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# Analysis and forecasting of statistical indicators of health in Romania between 1997 and 2016

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***Abstract:*** *Quantitative indicators related to health issues reflect a reality in the public health system of Romania. To accurately analyze social and health phenomena econometric models which have been provided by Microsoft Excel were used. The forecast covers the period 2015-2016 and is relevant for the analysis of the chosen indicators*.

***Key-words:*** *multiple regression, forecasting, public health system, econometric model*

## 1. Introduction

The use of social marketing in public health campaigns had as effect designing and implementing successful campaigns. The steps needed to design and implement a public health campaign are initiated in the context of identifying a health problem of the population that could be solved or alleviated through such a program (Brătucu, Enache and Pralea, 2013).

Statistics from recent years place Romania among the countries situated on an average level in terms of standardized rate of mortality among the Member States of the European Union, with smallest incidence and prevalence rates, but with a growing trend. Cancer is a major public health problem throughout the world, there is a considerable variation in incidence, mortality, survival, environmental determinants, joint programs of prevention, detection, treatment, palliative programmes (Department of Public Health, 2011).

In order to analyze all the information, based on a knowledge gained by studying econometrics, there were analyzed several aspects and socio-economic phenomena. For the present paper, Microsoft Office Excel was used and it helped in drawing conclusions that are derived from the Excel outputs.

For analyzing the multiple regression model data has been used, referring to: the number of health units, the net investments in health, number of beds in public hospitals, the number of health professionals, the number of patients that get out of

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the hospital, the average number of employees in health system and the net average monthly earned in health system. This information was obtained for 18 years, from 1997 to 2014. Source data can be checked on www.insse.ro and relates to statistics date from Romania.

Multiple regression analysis is useful for building econometric models. Thus, a social-economic phenomenon is influenced by the action of several factors. Multiple regression analysis allows the estimation of the econometric model parameter allows analyzing correlations between variables, testing the significance of the explanatory variables, helps establishing the validity of the multiple regression models and its use for prediction (Duguleană, 2011).

To highlight the law which is manifested in each link, and to measure its tendency statistical equations are used to appropriate estimate and express the relationship between the form factor and the resultant feature. This function is known as the regression function (Petcu, 2009).

Multiple regression purpose is to highlight the relationship between a dependent variable (explained endogenous) and lots of independent variables (explanatory factor, exogenous). The more explanatory variables inputs are introduced into the model, the easier it will be to identify a better model.

## 2. Econometric model construction and forecasting

The data used in the analysis are about: the number of health units (number of units), the net investments in health system (million lei current prices), the number of beds in public hospitals (thousand beds), the number of healthcare professionals (thousand), the number of patients whom get out of the hospital (thousand), the average number of employees in health system (thousand) and the net average monthly earned in health system (lei/employee).

Multiple linear regression model equation will look like this:

$$Y=\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5,$$

where:

Y – the number of health units;
$X_1$ – the net investments in public health system;
$X_2$ – the number of beds in public hospitals;
$X_3$ – the number of professional staff in public health system;
$X_4$ – the number of patients whom get out of the hospital;
$X_5$ – the average number of employees in public health system;
$X_6$ – the net average monthly earned in public health system.
$\beta_0$, $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$, $\beta_6$ – the parameters of the regression model;
e – variable error;

The following table presents the data used for the multiple regressions. There should be mentioned that the analysed period is between 1997 and 2014.

