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Quantitative Aspects of the Gap between Romania and the European Union

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Abstract: GDP per capita is an indicator that can be used in performance for international comparisons performance and which will provide information on the existence of differences of development. In this study we aim to determine the current position of Romania, starting from the evolution of GDP per capita in Romania and the EU average foreshadowed during 1990-2013 years. Taking into account the position of our country at the pole of poverty in the EU, we want to quantify the changes that have recorded growth rates, so Romania to reach the EU average. We pay special attention to the analogy by extrapolation method that can quantify the evolution of the gap, expressed in time, and thus, we use the parabolic functions.

Keywords: GDP per capita; time series; extrapolation by analogy

Introduction

An indicator that captures the level of development of a country and it can be useful in international comparisons is GDP per capita. It is a macroeconomic indicator which reflects the sum of the market value of all goods and services for final consumption goods in all branches of economy within a country within a year, reported on an inhabitant. (Modern Economy Macmillan Dictionary, 1999) Based on per capita GDP can highlight the material prosperity of individuals in a country. In this context an analysis of a country, like Romania, considered to represent a useful step. Romania in the last quarter century recorded two moments that marked the history. They are as follows: the former moment was the revolution of December 1989 when it was abolished the comunist dictatorship and when Romania went from centralized economy to a market economy; the latter moment was the accession to the EU in January 2007. In spite of significant economic and social costs borne by the population in transition to a market economy, Romania is far away from the registered EU development environment. This hypothesis of poor country EU has many causes, including: historical heritage, lack of coherent programs of development, lack of adequate transport infrastructure, the origins Balkan endemic corruption and exacerbated the political change of regime etc. For presenting the current level GDP per capita in the EU countries and also held the position of Romania, see Figure no. 1. Average number of this indicator in the EU is approximately 20,000 US $ / capita, ECAC cause countries in the left down rectangle to range below average UE. As it could be seen, Romania

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registered last place in terms of GDP / capita, having about 8,500 US $ / capita, after Bulgaria. We precise that this chart was made and also used data from Wolfram program Mathematica. Taking into account this position of Romania in the EU, our approach tries to analyze the GDP per capita in the period 1990-2013, in order to determine if there are prerequisites for Romania to register an elimination of gaps separating the EU, or is condemned to remain the EU periphery.

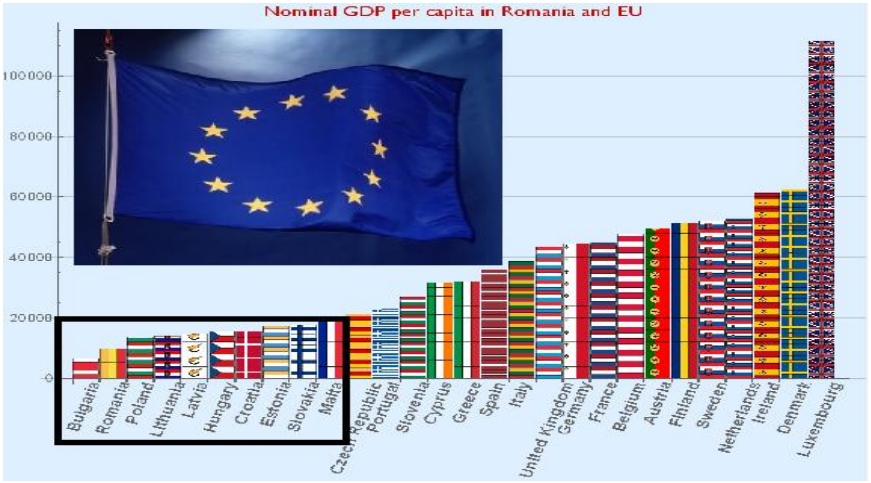

Figure 1.

Evolution of nominal GDP per capita in Romania and the EU average is shown in Figure no. 2 in which it can be seen, on the one hand, much lower initial level of the indicator recorded by Romania and, on the other hand, this gap not diminish during the period.

