

The Pattern of Forecast Analysis concerning the Romanian Civil Active Population on Clusters

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Abstract

The article approaches the active population, an important indicator of labor market. The strength of this research is the forecast realized using like methods the cluster and regression analysis. The forecasting approach has as a starting point the values of the registered civilian workforce between 1990 and 2010 in counties, data that will be grouped in clusters (formed by groups of counties) based on the similarities in terms of the analyzed indicator. Through the regression method it is performed a modeling and then a forecast of each cluster and of the total civil active population for 2013, 2014 and 2015.

The paper's originality results from combining the two methods used with the aim to forecast the indicator established for that horizon of interest. The importance of the subject has its essence in the role that the working population, and namely, the civil one, has in providing employment, given that the employed are a part of the active population. Following the forecast made, it is expected a slight increase from one year to another concerning the volume of the analyzed indicator.

Key words: *civil active population, cluster, regression analysis, forecast*

Jel Classification: *C53, C38, J82, J11*

Introduction

The present research supposes a theoretical and practical analysis of the civilian workforce, as main source of labor at macroeconomic level. The topic indicates an interdisciplinary approach in some scientific fields, as economic and statistical one, in general, and the informational system field, as one of the main components of the labor market management. Studying this indicator is a decision justified by its importance in every national or international economy, due to its components, especially the employees, as the first production source.

Using the levels reached by the civil active population on Romanian counties, the paper aims to study the evolution of this indicator from 1990-2010, then, according to the similarities between trends by county, to form groups (clusters), the aggregate economic phenomena obtained being analyzed and projected using a regression method.

The problem that determined an overall analysis concerning the evolution of the active population and then, its forecast, is derived from the fact that our country is among the European states with the highest risk in terms of aging. This demographic crisis that we should expect is contained in a report published by the European Parliament, which claims that by 2060

the population over 65 will triple, as compared to the population aged 15-64 years, while the activity rate will be diminishing.¹

The statistical perception and determining of the analysed indicator differ from country to country and also between the statistical institutions of each nation, fact that justifies the importance that must be given to the comparison made between the values of the active population of different countries². In its simplest form, the active population is an expression of labor supply and also the source of employment in the labor market, while the employed population, in its forms is one of the active population components. Overall, the active population includes the employed and the unemployed that meet the criteria established by the International Labor Office (ILO). According to *The statistical research on labor in households*, the economically active population comprises all persons supplying labor force to produce goods and services during a reporting period.

Macroeconomic statistics suggests *two forms* to express the active population:

- *total working population*: includes all persons able to work to produce goods and services during a reference period (the week before the interview) and includes the employed and unemployed population;
- *civil active population*: includes persons over 16 who can work as potential offer, to produce goods and services, embodied in the civil employed and the registered unemployed at the employment agencies.

On the other hand, the United Nations' statistics recommended expressing this indicator in terms of regular and current active population, demarcation made by referring to the following *criteria*:

- *the regularly active population* is determined from the census and the reference period is the number of weeks for which the individual has the status of mainly occupied person; under opposite circumstances, the population becomes regularly inactive;
- *the active current population* is determined from investigations of labor. If an individual has performed an economic activity for at least one hour during the reference week, he is included in the category of active current population. In the context of a prevailing vacancy, he is included in the current inactive population.

The International Labor Office statistics divides the active population into *regularly active population* (registered for a period exceeding one year) and *currently active population* (determined by referring to a day or a week).³ Regardless of the expression mode of specific active population it is evident its economic and statistical importance, because it has in its structure that part of population that is actually employed in economic activities: employees, employers, self-employed, members of agricultural societies or members of cooperatives. There are not included within the category of the active population: the housewives, the retirees or the persons exclusively being taken care of by others.

A decisive role in determining the values of this indicator is held by the National Institute of Statistics, using the labor balance at country, region and county level. The same institution, through the census of 2002 confirms the downward trend observed in the active population from the previous census in 1992, while diminishing the population's participation rate in the

¹ Societatea Academică din România, 2010, *Raportul Anual de Analiză și Prognoză*, disponibil la http://www.ardor.org.ro/documents/435_PWR-2010-1.pdf [accesat la 7 mai 2012]

² Marian Ionel, *Piața muncii în România*, Editura Universitaria, Craiova, 2007, p. 72

³ Constanța Mihăescu, *Populație & Ocupare. Trecut. Present. Viitor*, Editura Economică, București, 2001, p. 142

economic activity⁴. Below it is provided an overview of the active population evolution in Romania in the last eleven years.

