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## **ANALYZING "THE WORKFORCE COST" AND "THE NET NOMINAL EARNINGS" IN THE MAIN ECONOMIC ACTIVITIES, BY PRINCIPAL COMPONENT ANALYSIS**

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### **Abstract**

The "Workforce cost" and the "Net nominal earnings" are decisive characteristics of the labor market that reflect the labor supply of individuals and the labor demand of economic entities.

This paper aims at studying the statistical connections between the indicators "Average monthly workforce cost" and "Average monthly net nominal earnings", by the statistical method "Principal component analysis (PCA)", for the main activities of the national economy, in 2014.

The results obtained after carrying out this research showed that, on the one hand, there are significant correlations between these two indicators; on the other hand, there are also several similarities and differences between the analyzed economic activities.

### **Keywords**

Average monthly workforce cost, average net nominal earnings, economic activities, principal component analysis.

### **JEL Classification**

J30, J31, J32, C10, C38

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### **Introduction**

The statistical research on "the Average monthly workforce cost" and "the Average monthly net nominal earnings" aims mainly at obtaining the necessary information in order to indicate the statistical connections between the considered variables, the similarities or the differences between the two indicators, structured according to the national economic activities, as defined by the National Classification of Economic Activities (abbreviated in Romanian as CAEN Rev. 2), harmonized with the European classification in the field (i.e. NACE Rev. 2).

The reference period is the calendar year 2014; the latest statistics from the National Institute of Statistics - Romania (NIS) have been processed for the purpose of this analysis.

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In order to ensure a correct understanding of the indicators used in this study, we consider it appropriate to make some methodological specifications regarding their content.

The "Workforce cost" and the "Net nominal earnings" are decisive characteristics of the labor market, reflecting the labor supply of individuals and the labor demand of economic entities. From a methodological perspective, they are economic efficiency indicators, having a decisive role for the competitiveness of economic activities.

The first variable analyzed, i.e. "Workforce cost", represents the total expenditure borne by employers for the employment of personnel. It includes the gross amounts paid directly to employees (direct expenditure), i.e. salaries in cash and in kind, and other expenditures of the entity incurred by the workforce (indirect expenditure), relating to employers' social contributions, vocational training costs, other costs related to the employment taxes regarded as labor costs, wherefrom the received subsidies are deducted (Regulation EC no. 1737/2005).

A second variable included in our research, i.e. "Net nominal earnings", is obtained subtracting the following items from gross nominal earnings: tax, contribution of employees for health social insurance, individual contribution of state social insurance and employee contribution to unemployment insurance budget.

Average monthly earnings represent the ratio between amount paid to employees by economic units in the reference month, irrespective of due period and average number of employees. Average number of employees represents an arithmetic mean calculated based on daily number of employees in the reference month.

The net nominal earnings are directly influenced by the tax imposed on the gross nominal earnings. The net nominal earnings are intended to either satisfy the material and spiritual needs of employees or to saving.

According to the definition of the NIS, the gross nominal earnings comprise salaries, respectively rights in cash and in kind for employees for the work done (including for overtime) according to salary type, increases and indemnities as percent of salary or in fixed amounts, other additions to salary according to the law, amounts paid for time not worked (indemnities for rest and study leaves, holidays and days off, amounts paid from salary fund for medical leaves), premiums, holiday bonuses and other amounts paid from salary fund according to normative documents and collective labor contracts, amounts paid from net profit and other funds (including equivalent value of meal tickets).

For this statistical analysis, we took into account the following variables: "Average monthly workforce cost per employee" and "Net monthly nominal earnings" for the national economic activities of Romania, in 2014. The analysis method that can be applied in order to study the connections between them is "Principal component analysis" (PCA). After processing the data, we obtained, starting from a large set of data, several statistical indicators calculated for the two variables analyzed, and a graphical representation of the units analyzed through a system of factorial axes that highlights the similarities and differences between the main national economic activities.

## **1. Methodology**

The statistical method used is represented by "Principal component analysis (PCA)". Data processing, testing the indicators' significance and the graphical representations were performed by the SPSS statistical software.

The principal components analysis is a descriptive method that helps us to analyze the combinations of numeric variables. The objectives are:

- highlighting the statistical connections between the analyzed variables;
- highlighting the similarities/differences between the statistical units analyzed according to all recorded variables;
- explaining the similarities/differences between individuals, in terms of the analyzed variables.

The principal components analysis can be applied only to quantitative variables, expressed in the same measurement unit. If the variables are expressed in different measurement units, then their standardization is achieved (Pintilescu, 2007; Spircu, 2005).