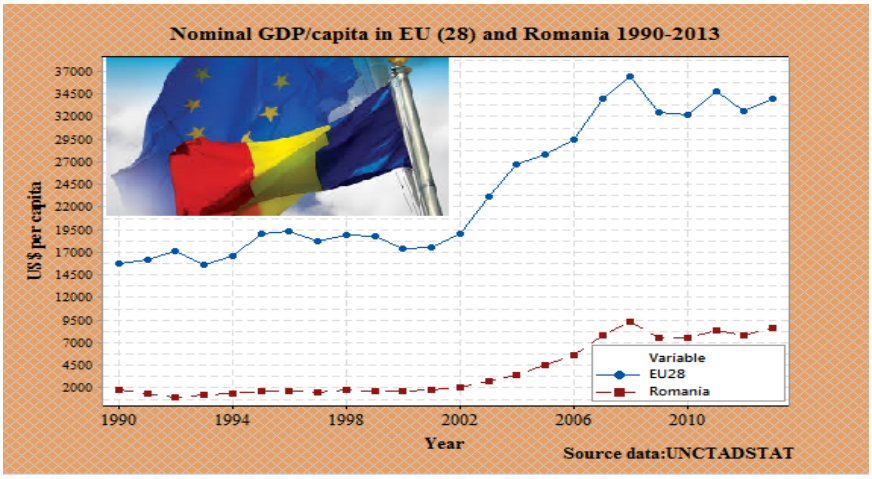

Figure 2.

Thus, in 1990 if the EU average GDP per capita was US $ 15,678 $ 1735US Romania scored in 2013 the following values 33916.5, 8592.2 respectively.

Based on data on the evolution of the difference between the level of GDP per capita in the EU average and Romania was obtained following regression equation:

Diference EU-ROM nom = 12596 + 590.3 t; where t is the time 1990 = 1

S = 1903.55; R-Sq = 83.4%; R-Sq(adj) = 82.7%

Analyze of Coefficients

Term	Coef	SE Coef	T-Value	P-Value
Constant	12596	802	15.70	0.000
t	590.3	56.1	10.52	0.000

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	400744191	400744191	110.60	0.000
Error	22	79717474	3623522		
Total	23	480461665			

The analysis result about significant coefficients and variation of the linear model of the relationship between the level recorded for the difference in GDP per capita between the EU and Romania. P-value for the null hypothesis tests each coefficient. That is equal to the coefficient zero (no effect). Therefore, low p-values suggest the predictor is a meaningful addition to your positive model. The positive sign t coefficient of regression equation highlights the direct relationship between time and the difference in GDP per capita, ie the passage of time this gap increases. The tendency is an ascending one, so the trend that we consider is "a broad, continues movement of the whole system" as defined by G Yule and MCKendall. (Yule & Kendall, 1969 p. 632) The value of this coefficient represents the average GDP gap change due to changes by one unit of time variable, i.e. the difference between GDP per capita increases by 590.3 USD from one year to another. This trend is displayed by the graph below:

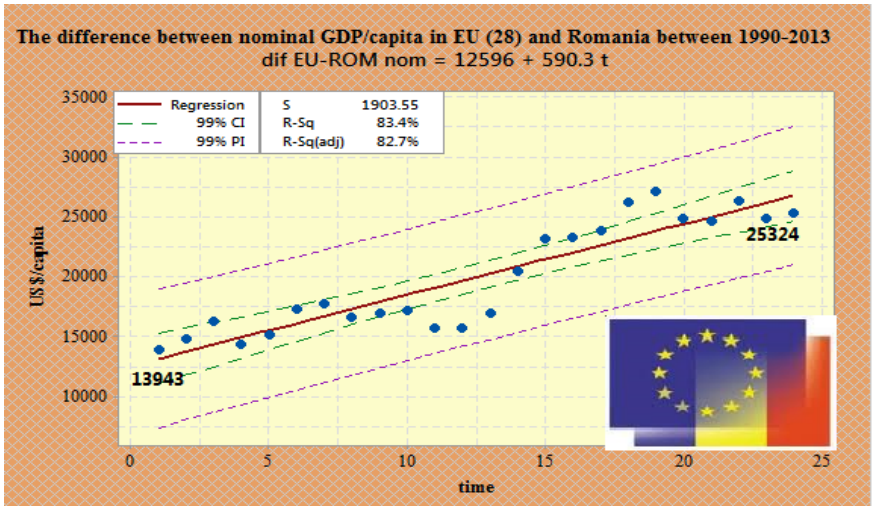

Figure 3.