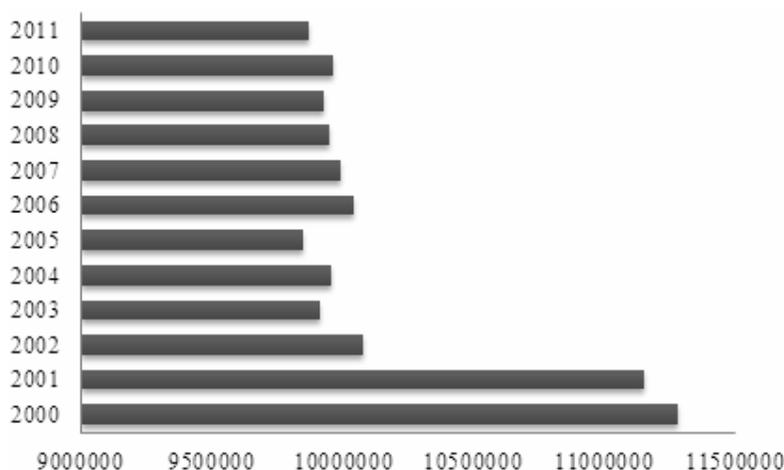


Fig.1. The active population trends in Romania during 2000 - 2011

Source: made by author

Basing on the current data between 2000-2011, we conclude, in accordance with Figure 1, that there is a decrease in the active population's volume in Romania starting with 2002 when this indicator was reduced with 1.203.676 persons compared with the year 2000, when the active population included 11.283.126 individuals. The lowest number in the present context appears in 2005 due to an employment volume of 9.146.572 persons (minimum value for the same period) and 704.462 of unemployed. The active population is presented in a similar way in 2011, when there are approximately 9.868.000 people, of which about 9.138.000 were employed and 730.000 unemployed.

The Forecast of Active Civil Population on Counties for the Years 2013, 2014, 2015

Source Data and Research Methodology

The data, representing the active civil population from Romania counties between 1990- 2010 were provided by the National Institute of Statistics⁵. In this research the cluster analysis and the regression method were used.

The cluster analysis includes methods for dividing a set of elements in separate groups so that each one is more similar to elements within the group, than with those outside the group. The methods proposed by the cluster analysis suppose the distribution of elements (observation units) in different groups, taking into account the situation in relation to a pivotal point (node), the choice of conditions, such as distance, to delimit each group in relation to other criteria⁶. Cluster analysis was used to group Romania's counties in homogeneous groups in terms of civil active population's levels in the considered period (1990-2010), to model these groups of counties with an econometric model to make predictions as closer to reality concerning the civilian working population of these groups formed for the future.

⁴ Eugenia Harja, *Analiza și prognoza statistică a numărului și structurii forței de muncă*, Editura Matrix Rom, București, 2004, p. 22

⁵ www.insse.ro

⁶ Alexandru Isaic Maniu, Daniela Ștefănescu, Eugen Pecican, *Dicționar de statistică generală*, Editura Universitară, București, 2003, p.188

The regression analysis is the approach method of the relationship between the "effect" variable and factors, given that such a relationship is assumed, and its existence is not clearly manifested, for each case, but it appears more evident as the number of cases increases⁷. Thus, it is a relation of stochastic dependence in which a random element is under consideration. The literature considers A. Bravais, F. Galton and K. Pearson initiators of the classical method of regression analysis. The subject was also analyzed by D.B. Pearson, N.R. Draper, H. Smith and R.H. Williams. The founders of the modern method of regression analysis are H. Wold, A. Walters, G.E.P. Box and G.M. Jenkins. Regression analysis is used to shape the groups of counties that were formed after the cluster analysis, through various econometric models that best approximated the evolution of the total civil active population in Romania or in groups of counties, between 1990 to 2010.

