Employment rate prognosis on the basis of the development environment trend displayed by years-clusters

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EMPLOYMENT RATE PROGNOSIS ON THE BASIS OF THE DEVELOPMENT ENVIRONMENT TREND DISPLAYED BY YEARS-CLUSTERS*

The authors analyze the dynamics of the employment rate in Romania and propose a forecast model for it.

In the paper we start with the hypothesis that the dynamics of the employment rate has a specific trend displayed by years-clusters differentiated on the value and the sign of the dynamics indexes of the phenomena by which we define the economic environment.

The forecast method that we propose takes into consideration the environment conditions in which the studied phenomenon evolves and it implies the use of statistical methods of multivariate analysis (Principal Component Analysis and Discriminant Analysis).

The application of such a forecast method supposes an algorithm that implies several stages: (1) the evaluation and synthesis of the inter-relations among the phenomena by which we describe the development environment employment rate dynamics; (2) the identification of the years-cluster to which the desired forecast horizon is classified; (3) the estimation of the employment rate dynamics for the specified forecast horizon. The proposed forecast model, examining the development environment of the influence factors, may be used for simulating forecast alternatives that can be considered for founding the economic development strategies.

Key words: employment rate, influence factors, trend by years-clusters, principal component analysis, discriminant analysis.

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1. INTRODUCTION

The analysis of a phenomenon dynamics, in the classical statistics, consists of measuring the time variation, decomposing by components the time series and extrapolating the time series, especially the trend and the seasonal variation. Papers of a high pedagogical quality deal with such issues [Granger, 1980; Coutrot, Droesbeke, 1990; Gourieroux, Monfort, 1990; Droesbeke ş.a., 1994; Gujarati, D , 1995; Makridakis, Wheelwright, Hyndman, 1997, Pecican, E. S., 2006].

The approach of the time series as stochastic processes using ARIMA models is presented in various papers published in the last two decades [Lütkepohl, 1993; Hamilton, 1994; Box, G. E. P., Jenkins, G. M. and Reinsel, G. C; 1994, Mélard, 1990; Brockwell, P.J. and Davis, R. A.; 2002; Green, W., 2005; Bourbonnais, 2005].

In most studies of time series analysis, one starts from the hypothesis of linearity. This hypothesis is opposing to the evolution of the specific transition and post-transition phenomena. For such situations, we propose a forecast model that takes into consideration the economic, social and political environment in which the analyzed phenomenon develops.

The changes that take place in the economic structure determine changes in the employment rate. During the transition period, Romania followed the path of opening to and joining the developed countries economies by economic restructuring and privatization process that generated economic downfalls, unemployment and inflation. After 2003, the Romanian macroeconomic outputs improved. They are reflected in the positive GDP growth rate generated by the high volume of investments and private consumption, as well as in the decrease of inflation, unemployment and budgetary deficit.

The highest increase in the GDP/inhabitant in Romania, during the entire transition period, took place in 2004, by 8.3% than the previous year.

The analysis of the GDP evolution, by national economic activities, show the special dynamics of the GDP in real-estate activities, beginning with 1997, when it was double than the previous year. A particular dynamics also had the activities of commerce and transportation and communication. The GDP in agriculture registered a varying evolution comparable with the evolution of the GDP in industry.

In the same period, the indexes of the employment rate dynamics show a general decreasing trend and specific variations under the influence of the deindustrialization process started in 1990, the privatization of public enterprises and the development of services specific to a market economy (financial, real-estate, banking, stock exchange services) and to an IT economy.

The population number, after 1990, decreased constantly with negative yearly average rhythms of -1.5% in 1992, comparing to -0.2%, in the previous decade.

At the latest Romanian population census in 18 March 2002, the population number reached 21,680,974 inhabitants. This level was smaller by 1,129,061 inhabitants than the level registered at the previous census in 1992. The decrease in the population number may be explained both by the natural increase (*Figure 1*) and the net migration, both of them having negative values.