## 2. Data and results

Table no. 1 shows the distribution of the indicators "Average monthly workforce cost per employee" and "Average monthly net nominal earnings", on a sample of 19 national economic activities, for 2014.

**Table no. 1 Distribution of the indicators "Average monthly workforce cost per employee" and "Average monthly net nominal earnings", on a sample of national economy activities, for 2014 (RON)**

No.	National economic activities	Average monthly workforce cost per employee	Average monthly net nominal earnings
1	Agriculture, forestry and fishing	2248	1270
2	Extractive industry	6740	3260
3	Manufacturing industry	2802	1578
4	Production and supply of electric and thermal energy, gas, steam and air conditioning	5565	3093
5	Water supply; sanitation, waste management and remediation activities	2726	1509
6	Constructions	2181	1240
7	Wholesale and retail trade; repair of motor vehicles and motorcycles	2421	1412
8	Transport and storage	3065	1707
9	Hotels and restaurants	1651	958
10	Information and communications	5679	3357
11	Financial intermediation and insurance	6523	3708
12	Real estate transactions	2429	1344
13	Professional, scientific and technical activities	4254	2442
14	Activities of administrative services and support services	2203	1261
15	Public administration and defense; public social insurance	3925	2754
16	Education	3039	1733
17	Health and social assistance	2861	1496
18	Arts, entertainment and recreational activities	2204	1249
19	Other service activities	2003	1141

*Source: Institutul Național de Statistică (National Institute of Statistics)*

Altogether, the information provided in this table reveals that the difference between the maximum and the minimum level of the two indicators is very high, and that more activities recorded low values and only a few activities recorded high values. Thus, the indicator "Average monthly workforce costs per employee" has the lowest value for the activity "Hotels and restaurants", i.e. 24.5% of the highest value recorded for the activity "Extractive industry" (1651 RON compared to 6740 RON). In its turn, the indicator "Average monthly net nominal earnings" also has the lowest value for the activity "Hotels and restaurants", i.e. 25.8% of the highest value recorded for the activity "Financial intermediation and insurance" (958 RON compared to 3708 RON).

By comparing the values recorded by the two indicators for the economic activities with the national average of 2988 RON for "the Average monthly workforce cost per employee" and of 1697 RON for "the Average monthly net nominal earnings", the economic activities were grouped into two broad categories. The first category includes 47% of the activities that recorded, for the two indicators, values higher than the national average; the second category comprises 53% of the activities that recorded values below the average per total economy.

At sectorial level, compared with the average per economy, "the Average monthly workforce cost per employee" was significantly higher for the following activities: "Extractive industry" with 125.6%, "Financial intermediation and insurance" with 118.3%, "Information and communication" with 90.1%, "Production and supply of electrical and thermal energy, gas, steam and air conditioning" with 86.2%, "Professional, scientific and technical activities" with 42.4%, "Public administration and defense; public social insurance" with 31.4%. For the activities "Transport and storage" and "Education", there was recorded a value higher only by 2%.

The most relevant values for the average monthly workforce cost per employee, registered below the average per economy, occur in the following activities: "Hotels and restaurants", lower by 44.7%; "Service activities", by 33%, "Constructions", by 27%; "Activities of administrative services and support services", by 26.3%; "Arts, entertainment and recreation", by 26.2%; "Agriculture, forestry and fishing", by 24.8%.

Regarding the variable "Average monthly nominal net earnings", the highest values above the national economy average, achieved in 2014, occurred in the following activities: "Financial intermediation and insurance", by 118.2%; "Information and communication", by 97.8%; "Extractive industry", by 92.1%; "Production and supply of electrical and thermal energy, gas, steam and air conditioning", by 82.3%; "Public administration and defense; public social insurance", by 62.3%; "Professional scientific and technical activities", by 43.9% ; "Education", by 2.1%; "Transport and storage", by 0.6%.

"The average monthly net nominal earnings" situated, in 2014, at a level far below the national economy average, were registered in the following activities: "Hotels and restaurants", lower by 43.5%; "Other service activities", by 32.8%; "Constructions", by 26.9%; "Arts, entertainment and recreation", by 26.4%; "Activities of administrative services and support services", by 25.7%; "Agriculture, forestry and fishing", by 25.2%; "Real estate transactions", by 20.8%; "Commerce", by 16.8%; "Health and social assistance", by 11.8%; "Water supply, sanitation, waste management and remediation activities", by 11.1%; "Manufacturing industry", by 7% .

The discrepancies among the values recorded between the different economic activities lead us to conclude that the national average calculated for the two indicators is not representative and, for this reason, we focused our statistical research, by using the

principal components analysis, on the study of connections, similarities and differences between the two variables considered.

