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# Forecasting Methods of the Enrolled Students' Number

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## Abstract

*The forecast of the enrolled students' number, annually, represents a very important activity, because on this number is based the foundation of the budget incomes and expenditure.*

*Choosing the method that will be used, in this case, it's a very difficult operation, taking into consideration that there are a lot of factors that influence the evolution of the enrolled students.*

*In this paper, after a short presentation of some forecasting methods, that can be used in this case, we realized a forecast of the students' numbe that will be enrolled at Petroleum–Gas University.*

*The forecast emphasizes a slow but continuous trend of decreasing of the enrolled students, in the next five years and especially of those that pay tuition fee.*

**Keywords:** *enrolled students; forecast methods; time series; trend, budget*

**JEL Classification:** *C5; I21; I23*

## Introduction

Forecasting the students' number who are admitted each year represents an important activity for universities because this number is the basis of determining the incomes and thus the basis of foundation for operational plans or strategies. The accuracy of these forecasts is essential for any university that wants to be competitive in the educational area. Providing financial resources for universities to invest in the material base and in research involves a proper planning of these resources, which is not possible without a well-founded estimation of the annually admitted students' number. We can affirm that this prediction is fundamental in designing the revenue and expenditure budget and human resources planning, investment funds or administrative expenditures of universities, especially in the current circumstances when there is a clear tendency of reduction of the number of students.

In these circumstances a well done forecast would solve many of the university's planning problems. It should be noted however that there are a lot of factors and conditions that permanently influence the annual number of students who are admitted to universities, which makes achieving the forecast to raise some problems. Therefore, an estimation of the number of

students with a high level of trust requires an analysis of all influencing factors and also of the trends outlined in its evolution in recent years. On the other hand, achieving a proper forecast largely depends on choosing the method that is most likely to be successful in each case.

## Classification of the Methods Used in the Forecasting the Number of Admitted Students

To forecast the number of students annually admitted, we can use a wide range of methods and techniques, such as: qualitative methods (especially Delphi method[1]), time series analysis, fuzzy time series analysis[2], model of transition (as Markov Chains[3]), neural network model[4], regression analysis[5] etc. Selecting the forecast method depends on the amount and quality of available data, of objectives, of the estimated costs of the activity of forecasting and of the possibility of using existing software.

We will further briefly present some of the listed methods that we consider to be easily applied in forecasting the number of annual admitted students.

a) *The extrapolation method* based on time series[6] consists of future extending of the evolution noted in the past, assuming that the trend of the variable that is subject for forecasting will not change substantially in the future. This method can also be applied with good results in forecasting the number of students[7], which, as presented above, it has shown a trend of steady decline in recent years at national level. We also consider that, at least on average term, this trend will be maintained.

Depending on the trend of evolution of the number of students we can use two methods of extrapolation, based on time series:

- extrapolation using absolute average change;
- extrapolation using the average index.

Extrapolation using *absolute average change* can be used within universities whose number of students evolves under the form of arithmetic progression, a frequently met situation. Depending on maintaining or not the intensity of the outlined trend, extrapolation will be applied in mechanical or heuristic version.

The trend calculation in case of *mechanical* extrapolation will be:

$$\hat{Y}_t = Y_O + t \cdot \overline{\Delta} \qquad (1)$$

[1] Lazar C., Lazăr M., Delphi – The Highest Qualitative Forecast Method, *Buletinul Universității de Petrol-Gaze din Ploieşti*, Seria Ştiințe Economice, Vol. LX, Nr. 1/2008, pp. 31-36

[2] Chen, S. M., Hsu, C.C., A New Method to Forecast Enrollments Using Fuzzy Time Series, *International Journal of Applied Science and Engineering*, vol 2, issue 3, 2004, p. 234-244

[3] Lazăr, C., Lazăr, M., Short term forecasting methods applied in economy in crisis situation. Case study on Romanian tourism, *Metalurgia Internațional*, vol. XIV, nr.11, Scientific Publishing House FMR, 2009, pp. 171-173