Stages of Research

The method employed involves the analysis and forecasting of the real values' dynamics of the aggregate phenomenon structural components, grouped in clusters, using their weights in the aggregate phenomenon. By this method many advantages will be obtained concerning the regression equation parameters, in term of quality, and thus the quality of the forecasts is improved.

The suggested method for analyzing and forecasting the aggregate economic phenomena involves the following *steps*⁸:

- I. The analysis and forecast of the aggregate phenomenon through the classical method of regression analysis.
- II. Calculating of weights for each component by aggregation phenomenon for each year from 1990 to 2010;
- III. Grouping the components weights depending on their dynamics characteristics using the cluster analysis;
- IV. Modeling of clusters by a regression model;
- V. Testing the assumptions regarding the modeling errors resulting after the regression models;
- VI. The prediction using the regression method;
- VII. To correct the predicted weights according to the restrictions set a priori;
- VIII. Calculating of the absolute values predicted for the aggregate phenomenon's components, structured in clusters, for a predicted horizon, by combining the predicted absolute values with the predicted weights of each cluster in each year.

The fundamental principle of this method is an analytical model of the phenomenon aggregate weights combined with regression analysis applied to time series. This principle was first introduced by prof. E. Jaba and C. Turturean in 2006.

Data aggregation at the group level is made by summarizing the weighted active civil population in the counties of the total active civil population of Romania (except for Bucharest). In analyzing and forecasting the evolution of the levels achieved by the civil population in

⁷Ibidem, p.51

⁸Elisabeta Jaba, Ciprian Ionel Turturean, „Method for the Analysis and Forecast of the Components' Evolution in an Aggregate Economic Phenomenon using their Weights. Application on the Exports of EU-15 Countries from 1996 to 2005”, *Anuarul Institutului de Cercetări Economice*, „Gh. Zane” TOMUL nr. 15/2006, Editura Academiei Române, Iași, 2006

Romania counties, grouped into clusters, was chosen to express it in relative values. In this approach one must take into account the restrictions defined by relations (1) and (2).

$$100 \% = \sum_{i=1}^k p_{it}^{\%}, \forall t \quad (1)$$

$$0\% \leq p_{it}^{\%} \leq 100\%, \forall i = \overline{1, k} \quad (2)$$

Using relative values several advantages are obtained:

- It is reduced the variance of the phenomenon amplitude from $(-\infty; +\infty)$ to $(0\%; 100\%)$;
- It is reduced the variance, respectively the standard deviation corresponding to the phenomenon, which will have a positive influence to the estimations' quality made on these values, as an alternative to the standard value.

The only variable used in absolute value is the volume of the active civil population from Romania.

Data Analysis and Forecast Results

I. The analysis and forecast of the aggregate phenomenon through the classical method of regression analysis. To analyze the total volume of active civil population of Romania between 1990- 2010 a specific method of time series analysis will be used. Because the time series has a low volume (21 records), it is chosen the analysis based on trend adjustment method using an analytical function. The best model will be chosen considering the following *criteria*:

- R^2 value (determination coefficient) and R^2 adjusted value is the higher;
- R^2 value is significantly different from zero.

The next step involves testing the regression model parameters, taking into account:

- *the criterion of parameters significantly different from zero*;
- *the criterion of the best model*: it is used if, following a cumulative application by using the first three criteria, several models are obtained. In this situation, it will be chosen the model that generates the minimum mean square error;
- *the criterion of the simplest model*: it is used if, following a cumulative application by using the first four criteria, several models are obtained.

Thus, the evolution of active civil population of Romania was best modeled by a cubic model (Cubic), as its determinative coefficient R^2 has the maximum value and the model is validated as suitable for modeling the indicator's volume through a Sig value = 0.000, lower to a risk of 5% considered. The graphical representation for the analyzed indicator is presented in Figure 2.

