Innovations

Analyzing the Economic Growth of the Indian State and Union Territories Using Factor Analysis Technique

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Abstract:
Indian economy has gone through many phases. In this paper researchers have focusedon the current economic situation of India. Economic growth of Indian states and union territories has been analyzed using the factor analysis as a mathematical tool. This paper is based on scientific methodology and researcher has used 28 states and 5 union territories to collect the data. To understand the economic development, in this research total 17 parameters are selected.To analyze these variable,Principal component analysis is used and 17 variables are classified under two common factors by using the Varimax rotation method. This research is an extension to the previous researches and a platform for the upcoming research. SPSS is used as a mathematical tool to derive the results. Data is collected from MoSPI (GSDP data 2017-18).
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1. Introduction:

India is holding a strong position in the world's economy. Indian GDP (Gross Domestic Products) is fluctuating from time by time. Simply we can classify the Indian economy in three sectors like primary, secondary and territory sectors. But this is not as simple as it looks. There are many direct and indirect factors playing an important role in economic growth. This research paper is based on the factors that are influencing the Indian GDP directly and indirectly. To understand the contribution of these factors the factor analysis technique is applied. This factor analysis technique is the factor reduction technique. In this research out of 36, total of 33 states/UT are selected. The data of 33 states/UT is collected from the government website MoSPI (Ministry of Statistics and Programme Implementation). Under this research 17 variables have been selected.

Gross domestic products is the method to calculate and represent the economic growth of the countries. India is also one of them which is using the same calculator. India is holding the seventh position in the world's economy. And the contribution is characterized on the basis of agriculture, industry and service sector. India had a tough fight to get to this rank with the other countries. According to KaushikBashu&Annemie (2007), this takeoff was not easy and after 1990 factors like banking, industry, service and so on factors were pushing the Indian growth. Indian economy has two main indicators micro-economy indicator and macro-economy indicator and to understand large set of data, factor analysis is the right technique. In fact, Felix Atanga&Adongo explains that factor analysis method served as a unique tool which can effectively reduce and group variables into fewer factions with little loss of variable information. Anwar Ali and Faiz Shaikh is concentrated on the analysis of the GDP of Pakistan. Authors have considered 64 districts of Pakistan. They have applied principal component analysis and maximum likelihood method of factor analysis. The study concludes that there is a shift in GDP contribution from Agriculture sector to Nonagriculturalsector.Noora Shrestha, author talks about the advantages of using the factor analysis in context of developing a questionnaire. This study proposed the factor analysis to identify the factors underlying the variables of the questionnaire to measure the tourist satisfaction. Factor analysis can remove the irrelevant questions from

