

THE FORECAST OF THE NUMBER OF TEACHERS IN PRE-UNIVERSITY EDUCATION IN ROMANIA

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Abstract: *In the era of the knowledge society, in the context of the challenges produced by globalizing tendencies and the need of keeping national identity, the countries of the world must set on the first positions of national priorities the educational system with all its components, including its subsystem, pre-university education. In post December Romania we have acknowledged the consistency of all governments, at a declamatory level the political actors setting education as a national priority. Unfortunately, this consistency wasn't continued in the operational plan. The budget allocations for education were approximately equal in relative figures, while we recorded a massive decrease of school population, followed, obviously by a decrease in the number of teachers in pre-university education as well as a drop of the attractiveness of a teaching career. To ensure the continuity of the Romanian people on the current territory and to keep cultural identity, we must apply a series of measures at a macro level concerning stopping the demographical drop and reducing emigration of families or work force. Successfully implementing such policies will implicitly lead to mending the problem of the number of students and teachers from pre-university educational level, the effects being seen some immediately, some on a medium term and, most importantly, on the long term.*

Key words: *education, pre-university education, education levels, teachers, educational policies.*

JEL Classification: *I21, I28.*

1. Introduction. Actuality and importance of the tackled problem

In the context of complex problems generated by maintaining an equilibrium between globalizing – mainly in economy, on the one side and the necessity of keeping cultural identity, preserving peoples' traditions and customs, the objectives of educational systems must also cover the efforts towards balancing these issues.

The exponential development of the information and communication technologies, the growth of family and work force migration represent a small part in the multitude of restrictions which contemporary people are dealing with. Even though human beings tend to adapt to their environment, educational systems must ensure the increase in the degree of adaptability so that the graduates get clear reference points in their socio-professional orientation, when setting personal objectives, but also the competences necessary to follow and accomplish them.

The political deciding parties from most countries are aware of the importance of educational systems in the current context and set them as top priorities in the area of concerns. But this intention isn't always and everywhere followed by actual efforts, mainly when it comes to budget allocations. In Romania in the past three decades, education and health have been the Cinderellas of the budget, even though in political discourses they were powerful weapons and were always considered as national priorities. Certainly during crisis periods, not particularly global ones like the one we are experiencing right now (generated by COVID 19), the lack of reform in the aforementioned fields is more noticeable and it is more accessible to observers. We don't have to reinvent the wheel to set these two major systems on the top two places, each having arguments to be placed on the first place.

The highest scientific forum of the country, The Romanian Academia, carried out a study with a wide area of coverage published in 2015 called *Romania's development strategy over the next 20 years*, in which they approach problems from important fields for the period between 2016-2035. Special attention is given to education, one of the presented projects being called "School and education as seen by the Romanian Academia". The

authors start from a free analysis of the current educational system, they set the group of values on which education should rely, they elaborate “Educated Romania – 2035 vision”, they set the strategic targets for education and they suggest seven programs for accomplishing them: 1. Start in education; 2. Autonomy and responsibility; 3. Authentic learning for all; 4. Well-being and self-esteem; 5. Excellency in teaching; 6. School and university, open; 7. Curious minds, creative minds.

Concerned about the estate and the direction of the Romanian university educational system, after analyzing the budgetary allocations and the discouraging evolution of the number of students, we continue the series of studies, having as purpose, this time, analyzing the evolution of the number of teachers from pre-university education, identifying the trends and forwarding a 2050 prognosis.

2.1. Number of teachers vs number of students

We set the purpose of observing the way in which the number of teachers evolved parallel to the number of students, a relevant indicator in the field of education being the number of students allotted to a teacher. The values of the increase rhythm for students and teachers and those of the aforementioned ratio are determined in the following table (Table no. 1).