Analysis of the evolution of the difference between GDP per capita in the EU and Romania can be achieved in terms of time, ie to determine the time gap separating the two entities. For this purpose we use an extension by analogy. Extrapolation method starts from time functions of the indicator compared in the two entities compared to a time lag. (Hetman, 1969) The method evidences such premises if there is a leveling of the indicator and also determine the range time you might realize.

Thus, for an evolution of indicators that can be adjusted by a second-degree regression function of time, we have:

$$y_1 = a_1 + b_1 t_1 + c_1 t_1^2 \qquad y_2 = a_2 + b_2 t_2 + c_2 t_2^2$$

Let's suppose it exists a time delay d between the first and second regression of the form:

$t_1 = t_2 + d$ and solve the equation $d = solve(y_1 = y_2, d)$

it will obtain the time lag depending on the time recorded by one of the functions of regression. The result will be one of the form:

$$d_1 = \frac{1}{2}\frac{-2c_1t_2-b_1+\sqrt{4c_1c_2t_2^2+4b_2c_1t_2-4a_1c_1+4a_2c_1b_1^2}}{c_1}; d_2 = -\frac{1}{2}\frac{2c_1t_2+b_1+\sqrt{4c_1c_2t_2^2+4b_2c_1t_2-4a_1c_1+4a_2c_1b_1^2}}{c_1}$$

The difference is a null one after solving the following relations:

$$m_{1,2} = solve(d_1 = 0, t_2) \qquad n_{1,2} = solve(d_2 = 0, t_2)$$

$$m_{1,2} = \frac{1}{2}\frac{-b_1+b_2+\sqrt{-4a_1c_1+4a_1c_2+4a_2c_1-4a_2c_2+b_1^2-2b_1b_2+b_2^2}}{c_1-c_2} =$$

$$= -\frac{1}{2}\frac{b_1-b_2+\sqrt{-4a_1c_1+4a_1c_2+4a_2c_1-4a_2c_2+b_1^2-2b_1b_2+b_2^2}}{c_1-c_2}$$

$$n_{1,2} = \frac{1}{2}\frac{-b_1+b_2+\sqrt{-4a_1c_1+4a_1c_2+4a_2c_1-4a_2c_2+b_1^2-2b_1b_2+b_2^2}}{c_1-c_2} =$$

$$= -\frac{1}{2}\frac{b_1-b_2+\sqrt{-4a_1c_1+4a_1c_2+4a_2c_1-4a_2c_2+b_1^2-2b_1b_2+b_2^2}}{c_1-c_2}$$

Based on data recorded in the evolution of GDP per capita in the EU and Romania in the period 1990-2013 it was obtained regressions presented in Table no. 1. Also, the result presents that the two regressions are statistically significant as independent variable time it has influence on GDP per capita in the EU and Romania. It is also noticed high values of R-Sq measurements which designates the respective 87,3% and 89,0% of the variation in GDP per capita in both EU and Romania, and thus is explained by the time variable.

Table 1.

Polynomial Regression Analysis: EU28 versus t The regression equation is: **EU28 = 14876 + 249.3 t + 28.76 t^2**	**Polynomial Regression Analysis: Romania versus t** The regression equation is: **Romania = 1323 - 120.0 t + 19.92 t^2**
S = 2774.10 R-Sq = 87.3% R-Sq(adj) = 86.1% Analysis of Variance Source DF SS MS F P Regression 2 1114362877 557181439 72.40 0.000 Error 21 161607720 7695606 Total 23 1275970597 Sequential Analysis of Variance Source DF SS F P Linear 1 1078100659 119.87 0.000 Quadratic 1 36262218 4.71 0.042	S = 1035.48 R-Sq = 89.0% R-Sq(adj) = 87.9% Analysis of Variance Source DF SS MS F P Regression 2 181644101 90822050 84.71 0.000 Error 21 22516443 072212 Total 23 204160544 Sequential Analysis of Variance Source DF SS F P Linear 1 164245936 90.53 0.000 Quadratic 1 17398165 16.23 0.001