[4] Pouramini, J., Forecasting Number of Studens Applicant for Courses by Artificial Neural Networks, *Journal of Mathematics and Computer Science*, No 12, 2014, pp. 263-270

[5] Walczak S., Sincich, T., A comparative anallysis of regression and neural networks for university admissions, *Information Sciences*, No 119, 1999, p. 1-20

[6] Lazăr, C., Lazăr, M, *Previziune economică şi financiară. Teorie şi aplicații*, Corint Publishing House, Bucharest, 2014, p. 211

[7] Chau-Kuang, C., *An Integrated Enrollment Forecast Model*, IR Applications, Association for Institutional Research, vol 15, 2008, pp. 1-17

where:

$\hat{Y}_t$ - adjusted variable for the analysed period;

$Y_o$ – the value of the variable in the base year;

$t$ – the number of years (or other units of time) from the trend calculation period (t=$\overline{0,n}$);

$\overline{\Delta}$ - the absolute average change of variable y in the previous period:

$$\overline{\Delta} = \frac{Y_n - Y_0}{n} \tag{2}$$

where n represents the number of terms minus 1.

The forecasted values will be calculated according to the relation:

$$\hat{Y}_{n+p} = Y_n + p \cdot \overline{\Delta} \tag{3}$$

where:

$\hat{Y}_{n+p}$ - the extrapolated variable for horizon p of the forecast;

$Y_n$ – the value of the variable in the last year of the previous period;

$p$ – the number of years (or other units of time) from the forecasting period.

In *heuristic* extrapolation, a correction coefficient *K* is considered, which indicates the estimates given by experts on changing the evolution of the analysed phenomenon.

Accordingly, the calculation will be:

$$\hat{Y}_{n+p} = Y_n + p \cdot \overline{\Delta} \cdot K \tag{4}$$

where:

K – correction coefficient, that can be: k>1, increasing the trend or k<1, decreasing it;

Extrapolation using *the average index* can be applied to universities where the number of students is evolving under the form of geometric progressions (the dynamic indices with a chain base are approximately equal).

The calculation will be:

$$\hat{Y}_{n+p} = Y_n \cdot \overline{I}^p \text{ - in case of mechanical extrapolation} \tag{5}$$

$$\hat{Y}_{n+p} = Y_n \cdot \overline{I}^p \cdot K \text{ - in case of heuristic extrapolation} \tag{6}$$

where:

$\overline{I}$ - represents the annual average index

$$(\overline{I} = \sqrt[n]{\frac{Y_n}{Y_0}}) \tag{7}$$

We believe, however, that extrapolation using average index cannot be applied in the following

period except for some recently established private universities, which are now in full development.

b) *The simple exponential smoothing method* is used for statistical series with constant, horizontal evolution, with no cyclical variations and without trend. We appreciate that this method can only be applied in the forecast of the number of students financed from the state budget which in recent years has progressed almost constantly, with minor fluctuations from one year to another.

The simple exponential smoothing method is based on the idea that the forecast for the following period is equal to the current period, plus a proportion of the forecast error or otherwise, the new forecast is equal to the previous forecast plus a forecasting error, adjusted with a coefficient:

$$\hat{Y}_{t+1} = \hat{Y}_t + \alpha \cdot e_t \tag{8}$$

where:

$\hat{Y}_t$ – the forecast for the period $t$;

$\hat{Y}_{t+1}$ – the forecast for the period $t+1$;

$Y_t$ – the registered value for the period $t$;

$e_t$ – the forecast error ($e_t = Y_t - \hat{Y}_t$) ;

$\alpha$ – the smoothing coefficient (a number between 0 and 1).

Replacing in the previous calculation $e_t = Y_t - \hat{Y}_t$, it results the following:

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t \tag{9}$$

According to the exponential smoothing method, the latest observations contribute with the most information to the substantiation of the future development of the planned phenomenon[8].

c) *The method of the trend functions* is a method commonly used in the forecasting activity[9], which is based on adjusting the dynamic series using mathematical, analytical functions, suitable to the evolution form. The main problem in applying these methods consists in choosing the right type of function $\hat{Y}_t$ which estimates the central trend of the series.