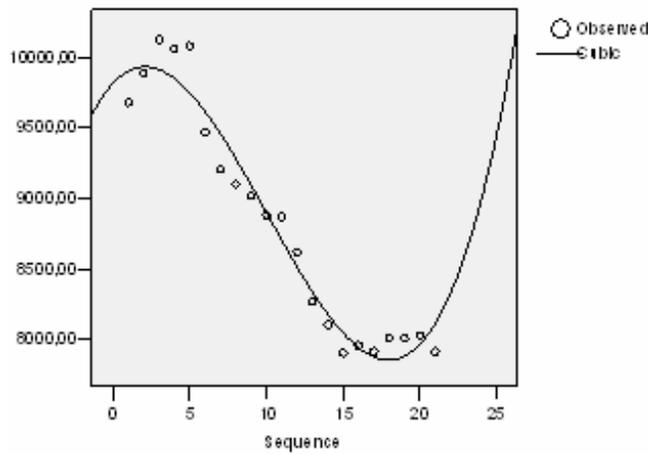


Fig. 2. The evolution of active population in Romania during 2000 - 2011

Source: made by author

The econometric cubic model validated has the following form:

$$Y_{total} = 1,03t^3 - 31,24t^2 + 9812,57 + \varepsilon \tag{3}$$

where Y_{total} represents the volume of the active population from Romania, ε is the modeling error and t is the year.

Based on this model, predictions can be made, for a near horizon, concerning the volume of the total active civil population from Romania and its increase/decrease for the future predicted can be estimated.

II. The calculation of weights corresponding to each component of the aggregate phenomenon for each year separately. The weights for each county are calculated, according to the period 1990-2010, like a ratio between the active civil population's volume at that time at county level and the civil active population of Romania (except for Bucharest⁹).

III. The grouping of active civil population's weights on counties, reported to the total value for the indicator analyzed for Romania, for the period 1990-2010 (calculated in accordance with its evolution in the previous phase) using the hierarchical cluster analysis. The active civil population weights calculated for each county of Romania for all 21 years counted were grouped as homogeneous groups in terms of the indicator's level for the years considered. The image that presents the way in which the groups, called clusters, are formed is represented in a dendrogram as in Figure 3 below:

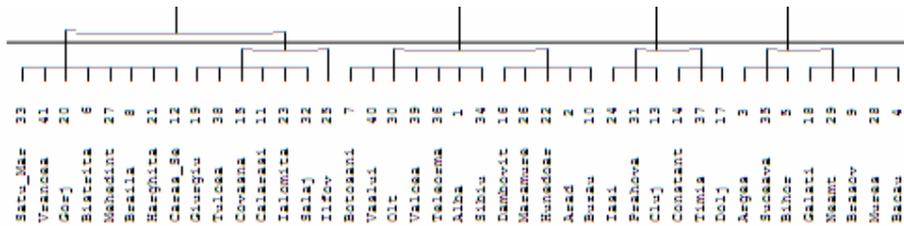


Fig.3.The dendrogram of counties grouped on clusters

⁹The values corresponding to Bucharest differ significantly from the civil active population in all other counties, which would lead to the formation of two groups: Bucharest, on the one hand, and other counties, on the other.

According to this, five clusters are formed, having the following structure:

- Cluster 1: Alba, Arad, Botoșani, Buzău, Dâmbovița, Galați, Hunedoara, Maramureș, Neamț, Olt, Sibiu, Teleorman, Vâlcea, Vaslui;
- Cluster 2: Argeș, Bacău, Bihor, Brașov, Mureș, Suceava;
- Cluster 3: Bistrița-Năsăud, Brăila, Caraș-Severin, Gorj, Harghita, Mehedinți, Satu Mare, Vrancea;
- Cluster 4: Călărași, Covasna, Ialomița, Giurgiu, Ilfov, Sălaj, Tulcea;
- Cluster 5: Cluj, Constanța, Dolj, Iași, Prahova, Timiș.

In terms of graphics, the evolution of the active civil population's weights on counties is presented in Figure 4. It is observed that the counties within the fourth cluster summarizes the smallest share of civil active population, reported to the total value of the indicator under consideration, for the period 1990-2010 and the counties from the first cluster recorded the highest share.