Table no. 1. Number of students vs number of teachers in Romanian pre-university education between 1995-2018

Year	Number of students enrolled in pre-university education			Number of teachers in pre-university education			Number of students/teacher
	Total	Rhythm of growth with the fixed 1995 base	Rhythm of growth with chain base	Total	Rhythm of growth with the fixed 1995 base	Rhythm of growth with chain base	
1995	3669248			244640			15,00
1996	3674597	0,15%	0,15%	250612	2,44%	2,44%	14,66
1997	3659208	-0,27%	-0,42%	248231	1,47%	-0,95%	14,74
1998	3598666	-1,92%	-1,65%	249002	1,78%	0,31%	14,45
1999	3509449	-4,36%	-2,48%	238820	-2,38%	-4,09%	14,69
2000	3421091	-6,76%	-2,52%	232956	-4,78%	-2,46%	14,69
2001	3356231	-8,53%	-1,90%	236803	-3,20%	1,65%	14,17
2002	3270786	-10,86%	-2,55%	222744	-8,95%	-5,94%	14,68
2003	3214999	-12,38%	-1,71%	216550	-11,48%	-2,78%	14,85
2004	3108634	-15,28%	-3,31%	219716	-10,19%	1,46%	14,15
2005	2996029	-18,35%	-3,62%	213736	-12,63%	-2,72%	14,02
2006	2911213	-20,66%	-2,83%	210180	-14,09%	-1,66%	13,85
2007	2846904	-22,41%	-2,21%	207537	-15,17%	-1,26%	13,72
2008	2781039	-24,21%	-2,31%	205200	-16,12%	-1,13%	13,55
2009	2735424	-25,45%	-1,64%	199254	-18,55%	-2,90%	13,73
2010	2682489	-26,89%	-1,94%	185854	-24,03%	-6,73%	14,43
2011	2610022	-28,87%	-2,70%	181731	-25,71%	-2,22%	14,36
2012	2688590	-26,73%	3,01%	182548	-25,38%	0,45%	14,73
2013	2649040	-27,80%	-1,47%	184372	-24,64%	1,00%	14,37
2014	2615722	-28,71%	-1,26%	181174	-25,94%	-1,73%	14,44
2015	2553861	-30,40%	-2,36%	175410	-28,30%	-3,18%	14,56
2016	2524399	-31,20%	-1,15%	174244	-28,78%	-0,66%	14,49
2017	2497768	-31,93%	-1,05%	174474	-28,68%	0,13%	14,32

2018	2466269	-32,79%	-1,26%	172803	-29,36%	-0,96%	14,27
Average	3001737	-18,98%	-1,70%	208691	-15,33%	-1,47%	14,37

Source: own processing based on the number of students and teachers taken from the INS-tempo-online platform.

While the number of students dropped with 32.79% in 2018 compared with 1995, the decrease of the number of teachers is somewhat smaller, being of -29.36%. This fact, enforced by the average values of the annual decrease rhythms with chain base, that is – 1.7% compared to - 1.47%, allow us to assert that the decrease of the number of students was more accelerated than the decrease of the number of teachers from pre-university education.

A smaller value of the number of students allotted to a teacher should naturally make for a much more qualitative teaching act. The average annual value of this indicator during the analyzed period is of 14.47 students/ teacher. The evolution of this indicator doesn't show major changes, the minimum of 13.55 students/teacher being registered in 2008. In the opposite corner, the value of 15 students/ teacher registered in 1995, represents the maximum value of the indicator.

We notice that the trend is a slowly decreasing one, a more accentuated decrease being registered between 2003-2008, when, as we remember, mostly because of consumption, Romania's economy 'was on fire'. Starting with 2019, clearly because of the crisis started by the austerity measures, the indicator starts to rise, practically having, during 2010-2018, values close to the average of the entire analyzed period.

While the indicator hasn't registered significant changes for the entire pre-university education, we should analyze the facts on educational levels. This approach will lead us to the average values presented in Table no. 2.