The functions that are often used for adjusting and forecasting based on dynamic series are: linear, parabolic, exponential, logarithmic and logistic.

We believe, however, that forecasting the number of students for the next 4-5 years, the linear trend function is the best solution. It is used in linear developments, a situation encountered in most universities.

The linear trend function has the equation of a line as an analytical expression:

$$\hat{y} = a + bt \tag{10}$$

where:

[8] Makridakis, S. et al., The Accuracy of Extrapolation (Time Series) Methods:Results from a Forecasting Competition, *Journal of Forecasting*, No 1, 1992, pp. 111-115

[9] Lazăr, C., Lazăr, M, *Previziune economică şi financiară. Teorie şi aplicaţii*, Corint Publishing House, Bucharest, 2014, pp. 103-104

a – free term with no economic significance;

b –is the slope of the trend line (it approximates the average growth);

Parameters a and b are determined through the method of the least squares.

After replacing the values of a and b, the adjustment function thus obtained explains the evolution trend of the phenomenon from the previous period, but also underlies the forecasting of the value of the dynamic series' terms.

d) *The linear regression method is* more rigorous and of increased complexity, compared to the methods based on the analysis of dynamic series, the causal methods, also called exogenous methods, assume the existence of a cause - effect relationship between the variables that are to be predicted and one or more independent variables. First, we are looking for the form of this relationship as it is used to predict dependent variable values on the assumption that there is a future sequel of the cause – effect relationship.

Through the regression analysis we understand a class of methods using a regression equation based on experimental data, values of a given variable can be predicted (resultant variable), assuming known or predicted values of other variables (exogenous, independent)[10].

In the case of *simple linear regression,* the relationship between the effect variable (y) and the cause variable (x) has the following form:

$$y_t = a + bx_t + e_t \tag{11}$$

where*:*

*y* – the dependent variable that is to be predicted (resultant variable);

*x* – independent variable (causal variable, influence factor);

*a* – shows a basic level of the dependent variable that does not depend on the independent variable and indicates the point where the line crosses OY axis (in the rectangular axis system);

*b* –parameter that signify a marginal growth (the change of dependent variable y when the independent variable x, change whit a unit);

$e_t$ –represents the residual component (random error) for each unit, i.e. the part of variable y that cannot be measured through the causal relationship with variable *x.*

If the current period is n (t = n) the forecast for the period n + p will be:

$$\hat{y}_{n+p} = a + b\hat{x}_{n+p} \tag{12}$$

The linear regression method is often used in forecasting the number of students, usually using as an independent variable, especially the number of high school graduates who have passed the baccalaureate.

## Factors that Influence the Dynamics of the Number of Admitted Students

The evolution of the number of students annually admitted in universities is determined by a variety of objective or subjective factors, internal or external to universities. Knowing these

[10] M a r i n o i u , C., L a z ă r , C.**,** Model de regresie pentru evidențierea unor determinanți ai produsului intern brut, *Studii şi Cercetări de Calcul Economic şi Cibernetică Economic*, Nr. 4, ASE, Bucharest, 2004, pp.149-159

factors, the manner and the measure in which they influence the dynamic of the number of admitted students, is essential to substantiating forecasts and policies in this field.

The researches made in the field of education[11] and the statistics data show that the evolution of the number of admitted students is primarily influenced by the dynamics of the number of high-school graduates who pass the baccalaureate, which is in turn determined by the evolution of the number of children.

In Romania, the direct link between the evolution of the number of children and the evolution of the number of high school graduates who have passed the baccalaureate is more than obvious (Table no.1)

Data presented in table no. 1 reveal that the sharp decrease (over 30%) of the number of live births in the period 1988-1995 resulted in a significant reduction of the number of graduates in the period 2006-2013 (by 30%) .