| Year | No. of public hospitals | Net investments in public health system | No. of beds in public hospitals | No. of professional staff in public health system | No. of patients whom get out of the hospital | The average number of employees in public health system | Net average monthly earned in public health system |
|---|---|---|---|---|---|---|---|
| 1997 | 418 | 355.5 | 163787 | 41301 | 4066 | 320887 | 463440 |
| 1998 | 416 | 351 | 161952 | 42498 | 4010 | 310871 | 850351 |
| 1999 | 428 | 456.8 | 161651 | 46238 | 4060 | 283209 | 1506768 |
| 2000 | 442 | 175.3 | 164294 | 45786 | 4303 | 304989 | 1768105 |
| 2001 | 446 | 302.6 | 165355 | 46773 | 4640 | 304040 | 2624161 |
| 2002 | 447 | 2521.4 | 160376 | 45805 | 4867 | 312688 | 3194582 |
| 2003 | 427 | 2867.2 | 140818 | 46919 | 4538 | 312877 | 4126723 |
| 2004 | 425 | 3266.7 | 140406 | 48150 | 4569 | 306153 | 5206553 |
| 2005 | 433 | 1130.8 | 140919 | 47388 | 4201 | 321101 | 676 |
| 2006 | 436 | 458.6 | 139785 | 46936 | 4782 | 328331 | 823 |
| 2007 | 447 | 1156.6 | 135650 | 48199 | 4483 | 343198 | 948 |
| 2008 | 458 | 1223.5 | 135667 | 50267 | 4765 | 350278 | 1266 |
| 2009 | 474 | 1275.6 | 136054 | 50386 | 4834 | 377796 | 1342 |
| 2010 | 503 | 980.5 | 127949 | 52204 | 4923 | 365901 | 1226 |
| 2011 | 464 | 943.9 | 124667 | 52541 | 4516 | 332652 | 1210 |
| 2012 | 473 | 1283.5 | 125226 | 53681 | 4305 | 321165 | 1315 |
| 2013 | 480 | 952.9 | 125384 | 54086 | 4319 | 321489 | 1456 |
| 2014 | 478 | 1020.1 | 124999 | 54929 | 4120 | 323080 | 1496 |

Source: Statistical Yearbook of Romania, 2013

Table 1. Data used for multiple regression

The table of the regression for the data presented can be found below. With the Data Analysis tool the following results were obtained:

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.9692326 |
| R Square | 0.9394118 |
| Adjusted R Square | 0.9063637 |
| Standard Error | 9.5863738 |
| Observations | 18 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 6 | 15673.616 | 2612.2693 | 28.425573 | 4.41E-06 |
| Residual | 11 | 1010.8842 | 91.898563 | | |
| Total | 17 | 16684.5 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -287.21593 | 147.11364 | -1.9523407 | 0.0768107 | -611.01086 | 36.578997 | -611.01086 | 36.579 |
| X Variable 1 | -0.0003931 | 0.006606 | -0.0595068 | 0.9536158 | -0.0149327 | 0.0141464 | -0.0149327 | 0.014146 |
| X Variable 2 | 0.0011754 | 0.0004901 | 2.3980637 | 0.0353535 | 9.66E-05 | 0.0022541 | 9.66E-05 | 0.002254 |
| X Variable 3 | 0.0082452 | 0.0015372 | 5.3636542 | 0.000229 | 0.0048618 | 0.0116286 | 0.0048618 | 0.011629 |
| X Variable 4 | 8.42E-06 | 2.28E-06 | 3.6930944 | 0.003544 | 3.40E-06 | 1.34322E- | 3.40E-06 | 1.34E-05 |
| X Variable 5 | 0.000522 | 0.0001574 | 3.3176933 | 0.0068593 | 0.0001757 | 0.0008683 | 0.0001757 | 0.000868 |
| X Variable 6 | -6.74354E- | 4.01E-06 | -0.1679994 | 0.8696327 | -9.50916E- | 8.16045E- | -9.51E-06 | 8.16E-06 |

Table 2. Table of the regression model with six explanatory variables

Determination coefficient was 0.93, which indicates that the model explains the variance in the number of hospitals in a 93% and the correlation coefficient of 0.96 shows a strong correlation between indicators. It notes that should be removed from model variables $X_1$ and $X_6$. The p-value of the $X_1$ variable 0.953 is higher than 0.05 and will be removed to obtain a better regression model. The same procedure was made for the $X_6$ variable.

The theoretical value of Student ration corresponding to 12 degrees of freedom and a significance level of 95% is 2.178. Using the Student test for these values of the economic variables used in the econometric model can be seen: the number of beds in public hospitals, the number of health professionals, the number of patients out of the hospital, the average number of employees in health system

significantly influence the dependent variable, and other variables (net investments in public health system and the net average monthly wage in health system) does not influence significantly the number of health units. Therefore, the variables which do not significantly influence the chosen Y variable will be removed from the econometric model.

