The use of Factor Analysis to Determine the Important Factors that Affecting the Inflation rates in Sudan, (1970-2014)

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ABSTRACT

Inflation is the rate of change in the price rises during a certain period of time, Economy and be influenced by inflation when prices are high in the case of continuous periods. The research aims to identify the most important variables affecting inflation in Sudan (1970-2014), The researcher has relied on secondary sources of data , where data were obtained from the Central Bank of Sudan from (1970-2014),The researcher following the descriptive and analytical approach through the application of one methods of multivariate analysis (factor analysis) on these variables, So as to learn the extent of his contribution to the extraction of these variables in the new few factors contain the greatest influence of variables with a reverse key dimensions of these variables. It was use of the Statistical Package for the Social Sciences (SPSS) in the processing and analysis of data. It concluded that the results of the research sample was sufficient As indicated in the test value (Kaiser-Meyer-Olkin) (0.638), Also, Bartlett explained that the test correlation relationships between variables search function morally, And also the standard Kaiser detect the presence of workers increase their roots from the correct one, The factors explained 88.179 % of the total variation , so that the shares first factor to 71.176 %, while the shares of second factor to 17.003 %, We also find that the first factor more variables , the highest contribution of imports and exports, followed by the then government spending and foreign investment and financing costs (it was an inverse relationship)and gross domestic product, While more variables contribution in the formation of second factor is the investment and the exchange rate and the general level of prices and the money supply.

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Introduction:

The inflation considered one of the important macroeconomic indicators which leading the creation of set of economic, monetary and social effects as influenced by some factors, and these effects are what make the inflation phenomenon the most important structural imbalances in the economies of the third world countries, the inflation rate is varying from year to year depending on factors affecting inflation. Multivariate analysis models will be use to extract the most important factors contributing to the rate of inflation in Sudan. The inflation in Sudan had reached high rates after the global financial crisis and the secession of the South Sudan, Sudan central bank data indicate that in the last decade (2004 to 2014) the inflation rate increase 4 times to reach 35.14 in 2014.

The difficulty of studying methods of multivariate analysis is due to the need of understand and explain the interrelationships among the variables that affect the phenomenon under study and also the magnitude of data that must be analyzed, in addition to the more advanced mathematical techniques for deriving statistical methods help in statistical inference for multiple variables, since this study aims to see and view more of statistical methods for the analysis of multivariate, Algebraic and other statistical methods has been selected to interpret the results, where we will apply these methods in the analysis of economic indicators and monetary variables that are related to inflation rates and the extent of any appropriate measures have (Joseph, 2013).

Factor analysis is a statistical technique designed to interpret positive correlation which is a statistically significant - between the different variables transactions, in other words, factor analysis mathematical process aim to rationalize the correlation between different variables in the analysis down to the common factors that describes the relationship between these variables and interpreted. The factor analysis approach is statistical method use to analyze multiple data associated with each in different level of correlation in the form of an independent rankings list on the basis of the quality of the rating, the researcher examine these rank and levels between variables and recognize the common characteristics in accordance with the theoretical framework and scientific logic (Faraj, 1991).

This paper aim to apply the multivariate analysis methods to explain monetary and economic factors that have role in Sudan inflation.

The problem of the study:

In different research aspect many of the studies depend on statistical methods in Understand the relationships between the variables of the study; however in the field of economic some of statistical models are used those approaching economic models in the functions form, such as linear regression and multiple and simple as well as time series analysis, however in this paper and cause of the Multitude of monetary, economic indicators that involve in inflation and cause of the difficulty of knowing the relationship between these variables and indicators as well, we would like to apply one of the multivariate analysis methods (factor analysis) on these variables and through it we wish to answer the following questions:

1. What is the relationship between monetary and economic indicators of the inflation in Sudan .
2. What are the monetary and economic factors that can be summarized as having a bearing on inflation in Sudan to less number of factors reflect the key dimensions of these indicators?
3. What are the variables that have the biggest impact of inflation in Sudan?

The objectives of the study

1- Knowledge the relationship between monetary and economic indicators of the Sudan inflation.
2- Summarize the monetary and economic indicators that are related to inflation in Sudan to less number of factors reflect the basic dimensions of these indicators.
3- Highlight the variable that have the Major influence on inflation in Sudan.