**Table 1.** The evolution of live births' contingent between1988 and 1995 and of high-school graduates who have passed the baccalaureate, in Romania between 2006 and 2013

| **Live Birth** | | **Graduates** | |
|---|---|---|---|
| **Year of birth** | **Number of live birth** | **Year of graduate** | **Number of high-school graduates who have passed the baccalaureate (18 years aged)** |
| 1988 | 370534 | 2006 | 174078 |
| 1989 | 369179 | 2007 | 188123 |
| 1990 | 362017 | 2008 | 204883 |
| 1991 | 307523 | 2009 | 204883 |
| 1992 | 260943 | 2010 | 163545 |
| 1993 | 255503 | 2011 | 111922 |
| 1994 | 246736 | 2012 | 92209 |
| 1995 | 236640 | 2013 | 114652 |

Data source: Substantiating note to the Government Decision no. 327/2014 regarding the approving of the enrolment figures for the preuniversity and tertiary education in the school year/academic year 2014/2015

It is observed from the plot in Fig. 1 that in the period 2006 - 2009, although the number of those aged 18 had begun to enter a downward trend, the number of those who opted to attend a higher education institution was maintained on an ascending line. The year 2009, marking the beginning of the financial crisis in Romania, also marks the beginning of the decrease in the number of students.

Therefore, among the factors that affect the evolution of the number of students annually admitted in universities and implicit of the graduates we can list not only the demographic ones but also those related to the economic and social development, economic growth, political changes, etc.

In this context we may consider indicators such as Gross Domestic Product per inhabitant, unemployment rate, level of taxes etc. Thus, in the year 2009, Gross Domestic Product per inhabitant is reduced compared to the year 2008 by almost 2%, the real wage by 4% and unemployment rate raised by almost 80%.

The increase of the unemployment rate and the reducing of the purchasing power of the population in conditions of the economic and financial crisis have led to the decline of opportunities for young people to attend an university with a tuition fee.

[11] G e r a l d , D. E., H u s s a r , W. J., *Projection of Education Statistics to 2009*, National Center for Education Statistics, Vol 1, Issue 4, 2007, pp. 123-127

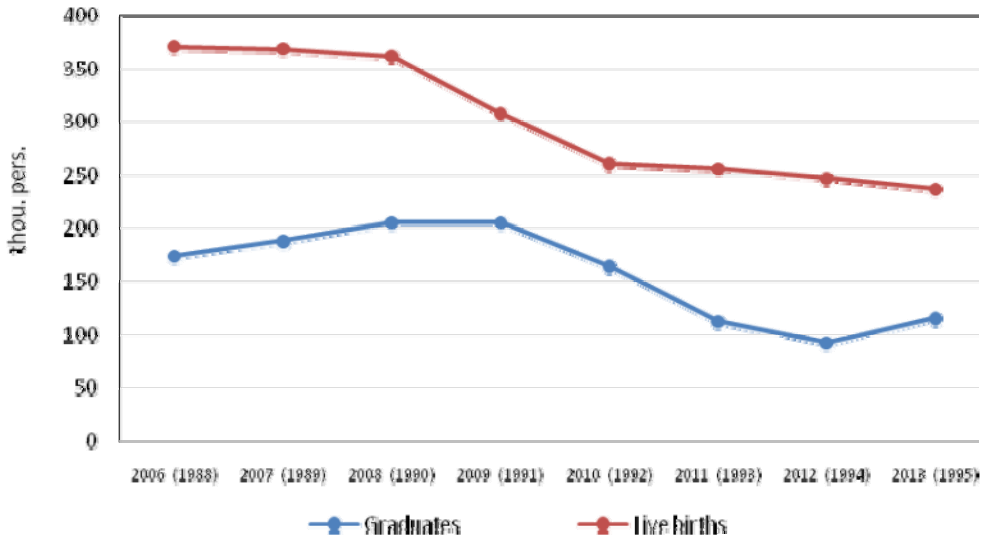


**Fig. 1.** The evolution of live births' contingent between 1988 and 1995 and of high school graduates who have passed the baccalaureate in Romania between 2006 and 2013

Data source: Substantiating note to the Government Decision no. 327/2014 regarding the approving of the enrolment figures for the pre-university and tertiary education in the school year/academic year 2014/2015

The dynamics of the number of students is influenced also by factors internal to the universities[12], most important being: the quality and diversity of curricula, the location and prestige of the university, the tuition fees, facilities for students, recruitment policy etc.