By eliminating the variables which did not influence significantly the number of sanitary units, the model can be described as:

SUMMARY OUTPUT

| *Regression Statistics* | |
|---|---|
| Multiple R | 0.968500326 |
| R Square | 0.937992882 |
| Adjusted R Square | 0.918913769 |
| Standard Error | 8.92083887 |
| Observations | 18 |

ANOVA

| | *df* | *SS* | *MS* | *F* | *Significance F* |
|---|---|---|---|---|---|
| Regression | 4 | 15649.94224 | 3912.48556 | 49.1633374 | 1.00E-07 |
| Residual | 13 | 1034.55776 | **79.58136614** | | |
| Total | 17 | 16684.5 | | | |

| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
|---|---|---|---|---|---|---|---|---|
| Intercept | -301.612429 | 122.6817766 | -2.458494137 | 0.02875026 | -566.6502935 | -36.57456364 | -566.650294 | -36.5746 |
| X Variable 1 | 0.001190983 | 0.000335294 | 3.552051733 | 0.00354246 | 0.000466624 | 0.001915343 | 0.00046662 | 0.001915 |
| X Variable 2 | 0.00825884 | 0.00133151 | 6.202612824 | 3.21E-05 | 0.005382288 | 0.011135392 | 0.00538229 | 0.011135 |
| X Variable 3 | 8.70E-06 | 2.05E-06 | 4.246350159 | 0.00095364 | 4.27E-06 | 1.31E-05 | 4.27E-06 | 1.31E-05 |
| X Variable 4 | 0.000553409 | 0.000123019 | 4.498566693 | 0.00059885 | 0.000287643 | 0.000819175 | 0.00028764 | 0.000819 |

Table 3. Table of the regression model with four explanatory variables

The determination coefficient $R^2$ shows the model validity. The value is 0.937 and explains the variable variation for the dependent variable in the proportion of 93.7%. Fisher Test value indicates a significant overall regression, Significance F value being very small. Applying Fisher Test, it can be seen from the previous regression table that F * = 49.16. This value is compared with a theoretical Fisher value with 4 and 13 degrees of freedom, which for a significance level α = 5% is $F_{k,n-k-1}^{\alpha=5\%} = 3{,}18$. As F* > theoretical F, the alternative hypothesis $H_1$ is accepted, so overall the regression is significant and the model is well constructed.

Below can be seen the evolution of the independent variable that was chosen for this model:

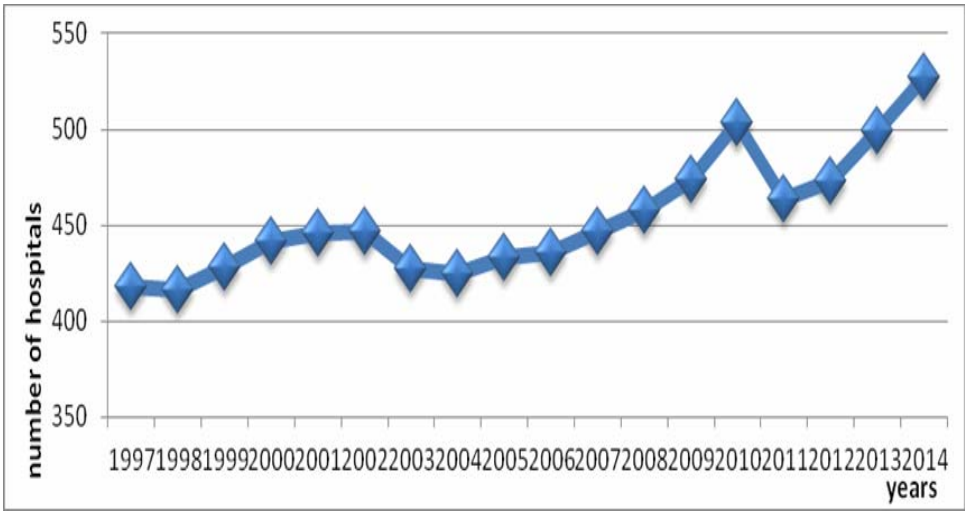


Figure 1. Evolution of the number of hospitals in Romania between 1997-2014

As it can be seen, the number of hospitals in Romania has continuously increased from 1997 till 2010. This increase was followed by a decrease in the number of hospitals in 2011. First we will analyze the intensity and direction of the link between the dependent variable and each of the six exogenous variables. In order to do this, we have to calculate the linear correlation coefficient Pearson.

Based on the results, we can draw the following conclusions: between the number of health units and net investments in health system there is a reverse and very low intensity link, the correlation coefficient being -0.068.

The link between the number of health units and the number of beds in public hospitals is also a reverse one, with medium intensity, with the correlation coefficient value -0.696. A direct link was calculated between the dependent variable and variables related to the number of patients that get out of the hospital and the average number of employees in public health system, for which calculated coefficients were 0.195 (weak connection) and 0.481 (average connection). Monthly net nominal average wage in public health system is in reverse connection with the dependent variable, having a correlation coefficient of -0.462.