the questionnaire which will give a clearer understanding of the variables.VivekPrabhu and KarthikaRavichandra talks about the historical movement of the Indian economy, keeping a view over the presents ups and downs and forecasting the future of the economy based on factual data. Time series analysis and forecasting is used a mathematical tool. In the conclusion of the study authors proposes a positive upcoming trend. DeveshKapur, his study is based on analyzing the merits and demerits of the Indian states. Author compared the success and failures of the Indian states based on the facts and figures. Socio-economic indicators as well as post liberalization changes are analyzed by the author.Indian economy faced the challenges during demonetization. ShaileshRastogi, Vidya Suresh and David Leonard, focused on the after effects of the demonetization over the Indian economic growth. Financial inclusion is at the very center of the study. Authors have explored the post demonetization effects, when on 8th November, 2016 Rs.500 and Rs.1000 currency notes were declared as, no longer valid bills of exchange.The world economy is scattered during Covid pandemic and Indian economy is faced the worse economic situation of the decades.MihirBhattacharya and Panchali Banerjee, authors have based their study over the Covid-19 pandemic. They have analysed the socio-economic effect of Covid-19 over the 22 states of India. They have ranked the states based on the various health and economic variables. Their results show that, all the states except Delhi, Kerala and Jammu & Kashmir report a deficit in health facilities.Mike Wright, Geoffrey Wood, Aldo Musacchio, etc. explained the role and importance of the state capitalism in the Covid-19 pandemic times. Authors define state capitalism as an economic system in which the state uses the various tools for proactive intervention in economic production and the functioning of markets.T. Johnson is discussing the different remedial measures to improve the state of the Indian economy. 15 different factors which are directly and indirectly effecting the Indian economy are analysed by using Fuzzy cognitive maps technique and the author is highlighting land and human resource as the strength factors.Mandip Singh and Kuldip Kaur tries to understand the role of the service sector in the growth of the Indian economy. Authors have talked about the telecommunicate, construction and hospitality industry Holub's methodology and VAR methodology are used under the time series to achieve the results. Sanjay Kumar has dedicated his study to understand the corresponding impact of economic growth and poverty reproduction in the light of the progress of financial sector development. His paper uses the principal component analysis to construct a financial depth index. This research helps in understanding the strengths and weakness of the Indian financial sectors. Anita Bai, Swati and Deshpande, authors are evaluating the economic conditions of 18 different cities of the world based on 15 different parameters. Authors have used the factor analysis as the analytical tool and they have collected the data from IMF. The results shows that the official world ranking and the results from the study are almost similar.AdemirAbdic, Emina and AdemAbdic analyses the GDP of Bosnia and Herzegovina. The goal of the authors is to estimate and validate different factor models. Mincer-zarnowitz regression was used for efficiency forecast of the individuals. Diabold-mariano test was used for comparison. Granger-ramanathan regression was used for the justification of combination of two factors.Eyiah, Bosson and Joseph, authors sought to model the relationship between GDP and 29 macroeconomics variables in Ghana using the principal component analysis and multiple linear regression. For this research economic data with 583 points were collected from 1990 to 2018. Their results talk about the closed economic structure of Ghana.CristinaVeith, Simon Nicoleta, etc., revolves their research around the concept of green economics. Factor analysis, Kaiser-Meyer-Olkin test, Bartlett's test is used as the mathematical instruments to conduct an empirical study. The study is based on Romania and in conclusion authors are proposing different plans based on the post Covid-19 trends. Adam Sulich and MalgorzataRutkowska research paper deals with the idea of green management in the regions of Poland. The study revolves around the concept of sustainable development. Authors propose that green management is an element of the green economy. They have used factor analysis as tool for the descriptive method. In the research, they have found the importance of the green economy and they believe that humanity should switch towards the green economy to have sustainable future.

2. Mathematical Description of The Factor Analysis Model:

To understand the large set of data factor analysis model is applied. The mathematical expression of the model is as follows:
Let's assume that the X is a random observation vector, with 'n' components, and μ is a mean vector and covariance matrix represents by∑. The Factor analysis model suggest that X is linearly dependent upon a few unobservable random variables called common factors which represents by F_1,F_2,F_3,…….,$F_m$and variation $\varepsilon_1, \varepsilon_2, \ldots\ldots, \varepsilon_n$called error or sometimes specific factors. So, the factor analysis model is as follows:

$$X_1 - \mu_1 = \beta_{11}F_1 + \beta_{12}F_2 \cdots\cdots + \beta_{1m}F_m + \varepsilon_1$$
$$X_2 - \mu_2 = \beta_{21}F_1 + \beta_{22}F_2 \cdots\cdots + \beta_{1m}F_m + \varepsilon_2$$
$$\vdots \qquad\qquad \vdots \qquad\qquad \vdots$$
$$\vdots \qquad\qquad \vdots \qquad\qquad \vdots$$
$$\vdots \qquad\qquad \vdots \qquad\qquad \vdots$$
$$X_n - \mu_n = \beta_{n1}F_1 + \beta_{n2}F_2 \cdots\cdots + \beta_{nm}F_m + \varepsilon_n$$

We can express the Linear Regression equation in Matrix form also:

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ \vdots \\ \vdots \\ X_n \end{bmatrix}_{n\times 1} - \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \vdots \\ \vdots \\ \mu_n \end{bmatrix}_{n\times 1} = \begin{bmatrix} \beta_{11} & \beta_{12} & \cdots & \beta_{1m} \\ \beta_{21} & \beta_{22} & \cdots & \beta_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \beta_{n1} & \beta_{n2} & \cdots & \beta_{nm} \end{bmatrix}_{n\times m} \begin{bmatrix} F_1 \\ F_2 \\ \vdots \\ \vdots \\ \vdots \\ F_m \end{bmatrix}_{m\times 1} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \vdots \\ \vdots \\ \varepsilon_n \end{bmatrix}_{n\times 1}$$

$$[X]_{n\times 1} - [\mu]_{n\times 1} = [\beta]_{n\times m}[F]_{m\times 1} + [\varepsilon]_{n\times 1}$$