## Forecasting the Number of Students Who Are to Be Admitted to the Petroleum-Gas University of Ploiesti in the Period 2015-2020

In carrying out the forecast of the number of students annually admitted to the Petroleum-Gas University of Ploiesti we must start from an analysis of their evolution in the past. In the period 2004 - 2014, the number of admitted students evolved differently by the two categories: students financed from the state budget and those who pay taxes.

Therefore, in that period, the number of students admitted to the University Petroleum - Gas of Ploiesti decreased with 22.0%, meaning an absolute decrease of 730 students.

Given the fact that over 50% of the total number of admitted students is represented by those who are paying tax, their evolution will print the general trend.

**Table 2.** Evolution of the number of students of Petroleum-Gas University of Ploiesti, by the way of financing in the period 2004 – 2015

| Academic year | Total students | by the way of financing : | |
|---|---|---|---|
| | | from the Budget | paying tax |
| 2004/2005 | 3320 | 1173 | 2147 |
| 2005/2006 | 4653 | 1138 | 3515 |
| 2006/2007 | 4377 | 1240 | 3137 |
| 2007/2008 | 4014 | 1195 | 2819 |

[12] McPherson, M., Scharpiro, M., Does Student Aid Affect College Enrollment?, New Evidence on a Persistent Controversy, *The American Economic Review*, vol 81, No1, 1991, pp. 309-319

*Table 2 (cont.)*

| | | | |
|---|---|---|---|
| 2008/2009 | 4919 | 1393 | 3526 |
| 2009/2010 | 4921 | 1393 | 3528 |
| 2010/2011 | 4110 | 1372 | 2738 |
| 2011/2012 | 3016 | 1229 | 1787 |
| 2012/2013 | 2652 | 1210 | 1442 |
| 2013/2014 | 2772 | 1266 | 1506 |
| 2014/2015 | 2590 | 1239 | 1351 |

Data source: The evidences of the Petroleum – Gas University of Ploiesti

The data presented in Table and Fig. no. 2 show on one hand a tendency of maintaining the same level of the number of admitted students, financed from the budget, and one the other hand of reducing the number of those paying tax, respectively more than 50% in 2014 compared to 2005.

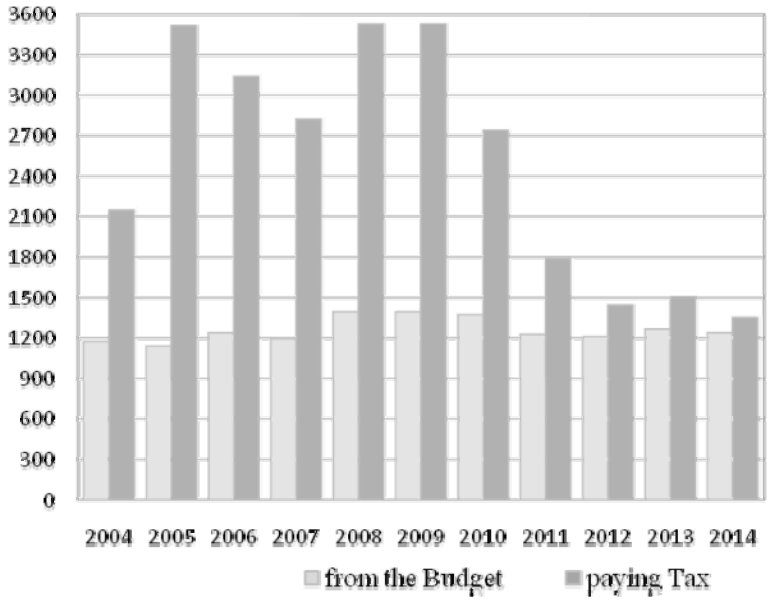


**Fig. 2.** Evolution of the number of students of Petroleum-Gas University of Ploiesti, by the way of financing in the period 2004 – 2015