The birthrate and the death rate vary from one year to another on the whole period taken into consideration. If before 1992 the natural increase was positive, beginning with 1992, the natural decrease has become negative (*Figure 1*).

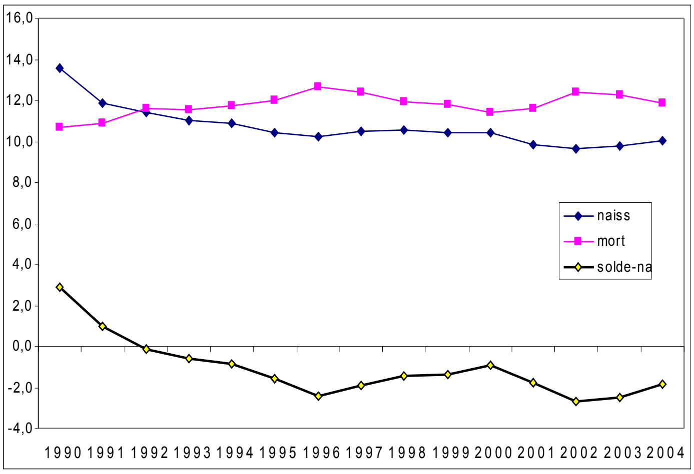


Figure 1. *The dynamicsof the birth rate, death rate and natural growth in Romania, in the period 1990-2004*

The number of births and deaths has a decreasing trend, though the births decrease is more important. Thus, the natural growth is negative during all the period.

The analysis of these two phenomena related to the evolution of the population by age groups underlines an ageing population process that will have a direct impact on births and, implicitly, on active population.

Another characteristic of the transition period is pointed out by the specific dynamics of the population number by residence area: urban and rural. The population number by residence area follows a general decreasing trend related to the trend of the overall population number. The specificity of this evolution is given by the change of the population dynamics by the two residence areas. If until 1992, there had been an increase of the urbanization index in Romania, reaching to an urban population of 54.3%, after that period we notice a decrease of the urban population. The trend of the dynamics of population on residence areas is reversed beginning with 2001. The measures specific to the privatization policy of public enterprises show their effects and we notice an unemployment increase.

Consequently, the remaining working force redirects itself to rural area or to external migration.

Migration in Romania develops under the influence of the changes in the economic structure of the country. This phenomenon evolved as permanent migration and temporary migration. The permanent migration had as main incentive the political and ethnical reasons, specific to the period before 1989, while the temporary migration is generated by economic reasons, especially after 1989. The first type of migration, the permanent legally migration, had a decreasing trend until 2001-2002. After these years, we notice an in increasing trend, thus, in 2004 there were 13,082 persons that emigrated.

The direct effect of emigration is the emergence of the population shortfall registered by the 2002 population census as compared to 1992. Out of the 1.1 million inhabitants' deficit, 362,000 inhabitants emigrated legally, 356,000 represent the negative natural increase and the difference may be explained by the illegal emigration that is not statistically registered.

Therefore, the dynamics of the employment is directly correlated with the dynamics of the economy and the life conditions of a population. Hence, it appears the importance of the evaluation and the analysis of this issue's dimensions, especially in the process of creating a development strategy [Blanchard, 1997; Stiglitz, Walsh, 2004].

2. DATA AND WORKING METHOD

In our study, for expressing the employment we used the employment rate. The dynamics of the employment rate and of the influence factors, demographic and economic, is evaluated through indexes.

The observed period is 1990-2004, and the forecast horizon refers to the years 2007-2009. The data are obtained from the official statistics [Anuarul Statistic al României, 1991-2005] and they were processed with the SPSS software.

The variables considered in our study are the independent variables, $X_1,..., X_7$, and the variable X_8 (Employment rate), presented in *Table 1.*

Table 1: The variables considered in the study

Variables	**Variable Name in SPSS**
X_1 : Death rate	*death_rate*
X_2 : Birth rate	*birth_rate*
X_3 : Life expectancy	*life_expect*
X_4 : Unemployment rate	*unempl_rate*
X_5 : GDP/inhabitant	*GDP_inhab*
X_6 : Number of emigrants	*emigr*
X_7 : Net migration	*net_migr*
X_8 : Employment rate	*empl_rate*

According to the working hypothesis, the employment rate dynamics has a specific trend defined by years-clusters with respect to the values of the dynamics indexes and the trend related to the changes made in the economic, social and political environment.

