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THE RELATIONSHIP BETWEEN INFLATION AND THE MAIN MACROECONOMIC VARIABLES IN ROMANIA

Empirical study

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Reference interest rate
Price stability

JEL Classification
C10, E31

Abstract

The inflation is considered an important economic phenomenon that adversely affects the economy of a state.

The purpose of this study is to highlight the significant statistical connections between the inflation rate and the main macroeconomic variables influencing the inflationary phenomenon (money supply, the monthly net average nominal wage, exchange rate, reference interest rate), depending on the monetary policy strategy adopted by the National Bank of Romania.

The research is conducted using monthly data for the period June 1997 – December 2013, with the explorative method of Principal Components Analysis.

The results indicate the fact that for the period June 1997 – July 2005, the inflation rate is strongly correlated with the growth rate of monthly net average nominal wage, while for the period after the adoption of the direct targeting regime in August 2005, it is observed a strong link between the inflation rate and the reference interest rate.

Introduction

The inflation represents an imbalance between the real economic variables and nominal, monetary variables. The inflationary phenomenon cannot be explained only by a cause-effect analysis. As it is found at the confluence of such diverse and contradictory processes, the analysis becomes complex.

Another important issue is the distinction between the causes of inflation and the symptoms of inflation. For instance, the price growth does not cause inflation, but it is a symptom of inflation. The excessive growth of the demand in relation to the supply represents the cause of inflation because the existing quantity of goods and services is lower than the one needed, thus the prices are growing.

The importance of the inflationary phenomenon that occurs globally, with characteristics specific to each economy, makes the subject of research for the specialists in the field. On the short term, there are many factors from the domestic economy as well as from the external environment that influence the aggregate supply and demand. On the medium and long term, the monetary policy has the main role of maintaining price stability.

In Romania, the monetary policy strategy adopted by the National Bank until 2005 was based on using the monetary base as an operational objective and of the money supply as an intermediate objective. The level of the inflation rate has recorded extremely high values (295% in 1993) with negative repercussions on the national economy.

The preparation of the process of accession to the European Union involved the fulfillment of more specific criteria. These include the one referring to the inflation rate. Thus, beginning with August 2005, the National Bank of Romania has moved to the direct inflation targeting regime, the primary objective being to ensure price stability.

The paper is divided as following: Part 2 presents the literature review. Part 3 presents the used methodology, more precisely the Principal Component Analysis method, with its main characteristics. Then, in part 4, the empiric results of the study that show the main correlations between the analyzed variables are emphasized. The last part of the paper contains the main conclusions.

Literature review

The studies that analyze the causes of the inflationary phenomenon are numerous. In the countries from the Central and Eastern Europe the inflation rate had a high variation during the time of the economic transition, the econometric relationships between the money supply, wages, exchange rate and inflation rate being highly unstable.

According to the specialized literature, on the long term, the inflationary phenomenon is considered a monetary one, while on the short and medium term it is influenced by the relative flexibility of salaries, prices and interest rates.

Golinelli and Orsi (2002) analyze the inflation in the Czech Republic, Hungary and Poland between 1991 and 2000. They conclude that the indicator "output gap" (the difference between the achieved GDP and the potential GDP) and the exchange rate have a significant influence on the inflationary phenomenon during the transition period of these countries. The same conclusions were reached by Dedu and Dumitrescu (2009), who analyzed the inflationary phenomenon in Romania.

Hammerman (2007) studies the non monetary factors in Romania, such as structural reforms and employment, concluding that they have a high influence on the inflation rate. Also, Boţel (2000) highlights several causes of inflation in Romania, including: increased labor costs, currency depreciation, evolution of taxation, financial indiscipline. Căpraru and Ihnatov (2011) highlights that inflation in Romania is driven mainly by international price shoks.