In order to achieve these research objectives, the SPSS data processing triggered the following results:

**a. Descriptive statistics indicators (Descriptive Statistics output)**

At the sample level (the 19 activities), "the Average monthly workforce cost per employee" recorded an average of 3395.74 RON, with a standard deviation of 1593.869 RON, and "the Average monthly net nominal earnings" recorded an average level of 1921.68 RON, with a standard deviation of 876.831 RON.

**b. The correlation matrix**

The correlation matrix of variables is the symmetrical square matrix obtained by multiplying the matrix of the initial data table with its transpose (the Correlation Matrix output). The determinant of the correlation matrix, which can range between 0 and 1, shows the intensity of the correlations between variables (Everitt, Dunn, 2001).

**Table no. 2 The correlation matrix of the variables "Average monthly workforce cost per employee, per activity" and "Average net nominal monthly earnings per the activities of the national economy"**

Correlation Matrix <sup>a</sup>			
		Average monthly workforce cost per employee, per activity	Average net nominal monthly earnings per the activities of the national economy
Correlation	Average monthly workforce cost per employee, per activity	1.000	.978
	Average net nominal monthly earnings per the activities of the national economy	.978	1.000

*Source: SPSS processing, based on the data in table no.1*

The correlation coefficient of the two variables, i.e. 0.978, indicates that there is a strong connection between the variables "Average monthly workforce cost per employee" and "Average net nominal monthly earnings", for the national economic activities. Within the system of the factorial axes, the points represented by these variables will be located in the same quadrant within a short distance from each other.

**c. Calculating the distance (statistics)  $\chi^2$**

$\chi^2$  statistics is used to test the hypothesis of the independence of the studied variables. For this purpose, the hypothesis  $H_0$  is formulated, which admits that there is no statistical relationship between the two variables ("Average monthly workforce cost per employee" and "Average net nominal monthly earnings"). Hypothesis  $H_1$  is the hypothesis of dependence, which acknowledges that there are statistical connections between the two variables.

**Table no. 3 Value of the test statistics  $\chi^2$**

<b>KMO and Bartlett's Test</b>		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	51.741
	df	1
	Sig.	.000

*Source: SPSS processing, based on the data in table no.1*

In table no. 3 is presented  $\chi^2$  statistics, based on the data from table no.1 (KMO output and Bartlett's Test) (Dimitrios, Stephen, 2011).

The calculated value of the test statistics  $\chi^2$  is 51.741. The significance level appropriate to this value is Sig. = 0.000 < 0.05; therefore it rejects the hypothesis  $H_0$ . Thus, it can be guaranteed, with a 95% probability, that there are significant statistical connections between the statistical variables considered. In this situation, the principal component analysis can be applied to the data considered. The simultaneous analysis of the results obtained by testing the hypothesis of independence, using the test statistics  $\chi^2$  and the value of the determinant of the correlation matrix allows us to identify the properties of this matrix of interest to the PCA (Pintilescu, 2007; Spiricu, 2005). The identification of the connections between variables is facilitated by calculating the Kaiser-Meyer-Olkin statistics (KMO), Measure of Sampling Adequacy. The value of the KMO statistics can range between 1 and 0. A value greater than 0.5 indicates that there are significant connections between the statistical variables; therefore, the PCA can be applied (Benzecri, 1992). For the variables "average monthly workforce cost per employee" and "average net nominal monthly earnings", we obtained the value of 0.5 (table no.4), which indicates that there are statistical connections between variables.

**d. The eigenvalues of the correlation matrix associated with each factorial axis and the variance explained by each factorial axis (Total Variance Explained output)**

The eigenvalues of the correlation matrix are those values that correspond to the inertia (spreading) explained by the factorial axes. Their sum is the total inertia of the cloud of points equal to the number of the statistical variables of the original data table, i.e. the sum of the main diagonal elements of the correlation matrix ( $1.978 + 0.22 = 2$ ).

**Table no. 4 The eigenvalues and the variance explained by the factorial axes**

Component	<b>Total Variance Explained</b>					
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.978	98.901	98.901	1.978	98.901	98.901
2	.022	1.099	100.000	.022	1.099	100.000

*Source: SPSS processing, based on the data in table no.1*

The software displays these values as absolute (column Initially Eigenvalues Total) or as relative (column Initial Eigenvalues % of Variance), as a percentage of the total inertia and as well as cumulated relative values (column Cumulative %) (Field, 2009). The first factorial axis explains 98.901% of the total variance of the cloud of points, and the second

factorial axis explains 1.099%. The most important differences between the national economic activities in terms of the recorded variables are highlighted by the first factorial axis. In interpreting the factorial axes, we should take into account that the first factorial axis is the one that explains the key differences between the economic activities. In other words, it is sufficient to explain the first factorial axis due to the high share of the variance explained by it (Kachigan, 1982).