In order to verify this hypothesis, we made the analysis and prognosis of the economic phenomena in their interrelation and we noticed that the employment rate forecast for a given horizon depends on the years-cluster characterized by a dynamics specific to the economic, social and political environment, for the analyzed period.

Considering the various dynamics for the analyzed period, a transition period, the employment rate forecast imposes the use of a method that takes account of the specific variations, with different trend and changing trend, for the phenomena that determines the employment rate. A trend extrapolation of the employment rate, as in the classical prognosis, for the entire period, would bring serious deviations from the normal path of evolution of the phenomena.

We propose method of a phenomenon level forecast based on the forecat of the its development environment. This method takes in consideration the trend observed for the years-clusters defined upon the dynamics of the influence factors. The years-clusters actually highlight the relationships between the dynamics of the influence factors and the employment rate dynamics.

The application of the proposed method supposes an algorithm with several stages, using statistical methods of multivariate analysis.

i. In the first stage we evaluate and synthesise the interrelations among the phenomena that characterize the development environment of the employment rate dynamics. We identify years-clusters based on the interrrelations between the employment rate dynamics and the influence factors dynamics, using the Principal Component Analysis (PCA).
ii. In the second stage we identify the years-cluster in which a specified forecast horizon is classified. In this stage we use the Fisher's classification functions defined by the Discriminant Analysis (DA). The

forecast horizon is classified in the years-cluster for which the Fisher's classification function from DA gives the highest score. The scores are computed based on the estimations of the influence factors for the forecast horizon. The estimations are obtained for the trend models we chosed.

In the third stage we estimate the parameters of the employment rate forecast model defined by the trend corresponding to the years-cluster to which belongs the forecast horizon and identified by the mximum score of the Fisher's classification function in DA.

3. RESULTS

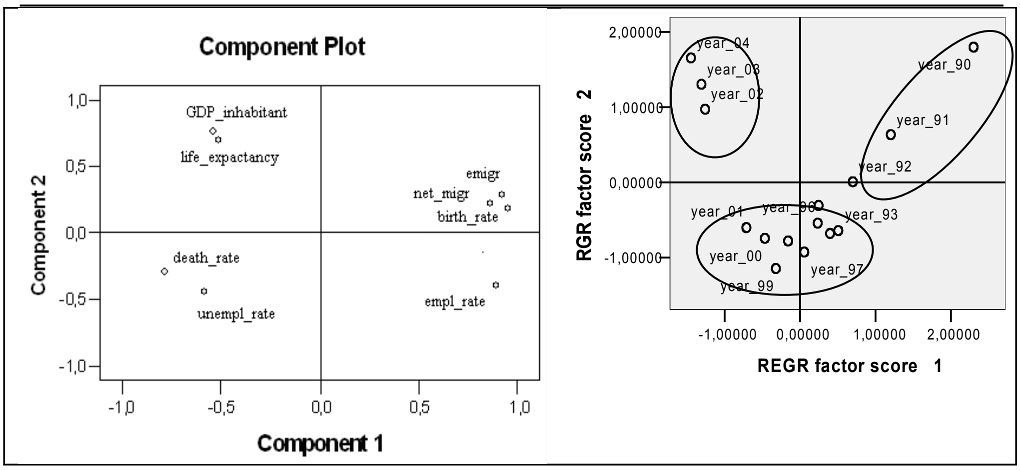
Analysing the data on the dynamics of the employment rate and of the influence factors for the period 1990-2004, using the Principal Component Analysis (PCA), we obtained three years-clusters, defined by diferent trend models (Figure 2). For making the forecast, we considered the years-cluser with the highest score obtained by the Fisher's classification function in Discriminant Analysis (DA).