The shapes of the two regressions are relatively similar but, of course, with different values, highlighting the gap between them. It can be seen in this Fugure no.4 in which besides EMPR values and adjusted confidence intervals are found .The confidence bands (or confidence intervals, CI) illustrate the range of values for the Population Likely Means. They represent a series of confidence intervals span the range of Observed That density values.

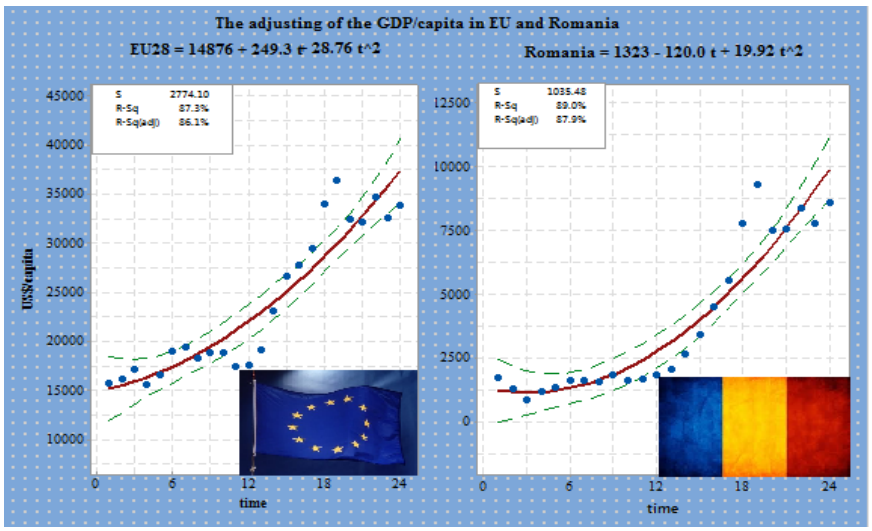

Figure 4

Applying the relation d according to t2, to the actual data is will be obtained:

$$d_1 = -t_2 + 3.012048193 + 0.002008032129\sqrt{3.5806210^5 t_2^2 + 3.10378510^6 t_2 + 1.7098485010^8 d_2}$$

$$= -t_2 + 3.012048193 - 0.002008032129\sqrt{3.5806210^5 t_2^2 + 3.10378510^6 t_2 + 1.7098485010^8}$$

Now, it will be choosing an acceptable solution $d_1$whose representation is shown in Figure no. 5.

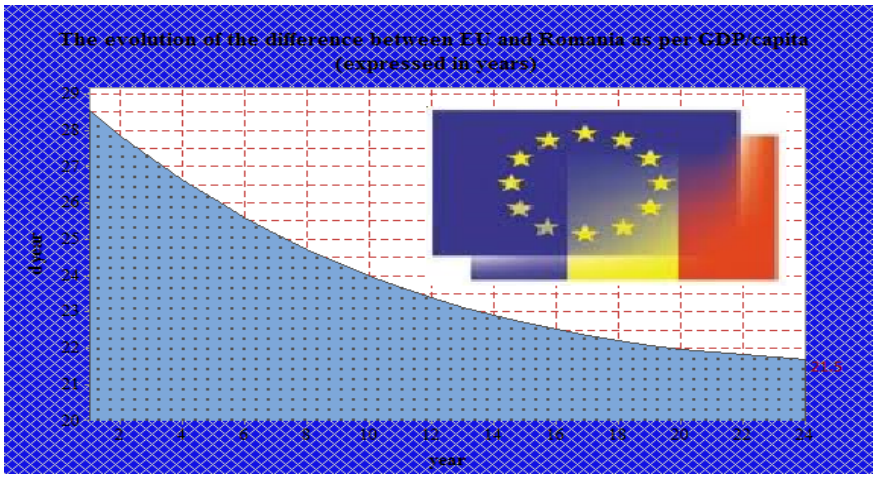

Figure 5

As you can see the time lag between GDP per capita of the EU average and Romania recorded a downward trend from 28,5 years to 21,7 years in the period 1990-2013. It is a modest reduction abd it

