regions) and the estimation of specific coefficients (constant or coefficients of the independent variables) for each time series considered as a dependent variable - fixed effects.

2009 period.

Data for each county's public healthcare expenditure were taken from the website reports of the National and the Regional Health Insurance Houses. The explanatory variables were taken from the Tempo database of the National Institute of Statistics (NIS), for the very same period and for the same 42 cross sections. Considering the fact that Romania's population is primarily feminine, the risks women are exposed to are higher, the wider variety of medical cases for women with higher costs (maternity and others), a higher female life expectancy and nevertheless the tax demanded by the NIS for the population data on counties and age groups, we decided to try the female population share as a potential explanatory variable of our models.

When testing for stationarity in panel data several tests are available. Then, these models were estimated using the least squares method for panel data (Pooled OLS) and the constant effects (factors) model (Fixed Effect Model-FEM). In order to estimate the parameters of the models we built, we used the Gretl[6] software package.

The following notations are used:

ChSanatate = regional per capita healthcare expenditure;

GDP = regional real per capita gross domestic product;

Pf = the ratio of the female population to the total population of the region;

u, v, z = residual variables.

In order to verify the existence of a dependency relationship between the regional per capita healthcare expenditures (ChSanatate) and the regional real per capita gross domestic product (GDP), the ratio of the female population and the total county population (Pf), and then for the both factors, we've constructed the following linear econometric models:

Table no. 1.

The results of the econometric estimation, for the NUTS III counties, regarding the dependency between per capita healthcare expenditure and per capita GDP (1st model), female population/total population ratio (2nd model), and both factors respectively (3rd model)

Model	**1st Model**		**2nd Model**		**3rd Model**	
Estimation Method	**OLS**	**FEM**	**OLS**	**FEM**	**OLS**	**FEM**
Constant term	184.462*** (0.0000)	63.4788** (0.0106)	-11099.4*** (0.0000)	-19106.0** (0.0267)	-4910.27*** (0.0004)	2105.17 (0.6458)
GDP	0.0197559*** (0.0000)	0.0267745*** (0.0000)			0.0138586*** (0.0000)	0.0269422*** (0.0000)
Pf			22759.5*** (0.0000)	38435.7** (0.0229)	10174.0*** (0.0003)	-4003.10 (0.6558)
Adjusted R^2	0.488428	0.956998	0.412830	0.839361	0.525210	0.956721
F Statistic	160.4449	89.48976	118.4153	21.77614	93.36706	86.85356
F Statistic Probability	3.68e-26	2.01e-75	3.71e-21	1.83e-40	7.58e-28	1.74e-74
Number of observations	168	168	168	168	168	168

Source: Authors' processings

[6] Gnu Regression, Econometrics and Time-series Library is a free open-source cross-platform software package for econometric analysis, written in the C programming language.

Model I: ChSanatate = f (GDP) + u => ChSanatate = a0 + b0 *GDP + u

Model II: ChSanatate = f (Pf) + v => ChSanatate = a1 + b1 *Pf + v

Model III: ChSanatate = f (GDP, Pf) + z => ChSanatate = a2 + b2 *GDP + c2 *Pf + z

The results we obtained by estimating these models and by using statistical data corresponding to Romania's forty-two regions are shown in the Table no. 1. Within parentheses there are the p-values, and *** designates the 1% significant coefficients while ** designates the 5% significant coefficients.

From the analysis and the tests of the results obtained for the three models, by using data corresponding to Romania's 41 counties and Bucharest, we have found them to be significant (except for the constant term and the female population to total population ratio of the third model for the case of fixed effects model for panel data). In order to choose between the estimators we've obtained by the least squares method[7] for panel data and the ones we've obtained from the constant effects model[8], we've applied an F test[9], which was based on the assumption that all free terms are constant, and we've found that the best estimator was obtained for the model with *constant effects.*

The choice for the best econometric model from the three above considered models, when applying the constant effects model, was realized as follows:

- after comparing the 1st model with the 2nd model based on the determination ratio, we found that $R_1^2 > R_2^2$, so the 1st model explains the variation in the healthcare expenditure better;
- after comparing the 1st model with the 3rd model, we may conclude that by introducing the ratio of the female population to the total population variable into the 3rd model, its performance level as compared to the 1st model is decreased. The influence of this variable upon per capita healthcare spending is less significant than that of the per capita gross domestic product. All in all, the model that best explains the variation in per capita healthcare spending for the counties of Romania is the 1st model.