The estimation of the employment rate was made within the years-cluster with the highest score, based on the estimations of the influence factors computed for the trend models estimated by the OLS method.

The obtained result forecasts the employment rate in Romania, in 2007, in a years-cluster with positive trend, and in 2008 and 2009 in a years-cluster with constant trend. Therefore, if the evolution conditions of the influence factors in the years-cluster in which the year 2009, the forecast horizon, is classified are preserved, then we look forward to a dynamics with constant trend.

3.1. YEARS-CLUSTER WITH RESPECT TO THE DYNAMICS OF THE OBSERVED PHENOMENA

Using the PCA method [Hotelling H.,1933; Anderson, T.W., 1958 ; Escofier B., Pages J., 1998] in the analysis of the employment rate dynamics and of the influence factors dynamics, three years-clusters were identified. The results are shown in Figure 2.



(a) **(b)**

Figure 2. *Factorial map of the macroeconomic variables (a) and the years-clusters defined by the dynamics of the employment rate (b),in Romania, during 1990-2004*

The years-clusters show characteristics specific to the dynamics of the analyzed phenomena. Therefore:

- the 1st cluster consisting of the years 1990-1992 (*tend_pos*) is characterized by a positive dynamics of the phenomena such as: the employment rate, the natural growth, the net migration and the number of external emigrants. It is also characterized by a negative dynamics of the GDP/inhabitant, life expectancy, deathrate and unemployment rate;
- the 2nd cluster made up of the years 1993-2001 (*tend_ct*) is characterized by a stationary dynamics of the analysed phenomena;
- the 3rd cluster comprising the years 2002-2004 (*tend_neg*) is characterized by a positive dynamics of the GDP/inhabitant, life expectancy, deathrate and unemployment rate, and by a negative dynamics of the employment rate, natural growth, the net migration and the number of external emigrants;the years 1993 and 1994 have singular values.

3.2. FISHER'S CLASSIFICATION FUNCTIONS COEFFICIENTS

According to the working hypothesis, formulated on the basis of the economic growth theory, there are correlations between the employment rate dynamics and the influence factors dynamics. In order to identify this type of correlations we use the DA.

In the DA we considered as dependant variable the dynamics of the employment rate defined by the three years-clusters previuosly identified with PCA, and as independent variables the dynamics of the influence factors.

The Fisher's classification functions coefficients may be used directly for classification. For each cluster we obtained a set of coefficients, as presented in Table 2. A new case, the forecast horizon year, will be assigned to the cluster for which the largest discriminant score is obtained.

Table 2. *Fisher's classification functions coeficients*

Classification Function Coefficients

	group_oc		
	tend_pos	tend_ct	tend_neg
mortal_pourc	108815,1	109810,4	111727,1
tx_nat_pourc	12623,330	12711,779	12914,911
esp_vie	200919,2	202767,5	206376,1
tx_chom	929,096	952,137	977,853
PIB_loc	2555,278	2591,575	2655,410
nr_emig_ext	-,015	-,016	-,016
solde_migr	-5943,700	-5947,881	-6079,347
(Constant)	-159158	-162111	-167954

Fisher's linear discriminant functions

The Fisher's classification functions of a forecast horizon in a years-cluster characterized by a specific dynamics of the employment rate are defined as follows:

- for 1st cluster (*tend _pos*):

$$y_{tend\_pos} = -159158 + 108815{,}1 \cdot X_1 + 12623{,}33 \cdot X_2 + 200919{,}2 \cdot X_3 + 929{,}096 \cdot X_4 + 2555{,}278 \cdot X_5 - 0{,}015 \cdot X_6 - 5943{,}7 \cdot X_7$$

- for the 2nd cluster (*tend _ct*):

$$y_{tend\_cts} = -162111 + 109810{,}4 \cdot X_1 + 12711{,}779 \cdot X_2 + 202767{,}5 \cdot X_3 + 952{,}137 \cdot X_4 + 2591{,}575 \cdot X_5 - 0{,}016 \cdot X_6 - 5947{,}881 \cdot X_7$$