is not able to contribute to an equalization of the two entities. The level indicator also considering the shape of the curve which becomes asymptotic to a gap of about 21 years, no future is not supposed eradication of the difference between Romania to the EU average, of course, by maintaining the same growth rates of GDP per capita. This gap of GDP of Romania's per capita versus the EU average is due to both initial level much lower in the register of Romania and average annual growth index sufficiently large to read this gap.

Table 2. GDP/capita in EU and Romania

Year	Time	EU 28	Romania
1990	1	15678.13	1734,97
2013	24	33916.5	8592.195
$\bar{I}$ of rising		**1.034118**	**1.072035**

Source of the data: UNCTADSTAT

Please note that it is envisaged geometric average growth index, determined according to the relationship:

$$\bar{I} = \sqrt[n-1]{\frac{y_n}{y_1}}$$

As it can be seen, the level of about 10 times lower GDP per capita in Romania could not be compensated by an increase in the index development environment from Romania so as to ensure eradication of the difference between the two entities compared.

We consider this approach useful in determining the level of time in which the GDP per capita in Romania will achieve a greater number of times. The relationship of calculation will be of the form:

$$t = \frac{\ln n}{\ln \bar{I}}$$

The results were recorded in the Figure no. 6 which shows that the period doubling GDP per capita in Romania is 9,6 years, the tripling of 15,7 years, 4 times increase of 19,9 years and 23,1 years for 5 times.

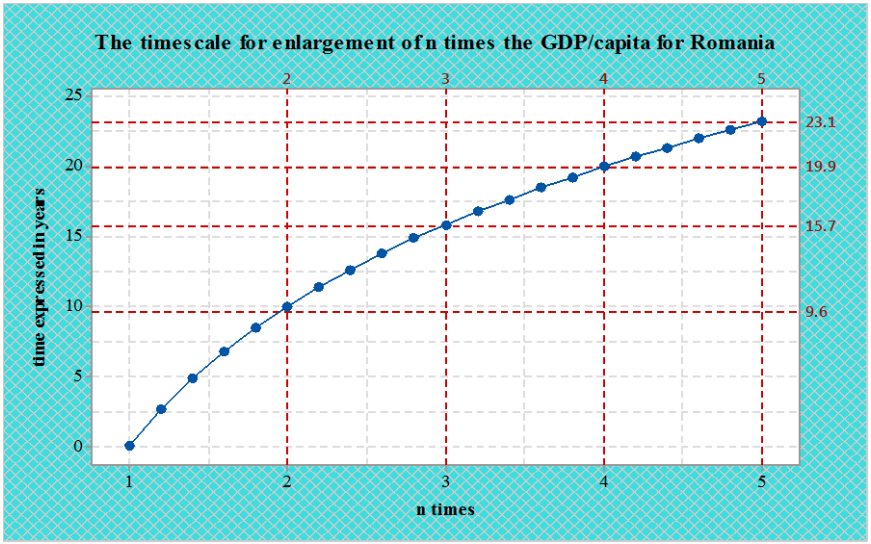

Figure 6.

If Romania had registered an average annual growth index greater time required for registering a GDP per capita of more than a number of times shown in the Figure no. 7. On the horizontal axis are submitted the number of times the GDP per capita and increasing of the number of times of the average annual growth index of GDP per capita, and the vertical axis the time required enlarging this indicator.