Then we have graphically represented the experimental values in light grey + and the ones adjusted by the optimum chosen model in dark grey ×, processing the data with the Gretl software.

[7] From an econometric point of view, the existence of individual effects imposes the choice for an estimation method that would produce non-shifted results. Where there are individual effects and they are correlated with the independent variables, the OLS estimation (Ordinary Least Squares) produces shifted and inconsistent results. Under these circumstances, it's compulsory to use an estimation method that takes into account the presence of individual effects and that produces non-shifted results. There are two alternative estimation methods: random effects estimation (RE - Random Effects) and fixed effects estimation (FE - fixed Effects).

[8] For the fixed effect model we consider the counties to differ relatively to the intensity dependence between two variables, through constant terms. The constant term is considered to break down into a deterministic and a random component.

[9] If the calculated value of the F statistics is higher than the tabled value, then the null hypothesis of constant terms' equality is rejected. In these circumstances we may say that the fixed-effect model is preferable to the mutual constant model.

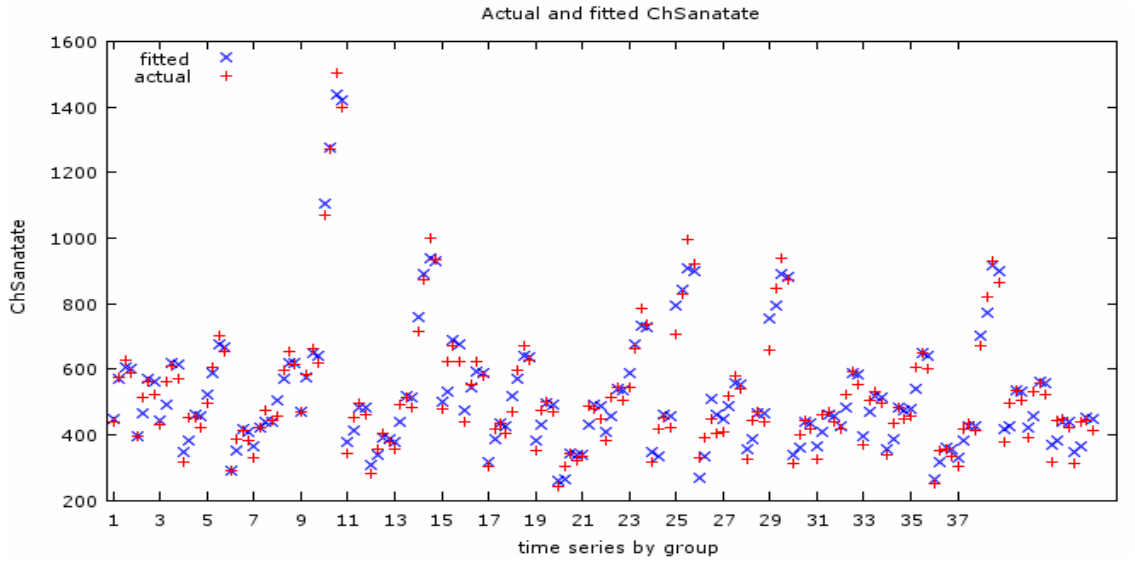

Fig. No. 1 Experimental values of the regional per capita healthcare expenses and the ones adjusted through the 1st model –FEM

The regional allocation of resources is mainly oriented towards the capital city of Romania (the highest peak), Bucharest having the level of these annual expenditures of over 1400 lei per capita. The counties that have university healthcare units and hospitals, like Cluj, Timiş and Iaşi, have their healthcare resources situated within the 800 -1000 lei per capita interval.