- for the 3rd cluster (*tend _neg*):

$$y_{tend\_neg} = -167954 + 111727{,}1 \cdot X_1 + 12914{,}911 \cdot X_2 + 206376{,}1 \cdot X_3 + 977{,}853 \cdot X_4 + 2655{,}41 \cdot X_5 - 0{,}016 \cdot X_6 - 6079{,}347 \cdot X_7$$

3.3. THE CLASSIFICATION OF THE HORIZON 2008 IN A YEARS-CLUSTER

The identification of the cluster to which a forecast horizon will be assigned supposes the calculation of the Fisher's classification functions scores in DA, for each cluster based on the estimations for the influence factors The forecast horizon will be assigned to the cluster for which the largest score was obtained.

The trend model for each influence factor and the estimations of the trend model parameters

The trend model parameters for each influence factor were estimated using the OLS method.

After estimating and testing the significance of the parameters in the models identified graphically, we chosed the best model for each influence factor based on the R Square value. For the chosed model, we obtained the estimated values of the parameters, the test values and their coresponding probabilities (see Table 3).

Table 3: *The trend model for the influence factors, the estimated values of the parameters, the statistical tests and their coresponding probabilities*

The influence factors and the trend models	The estimated values of the trend model parameters			
	a	**b**	**c**	**d**
X_1: Death rate $X_1 = a + b \cdot t + c \cdot t^2$	a = 0.992 (t=28.825) (Sig.=0)	b = 0.031 (t=3.082) (Sig.=0.009)	c = -0.001 (t=-2.487) (Sig.=0.029)	
X_2: Birth rate $X_2 = a + b \cdot t + c \cdot t^2 + d \cdot t^3$	a = 4.608 (t=6.308) (Sig.=0)	b = -2.096 (t=-5.478) (Sig.=0)	c = 0.223 (t=4.076) (Sig.=0.002)	d = -0.008 (t=-3.398) (Sig.=0.006)
X_3: Life expectancy $X_3 = a + b \cdot t$	a = 0.991 (t=212.523) (Sig.=0)	b = 0.002 (t=3.758) (Sig.=0.002)		
X_4: Unemployment rate $X_4 = a + b \cdot t + c \cdot t^2 + d \cdot t^3$	a = 0.000	b = 1.359 (t=3.475) (Sig.=0.005)	c = 0.18 (t=-3.23) (Sig.=0.008)	d = 0.007 (t=3.022) (Sig.=0.012)
X_5: GDP/inhabitant $X_5 = a + b \cdot t + c \cdot t^2$	a = 0.961 (t=6.311) (Sig.=0)	b = -0.099 (t=-2.262) (Sig.=0.043)	c = 0.01 (t=3.861) (Sig.=0.002)	
X_6: Number of emigrants $X_6 = a + b \cdot t + c \cdot t^2 + d \cdot t^3$	a=109846.5 (t=8.188) (Sig.=0)	b=-32794.2 (t=-4.667) (Sig.=0.001)	c=3564.881 (t=3.552) (Sig.=0.005)	d=-122.996 (t=-2.976) (Sig.=0.013)
X_7: Net migration $X_7 = a + b \cdot t + c \cdot t^2$	a = 0.751 (t=5.34) (Sig.=0)	b = -0.132 (t=-3.271) (Sig.=0.007)	c = 0.006 (t=2.417) (Sig.=0.032)	

Estimations of the influence factors's for a forecast horizon

Considering the estimated trend model for each influence factor, we calculate the estimations of the influence factors for the specified horizon by replacing the time variable with the corresponding values for the forecast horizon. The results are presented in Table 4.