Pelinescu and Dospinescu (2006), based on an autoregressive econometric model, examines the impact of certain factors (oil price, EUR / RON exchange rate) on inflation, creating a prediction model for the inflationary phenomenon. Budina et al. (2006) show in the study for the period 1992-2000 that inflation is a monetary phenomenon in Romania.

Kamin and Khan (2003) investigate the relationship between the inflation rate and the exchange rate in several countries from Asia and Latin America. Thus, exchange rate changes affect the inflation rate in the industrialized countries from Asia and most of Latin American countries. In the UK also, research conducted by Campa and Goldberg (2002) and Kara and Nelson (2002) have shown the correlation between the inflation rate and the exchange rate.

Research methodology

The Principal Component Analysis (PCA) is a descriptive method for the multidimensional analysis of data. It is applied in the study of the correlations between the numeric variables.

The application of the method can be done in order to reach the following three objectives (Pintilescu, 2007):

- the emphasis of the statistical connections between the considered variables;
- the emphasis of the similarities, respectively of the differences between the statistical units

considered according to the assembly of the recorded variables;
- the explanation of the similarities, respectively of the differences between individuals from the point of view of the considered variables.

The PCA method can be applied only in the case of the quantitative variables that can be expressed in the same unit of measurement or in different units of measurement.The initial data consists of the observed values of variables X_j, with j = 1, p, for *n* statistical units. The data table used in PCA is a table with *n* rows (*n* individuals) and *p* columns (*p* variables). The *n* statistical units can be represented in the space of the variables and the *p* variables can be represented in the space of the statistical units.

Starting from the studied *p* variables, the principal components analysis emphasizes straight ordered hierarchical *p's,* called factorial axes or principal components. These axes represent linear combinations of the initial variables and have the advantage of not being correlated between them, unlike the analyzed variables.

A part of the information contained in the original data table is associated to each factorial axis. This part is called inertia or explained variance. The eigenvalues (λ_k) are arranged downwards and their sum is equal to the number of the initial variables. This sum measures the total variance of the point cloud.

The factorial axes determined by the principal component analysis method are ranked in descending order according to their discriminatory power. Data analysis will be limited to the first factorial axes which focus much of the initial information.

In order to assess the similarities, respectively the differences, between the statistical units according to the recorded variables, it is necessary to measure the distances between the points that are represented by them.

The distance between two units is the Euclidian distance, defined by the relationship:

$d^2(i,i') = \sum_{j=1}^{p} \frac{(x_{ij}-x_{i'j})^2}{\sigma_j^2}$, where $d^2(i,i')$ = distance between statistical units i and i'

x_{ij} = the value of variable X_j observed for *i*

$x_{i'j}$ = the value of variable X_j observed for *i'*

σ_j^2 = variance of variable X_j

In order to analyze the connection between the two variables (X_j, $X_{j'}$), the correlation coefficient between the two is calculated according to the relation:

$r_{X_jX_{j'}} = \frac{cov(X_j,X_{j'})}{\sigma_j \sigma_{j'}}$,

where: cov (X_j, $X_{j'}$) is the covariance between variables X_j and $X_{j'}$;

σ_j, $\sigma_{j'}$ are standard deviations of the variables X_j, and $X_{j'}$.

The correlation matrix presents the values of the correlation coefficients between the variables, taken two by two ($r_{xixj'}$), being a square matrix, symmetric in respect to the main diagonal.

The Chi-square statistic is used in order to test if there is a statistical connection between the variables.

The two hypotheses tested are:

H_0: hypothesis of independence between variables

H_1: hypothesis of dependence between variables

If the value of the Chi-square test is higher than the theoretical value, then the H_0 hypothesis is rejected with a probability of 95%.

Also, the identification of the existence of the connections between variables can be calculated using the KMO statistics that can register values between [0, 1]. A value higher than 0.5 shows that significant statistical connections exist between the statistical variables.

The eigenvalues correspond to inertias explained by the factorial axes. Their sum represents the total inertia of the point cloud and is equal to the number of statistical variables from the original data table, respectively with the sum of the main diagonal elements of the correlation matrix.