Methodology and analysis approach

This paper is based on the use of the descriptive method in the theoretical aspect of the study and analytical method in the practical side (factor analysis), data were processed using the Statistical Package for Social Sciences (SPSS).

Data sources:

The study relied on secondary sources to collect the data, such as economic and monetary information from Bank of Sudan and the Central Bureau of Statistics in the period (1970- 2014), also many of scientific paper and report related to the inflation in Sudan was reviewed.

Variables of the study:

This dependent variable in this study is inflation INF, while money supply M2 , exchange rate EX, gross domestic product GDP, exports IMP, imports EXP investment INV, government spending G, funding costs (margin profit) COST, foreign investment, FDI and the general level of prices GLP are all the set of independent variables.

$$INF = f(M_2, EX, GDP, IMP, EXP, INV, G, COST, FDI, GLP)$$

Data Analysis and discussion of the results:

Descriptive statistics of economic and monetary indicators that involve in rate:

Table(1) shows the descriptive statistics of study variables, means and standard deviation SD of economic and monetary indicators, we found that the mean general level of prices (41.291) with a standard deviation (56.994), for other indicators please see table(1) bellow:

Table (1): Descriptive statistics of economic and monetary indicators that involve in rate:

Variables	SD	Mean	Sample Size
The general price level(GPL)	56.994	41.291	45
Gross domestic product (GDP)	60489.444	38116.719	45
Exports (EX)	6941.382	4355.673	45
Government spending(G)	4455.266	2826.037	45
Imports(IM)	9022.480	6059.674	45
Exchange rate(ER)	1.2413	1.0407	45
Money supply M2	13162.06	7202.000	45
Finance costs (profit margin)(COST)	9.64056	16.237	45
Foreign Investment(FDI)	1156.61	1643.60	19
Investment(INV)	82771.50	30902.68	35

Source: study output

Test the adequacy of the sample size and test the correlation matrix:

To run these tests the following procedures are used:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy. KMO:

This test is used to test the adequacy of the sample size the sufficient sample size must not be less than the 0.50 value, given the Table (2) we find that the KMO test value equal to (0.638) which indicates that we have sufficient sample size.

Bartlett's Test of Sphericity:

Used test whether the original correlation matrix is unit matrix or not, If the correlation matrix is not a matrix unit indicates that the absence of relations between the variables and that is what is required when using the method of the main components method in factor analysis. Given Table (2), we found that Bartlett test value equal to (389.710) and the level of significance (.000), and this shows that the test D. (moral) statistically significant at a moral level (0.01) and therefore conclude that the matrix correlation is not identity matrix type

Table(2): The adequacy of the sample size, KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.638
Bartlett's Test of Sphericity	Approx. Chi-Square	389.710
	Df	45
	Sig.	.000

Source: study output

Examine the correlation matrix of relationships:

b. Factor Matrix - This table contains the unroasted factor loadings, which are the correlations between the variable and the factor. Because these are correlations, possible values range from -1 to +1. On the /format subcommand, we used the option blank(.30), which tells SPSS not to print any of the correlations that are .3 or less. This makes the output easier to read by removing the clutter of low correlations that are probably not meaningful anyway.

In order to make the matrix valid for factor analysis it must show at least some correlation to reach to ((0.3)) or higher, if we do not find this result, we judge the matrix as invalid for factor analysis and therefore overlook to use the main components.

Given Table (3), we found that the correlation matrix contained some variables with ((0.3)) and above which shows the possibility of using the method of the main components in the analysis.

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Table(3):Correlation Matrix[a]

	GLP	GDP	EXP	G	IMP	EX	M_2	COST	FDI	INV
GLP	1.00	.987	.648	.873	.659	.719	.988	-.635	.679	.743
GDP	.987	1.00	.734	.933	.748	.616	.992	-.681	.737	.679
EXP	.648	.734	1.00	.891	.953	.155	.664	-.733	.773	.234
G	.873	.933	.891	1.00	.921	.369	.896	-.760-	.829	.450
IMP	.659	.748	.953	.921	1.00	.175	.679	-.762	.856	.249
EX	.719	.616	.155	.369	.175	1.00	.623	-.457	.311	.734
M_2	.988	.992	.664	.896	.679	.623	1.00	-.609	.672	.712
COST	-.635	-.681	-.733	-.760	-.762	-.457	-.609	1.00	-.641	-.184
FDI	.679	.737	.773	.829	.856	.311	.672	-.641	1.00	.488
INV	.743	.679	.234	.450	.249	.734	.712	-.184	.488	1.00
a. Determinant = 5.82E-013										