Table no. 2. Averages of the ratio no of students per teacher, on levels, in Romanian pre-university education during 1995-2018

<i>The average of the ratio no of students/ teacher</i>					
<i>Pre-university education</i>	<i>Primary school (including special education)</i>	<i>Secondary school (including special education)</i>	<i>High school</i>	<i>Vocational education</i>	<i>Post-high school and craftsman education</i>
14,37	18,05	11,31	12,51	93,78	47,84

Source: own processing based on the number of students and teachers taken from the INS-tempo-online platform.

We got an average value of 18.05 students/ teacher in the case of primary school. Compared to the average of 14.37, in our opinion, this is a high value knowing that primary school years are fundamental to students accumulating values – knowledge, abilities, behavior, attitudes etc -, forming and developing cognitive, affective and psychomotor structures. From a wider perspective, these years model their personality. The quality of acquisition at this level influences the quality of the students entire educational development in a decisive way. More over, simultaneous learning is an indicator which both reflects a big effort of the teachers and stands as an important factor of school failure.

Values below the average of the entire pre-university educational system are registered in the case of secondary and high school level, whereas in the case of vocational and post-high school levels calculating such an indicator is irrelevant because practically it is an abnormal situation. In 2011, vocational education was practically annulled and the

share of teachers who were working mainly in these two areas was irrelevant, but precisely these teachers were included in the reports. After 2012, once vocational education was re-established, a lot of teachers, although they were hired at high-school or even secondary school level, took classes in vocational schools as well, the system lacking teaching personnel for vocational education. This was due to its disappearance few years earlier.

2.2. Multi-decade prognosis of the number of teachers in pre-university education

Taking into account some data and affirmations from the previous paragraphs, as well as being led by the logics of economy, we can assume that the number of teachers depends significantly on the number of students from pre-university educational system.

To determine the linear regression which varies the number of teachers with the help of Eviews, we will use the series (Table no. 3):

Table no. 3. Number of students enrolled and of teachers from pre-university education in Romania between 1995-2018

Year	Number of students (x_i)	Number of teachers (y_i)
1995	3.669.248	244.640
1996	3.674.597	250.612
1997	3.659.208	248.231
1998	3.598.666	249.002
1999	3.509.449	238.820
2000	3.421.091	232.956
2001	3.356.231	236.803
2002	3.270.786	222.744
2003	3.214.999	216.550
2004	3.108.634	219.716
2005	2.996.029	213.736
2006	2.911.213	210.180
2007	2.846.904	207.537
2008	2.781.039	205.200
2009	2.735.424	199.254
2010	2.682.489	185.854
2011	2.610.022	181.731
2012	2.688.590	182.548
2013	2.649.040	184.372
2014	2.615.722	181.174
2015	2.553.861	175.410
2016	2.524.399	174.244
2017	2.497.768	174.474
2018	2.466.269	172.803

Source: INS – tempo-online platform.

The upload of the two series into Eviews leads us to the following scatter diagram (Figure no. 1):