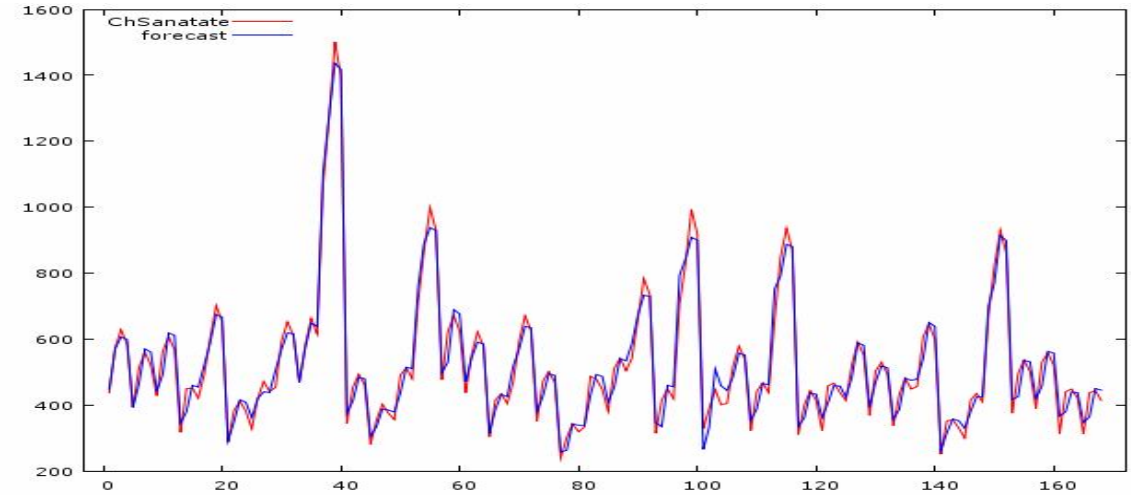

Fig. No. 2 Experimental values of the regional per capita healthcare expenses and the ones foreseen by the 1st model -FEM

The random effects regression model, Random Effect, assumes that the average individual effect is expressed in the constant term and the error term includes the unobserved individual effect[10]. In order to test and decide between the models with fixed effects and the ones with random effects, a Hausman test[11] is carried out. This test checks the two models and tracks the estimators'

[10] For this model we consider the counties to differ in the linear relation through the random errors' series.

[11] If its statistical value is greater than a tabled value, the hull hypothesis would be rejected, further considering that the second model suits best for the two variables' relationship analysis. For a more detailed presentation of this test we recommend: Hausman, J. (1978), *Specific Tests in Econometrics*, Econometrica, 46.

inconsistency and efficiency.

Which panel method should be used? According to some sources, the answer to this question largely depends on the used data set. If there is a logical presumption that would favor the fixed effects model, such as a relatively small set of units (e.g. the EU member states, the regions of a state, etc.) then we will use the fixed effects model. But if we have a large set of data, consisting of a large number of randomly selected individual observations, it will be recommended to use the random effects model[12].

Because of certain heterogeneity in the countries' behavior, panel data econometric methods are more and more often used for the empirical analysis of commercial flows. From an economic point of view, for the cases we have studied, the individual effects seem appropriate.

For the present context, it's not recommended to develop any forecasts based on these models, both nationally or regionally, due to the decline phase of the variables included in the models. In the future, due to the economic policy measures to be applied for the health sector, the levels of these indicators are expected to revert.

Conclusions

In conclusion, the evolution of the Romanian healthcare system in its classical shape of public per capita healthcare expenditure is closely related to the socio-economic changes taking place in Romania.

For our country, the events that took place at the end of 1989 and during the following successive political changes imposed a new strategy for acting upon the socio-economical life, and even upon Romania's healthcare sector.

Regarding the financing of the healthcare sector, from the early 90s and up to the 1998 reform, the figures show that Romania was situated at the end of the top as percentage of GDP allocated for the healthcare sector. After 1998, the percentage of public healthcare expenses in the GDP increased, so the contributions paid by both the employers and employees have become the main financing source of the new social health insurance system. Nevertheless, the increase hasn't been significant (of appreciatively only 1% of GDP) and unfortunately this increase hasn't influenced the qualitative evolution of the healthcare system.

For multifactor correlations, the exogenous variables have different influences upon the resulting variable; some greatly influence the effect phenomenon, and therefore they should be taken into account, while others exert a less important action and may be neglected. Correlation methods simplify the calculations and conclusions, because it is very difficult to quantify the set of all causal factors acting upon a socio-economic phenomenon or process.

Our four year panel study on the regional public healthcare expenditure proved that they are explicated to a great extent by the regional GDP. Other strong correlation variables were not found statistically significant, this being the purpose of our future research in the field.

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