$I_n=\sum_{k=1}^{K} \lambda_k$, where: I_n represents the total inertia of the point cloud.

The variation explained by each factorial axis is calculated according to the relation:

% Variance = $\frac{\lambda_k}{I_n}$

The number of factorial axes that are to be interpreted in the analysis is chosen according to the following criteria:

- Kaiser criterion according to which the number of factorial axes for which the corresponding eigenvalues are higher than 1 are chosen.

- Cattell's criterion implies the graphic representation of the eigenvalues and tracking a sudden fall of the inertia explained by them.

- Benzecri's criterion which implies choosing the number of axes that explains over 70% of the total variance of the point cloud.

The position of the variables in the factorial axes system can be visualized with the help of graphs. Their interpretation allows the identification of the orientation and intensity of the connection between the variables:

- for the orientation of the connection between variables: there is a direct connection between the variables represented on the same side of a factorial axis;

- for the intensity of the connection between variables: there is a strong connection

between the variables represented near the correlation circle.

Empirical results

By using the Principal Component Analysis method, applied on the data used in this study, the results presented in this section are obtained.

The data used

The empirical study aims to identify the intensity of the connections between the inflation and the other variables that exert influence on the inflationary phenomenon in Romania.

The values of the variables included in the study are taken from the annual reports of the National Bank of Romanian (retrieved from www.bnr.ro) for the period June 1997 – December 2013. The variables used in this analysis are the following:

- inflation rate (%);
- reference interest rate (%);
- the growth rate of the money supply in a narrow sense, M1 (%);
- the changes in the exchange rate Leu/Euro (%);
- the growth rate of the monthly net average nominal wage (%).

The justification for the choice of this period is given by the last main stage of liberalization of prices and the full liberalization of the foreign exchange market that took place in the first half of 1997. By that time, the values of the macroeconomic variables cannot be considered as having a high relevance. Using this type of factorial analysis, we can identify the factors that significantly influence the inflationary phenomenon. Given the change of the monetary policy regime in August 2005, we divided the data into two sub-periods:

- first period between June 1997 and July 2005;
- second period between August 2005 and December 2013.

Evolution of economic variables during June 1997 – July 2005

The evolution of the inflationary phenomenon in Romania, after 1990, reflected the structural imbalances of the national economy. Among the determinant factors, it is highlighted the granting of salary increases and various bonuses unrelated to the labour productivity growth, the reduction of working hours provided that productivity of the work remained unchanged, the reimbursement of shares to employees.

In order to identify the relationship between the macro-economical variables taken into consideration and highlight the most representative factors of influence for the inflationist phenomenon, there are undertaken the following stages:

Chi-square test for independence. The two tested hypotheses are:

H_0: hypothesis of independence between variables

H_1: hypothesis of dependence between variables

Based on the data presented in Table No.1, the value of the test statistics χ^2 with a level of significance Sig=0.000 smaller than 0.05 was estimated. This result shows that the assumption H_0 which admitted the existence of the independence of variables is rejected.

As a consequence, it can be estimated with a probability of 95% that there are statistical relationships between variables. The description of the meaning and the intensity of these relationships use the method of Analysis of the Main Components.

Correlation matrix. Table No. 2 shows a positive correlation between variables. Between the inflation rate, the reference interest rate, the money supply increase rate, the exchange rate variation and the growth rate of the monthly net average nominal wage, there are significant relationships (direct ties as the value of the coefficients is positive).

The inflation rate is strongly correlated to the variation of the monthly net average nominal wage, the money supply variation and the reference interest rate.

Eigenvalues of the correlation matrix and the inertia explained by factorial axes. The values corresponding to the five factorial axes and the inertia explained by each axis are presented in Table No.3.

The highest value corresponds to the first factorial axis which explains 69.29% of the total inertia of the point cloud. The first two factorial axes account for 88% of the total inertia. The first two factorial axes are interpreted according to Benzecri criterion.