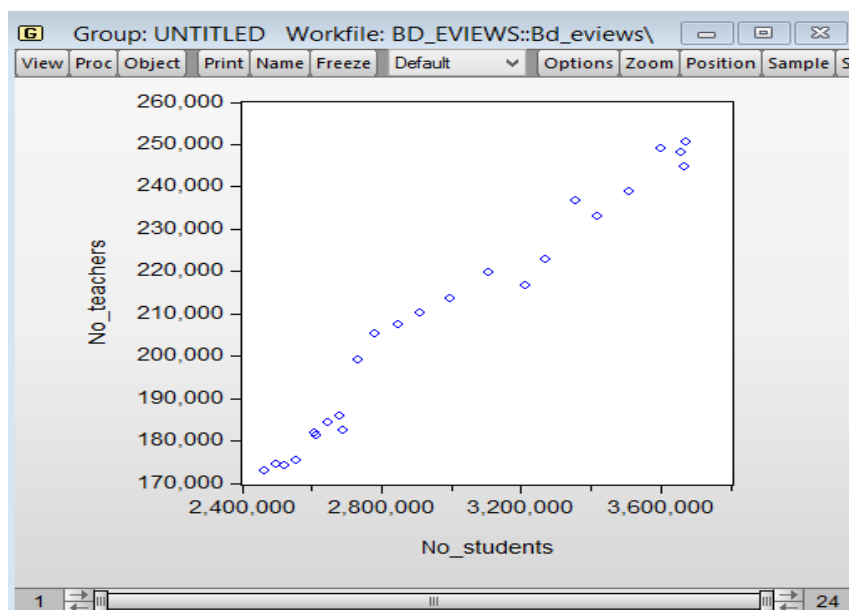


Figure no. 1. Scatter diagram in Eviews for the evolution of the number of teachers based on the number of students enrolled in the pre-university educational system

According to the diagram, we assume that we have a linear dependency of the number of teachers based on the number of students, that is after the model:

$$Y = \beta_1 + \beta_2 X + u \tag{1}$$

We are calculating the parameters of this regression, meaning we determine \mathbf{b}_1 estimations for β_1 and \mathbf{b}_2 for β_2 (Figure no. 2).

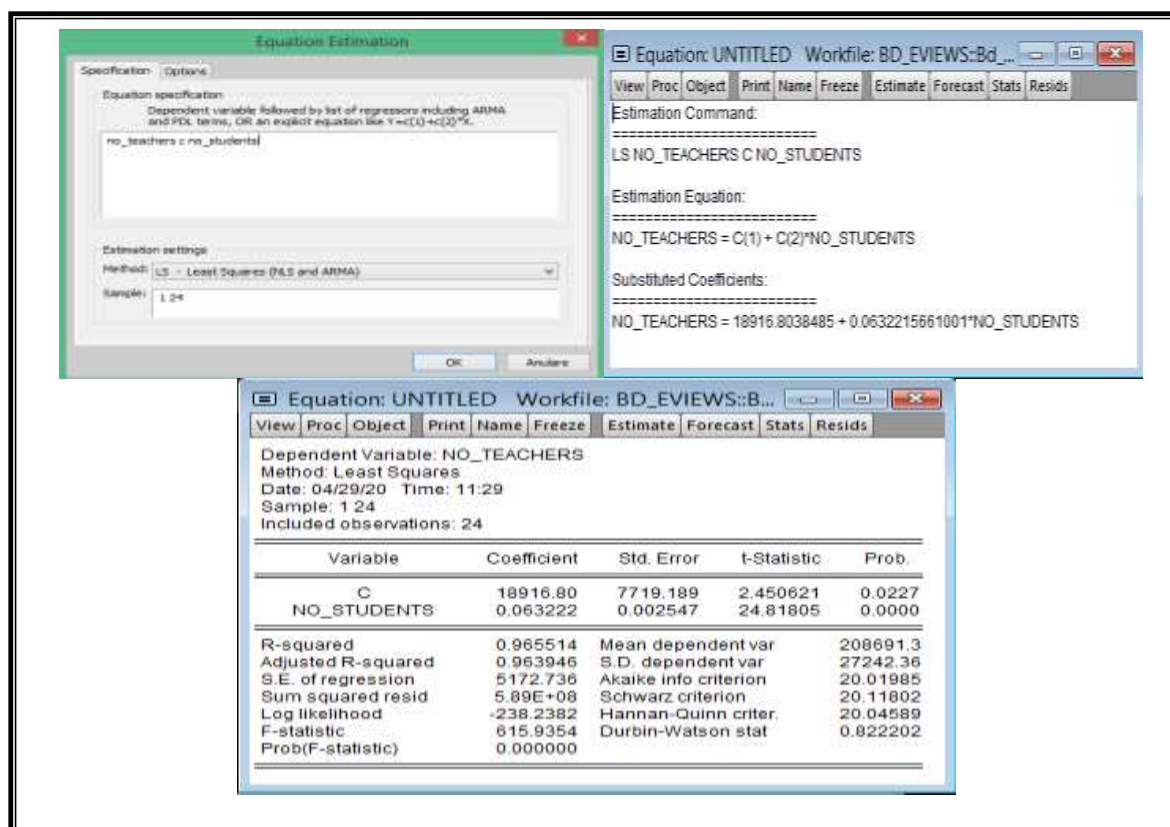


Figure no. 2. Eview model of the linear regression for the evolution of the number of teachers based on the number of students enrolled in pre-university education in Romania between 1995-2018