Source: study output

Determine the number of key components:
Table (4): Total variance explained

Component (factor)	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	7.11	71.18	71.18	7.118	71.176	71.18	5.262	52.619	52.619
2	1.70	17.0	88.18	1.700	17.003	88.18	3.556	35.560	88.179
3	.577	5.77	93.95						
4	.365	3.65	97.60						
5	.134	1.34	98.93						
6	.072	.722	99.65						
7	.031	.307	99.97						
8	.003	.032	99.98						
9	.001	.008	99.99						
10	.000	.003	100						

Source: study output

Factor (Component), the initial number of factors is the same as the number of variables used in the factor analysis.

Initial Eigenvalues, eigenvalues are the variances of the factors. Because we conducted our factor analysis on the correlation matrix, the variables are standardized, which means that the each variable has a variance of 1, and the total variance is equal to the number of variables used in the analysis, in this case, 9.

Total, this column contains the eigenvalues. The first factor will always account for the most variance (and hence have the highest eigenvalue), and the next factor will account for as much of the left over variance as it can, and so on. Hence, each successive factor will account for less and less variance.

% of Variance - This column contains the percent of total variance accounted for by each factor.

Cumulative % - This column contains the cumulative percentage of variance accounted for by the current and all preceding factors. For example, the third row shows a value of 93.95. This means that the first three factors together account for 93.95% of the total variance.

Extraction Sums of Squared Loadings - The number of rows in this panel of the table correspond to the number of factors retained

Rotation Sums of Squared Loadings - The values in this panel of the table represent the distribution of the variance after the varimax rotation. Varimax rotation tries to maximize the variance of each of the factors, so the total amount of variance accounted for is redistributed over the three extracted factors. (http://www.ats.ucla.edu/stat/spss/output/factor1.htm)
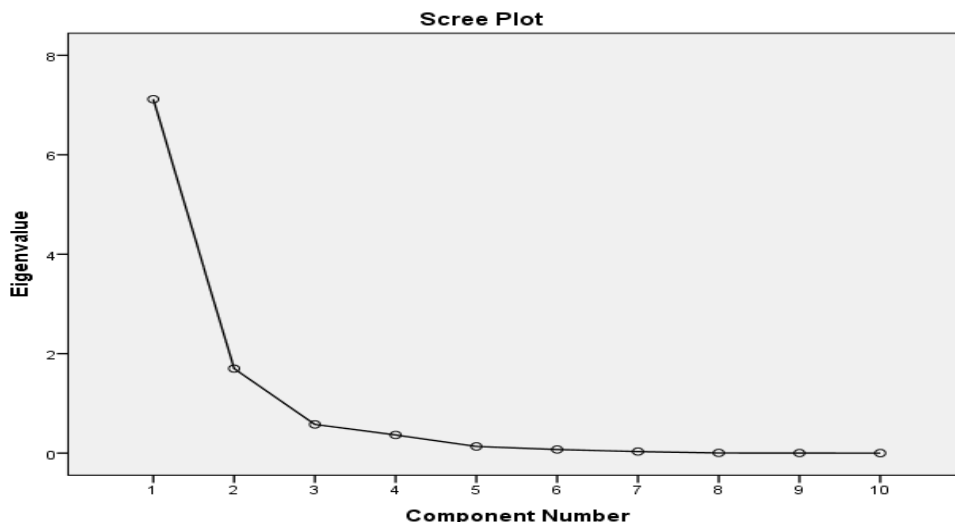
Figure (1): The scree plot graphs
Source: study output
The scree plot graphs the eigenvalue against the factor number. You can see these values in the first two columns of the table immediately above. From the third factor on, you can see that the line is almost flat, meaning each successive factor is accounting for smaller and smaller amounts of the total variance.

Correlation and Rotation
Table (5) below indicates that the rotation done is an oblique rotation, the result show that the factors are highly correlated, where the lowest rate is (0.677) to the variable financing costs (COST).

