

A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

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ABSTRACT- Economic growth and sound fiscal management are essential for the sustainable development of any country. In India, State Governments play a crucial role in promoting economic development through public expenditure, infrastructure investment, and social welfare programmes. Fiscal indicators such as Gross Fiscal Deficit, Revenue Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure significantly influence the economic performance of States and Union Territories.

This study examines the fiscal and economic performance of 31 Indian States and Union Territories during the period 2018–19 to 2024–25 using official government data. The study employs descriptive statistics, Pearson correlation analysis, multiple linear regression, K-Means clustering, Principal Component Analysis (PCA), and trend analysis to investigate the relationship between fiscal indicators and GSDP, classify States based on fiscal characteristics, identify the major dimensions of fiscal performance, rank States according to a composite index, and analyse trends over time.

The findings of this study provide valuable insights into the fiscal structure of Indian States and contribute to a better understanding of the relationship between government expenditure and economic development.

KEYWORD- fiscal management, economic growth, interest payment, capital expenditure, states, etc.

INTRODUCTION

Economic growth and sound fiscal management are essential for the sustainable development of any country. In India, State Governments play a crucial role in promoting economic development through public expenditure, infrastructure investment, and social welfare programmes. Fiscal indicators such as Gross Fiscal Deficit, Revenue Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure significantly influence the economic performance of States and Union Territories.

Gross State Domestic Product (GSDP) is one of the most important indicators used to measure the economic performance of a State. It reflects the total value of goods and services produced within a State during a financial year. The growth of GSDP depends on several fiscal and developmental factors that determine the efficiency of government spending and resource allocation.

Understanding the relationship between fiscal indicators and GSDP is important for evaluating fiscal sustainability, identifying patterns of government expenditure, and formulating effective public policies. Statistical techniques provide an objective framework for analysing these relationships and identifying significant determinants of economic growth.

This study examines the fiscal and economic performance of 31 Indian States and Union Territories during the period 2018–19 to 2024–25 using official government data. The study employs descriptive statistics, Pearson correlation analysis, multiple linear regression, K-Means clustering, Principal Component Analysis (PCA), and trend analysis to investigate the relationship between fiscal indicators and GSDP, classify States based on fiscal characteristics, identify the major dimensions of fiscal performance, rank States according to a composite index, and analyse trends over time.

The findings of this study provide valuable insights into the fiscal structure of Indian States and contribute to a better understanding of the relationship between government expenditure and economic development.

METHODOLOGY

The study is based entirely on secondary data collected from official publications of the Government of India. Fiscal and economic data were obtained for 31 States and Union Territories covering the financial years 2018–19 to 2024–25. The aggregate category "All States and UTs" was excluded from the analysis. Study Variables- •Gross State Domestic Product (GSDP) • Gross Fiscal Deficit (GFD) • Revenue Deficit (RD) • Interest Payments (IP) • Capital Expenditure (CAPEX) • Social Sector Expenditure (SSE) Study Period- Seven financial years – 2018-19 to 2024-25 Statistical Software

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The entire statistical analysis was performed using R Programming Language, which was used for data processing, visualization, statistical modelling, clustering, principal component analysis, and trend analysis.

Statistical Techniques Used

1.Descriptive Statistics

Descriptive statistical measures and graphical techniques were used to summarize the distribution and trends of fiscal indicators and GSDP.

2.Pearson Correlation Analysis

Pearson's correlation coefficient was computed to measure the strength and direction of the linear relationship among GSDP and the selected fiscal indicators.

3.K-Means Clustering

K-Means clustering was applied to classify Indian States and Union Territories into homogeneous groups according to their fiscal and economic characteristics. Variables were standardized prior to clustering, and the Elbow Method was used to determine the optimal number of clusters.