**e. The coordinates of the variables on factorial axes (Component Matrix output)**

The coordinates of the variables on factorial axes show the values of the correlation coefficients between variables and the respective factorial axis.

**Table no. 5 The coordinates of the variables "Average monthly workforce cost per employee" and "Average net nominal monthly earnings", per national economic activities, on factorial axes**

Component Matrix <sup>a</sup>		
	Component	
	1	2
Average monthly workforce cost per employee, per national economic activities	.994	-.105
Average net nominal monthly earnings, per national economic activities	.994	.105

*Source: SPSS processing, based on the data in table no.1*

These two values are coefficients of the linear equation showing the importance of each variable in the formation of the first factorial axis.

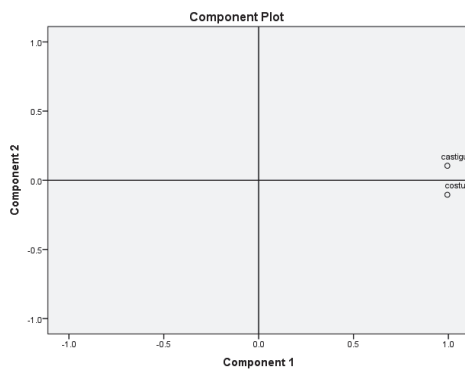
**Conclusions**

The graphical representation, which is actually a review of the previous results, allows viewing the position of variables within the system of factorial axes, identifying the direction and the intensity of the connections between variables, the similarities and the differences between the economic activities, as far as the two analyzed variables, i.e. "average monthly workforce cost per employee" and "average net nominal monthly earnings", are concerned. Each variable, respectively each economic activity, is positioned on this graph according to its coordinate on the respective axis. As far as direction is concerned, it can be considered that there is a direct connection between the variables represented on the same side (positive or negative) of a factorial axis. These variables are positively correlated with each other and have the same coordinate sign on the respective factorial axis.

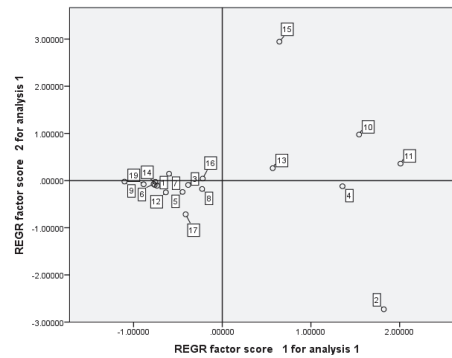
The coordinates of the variables "average monthly workforce cost per employee" and "average net nominal monthly earnings" are positive; this is why they are represented on the right side of the graph, very close to each other, revealing thus a strong direct connection between them, also confirmed by the high correlation coefficient obtained, i.e. 0.978 (table no.2). The position of the national economic activities on the first two factorial axes is shown in figure no. 2.

The first factorial axis highlights two homogeneous groups of statistical units (national economic activities):

- On the one hand, there is the first group which consists of the following activities: 2,4,10,11,13,15 - "Extractive industry", "Production and supply of electric and thermal energy, gas, steam and air conditioning", "Information and communications", "Financial intermediation and insurance", " Professional, scientific and technical activities ", " Public administration and defense; public social insurance ".
- On the other hand, there is the second group of units, which consists of the following activities: "Agriculture, forestry and fishing", "Manufacturing industry", "Water supply", "Sanitation, waste management and remediation activities", "Constructions", Wholesale and retail trade", "Repair of motor vehicles and motorcycles", "Transport and storage", "Real estate transactions", "Activities of administrative services and support services", "Education", "Health and social assistance", "Arts, entertainment and recreational activities", "Other service activities".



**Figure no. 1. Graphical representation of the variables' position in the first two factorial axes system**



**Figure no. 2. Graphical representation of the national economic activities on the first two factorial axes**

*Source: Processing based on data from the National Institute of Statistics*

There are differences as regards the variables analyzed, between these two groups of units. The most important oppositions are characteristic of the activities located in the extreme positions: between the left and the right side of the first factorial axis. Thus, it is noteworthy that the activities falling in the first group registered an "average monthly workforce cost per employee" higher than the average level (3395.74), and an "average net nominal monthly earning" higher than the average earnings at the sample level (i.e. the 19 classes of analyzed activities), as opposed to the activities of the second group, which recorded values under the average level. These differences between the national economic activities at the sample level, in terms of "the average monthly workforce cost per employee" and "the average net nominal monthly earnings", highlighted by the analysis of the first factorial axis, are the key differences that characterize them, as the variance explained by this axis is the highest (98.901%).



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