Table (5): **Cumulative variance after rotation**

Variables	Correlation
The general price level(GPL)	.971
Gross domestic product (GDP)	.965
Exports (EX)	.923
Government spending(G)	.972
Imports(IM)	.966
Exchange rate(ER)	.809
Money supply M2	.930
Finance costs (profit margin)(COST)	.677
Foreign Investment(FDI)	.761
Investment(INV)	.844

Source: study output

 Interpretation of factors
 Components analysis method designed to summarize a variety of factors, but there is no guarantee that we always get the factors that can be easily explained by its correlation with the changes, and one of the solutions to this problematic we use rotation axes method, which allow to us to explain the factors
 There are many methods to rotate the axes, most important and most frequently used is the Varimax method, which is designed to rotate axes with high saturation as possible, we will have obtained Rotated Component Matrix which shows the variable loading see table (6):

Note the following:

Main weights on the first factor was the GDP, exports and government spending, imports and financing costs and foreign investment which is inherently represent economic indicators, while main weights on the second factor were the general level of prices and the exchange rate and money supply, the public investment, all these factor monetary indicators, through the interpretation of the factors, we found that most of the changes in the inflation rate during the study period were due to due to the impact of economic and monetary indicators

Table (6): rotated factors matrix

Variables	Factors	
	First factor	Second factor
The general price level	.603	.779
Gross domestic product	.707	.682
Exports	.956	
Government spending	.906	.390
Imports	.977	.109
exchange rate		.897
Money supply	.633	.728
Finance costs	-.789	-.233
Foreign Investment	.817	.306
Investment	.119	.911

Source : study output

جدول رقم (7) العامل الاول :

Saturation	Variable name	Variable code
.603	The general price level	GLP
.707	Gross domestic product	GDP
.956	Exports	EXP
.906	Government spending	G
.977	Imports	IMP
.633	Money supply	M_2
-.789	Finance costs	COST
.817	Foreign Investment	FDI
.119	Investment	INV

$$P_{C1} = 0.603\text{GLP} + 0.707GDP + 0.956EXP + 0.906G + 0.977IMP \\ + 0.633M_2 - 0.789COST + 0.817FDI + 0.119INV$$

Table (2): The second factors

Saturation	Variable name	Variable code

.779	The general price level	**GLP**
.682	Gross domestic product	**GDP**
.390	Government spending	**EXP**
.109	Imports	**G**
.897	Exchange rate	**IMP`**
.728	Money supply	**M_2**
-.233	Finance costs	**COST**
.306	Foreign Investment	**FDI**
.911	Investment	**INV**

$$P_{C2} = 0.779GLP + 0.682GDP + 0.390G + 0.109IMP + 0.897EX + 0.728M_2 - 0.233COST + 0.306FDI + 0.911INV$$

Conclusions and Recommendations
Conclusion:
This paper aims to use statistical methods to gain results that can contribute to the knowledge of the most important factors that affect inflation rate in Sudan, study variables were subjected to analysis according to component method using SPSS software, the most important findings of the study as follow:
- Bartlett test has been applied, which revealed that the correlation relationship between variables, the result shows the possibility of using the key components in the analysis method.
- KMO test was used to measure the adequacy of the sample size and the result shows the lowest correlation was ((0.638)).

- Kaiser standard detected two factor with roots value higher than 1.0, these two factor explain more than 88.179% of the total variation, the first factor (economic indicators) contribute to 71.176%, while the second factor (financial indicators) contribute by 17.003% of the total variance,
This result approve by the Scree Plot which revealed a distinct change after the second factor which confirms that the first and second factor (Group I and II) explain most of the variation in comparison with the rest of the factors.
- To explain these two factors the study used Varimax method of how the biggest disparity, where the result showed that both the number of factors had strong weights, and through the interpretation of factors we can stated that most of the changes in the inflation rate during the study period attributable to the change in the monetary and economic indicators.
- The study found that the first factor saturated with the following variables: imports, the highest, followed by exports, government spending, foreign investment, cost of financing investment and gross domestic product.
- The second factor saturated with the following variables: investment, exchange rate, the general level of prices and the money supply.
Recommendations
 - The necessity of existence of a sophisticated statistical system to reflects the actual status to planners and policy makers of monetary and economic sectors.
 -Take advantage to offering the data for researchers to develop statistical models contribute to solving economic problems.
  -Unification of data collection methods according to statistical methods and classification, which will facilitate researcher contributing in the research.

- This study is highly recommended other researcher to do further studies on this topic.

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