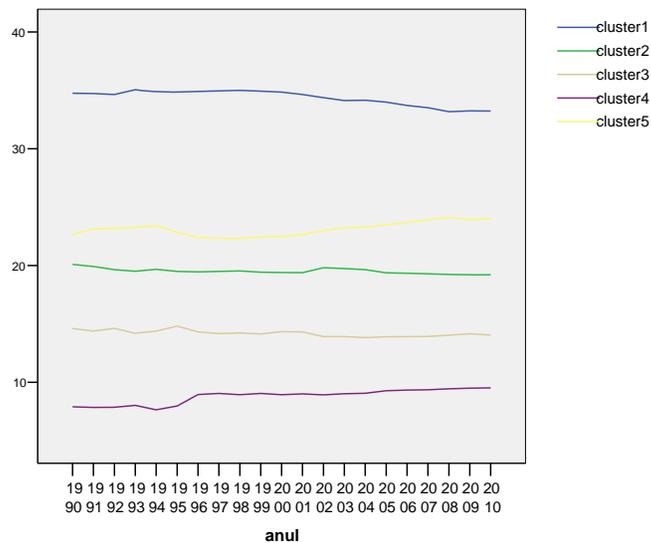


Fig.4. The evolution of civil active population' weights on clusters
 Source: made by author

Therefore, the development of the civil active population's share of the five groups of counties differs significantly between any two pairs of groups.

IV. The analysis and forecast of the civil active population weights' evolution (by counties) reported to the same indicator for Romania for the period 1990- 2010, using the analytical functions' modeling as a method of biased analysis. Modeling the evolution of civil active population weights by counties, divided into five clusters, and compared to the civil active population of Romania for the period 1990-2010 will be made following the same steps from the first stage of approach. The form of the validated model for every cluster formed will be presented, based on the statistically significant parameters. After data processing, the pattern characteristic to the first cluster has the following form:

$$y_{cluster1} = -0,009t^2 + 0,101t + 34,629 + \varepsilon_1 \tag{4}$$

where y represents the cumulative weight of the active civil population for the counties which form the cluster1, ε_1 is the modeling error and t is the year.

This step continues with choosing an appropriate regression model for *cluster 2*. The best validated model is the cubic model (Cubic). The result after data modeling by the cubic model is:

$$y_{cluster2} = -0,001t^3 + 0,021t^2 - 0,221t + 20,227 + \varepsilon_2 \quad (5)$$

Based on the statistically significant parameters, the model for *the third cluster* is as follows:

$$y_{cluster3} = 14,55 * 0,998^t + \varepsilon_3 \quad (6)$$

For *the fourth cluster* has validated a linear equation that describes better the trend of cumulative weights of civil active population and has the following form:

$$y_{cluster4} = 0,091t + 7,786 + \varepsilon_4 \quad (7)$$

For the *last group* of counties, the model validated is a quadratic one and has the form:

$$y_{cluster5} = 0,01t^2 - 0,163t + 23,333 + \varepsilon_5 \quad (8)$$

For all the five econometric models validated three hypotheses will be verified, followed by predictions for a horizon of interest concerning the Romanian active civil population: the modeling errors normality, the homoscedasticity and the lack of autocorrelation.

V. Testing the hypotheses for the classic regression model concerning the errors.

The *normality hypothesis* is verified through the nonparametric test Kolmogorov- Smirnov (K-S). The decision rules are: for a Sig value <0.05, the cluster modeling errors are not normally distributed, and for a Sig value > 0.05, there is a normal distribution law for errors. The result is shown in the table below.

Table 1. Testing the errors normality for all five clusters

		Modeling error cluster1	Modeling error cluster2	Modeling error cluster3	Modeling error cluster4	Modeling error cluster5
N		21	21	21	21	21
Normal Parameters	Mean	,000	,100	,001	,000	,000
	Std. Deviation	,142	,067	,177	,270	,305
Most Extreme Differences	Absolute	,150	,156	,133	,171	,151
	Positive	,150	,156	,133	,171	,139
	Negative	-,102	-,069	-,086	-,136	-,151
Kolmogorov-Smirnov Z		,687	,713	,611	,785	,694
Asymp. Sig. (2-tailed)		,733	,689	,850	,569	,722

Source: made by author

Table 1 shows the values for Sig higher than the risk of 0,05, fact that makes us affirm, with a confidence of 95%, that the normality hypothesis is validated.