Thus, the calculated values for the number of teachers are obtained as follows:

$$\hat{y}_t = 18916,80 + 0,06322 \times x_t \quad (2)$$

In the case of the Student test for this model, the hypotheses are:

$H_0: \beta_2 = 0$ – the no of students **is not** a significant factor for the number of teachers;

$H_1: \beta_2 \neq 0$ – the no of students **is** a significant factor for the number of teachers.

From Eviews $t_{calculated} = 24,818$

On the other side, inserting the corresponding function into Excel, for a level of 5% of significance, we get, $t_{critical} = 2,073873068$.

Obviously $|t_{calculated}| > t_{critical}$, which means that hypothesis H_0 is rejected.

In conclusion, the number of students **is a significant factor** for the number of teachers.

In case of the Fisher test, the hypotheses are:

$H_0: \beta_2 = 0$ – the model **is not** significant;

$H_1: \beta_2 \neq 0$ – the model **is** significant.

Because the probability (statistical - F) in this case is 0 (less than 0.05), we reject hypothesis H_0 and accept hypothesis H_1 , thus, the model **is entirely significant**.

To get a good prognosis, the residues must be homoscedastic, they shouldn't show autocorrelation and they should have normal distribution.

Homoscedasticity is checked with the help of the White test, the associated hypotheses being:

H_0 : the accidental errors are homoscedastic;

H_1 : the accidental errors are heteroscedastic.

If the associated probabilities of the calculated statistics are smaller than the chosen signification level, we reject **H_0** and accept **H_1** . In our case, we get (Figure no. 3):

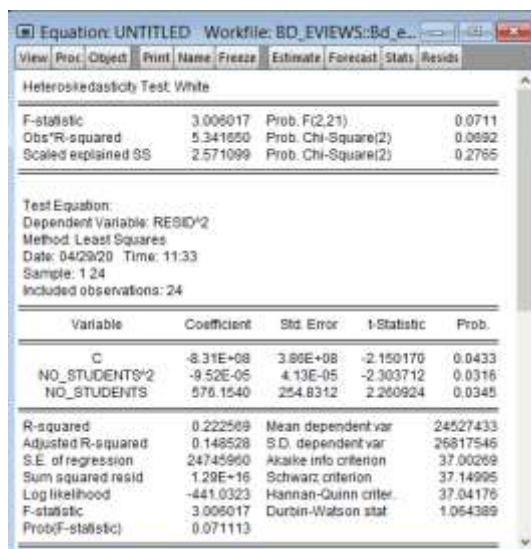


Figure no. 3. White test for checking the model’s homoscedasticity

We notice that the probabilities associated to the test are bigger than the chosen significance threshold, that is, 5%, so we can’t reject **H_0** meaning that the accidental errors are homoscedastic.

The error autocorrelation is tested with the help of the Durbin Watson test. Thus, in Eviews, with the option *View/Residual test/Correlogram – Q-statistics* we get (Figure no. 4):