Data source: The evidences of the Petroleum – Gas University of Ploiesti

The graphical representation clearly illustrates the significant reduction of the share of students admitted on fee based, from 65% in 2004 to only 52% in 2014.

Taking into consideration the two different types of evolutions, the forecast models will also be different; the total forecast number of admitted students being the result of the two components separately forecast.

*To forecast the number of students who are to be admitted to UPG Ploiesti, on the budget financed places*, for the next 5 years, several trend functions were tested, using the facilities provided for that purpose by the EXCEL program.

Considering the level of the R-Squared coefficient (determination coefficient $R^2$), that indicate the measure in which the selected function explains the evolution of the indicator to be planned, it revealed that the most appropriate function for the evolution of the students admitted to UPG

Ploiesti on places financed by the state budget is the polynomial function of 6 degree ($R^2$ = 0.85). But the forecast levels based on of this function are abnormal.

Therefore, from all tested versions of functions, we chose the polynomial function of 3 degree, by giving up the coefficient of determination, as unique criteria for selection. Although this explains the previous evolution only at a rate of 47.9%, it best characterizes the future evolution of the aimed indicator (Fig. 3).

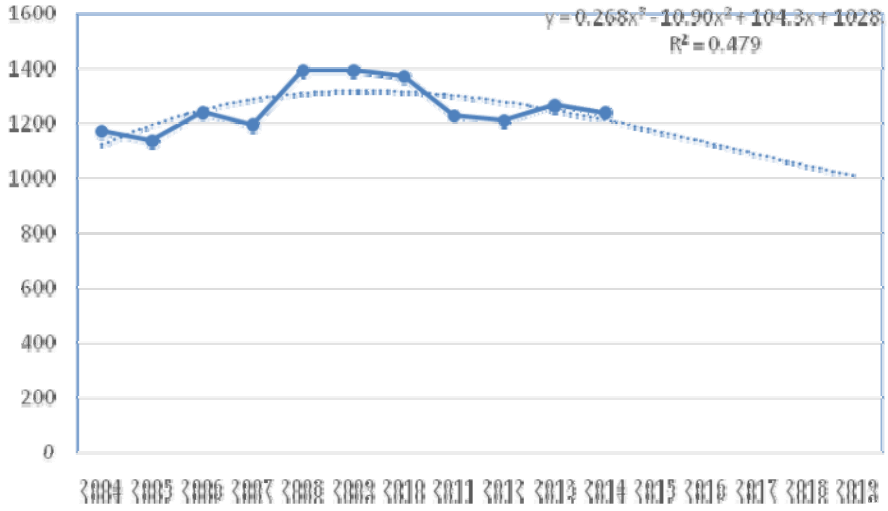


**Fig. 3.** The evolution of the number of students of Petroleum-Gas University of Ploiesti, on places financed by the state budget in the period 2004 - 2014 and the forecast for the period 2015 - 2019

Data source: Forecast based on the information taken from the evidences of the Petroleum - Gas University of Ploiesti

*To forecast the number of students who are to be admitted to UPG Ploiesti on tax places* for the next five years, several trend functions were also tested.

Also in this situation, taking into account the coefficient of determination $R^2$, the most suitable function proved to be also the polynomial of 6 degree ($R^2$= 0.98). The forecast levels based on this function were again abnormal.

For a sinuous evolution and with very different rhythms both in direction and intensity of the number of students admitted on tax places, none of the trend functions could be applied, the forecasts showing abnormal levels.