The homoscedasticity hypothesis. For verifying the errors' hypothesis of homoscedasticity (a constant variance of errors at the conditional distributions level) the Glesjer Test is used. The decision rules are: if we have a Sig value < α equal with 0,05, then the model for the cluster *i* is heteroscedastic, and if $Sig > \alpha$, then the model for the cluster *i* is homoscedastic. The result obtained after applying the Glesjer test for the five clusters is presented in Table 2:

Table 2. Testing the errors' homoscedasticity for all five clusters

ANOVA

Cluster <i>i</i>	Sig.
cluster 1	,125
cluster 2	,183
cluster 3	,759
cluster 4	,070
cluster 5	,134

Source: made by author

We can affirm, with a confidence of 95% that for the five clusters the model resulted is respected the homoscedasticity hypothesis, because the Sig values are higher than the risk of 5%.

The errors' autocorrelation hypothesis. This hypothesis is tested using the Runs test. The result is shown below.

Table 3. Testing the errors' autocorrelation hypothesis for the five clusters

Runs Test

	Modeling error cluster1	Modeling error cluster2	Modeling error cluster3	Modeling error cluster4	Modeling error cluster5
Test Value	-,02947	,09938	-,03507	-,04894	,08283
Cases < Test Value	10	10	10	10	10
Cases >= Test Value	11	11	11	11	11
Total Cases	21	21	21	21	21
Number of Runs	9	6	11	6	5
Z	-,887	-2,234	,000	-2,234	-2,682
Asymp. Sig. (2-tailed)	,375	,026	1,000	,026	,007

Source: made by author

The decision rules are identical to the previous tests: if the Sig value <0.05, the modeling errors for the cluster *i* are autocorrelated, and for a Sig value > 0.05, the modeling errors are not autocorrelated. It can be observed that there is autocorrelation between the modeling errors for the clusters 2, 4 and 5.

VI. The projection of the total volume of Romania's civil active population and its cumulative weights on the five clusters for 2013-2015. Assuming that all the conditions remain the same during modeling (the variance and trend series are constant), a forecast for the next three years will be made concerning the volume of total civil active population of Romania and its cumulative weights on clusters, based on the regression models resulted in the previous phases of the analysis. The result is presented in Table 4:

Table 4. The civil active population's weights cumulated on clusters and on total, projected for 2013-2015

Year	<i>Y</i> _{cluster1} -predicted	<i>Y</i> _{cluster2} -predicted	<i>Y</i> _{cluster3} -predicted	<i>Y</i> _{cluster4} -predicted	<i>Y</i> _{cluster5} -predicted	<i>Y</i> _{total} -predicted (thousand)
2013	32,04785	18,39672	13,77723	9,96805	25,23227	9923,569
2014	31,72318	18,08438	13,74595	10,05896	25,56376	9872,411
2015	31,38113	17,72098	13,71474	10,14988	25,91543	9776,095

Source: made by author

The weight of active civil population will record the highest increase for each year in the counties corresponding to cluster 1, respectively: Alba, Arad, Botoșani, Buzău, Dâmbovița, Galați, Hunedoara, Maramureș, Neamț, Olt, Sibiu, Teleorman, Vâlcea, Vaslui, at the other side being the counties that are included in cluster 4: Călărași, Covasna, Ialomița, Giurgiu, Ilfov, Sălaj, Tulcea. In terms of the civil active population projected, the analysis of results shows a slight decrease from year to year concerning the volume of this indicator in Romania for the period 2013 - 2015.

VII. *The correction of the weights predicted to meet the conditions described by equations (1) and (2).* To specify the values for the weights obtained in the forecast for on horizon of three years, the conditions described by the equations (1) and (2) shall be verified.