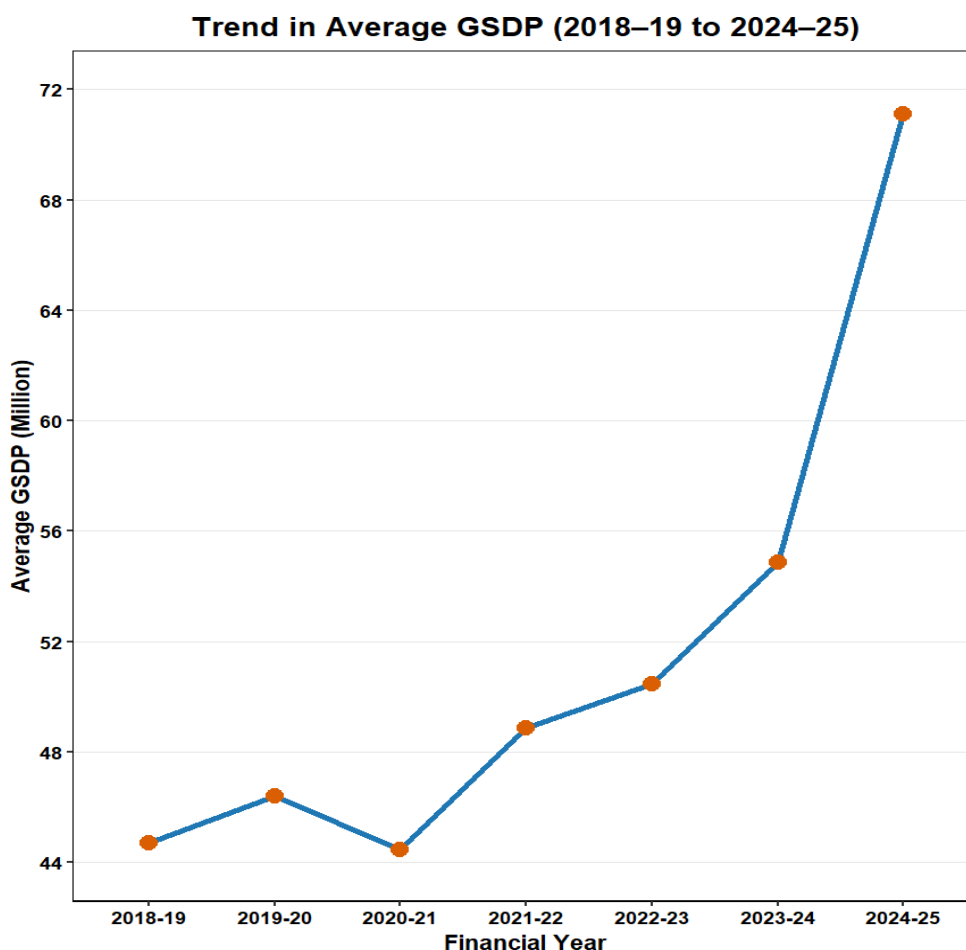
4.Principal Component Analysis (PCA)

PCA was employed to reduce the dimensionality of the dataset and identify the major components explaining fiscal and economic variation. The suitability of the data was assessed using the KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

5.Trend Analysis

Trend analysis was conducted using annual mean values of all fiscal indicators. Compound Annual Growth Rate (CAGR) was calculated to measure long-term growth across the study period.