So, final equation of the analysis model is:

$$X - \mu = \beta F + \varepsilon$$

This is a factor model equation. That shows that the factors F_1,F_2,F_3,…….,F_m have no correlation. Hence, this factor is known as orthogonal factor model.

3. Methodology:

In this researchpaperthe sample is based on the 33 states and union territories out of the total of 36 entities. The required sample of 33 is collected from the 28 states and 5 union territories. Factor analysis technique is applied to understand the role of the states and union territories in the Indian economic growth. To understand the nature of the economic growth, researchers have used the SPSS to conduct the factor scoring. The factor scoring is a technique that provides contribution of the common factors to understand the contribution of the states in the total Indian economy. In this research we have selected 17 variables, these variables are presenting the strong correlation coefficient among them.

3.1. Description Of the Economic Variables

There are 17 factors to represent the economic development of the Indian states. Details of these variables are as follows:

x_1 = Agriculture, Forestry & Fishing
x_2 = Mining & Quarrying
x_3 = Manufacturing
x_4 = Electricity, Gas, Water Supply & Other Utility Services
x_5 = Construction
x_6 = Trade, Repair, Hotels and Restaurants
x_7 = Transport, Storage, Communication & services Related to Broadcasting
x_8 = Financial Services
x_{10} = Public Administration
x_{11} = Other Services
x_{12} = Population
x_{13} = Area in Sq. Km.
x_{14} = Per Capita Income
x_{15} = Tax Revenue (Rs. in Crore)
x_{16} = Non-Tax Revenue (Rs. in Crore)
x_{17} = Public Expenditure in Health

3.2.Composition of the Correlation Coefficient Matrix:

Before conducting the factor analysis technique itsessential to check the relationship bond between the factors. Correlation coefficient is the indicator of the strength between variables. On the basis of these 17 variables the correlation matrix is as follows:

Table: 1- Correlation Coefficient Matrix

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}
x_1	1																
x_2	.602	1															
x_3	.638	.610	1														
x_4	.788	.725	.864	1													
x_5	.806	.457	.768	.794	1												
x_6	.749	.553	.851	.845	.905	1											
x_7	.783	.526	.752	.852	.879	.891	1										
x_8	.545	.564	.811	.840	.707	.822	.840	1									
x_9	.547	.401	.733	.726	.764	.841	.826	.872	1								
x_{10}	.863	.548	.715	.813	.877	.833	.908	.739	.701	1							
x_{11}	.738	.527	.739	.804	.900	.911	.915	.855	.857	.832	1						
x_{12}	.861	.480	.578	.674	.816	.674	.786	.541	.573	.921	.714	1					
x_{13}	.809	.764	.538	.722	.599	.564	.597	.468	.468	.659	.582	.650	1				
x_{14}	-.284	-.198	.037	.013	-.121	.008	.012	.140	.106	-.182	-.038	-.326	-.342	1			
x_{15}	.869	.565	.733	.810	.914	.840	.894	.706	.756	.958	.854	.951	.713	-.22	1		
x_{16}	.848	.577	.537	.646	.753	.630	.718	.468	.479	.887	.660	.913	.786	-.42	.888	1	
x_{17}	.885	.602	.676	.809	.895	.815	.889	.634	.659	.956	.808	.934	.736	-.22	.967	.914	1

According to the table-1, variables have the strong correlation between each other and only one variable x_{14} (Per capita income) is showing the negative relationship with other variables.