The representation of the variables on the first two factorial axes is rendered in Figure No.1.

The first factorial axis, the horizontal one, which accounted for 69.29% of the total variation, highlights a positive correlation with all the analyzed variables.

The second factorial axis indicates a positive correlation between the reference interest rate and the variation of the exchange rate and a negative correlation between these variables and the inflation rate, the variation of the money supply and the growth rate of the monthly net average nominal wage.

The units (months) on the first two factorial axis are illustrated in Figure No. 2.

The first factorial axis highlights two periods: the first includes the period June-

December of 1997 and the second period, the first months of 2005.

The first period is characterized by higher inflation rate, the growth rate of the monthly net average nominal wage, reference interest rate, exchange rate variation and money supply increase rate to some degree, unlike the second period in which these variables have low values.

The second factorial axis highlights the months of February and March in 1998 which are characterized by an increased value of the money supply in a narrow sense (M1), in contrast to the months of January, February in 1999 when the increase rate had values of approximately 20%.

During June 1997 – July 2005 the strongest correlation is between the inflation rate and the growth rate of the monthly net average nominal wage. The value of the monthly net average nominal wage in June 1997 increased by 100% compared to the same period of the previous year. The unitary costs of labour were the main factor which led to inflation, the financial indiscipline of the companies being seen mostly in higher wages than productivity could have justified.

Productivity is the main economic indicator, expressing the efficiency in the productivity of goods and services in economy. Productivity increased at a slower pace than salary increases during that period (due to the lack of work force in certain fields and the low level of unemployment as a consequence of the work force migration), and the positive gap between productivity and wages lowered competitiveness. The population life standards decreased significantly as the increase in individual wage was not sustainable.

During the first part of 1997 there was the last episode of the great stage in price liberalization when the previously imposed restrictions regarding food, electricity and gas prices were eliminated and such prices were no longer under-evaluated. Consequently, the inflation rate increased (over 150%). By the liberalization of prices, the monetary policy of providing subsidies to agriculture and energy industry showed the effort of the state budget to keep inflation under control.

The monetary authority used as the main operational objective the monetary base whose increase rate was intended to be lower than the inflation rate.

In the second half of 1998, as the inflation rate was going down, the National Romanian Bank reduced the interest rates in order to stimulate exports and economic growth. Nevertheless, this did not yield great results, the economy being dominated by the increase in imports and deterioration of external current accounts.

The tendency to correctly estimate the exchange rate of the Romanian currency especially during 2001-2004 has substantially supported the inflation reduction process, influencing and improving the external position of Romanian economy. Also, during the period between 2000-2004, the Romanian economy has witnessed a process of remonetisation, the average speed of yearly increase of the money supply was almost three times bigger than the GDP growth rate (Isărescu, 2006).

The reference interest rate decreased gradually on an accelerated disinflation, from a level of 35% in 2002 to the value of 17% in December 2004. The restrictive behavior of the monetary policy also aimed to mitigate the impact on prices and on inflationist anticipations of price adjustments and adverse supply shocks, among which the substantial increase of the international prices of oil and other raw materials stood out.

Evolution of economic variables during August 2005 – December 2013

The change in monetary policy took place in August 2005, after certain criteria were met, such as inflation rate decrease under 10%, the increase in credibility, transparency and responsibility of the Central Bank, a more flexible exchange rate of the national currency (Popa, 2009).

Thus, the monetary policy is oriented to reaching the inflation targets established by the monetary authority. Transition to inflation targeting regime showed how important is the reference interest rate as the main driving instrument of the monetary policy.

One of the advantages of the new standard in monetary policy is the closer control on the inflation rate, more responsibility of the Central Bank in fulfilling the fundamental objective, which requires a better understanding from the population.

Chi-square test for independence. The two tested hypotheses are:

H_0: hypothesis of independence between variables

H_1: hypothesis of dependence between variables

Based on the significance of the test (Table No.4), which is lower than the significance threshold of 0.05, we reject the H_0 assumption according to which there is no relationship of dependency between variables.