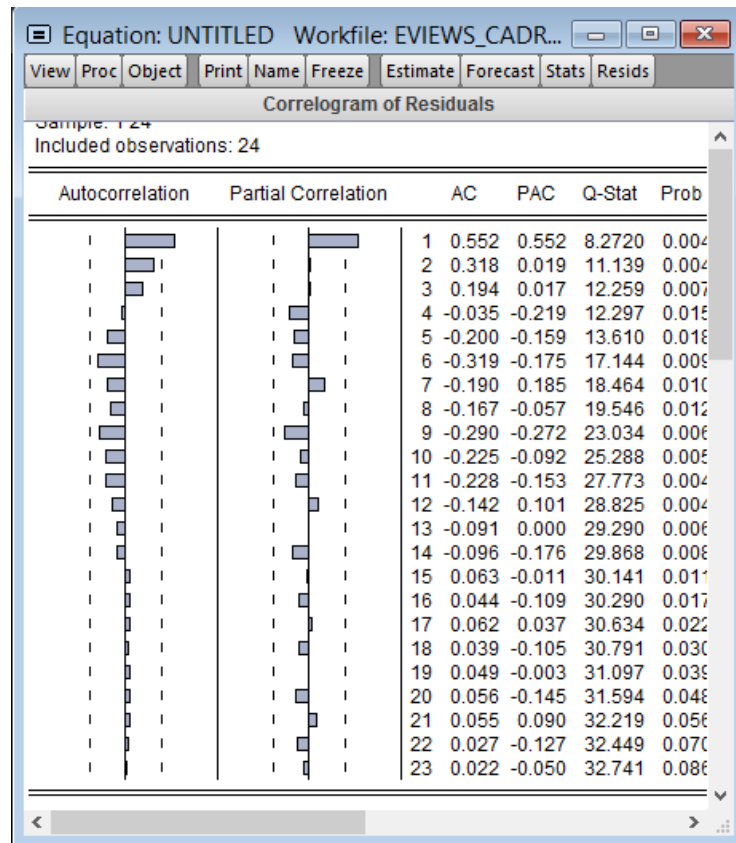


Figure no. 4. Residual correlogram

According to the results of this test, for the first lag there is a series error correlation (the value of the autocorrelation coefficient is over the interval indicated in the chart). It is a well-known fact that this test often renders weak results.

Next we will carry on the Breusch-Godfrey test to check error autocorrelation. The hypotheses associated to this test are:

H_0 : there is no serial error correlation of the regression equation;

H_1 : there is serial error correlation of the regression equation.

For the value of 1 for the number of included lags, we get (Figure no. 5):

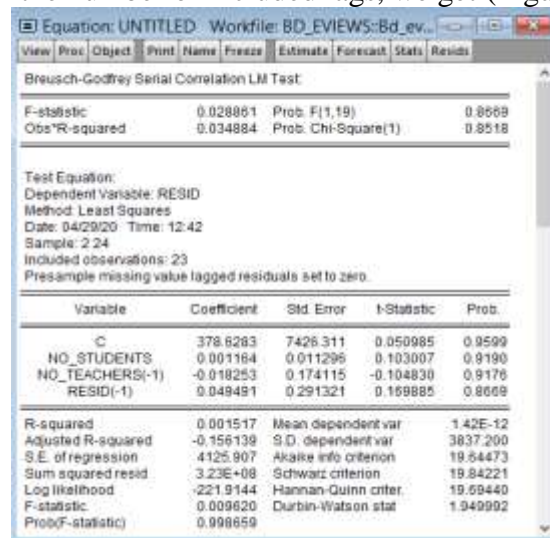


Figure no. 5. The Breusch-Godfrey test

The most important part of the test output is the first part which presents the two statistical tests *F-statistics* and *R-squared* and the probabilities associated to these tests. If the probabilities obtained are inferior to the level of relevance involved then the null hypothesis is rejected. In our case, the probabilities are bigger than 5% so we can't reject H_0 ; in conclusion there is no serial correlation of errors.

We will check the normal distribution of residues with the help of the Jarque-Bera test, the hypotheses being:

H_0 : the residues (errors) **have** a normal distribution;

H_1 : the residues (errors) **don't have** a normal distribution.

The H_0 hypothesis is rejected if there is a probability of <0.05 (Figure no. 6).