In this case, based on experience in the economic field and forecasting too, taking into account the influence of the many external factors that cannot be quantified and integrated into a simple model, we made an atypical forecast, using extrapolation based on average change, although the past evolution does not match this method.

The values that were forecast in this way describe closest to reality the future evolution of this indicator (Fig. 4).

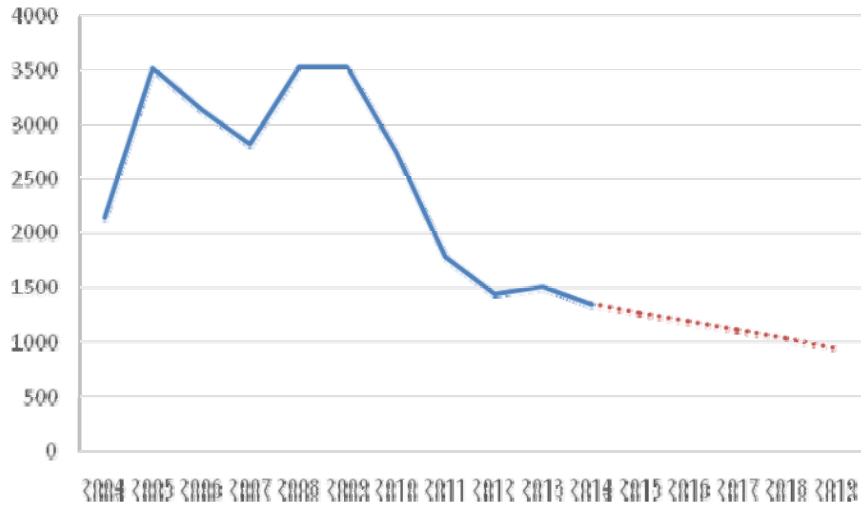


**Fig. 4.** The evolution of the number of students of Petroleum-Gas University of Ploiesti, on tax places in the period 2004 - 2014 and the forecast for the period 2015 - 2019

Data source: Forecast based on the information taken from the evidences of the Petroleum - Gas University of Ploiesti

Based on the forecast of the two categories of students admitted on the places financed by the state budget and those on the tax places, the evolution of total number of students admitted to UPG Ploiesti, for the next five years will be:

**Table 3.** The forecast of the number of students of Petroleum-Gas University of Ploiesti, by the way of financing in the period 2015 – 2019

| Academic year | Total students | by the way of financing : | |
|---|---|---|---|
| | | from the Budget | paying tax |
| 2015 | 2445 | 1174 | 1271 |
| 2016 | 2323 | 1131 | 1192 |
| 2017 | 2200 | 1088 | 1112 |
| 2018 | 2079 | 1046 | 1033 |
| 2019 | 1959 | 1006 | 953 |

Based on forecast data, in the next five years, the total number of students admitted to UPG Ploiesti will drop by almost 25% (-631 students), the number of those admitted on the places financed by the state budget will drop by 20% (-233 students) and of those admitted on tax places will drop by 30% (-398 students).

Also, the students admitted on tax places will be less than 50% of admitted students in 2019, according to the forecast made.

## Conclusions

Selecting the method of forecasting the number of admitted students represents a difficult endeavour, which cannot be simply the result of applying an algorithm, because in many cases predicted values tend to aberrant levels, even if the statistical and mathematical criteria are theoretically fulfilled.

But real situations are complex, difficult to predict because of the influence of exogenous factors, sometimes hard to quantify and even identify.

In these circumstances, a qualitative analysis is essential, as it involves a lot of experience from those who perform the forecast study.

In the specific case, analysed in this paper, by applying different methods of forecasting, for the two categories of students admitted to UPG Ploiesti, on places financed by the state budget and on tax places, resulted that the trend manifested in recent years of decreasing, continued. Thus, for the next five years, we estimate a reduction in the number of admitted students by about 25%, the reduction being more pronounced (-30%) in tax-paying students.

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