Correlation matrix. Correlations between the variables analyzed are presented in the Table No.5.

The inflation rate is strongly correlated to the reference interest rate. Also, there are positive and significant correlations between the variation of the monthly net average nominal wage and the variation of the money supply from a statistical point of view.

Eigenvalues of the correlation matrix and the inertia explained by factorial axes. The eigenvalues corresponding to the five factorial axes and inertia explained by each factor are shown in Table No.6

The highest value corresponds to the first factorial axis which explains 47.85% of the total inertia of the point cloud. According to Benzencri's criterion, we interpret the first two factorial axes.

In Figure No.3 are represented the variables on the two factorial axes. The first factorial axis highlights a positive relationship between all the variables under analysis.

The second factorial axis indicates a positive correlation between the monthly net average nominal wage and the money supply in a narrow sense and a negative correlation between these variables and the inflation rate, the rate of the reference interest rate and the variation of the exchange rate.

Graphical representation of the units (months) on the first two factorial axes is presented in Figure No.4.

The first factorial axis describes the months June, July, August of 2008 which are characterized by a high inflation and interest rate, unlike the period towards the end of 2013, when these variables registered low values.

The second factorial axis describes the year 2009 which witnessed a high depreciation of the national currency in comparison to the months from the middle of 2007, when the national currency increased in comparison to the euro.

Considering the evolution of the annual inflation rate in comparison to the implicit trajectory of the inflation target, the first years since the adoption of the direct targeting on the inflation could be split into two distinct time periods.

During the first period of approximately two years, the inflation rate remained within the variation scale around the central target spot, except the end of 2005 and the beginning of 2006, when the pace of price growth was above the upper limit of this interval.

During 2007 – 2010, the inflation rate had an ascending trend which led to the depreciation by more than 20% of the national currency and the beginning of recession of the Romanian economy.

Inflation continued to grow during the first part of 2011 due to an increased yearly dynamics of prices of food and fuel, increased yearly prices of energy. Then, there was again a decrease in the inflation rate, reaching a minimum of 1.55% in December 2013.

Since the end of 2011, the monetary authority begun a process of reducing the interest rate in monetary policy, reaching a level of 4 % in December 2013. The change was made gradually, as the inflation lowered during the target period.

Along 2008, the exchange rate evolved unevenly, at the end of the year the nominal depreciation was 10% in comparison to the Euro, which led to increased prices of the import goods and those priced in Euro.

Apart from the interest rate, an important role is played by the National Romanian Bank in maintaining the price stability and the monetary control.

Even though there is a long-term correlation between the money supply and the inflation, the unexpected changes between the money demand and turnover led to a change in focusing on the interest rate, not on the evolution of the quantity of money circulating when establishing the operational objectives of monetary policies.

Conclusion

The long-lasting signs of inflation in Romania determined some adverse economic effects such as nationwide decline of price competition, rising prices and the reduction of consumer purchasing power.

In this study the exploration method is used in an analysis of the main components in order to identify the significant relationships between inflation and the macroeconomic variables, highlighting the differences and resemblances between the values of these variables, depending on the period under analysis.

Due to the adoption of the system of directly aiming at inflation which started in August 2005, the period from June 1997 to December 2013 is divided in two stages, each having different characteristics. Thus, the results underline the fact that for the period up to the change in the strategy of monetary policy, the inflation rose significantly, against the background of wages increases not related to work productivity. The increase in the average monthly wage which is not related to an increased productivity led to a decrease in aggregate supply and employment.

The reference interest rate became the main instrument of monetary policy, starting with August 2005. The change in the monetary policy and making price stability a main objective allowed the Central Bank to control the inflation process. Once the inflation rate took a downturn, the monetary authority decided to gradually reduce the interest rate of monetary policy.