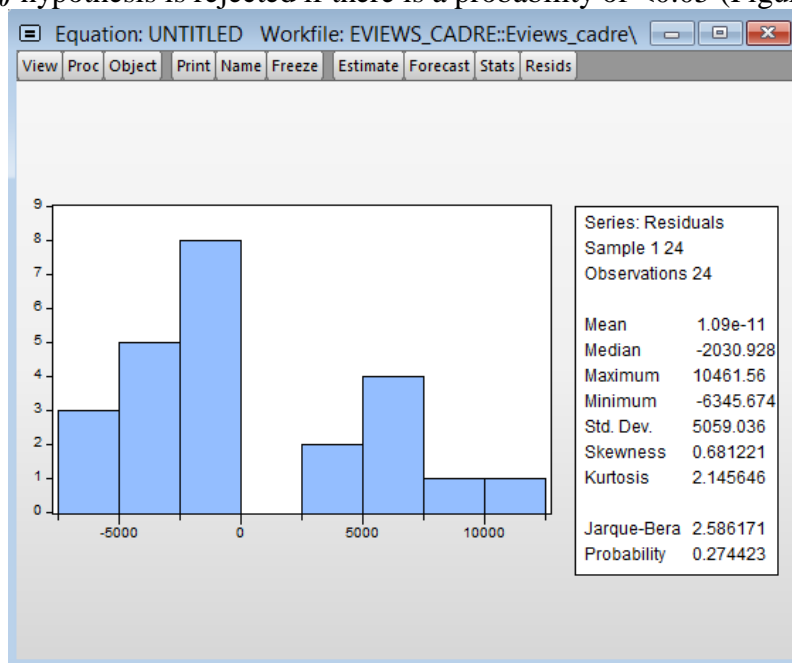


Figure no. 6. The Jarque-Bera test

Because the probability of Jarque-Bera statistics is 0.274 and it is bigger than the threshold of 0.05, we can't reject hypothesis H_0 ; so the residues have normal distribution.

Taking into account the results of the aforementioned tests, we can obtain relevant prognosis on medium and long term for the number of teachers from Romanian pre-university education based on the number of students.

Next, we estimate the reliability intervals for the regression coefficients and we analyze the best and worst case scenario.

The reliability interval for an estimator is determined with the formula:

$$\beta \in [b_{calculated} - t_{(\alpha;n-k)} \times err_{standard}, b_{calculated} + t_{(\alpha;n-k)} \times err_{standard}] \quad (3)$$

which means that β belongs to the interval with a probability of $1-\alpha$.

Taking the standard errors from fig. 2, knowing the value of $t_{critical}=2.073873068$, given by the EXCEL function at the relevance level of 0.05% and replacing in (3) we get (Table no. 4):

Tabel no. 4. Reliability intervals for the estimators of the regression model

Calculated value for b1	Standard error for b1	Calculated value for b2	Standard error for b2	Low limit of reliability	High limit of reliability	
18916,80	7719,189	0,063222	0,002547			
				<i>Estimation β_1</i>	2908,18	34925,42
				<i>Estimation β_2</i>	0,05794	0,06850

We can assert with a probability of 95%, that $\beta_1 \in [2908,18; 34925,42]$ and $\beta_2 \in [0,05794; 0,06850]$.

Thus, for the most favourable case of the prognosis, we can take this estimation into account:

$$\hat{y}_i = 34925,42 + 0,06850 \times x_i \quad (4)$$

For the most unfavorable case of the prognosis, the regression has the following form:

$$\hat{y}_i = 2908,18 + 0,05794 \times x_i \quad (5)$$

If we take the number of students from the prognosis carried out in ‘The study of the number of students from Romanian pre-university educational level’ in the three cases (moderate, pessimistic, optimistic) and taking into account the 3 models of the regression equation, that is (2), (4) and (5), the systematization of calculations leads us to Table no. 5.