Table 4: *Estimations of the influence factors for a forecast horizon*

The influence factors and the trend models	Year		
	2007	2008	2009
X_1: Death rate $X_1 = 0{,}992 + 0{,}031 \cdot t - 0{,}001 \cdot t^2$	1.232	1.23	1.22
X_2: Birth rate $X_2 = 4{,}608 - 2{,}096 \cdot t + 0{,}223 \cdot t^2 - 0{,}008 \cdot t^3$	-4.608	-5.881	-7.524
X_3: Life expectancy $X_3 = 0{,}991 + 0{,}002 \cdot t$	1.023	1.025	1.027
X_4: Unemployment rate $X_4 = 1{,}359 \cdot t - 0{,}18 \cdot t^2 + 0{,}007 \cdot t^3$	4.313	5.474	6.966
X_5: GDP/inhabitant $X_5 = 0{,}961 - 0{,}099 \cdot t + 0{,}01 \cdot t^2$	1.937	2.168	2.419
X_6: Number of emigrants $X_6 = 109846{,}5 - 32794{,}2 \cdot t + 3564{,}881 \cdot t^2 - 1$	-6042.78	- 21683.6	-42740.3
X_7: Net migration $X_7 = 0{,}751 - 0{,}132 \cdot t + 0{,}006 \cdot t^2$	0.175	0.241	0.319

Classification of the horizon 2008 in a years-cluster defined by the trend of the influence factors

The estimations of the values for each influence factor for the specified forecast horizon allow further on, using the Fisher's classification functions, to estimate the years-cluster to which the new case (the forecast horizon 2008) will be assigned.

Each cluster is characterized by a specific dynamics of the economic phenomena that define it. Thus, it is possible to characterize the year 2008 by the cluster to each it will be assigned.

The classification functions for the 2008 forecast horizon are:

- for the 1st cluster (*tend_pos*):

$$y_{tend\_pos} = -159158 + 108815.1 \cdot 1.23 - 12623.33 \cdot 5.881 + 200919.2 \cdot 1.025 + 929.096 \cdot 5.474 - $$
$$+ 2555.278 \cdot 2.168 + 0.015 \cdot 21683.6 + 5943.7 \cdot 0.241 = 110821.6$$

- for the 2nd cluster (*tend_ct*):

$$y_{tend\_cts} = -162111 + 109810.4 \cdot 1{,}23 - 12711.779 \cdot 5.881 + 202767.5 \cdot 1.025 + 952.137 \cdot 5.474 -$$
$$- 2591.575 \cdot 2.168 + 0{,}016 \cdot 21683.6 + 5947{,}881 \cdot 0.241 = 115778.5$$

- for the 3rd cluster (*tend_neg*):

$$y_{tend\_neg} = -167954 + 111727.1 \cdot 1.23 - 12914.911 \cdot 5.881 + 206376.1 \cdot 1.025 + 977.853 \cdot 5.474 -$$
$$- 2655.41 \cdot 2.168 + 0.016 \cdot 21683.6 + 6079.347 \cdot 0.241 = 115044.8$$

We notice that the largest score is obtained for the years-cluster *tend_ct*. Consequently, the forecast horizon, the year 2008, may be classified in the years-cluster with constant trend. As a result, the employment rate in 2008 will develop under the influence of the constant dynamics of the influence factors. The values for the classification functions for the years 2007, 2008 and 2009 are presented in Table 5.

Table 5: *The values for the classification functions for the years 2007, 2008 and 2009*

Classification functions	Year		
	2007	**2008**	**2009**
Positive trend	y_{tend_pos} = **130302,87**	y_{tend_pos} = 110821,6	y_{tend_pos} = 89888,79
Constant trend	y_{tend_ct} = 130234,84	y_{tend_ct} = **115778,5**	y_{tend_ct} =**96144,56**
Negative trend	y_{tend_neg} = 129720,93	y_{tend_neg} = 115044,8	y_{tend_neg} = 95109,22

4. THE EMPLOYMENT RATE ESTIMATED FOR THE YEAR 2008

The estimation of the employment rate for the year 2008 takes into considertion the level of the employment rate registered by the years-cluster *tend_ct*.