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Appendices

Appendix A

Table No.1

The value of the chi-squared test of independence

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.680
Bartlett's Test of Sphericity		
	Approx.Chi- Square	440.569
	df	10
	Sig.	0.000

Source: data processing in SPSS

Appendix B

Table No. 2

Correlation matrix

		Inflation rate	**Reference interest rate**	**Money supply**	**Exchange rate**	**Net wage**
Correlation	inflation rate	1.000	0.710	0.547	0.797	0.920
	reference interest rate	0.710	1.000	0.211	0.652	0.730
	money supply	0.547	0.211	1.000	0.149	0.537
	exchange rate	0.797	0.652	0.149	1.000	0.660
	net wage	0.920	0.730	0.537	0.660	1.000
Sig.	inflation rate	0.000	0.000	0.000	0.000	0.000
	Reference interest rate	0.000		0.018	0.000	0.000
	Money supply	0.000	0.018		0.072	0.000
	Exchange rate	0.000	0.000	0.072		0.000
	Net wage		0.000	0.000	0.000	

Source: data processing in SPSS

Appendix C

Table No.3

Eigenvalues and the inertia explained by factorial axes

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of variance	Cumulative %
1	3.465	69.295	69.295	3.465	69.295	69.295
2	0.944	18.876	88.172	0.944	18.876	88.172
3	0.367	7.337	95.509			
4	0.181	3.621	99.130			
5	0.043	0.870	100.00			