A quite strong and direct correlation with a coefficient of 0.87 can be observed between the dependent variable and healthcare professionals in public health system in Romania. However, it appears that the connection is weaker in the

recent years, which is due to the restructuring of the public health system and the number of health units abolished lately.

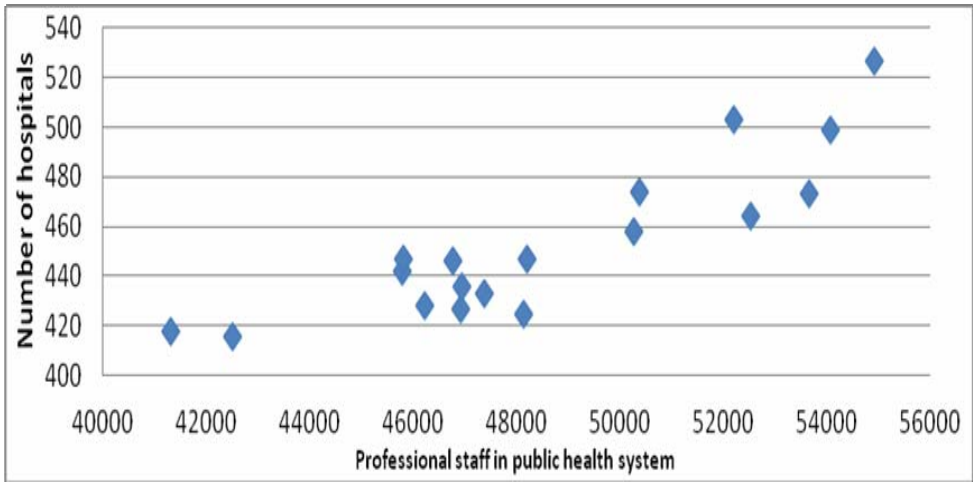


Figure 2. The correlation between the number of hospitals and healthcare professionals between 1997 and 2014

Further, the theoretical y values were calculated on the base of the calculated regression and the table shown above. Then the graphics were performed reflecting the adjustment variables investigated.

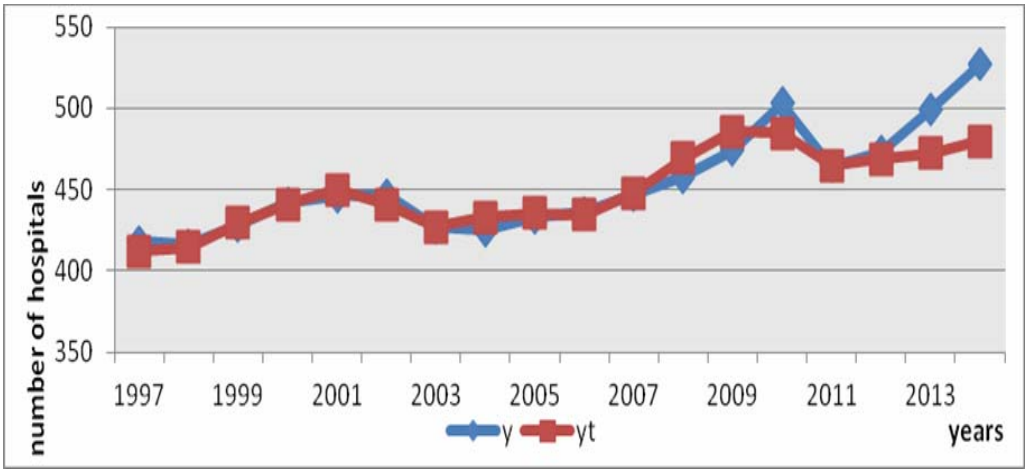


Figure 3. Adjustment of the number of hospitals in Romania between 1997 and 2014

To achieve the graphical analysis of the dynamics of variables evolution a forecast was made for each significant independent variable in the econometric model. Using MS Excel the forecast for the next 2 years was made, respectively 2015-2016. Using the known observations for each variable, it conducted a new regression table, further used to calculate the theoretical x. Dummy variables were chosen for each specific analysis and thus were obtained following graphic models:

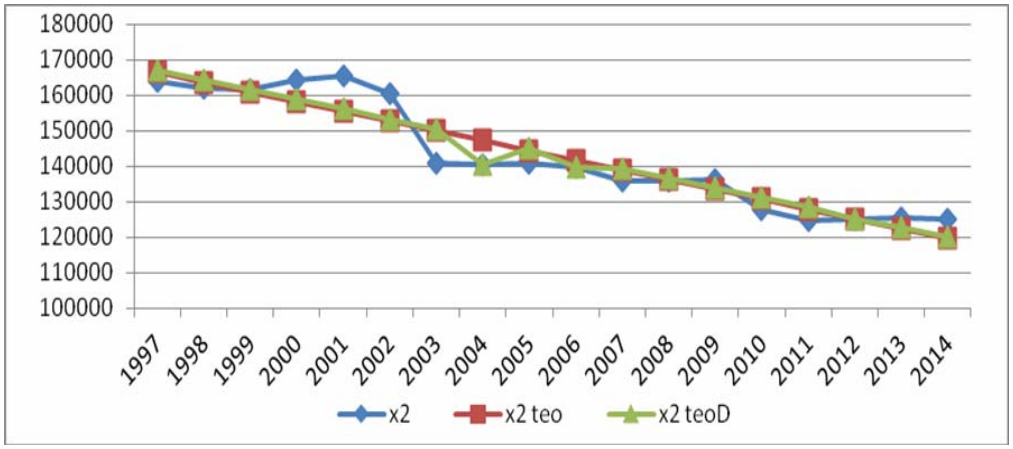


Figure 4. Adjustment of the number of beds in public hospitals

Regarding the adjustment of the number of beds in public hospitals, there can be noticed a continuous decline since 2001. Even if during this period, the number of hospitals had some small increases.

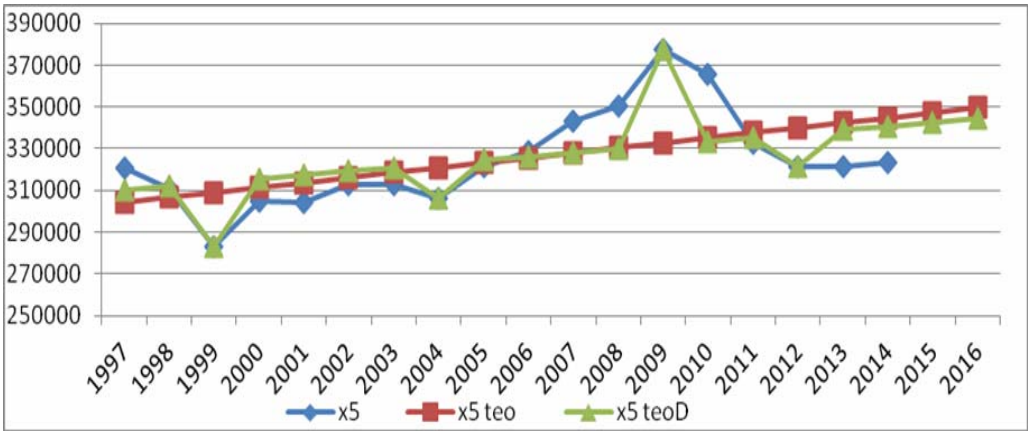


Figure 5. Adjusting evolution for the average number of employees in public health system

As shown in the above graph, the evolution of the average number of employees in the public health system had a slump in 1999, but it also had an increased return by the year 2009. Starting with 2010 their number will decrease continuously until 2014, the last year analyzed. This may be due to migration of health professionals in recent years from Romania. Because of the very low wages, many of the public health employees left their country for other countries such as France, England, Italy and Spain.