The condition $100\% = \sum_{i=1}^5 Y_{cluster_i(t)} \forall t, t = \overline{1990, 2015}$, refers to the fact that the amount of all the clusters, expressed as a percentage, should be equal to 100% for each year. Thus, when adding up the variables for the period 1990-2015, we see that the weighted sum is not equal to 100%, which indicates a violation of the restrictions given by the equations (1) and (2); this requires calculating the predicted values from the restrictions deviation values, making adjustments for the values originally predicted. The indicators, which represent the amount that will be made the adjustments, are called adjustment coefficients, noted c_t . In the case of an unbalanced adjustment, the equation (9) will be used to calculate c_t .

$$c_t = \frac{100\% - \sum_{i=1}^5 Y_{cluster_i(t)}}{5} \quad (9)$$

where:

$Y_{cluster_i(t)}$: represent the estimated weights of the civil active population from the group i , $i = \overline{1,5}$ at the moment t ;

c_t : is the unbalanced adjusted coefficient specific at the time t , belonging to the predicted horizon.

The correction of predicted weights will be made in accordance with the relation (10).

$$Y_{cluster_i_{adjusted}(t)} = Y_{cluster_i(t)} + c_t \quad (10)$$

VIII. *Predicting the absolute values for each group of counties.* The absolute values of the weights predicted for the civil active populations grouped into clusters are obtained by multiplying the projected volume of the indicator at the country level for 2013- 2015 with the corresponding values of the predicted adjusted weights, according to relation (11).

$$Y_{cluster_i_{prev_abs}} = Y_{total_prev} * Y_{cluster_i_{adjusted}} \quad (11)$$

The results are presented in Table 5.

Table 5. The absolute values of the civil active population's volume for each group of counties (thousand)

Year	$Y_{cluster1_{prev_abs}}$	$Y_{cluster2_{prev_abs}}$	$Y_{cluster3_{prev_abs}}$	$Y_{cluster4_{prev_abs}}$	$Y_{cluster5_{prev_abs}}$
2013	289092,6	166393,0	124871,8	90634,05	227832,5
2014	301188,0	172366,8	131389,4	96565,10	243011,0
2015	315904,2	179364,4	139320,1	103687,6	261271,9

Source: made by author

After correcting the weights, the volume of civil active population for the period in which the forecast is made is on the increase for each cluster separately. This expectation can be explained by the fact that the aging process is still not so fast as to influence the activation on the labor market in the coming years, fact that maintains the rate of inactivity in the labor market at a lower level, compared to the activity one.

Conclusions

The results we provide through the forecasting approach highlights a situation that could be interpreted in two ways: first, the growth of civil active population may be a consequence of increasing the share of civilian employment in total civilian workforce, as optimum scenario preferred, but also a prerequisite for attaining the Europe 2020 fundamental objective to achieve an employment rate of 70% in Romania in 2020. On the other hand, the forecast result may explain a possible increase in the volume of the registered unemployed, in which case there occurs the need to increase the promotion of active measures to prevent the unemployment and automatically, to stimulate the employment, being addressed both to the unemployed and to the employers.

The paper has a high level of originality that arises from the approach used to achieve the intended purpose and from the use of a complex database to describe the evolution of civil active population by county and by groups of counties. This approach is not found in the labor market literature, fact that is a strong point of this research. As future research directions, a quarterly analysis of the civil active population will be made, as base for a forecast using Box & Jenkins methodology.

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Demersul analizei de prognoză privind populația activă civilă din România pe clusteri

Rezumat

Articolul abordează conceptual și aplicativ un indicator fundamental al pieței muncii, populația activă. Punctul forte al acestei cercetări este efectuarea unei prognoze folosind ca metode analiza cluster și analiza de regresie. Demersul de prognoză are ca punct de plecare valorile populației active civile înregistrate în intervalul 1990- 2010 pe județe ale României, date care vor fi grupate în clusteri (formați din grupe de județe), în funcție de similitudinile existente din perspectiva indicatorului analizat. Prin metoda de regresie se efectuează o modelare și ulterior o prognoză a fiecărui cluster și a populației active civile totale pentru anii 2013, 2014 și 2015.

Originalitatea articolului rezultă din combinarea celor două metode utilizate în scopul prognozei indicatorului vizat pentru respectivul orizont de interes. Importanța subiectului își are esența în rolul pe care populația activă, în speță, civilă, îl deține în asigurarea ocupării forței de muncă, în condițiile în care populația ocupată este parte a populației active. În urma prognozei realizate se estimează tendințe de ușoară creștere de la un an la altul a volumului indicatorului de structură analizat.