Source: data processing in SPSS

Appendix D

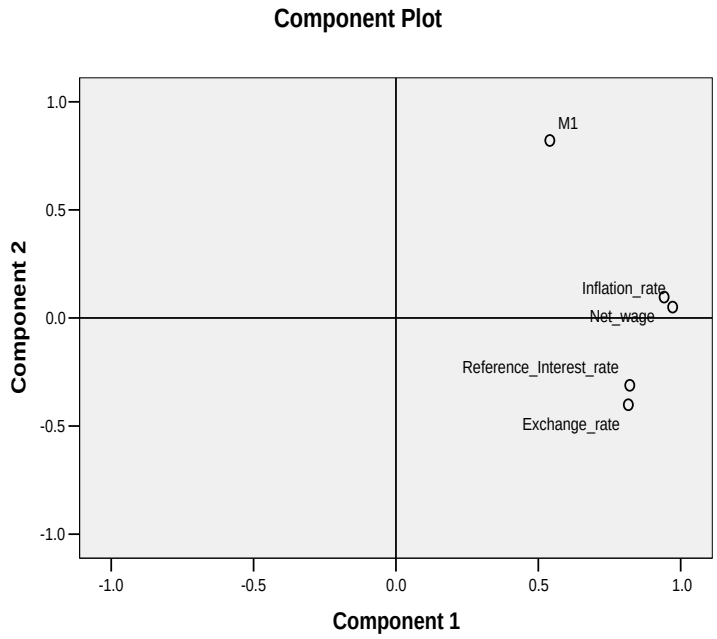

Figure No. 1 Position of the variables on the first two factorial axes

Appendix E

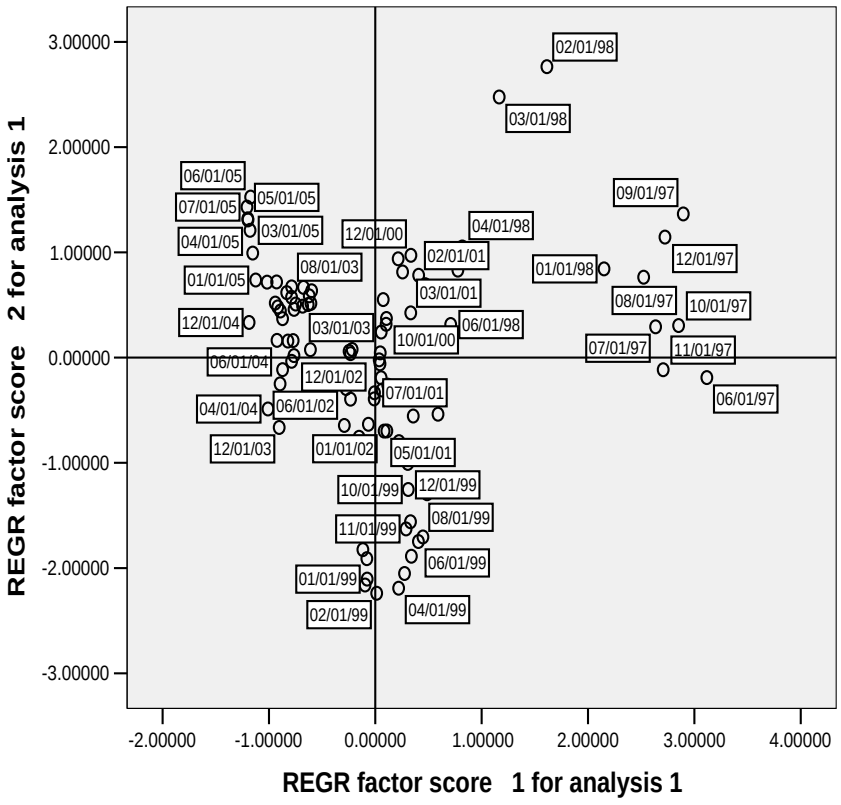

Figure No.2 Position of the units on the first two factorial axes

Appendix F

Table No.4
The value of the chi-squared test of independence

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.550
Bartlett's Test of Sphericity		
	Approx.Chi- Square	281.872
	df	10
	Sig.	0.000

Source: own processing SPSS

Appendix G

Table No. 5
Correlation Matrix

		Inflation rate	**Reference interest rate**	**Money supply**	**Exchange rate**	**Net wage**
Correlation	Inflation rate	1.000	0.617	0.168	0.122	0.379
	Reference interest rate	0.617	1.000	0.298	0.421	0.643
	Money supply	0.168	0.298	1.000	-0.411	0.740
	Exchange rate	0.122	0.421	-0.411	1.000	-0.088
	Net wage	0.379	0.643	0.740	-0.088	1.000
Sig.(1-tailed)	Inflation rate		0.000	0.042	0.105	0.000
	Reference interest rate	0.000		0.001	0.000	0.000
	Money supply	0.042	0.001		0.000	0.000
	Exchange rate	0.105	0.000	0.000		0.181
	Net wage	0.000	0.000	0.000	0.181	