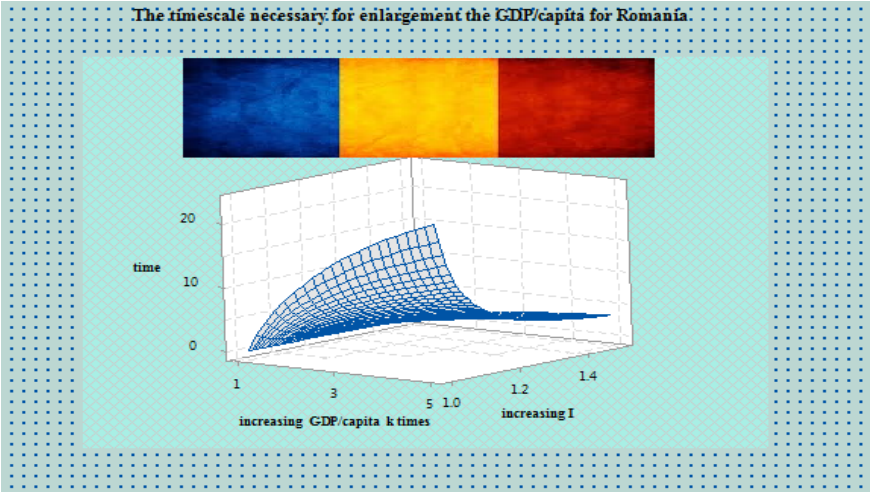

Figure 7.

Equalization of GDP per capita in Romania with that of the EU average in terms of effectiveness and growth indices initial levels can be determined based on the relationship:

$$t = \frac{\ln y_0^{UE} - \ln y_0^{ROM}}{\ln \bar{I}_{ROM} - \ln \bar{I}_{UE}}$$

in which:

y = GDP per capita in the initial period of the EU, namely Romania

$\bar{I}$ = average growth rate in the EU and Romania respectively.

As for Romania to register the same level of GDP per capita of the EU average requires about 61 years and taking into account the baseline or 1990 this will be done in 2050. If the average annual growth rate of Romania would have been bigger than a number of times, it is clear that the time of equalization it would have been much lower. This dependence between the increasing of a number of times of the average growth index of Romania on the time required to equalize the GDP per capita, under the conditions of keeping other factors unchanged thus, it is expressed in Figure no. 8. It can be seen that if the current conditions equalization will occur in 2050, given that the average growth rate of Romania was 1.5 times higher that equalization would have been produced in only five years, i.e. starting since 1994.

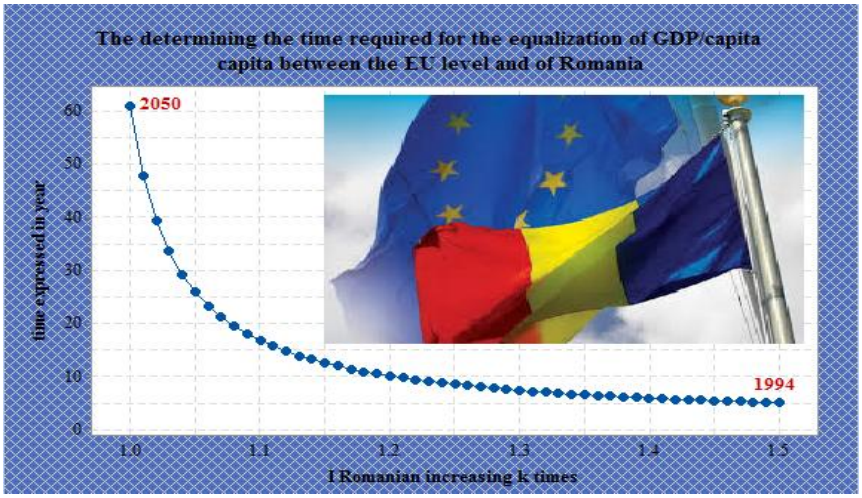

Figure 8.

For this comparison is relevant the average annual growth index; the determination is necessary to ensure equalization of per capita GDP over a certain period of time. The relationship of determination is of the form:

$$\ln \bar{I}_{ROM} = \frac{\ln y_0^{UE} - \ln y_0^{ROM}}{t} + \ln \bar{I}_{UE}$$

where t is the time that is supposed to equalize.

In the Figure no. 9 is shown the dependence of the time and average annual growth rate needed to ensure the equalization of per capita GDP. Dotted line figures index growth that was registered in Romania actually during 1990-2013.