3.3.Significance of The Correlation Matrix:

The next step is to compute the reliability and validity of the data. There are two methods to check the reliability and validity of the data, one is anti-image correlation and other is Bartlett's test of Sphericity. According to the anti-image correlation matrix if the diagonal values are greater than 0.50 then the data is significant. The anti-image correlation diagonal values of all variables are> 0.50, these values are as follows:$x_1 = 0.692, x_2 = 0.74, x_3 = 0.71, x_4 = 0.76, x_5 = 0.904,\ x_6 = 0.796,$ $x_7 = 0.765, x_8 = 0.718, x_9 = 0.791, x_{10} = 0.854, x_{11} = 0.878,\ x_{12} = 0.928,\ x_{13} = 0.809, x_{14} = 0.691, x_{15} = 0.791,$ $x_{16} = 0.88,\ x_{17} = 0.691$.This result shows that this data is significant for factor analysis.

Before performing the factor analysis it's important to measure the reliability & validity because reliability means to measure the consistency degree of measurement and validity refers to the closeness of the measured value. The other method of evaluating the reliability and validity is Bartlett's test. The Table-2 shows the KMO & Bartlett's test. From Table -2 represents that the KMO value is 0.769 which is greater than 0.50 and KMO measure the sampling adequacy if it is between 0.7 to 0.8 that shows the reliability is good. And significance probability of Bartlett's test of Sphericity is (0.000 < 0.01), which indicated that variables are suitable for factor analysis.

3.4. Method of Factor Analysis:Principal Component Analysis for Initial Extraction

Table-3 represents the result of 17 variables communality. Communalities explain the amount of variance a variable share with all the other variables. This is the picture that shows the proportion of variance that explained by the common factors. In this research the principal component method is used to extract the 17 variables. All variables contain near to 1 value only per capita incomeindex is 0.664, lowest among all.

3.5. Evaluate the Number of Factors:

There are many techniques to extract the common factors. The eigenvalue technique and Scree plot are most common techniques. Table–4 is the presentation of total variance by the principal component method. Basis of Eigen value extraction method there are only 2 factors, whose Eigen value is greater than one. First factor's Eigen value is 12.261 (>1) and the

cumulative variance proportion is 72.123% and the second factor whose Eigen value is 1.900 (>1) and percentage variance value is 11.178%. Third factor is not greater than one but near to one. The cumulative variance proportion of two components has reached to 83.301%. Which shows the good proportion to get the appropriate result. So, we have selected two common factors which represents the whole information about the data.

3.6. Identification of Common Factors by the Rotated Component Matrix:

The identification of common factors is a complicated task. Rotation of factors helps to address the problem. The purpose of rotation is to obtain the simple structure to understand the factors. Component matrix is complicated and the loading of the factors is not clear. So, to simplify the complication in this research we have applied the rotated component matrix method. Table-5 explains the loading of two factors. Here some factors loading are high and some are low. To analyze the rotation component matrix the Varimax with Kaiser normalization method is applied. According to the result high loading of the factors is a way of reduction of 17 variables under the two common factors. According to the rotated component matrix variable per capita income loading result is very low (-727) so, to get the right results the per capita income variable should be removed from the component list. After removing that we are left with only 16 variables.

Table 2 – KMO & Bartlett's Test Result

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.789
Bartlett's Test of Sphericity	Approx. Chi-Square	919.431
	df	136
	Sig.	.000

Table: 3 – Communalities Result (Extraction Method: Principal Component Analysis.)

Communalities		
	Initial	**Extraction**
Agriculture, Forestry and Fishing	1.000	.871
Mining and Quarrying	1.000	.917
Manufacturing	1.000	.809
Electricity, Gas, Water Supply & Other Utility Services	1.000	.921
Construction	1.000	.908
Trade, Repair, Hotels and Restaurants	1.000	.903
Transport, Storage, Communication &Services Related to Broadcasting	1.000	.930
Financial Services	1.000	.888
Real Estate, Ownership of Dwelling & Professional Services	1.000	.830
Public Administration	1.000	.944
Other Services	1.000	.889
Population	1.000	.931
Area	1.000	.864
Per Capita Income	1.000	.664
Tax Revenue	1.000	.979
Non-Tax Revenue	1.000	.927
Public Expenditure in Health	1.000	.952