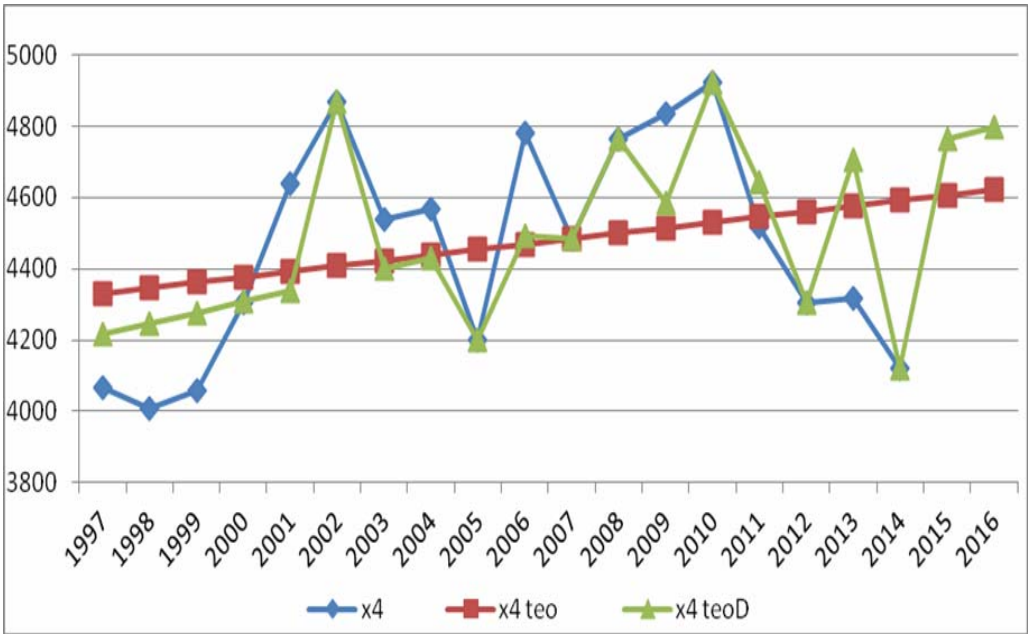


Figure 6. Adjusting the evolution of the number of people who came out of hospital in Romania between 1997-2014

In the chart shown above, large fluctuations can be seen in the evolution of the number of people who came out of hospital in Romania between 1997 and 2014. An increase was observed until 2002, when a downward trend persisted until 2006. Then an unexpected increase was recorded until 2010. Since then, the number of people who came out of the hospital has been decreasing.

This decreasing trend from the last studied years was not pictured in a healthier population, but it could be due to the large number of hospitals which were abolished because of the lack of medical staff, and also due to restructuring projects carried out by the Romanian government.

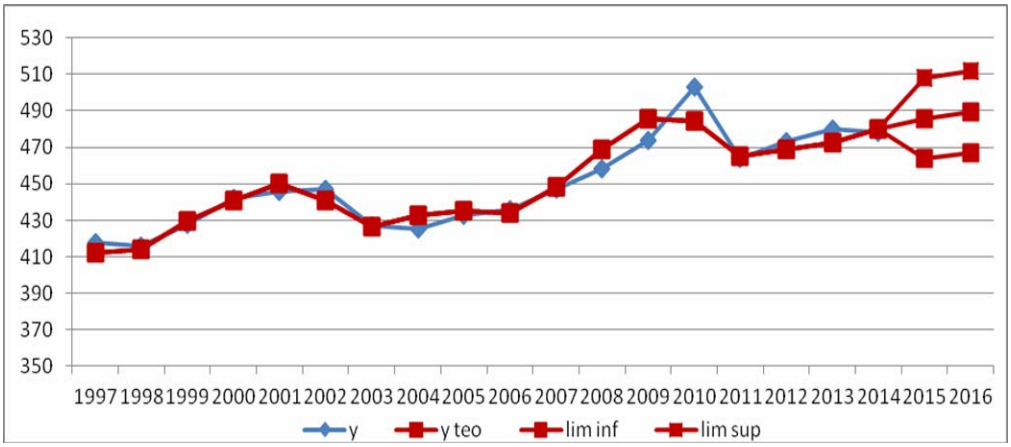


Figure 7. Adjusting the evolution of health units in Romania between 1997-2016

Using the data obtained by the forecast analysis for each independent variable, a forecast of the entire analyzed phenomenon can be made. It can be seen in the chart from above, the adjusted values, which were separated into three directions since 2014, fact which marks the lower limit and the upper limit. Between them the pointed forecasts are shown for the number of hospitals for the next two years. Between 2014 and 2016 the number of health units announces a slight increase.

## 5. Conclusions and discussions

The indicators used for this analysis are directly influenced by the economic and social phenomena in Romania. In the situation above presented, changes in the number of hospitals is the result of many influencing variables. Given the variables used for this analysis, it could be seen that two variables were removed from the model (net investments in public health system and monthly net nominal average wage in public health system).

Analyzing the variable related to the number of health units in Romania, between 1997 and 2014, the influence of decisions taken at national level can easily be seen. In 2011 there was a sudden decrease in hospitals number

following the abolishment made after considering the objective criteria set out in Article 2 of the Health Ministerial Order no.241/2011.

Following the forecast realized in this paper, an increase in the number of hospitals in the years 2015-2016 can be seen, growth which is beneficial to the economical and social development of Romania. The number of employees in public health system could increase and also the paid taxes to the state so that citizens will benefit from a large variety of quality health services.

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