Table no. 5. Multi-decade prognosis of the number of teachers from Romanian pre-university education

	Number of students (x_i)			Number of teachers (y_i)								
				<i>Moderate case Model (2)</i>			<i>Optimistic case Model (4)</i>			<i>Pessimistic case Model (5)</i>		
	<i>Year</i>	<i>2030</i>	<i>2040</i>	<i>2050</i>	<i>2030</i>	<i>2040</i>	<i>2050</i>	<i>2030</i>	<i>2040</i>	<i>2050</i>	<i>2030</i>	<i>2040</i>
<i>Moderate case</i>	1625031	1039199	453367	121651	84615	47579	146240	106111	65981	97062	63119	29176
<i>Optimistic case</i>	1890283	1359229	828176	138420	104847	71274	164410	128033	91655	112431	81662	50893
<i>Pessimistic case</i>	1359779	719169	78558	104882	64383	23883	128070	84188	40307	81694	44577	7460

In the optimistic case of the number of students prognosis, using optimistic case (model 4), the most favorable of the teachers estimation, so in the most favorable cases, according to our study, the number of teachers would drop by 2030 to around 165.000, in 2040 to about 128.000 and in 2050 below the threshold of 100000, meaning around 92000.

If we take the moderate case (model 2) and the same optimistic attitude towards the evolution of the number of students, then the number of teachers will be of about 138000 by 2030, it will drop to 100000 by 2040 and it will get to 70000 by 2050. Also in the optimistic case for the number of students, the pessimistic case or the number of teachers prognosis offers us as results about 112000 by 2030, about 82000 by 2040 and 51000 of teachers by 2050.

3. Conclusions. Recommendations

We have demonstrated a clear dependency between the number of teachers and the number of students, which was naturally expected. After the cases from the current study, we asserted that the number of teachers from pre-university education dropped with 1.47\$ every year, in absolute figures being in 2018 at the level of 172803 compared to 244640 teachers in 1995. In the moderate case of prognosis (model 2) and by taking the optimistic scenario for the evolution of students – association which we find relevant, the future estimations indicate, for 2030, 2040 and 2050 approximate levels of 138000, 100000, and 70000 of teachers. We keep in mind that the number of teachers decreases with about 30000 every decade.

A broader approach would be the one in which we would introduce in the model other relevant factors, like the birth rate, family emigration rate, early school abandonment rate. Of course, changes in the demographic trends would lead to an adjustment of the slope of the tendencies in the evolution of the number of students and teachers. Thus, obviously the solution would be one of policies, demographical ones at first, but also economic and social assistance ones. The people responsible must first of all acknowledge the tendencies, ascertain the catastrophic levels which could be reached in a couple of decades and generate policies that, once implemented, would stop the decrease, and would begin an ascending curve for the population number so, implicitly, for the number of students and teachers.

The number of teachers could be increased by introducing, taking the example of other countries, the teaching assistant who stands beside the tenured teacher during classes or reducing the ratio '*number of students per teacher*'. These measures could be adopted to increase the quality of education and they should be validated/ invalidated afterwards through the promotion rates of the national exams and through the results students gets to international tests, at which, unfortunately, we occupy very low positions.

If the policies meant to radically change the descendent demographical tendencies will not appear as soon as possible, the situation of teachers could be even worse than the moderate and optimistic cases presented in table no 5. Any delay of development in the case of such policies would just maintain the discouragement in the case of pre-university education graduates regarding a teaching career. In other words, we would witness an even bigger decrease of attractiveness for this profession. Obviously this would also mean a low level of absorption of the valuable graduates as teachers.

The vastest of the educational system, the complexity of the phenomena and of the relations between its entities, make us state that our study only takes a small part into account, having as objective that of identifying some current tendencies and to send an alarm signal. Obviously, the cases should take several other aspects into account, but disregarding the complexity of the studies, they have to be based on a country project and on a clear strategy for education. Our leading elite should just accept that such a basis was established in 2015 by the Romanian Academia in "*Romania's development strategy over the next 20 years*".

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