Figure 1: Scree Plot Eigenvalues

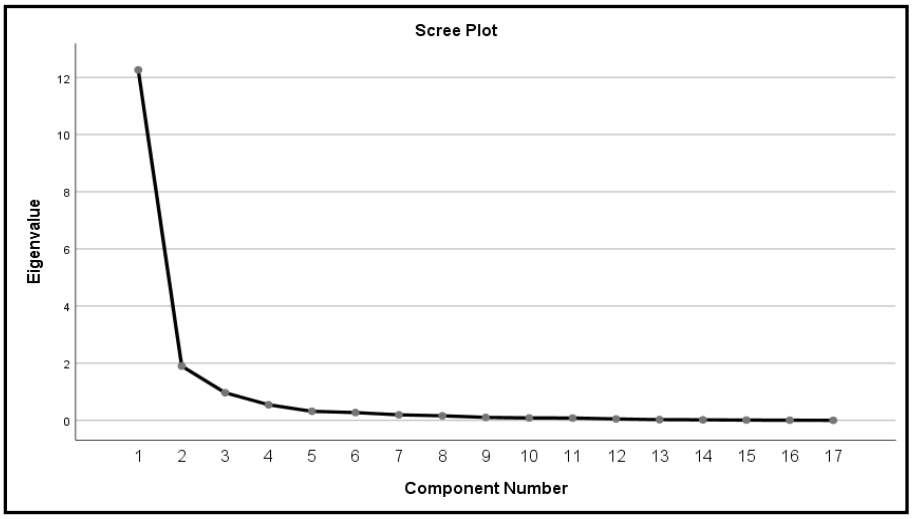

Table: 4 – Total Variance Extraction: Principal Component Analysis

Total Variance Explained									
	Initial Eigenvalues			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.261	72.123	72.123	12.261	72.123	72.123	8.375	49.264	49.264
2	1.900	11.178	83.301	1.900	11.178	83.301	5.786	34.037	83.301
3	.967	5.687	88.987						
4	.546	3.209	92.196						
5	.317	1.867	94.063						
6	.273	1.603	95.666						
7	.194	1.138	96.805						
8	.161	.946	97.751						
9	.104	.613	98.364						
10	.085	.499	98.863						
11	.081	.478	99.342						
12	.051	.299	99.641						
13	.026	.151	99.792						
14	.019	.111	99.903						
15	.009	.055	99.958						
16	.005	.032	99.990						
17	.002	.010	100.000						

Table-5 representing the result of rotated component matrix by using the varimax with Kaiser normalization method. Rotated component matrix is showing the loading result. Loading values which are greater than 0.40 will be represented in the rotated component matrix. According to the table we can categorize all variables into two groups. Group-1 & Group – 2 both will represent 8 – 8 variables each. Group-1 is representing 8 variables like Non tax revenue, Population, Agriculture, forestry

and fishing, Public expenditure in health, Land area, Tax revenue, Public administration and Mining and quarrying and group-2 is representing 8 variables like Financial services, Real estate ownership of dwelling & professional services, Trade & restaurants, Other services, Manufacturing, Transport & services related to broadcasting, Electricity & other utility services and Construction. So, both groups have equal variables.

On the basis of above analysis, we can reduce these 16 variables into two major factors i.e. First factor - "Agriculture and Tax Revenue", Second factor - "Manufacturing & Services" respectively.

Table-5 representing the result of rotated component matrix

Rotated Component Matrix[a]		
	Component	
	1	**2**
Non-Tax Revenue	.933	
Population	.860	
Agriculture, Forestry and Fishing	.858	
Public Expenditure in Health	.838	.501
Area In Sq. Km.	.812	
Tax Revenue	.784	.582
Public Administration	.760	.584
Mining and Quarrying	.579	
Financial Services		.918
Real Estate, Ownership of Dwelling & Professional Services		.892
Trade, Repair, Hotels and Restaurants	.458	.839
Other Services	.478	.815
Manufacturing		.804
Transport, Storage, Communication & Services Related to Broadcasting	.562	.769
Electricity, Gas, Water Supply &Other Utility Services	.551	.736
Construction	.616	.694

3.7.Calculationof Component Score Coefficient Matrix:

Table – 6 represents the component score matrix result that will help to determine the comprehensive score value. Factor score can be calculated by the following way:

$$F_1 = 0.209x_1 + 0.111x_2 - 0.106x_3 + \ldots\ldots\ldots\ldots\ldots\ldots + 0.122x_{15} + 0.282x_{16} + 0.168x_{17} \quad (1)$$

$$F_2 = -0.109x_1 - 0.035x_2 + 0.204x_3 + \ldots\ldots\ldots\ldots\ldots\ldots - 0.012x_{15} - 0.188x_{16} - 0.060x_{17} \quad (2)$$

From equation (1) & equation (2) we can calculate factor score and it is shown in Table-6.