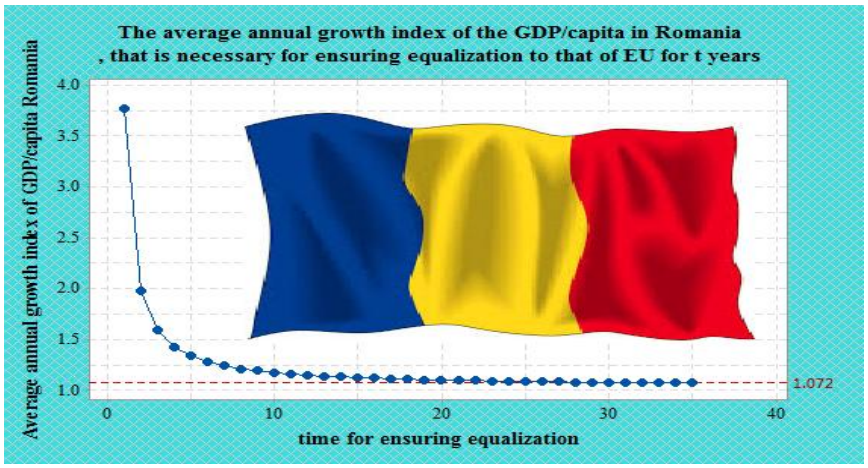

Figure 9.

But, in all our approaches we have used geometric average annual growth rate, which is the gap that relies only on extreme values of the indicators. This can be removed by calculating the growth medium parabolic index which takes into account all recorded values of indicators. Thus, if the designated growth medium parabolic index θ, with a_0 the initial series with n number of terms, we have the following relationship (Mihoc & Urseanu, 1962, p. 357)
:

$$a_0 + a_0\theta + a_0\theta^2 + a_0\theta^3 + \cdots \ldots \ldots \ldots \ldots + a_0\theta^n = \sum a_i$$

which can be processed as per the form:

$$a_0(1+\theta+\theta^2+\theta^3+\cdots\ldots\ldots\ldots\theta^n)=\sum a_i \Rightarrow \quad 1+\theta+\theta^2+\theta^3+\cdots\ldots\ldots\ldots\theta^n=\frac{\sum a_i}{a_0} \Rightarrow$$

$$\frac{\theta^{n+1}-1}{\theta-1}=\frac{\sum a_i}{a_0}$$

The determinating of the growth medium is done by solving parabolic equation above or on the use of tables. (Dobrescu, 1968, p. 353)
For data analysis we have:

$\frac{\theta^{24}-1}{\theta-1}=\frac{3653.048}{100}$ for EU

$\frac{\theta^{24}-1}{\theta-1}=\frac{5379.4393}{100}$ for Romania.

Whose solutions determine the following values of average of the annual growth indexes parable:

$$\bar{I}_{UE}=1.034;\ \bar{I}_{Romania}=1.064$$

As it can be seen, while the average annual growth indices of GDP per capita in the EU are equal, those afferent to Romania are sensitive smaller in the parabolic determining, comparing to those geometric, thus causing an even greater gap between the EU and Romania.

Conclusions

Our study showed that the level of development and economic growth of Romania is still far from the EU average index. In spite of increasing GDP per capita much higher in Romania, it was not enough to remove the gap from the EU. This is because the level of development in Romania, due to the legacy of the planned economy era and a relatively short time when EU accession. It is also added to this, the corruption that has noticeably diminished the development opportunities. The politicians did not issued plans for the development of Romania, limiting only to the issue of objectives, such as former finance minister said[1] "starting that Romania over the next 10-12 years will reach a GDP per capita equal to the EU average". Or in this work we have determined that this time is considerably higher. The benefits of the economic growth are still expected by the Romanian population, who came to believe that EU accession for which most people agree, and put his hope, this is more a political than an economic goal. Of course the internal factors are decisive in economic growth, but also external factors cannot be neglected.

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[1] See articole of Doru Cireașă, Vâlcov promite un PIB cât media UE în 10-12 ani/ Vâlcov promises a GDP as big as the EU average, in 10-12 years, *România Liberă/Free Romania newspaper*, 5 March.