Source: own processing SPSS

Appendix H

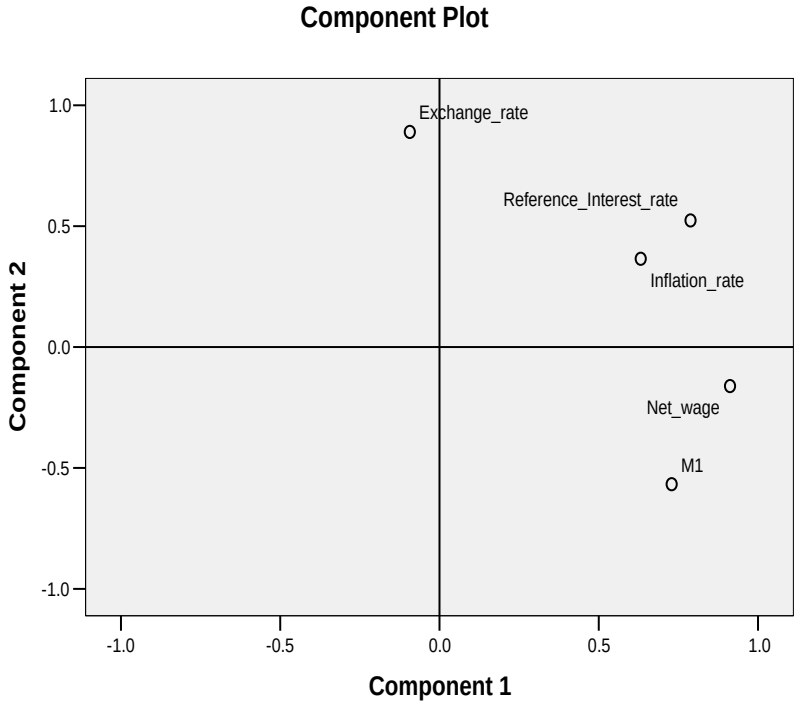

Figure No.3 Position of the variables on the first two factorial axe

Appendix I

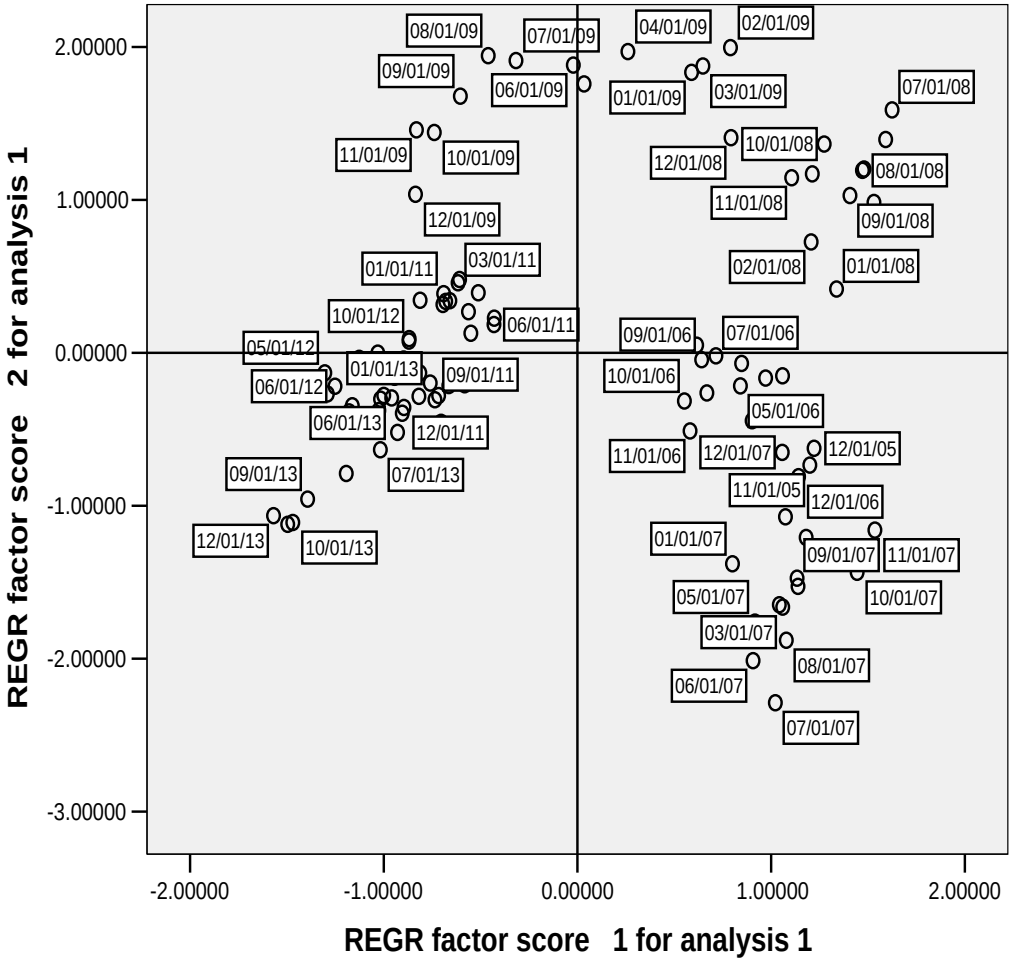

Figure No. 4 Position of the units on the first two factorial axes