Table – 7 represents the highest factor scoring of 10 states/UT on the basis of factor-1 and factor-2 respectively. As we can observe that in factor-1 highest loading is of Uttar Pradesh (3.39655) then Madhya Pradesh (1.72175), Rajasthan (1.60288), Andhra Pradesh (1.32413) and so on. Furtherin factor-2 the highest loadings are of Maharashtra (3.55235), Tamil Nadu (1.98871), Karnataka (1.69385), Delhi (1.48124), Gujarat (1.03741) and so on. On the basis of factor scoring, we can compute the rank of the states also.

Table: 6 – Component Score coefficient Matrix

Component Score Coefficient Matrix		
	Component	
	1	2
Agriculture, Forestry and Fishing	.209	-.109
Mining and Quarrying	.111	-.035
Manufacturing	-.106	.204
Electricity, Gas, Water Supply & Other Utility Services	-.015	.121
Construction	.023	.084
Trade, Repair, Hotels and Restaurants	-.082	.190
Transport, Storage, Communication & Services Related to Broadcasting	-.021	.131
Financial Services	-.190	.288
Real Estate, Ownership of Dwelling & Professional Services	-.177	.274
Public Administration	.112	-.003
Other Services	-.067	.175
Population	.218	-.120
Area In Sq. Km.	.234	-.150
Tax Revenue	.122	-.012
Non-Tax Revenue	.282	-.188
Public Expenditure in Health	.168	-.060

Table – 7: Highest factor scoring of The States and Union Territories

State/UT	F1	State/UT	F2
Uttar Pradesh	3.39655	Maharashtra	3.55235
Madhya Pradesh	1.72175	Tamil Nadu	1.98871
Rajasthan	1.60288	Karnataka	1.69385
Andhra Pradesh	1.32413	Delhi	1.48124
Bihar	.89732	Gujarat	1.03741
Jammu & Kashmir	.37510	West Bengal	0.67048
Jharkhand	.04994	Kerala	0.64609
Gujarat	.60124	Telengana	0.43342
West Bengal	.60214	Haryana	0.35571
Odisha	.56498	Punjab	0.09779

4. Conclusion:

This study highlights the impact of direct and non-direct factors on the Indian economy. According to this research, economic and non-economic activities are correlated with economic growth. The growth of Indian GDP is also based on the growth of the states and union territories. And consumption and expenditure both factors are equally participating in the Indian economy. Gross state domestic products mean the contribution ofthe consumption, expenditure and investment in the state and union territories.This study is sincerely based on the 2017 - 18 Indian Economic Year. This research explains the role of the sates and union territories in boosting the Indian economy. This research paper defines the percentage contribution of the sates as a whole. And the communality results defined that the Per capita income loading is very low (0.664>0.5). So, there are two possible outcomes but for the accuracy in research result this variable is not considered with the other variables. On the other hand, the factor scoring technique defines the highest scoring of both F_1 and F_2factors on the basis of state performances. As per the result Uttar Pradesh performance is high in comparison to the other states in F_1 but this result is based on 8 common factors out of 16. And same is with Maharashtra state its performance is high from the rest of the states in F_2, on the same 8 other common factors. So, we can say that the factor scoring is based on the types of variables and their

contribution in the states. Like Non-tax revenue rotated component value is 0.933 in factor F_1 means this factor is highly contributed in the Uttar Pradesh state GDP and on the other sidethe financial services rotated component value is 0.918 in factor F_2 which define that Maharashtra GDP is high based on this factor comparing to the non-tax revenue.The picture of Indian economy is ever evolving, it is the reflection of the Social – Political – Economic situation of the country.

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