We estimate the employment rate for 2008 based on the trend equation of the employment rate values in the cluster 1995-2001, (*tend_ct*), characterized by a stationary, constant dynamics of the analyzed phenomena.

We chose the linear trend model for which we obtain the following results: the Sig. value corresponding to the Fisher test is equal to 0.002 and the R Square value is equal to 0.879. (see Table 6 and Figure 3).

Table 6. *R Square and the coefficients of the trend model*

Model Summary and Parameter Estimates

	Model Summary					Parameter Estimates			
Equation	R Square	F	df1	df2	Sig.	Constant	b1	b2	b3
Linear	.879	36.312	1	5	.002	61.486	-.457		
Logarithmic	.716	12.585	1	5	.016	61.242	-1.301		
Inverse	.487	4.754	1	5	.081	58.759	2.426		
Quadratic	.914	21.146	2	4	.007	60.857	-.038	-.052	
Cubic	.930	13.207	3	3	.031	60.057	.873	-.319	.022
Compound	.880	36.691	1	5	.002	61.510	.992		
Power	.715	12.561	1	5	.016	61.257	-.022		
S	.486	4.734	1	5	.082	4.073	.041		
Growth	.880	36.691	1	5	.002	4.119	-.008		
Exponential	.880	36.691	1	5	.002	61.510	-.008		
Logistic	.880	36.691	1	5	.002	.016	1.008		

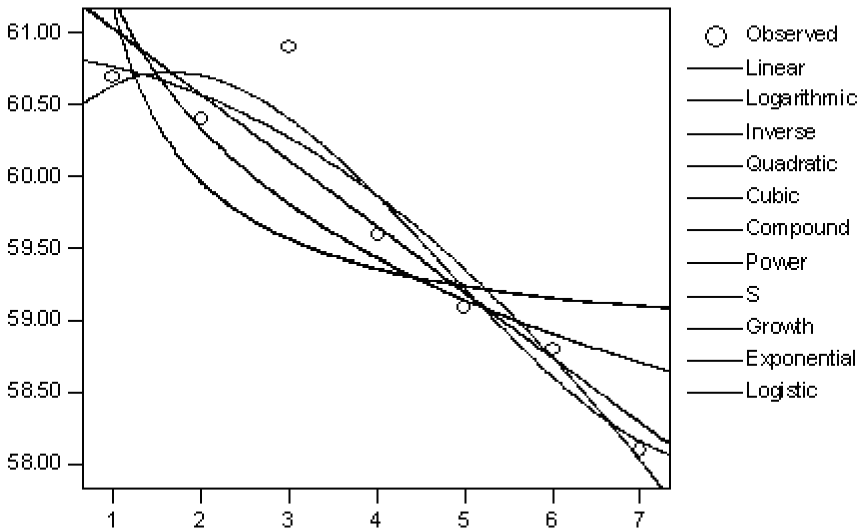


Figure 3. *Graphical determination of the employment rate trend model*

The estimated equation for the employment rate is:

$$Employment\ rate = 61{,}486 - 0{,}457t$$

(t=181,231) (t=-6,026)

(Sig.=0,002) (Sig.=0,000)

If we consider the dynamics conditions registered by the years-cluster *tend_ct*, which has a linear trend, we look forward to an employment rate equal to

55.24% for the year 2008. The 95% confidence interval for the employment rate are 52,85% and 57,33%.

CONCLUSIONS

In our study, we made the analysis of the phenomena dynamics which, consistent with the economic theory, has impact on the employment rate. This analysis highlighted a trend specific to the the transition period in Romania.

Traditionally, the statistical forecast is done by trend extrapolation. Such a forecast takes into account the trend for the overall time period. This implies the hypothesis of a similar evolution during the entire period, ignoring the specific trend of each factor that defines the development environment of the studied phenomenon.

The analysis we made for the period 1990-2004 underlines a different dynamics of the phenomena, changing both its sign and its value during the analysed period. This is a dynamics specific to the transition periods. Using the PCA we identified years-clusters defined by different dynamics of the influence factors that have impact on the employment rate.

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