Graphical Presentation

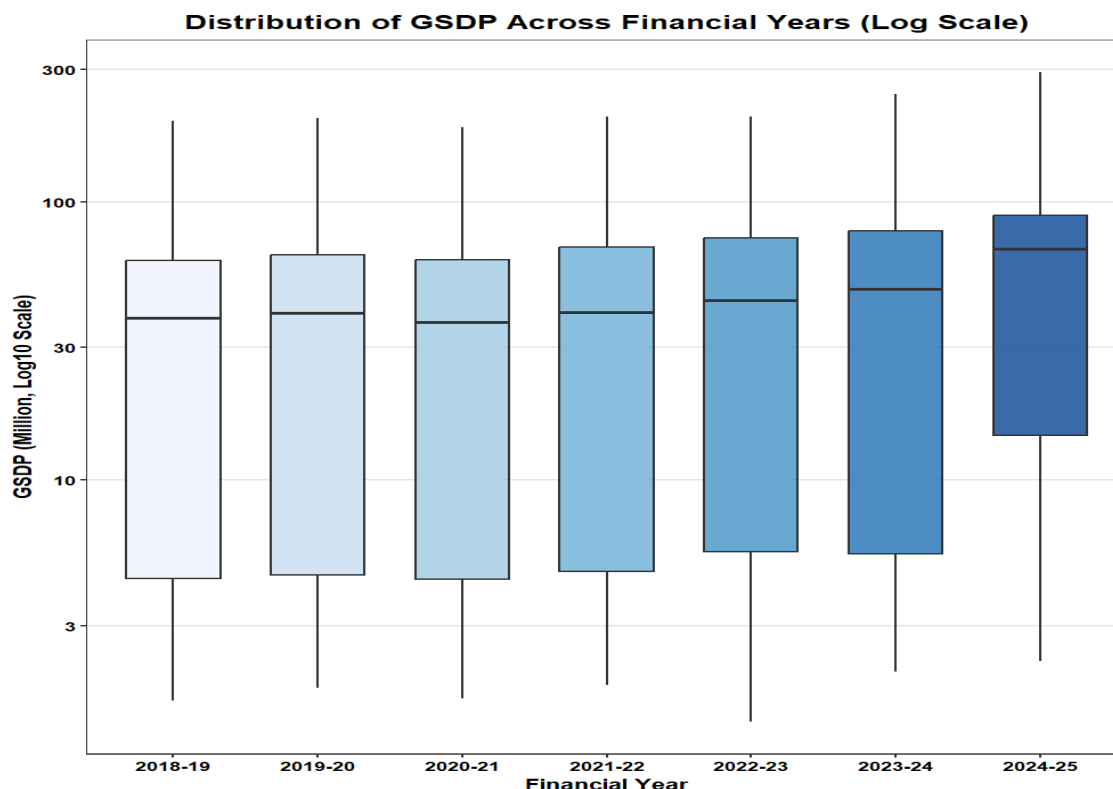


Insights:

1. Figure shows that the average GSDP of Indian States and Union Territories increased steadily over the study period, except for a slight decline in 2020–21, which corresponds to the COVID-19 pandemic.
2. A strong recovery was observed from 2021–22 onwards, with the highest average GSDP recorded in 2024–25, indicating

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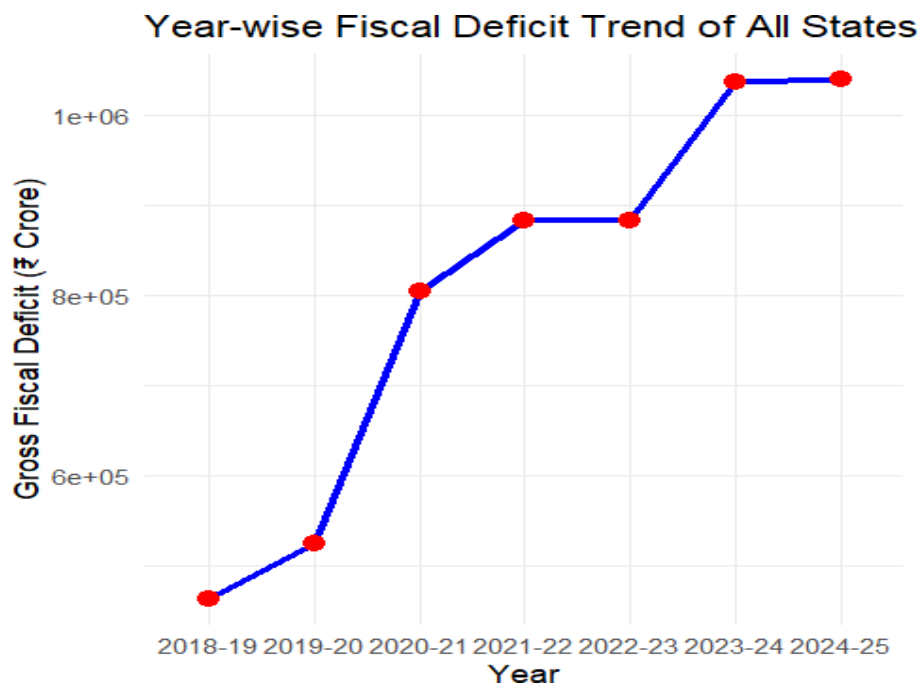
sustained economic growth in the post-pandemic period.



Insights:

1. Figure presents the distribution of Gross State Domestic Product (GSDP) across 31 States and Union Territories from 2018–19 to 2024–25 using a logarithmic scale.
2. The boxplots indicate a gradual upward shift in the median GSDP over the study period, suggesting overall economic growth.
3. A slight decline in the median is observed during 2020–21, reflecting the impact of the COVID-19 pandemic.
4. The distributions in the later years are positioned higher than those in the earlier years, indicating improved economic performance across most States and Union Territories.
5. The logarithmic scale reduces the influence of extremely large GSDP values, allowing a clearer comparison of the distributions across financial years.

Year-wise Trend of Fiscal Deficit of All States and Union Territories from 2018–19 to 2024–25

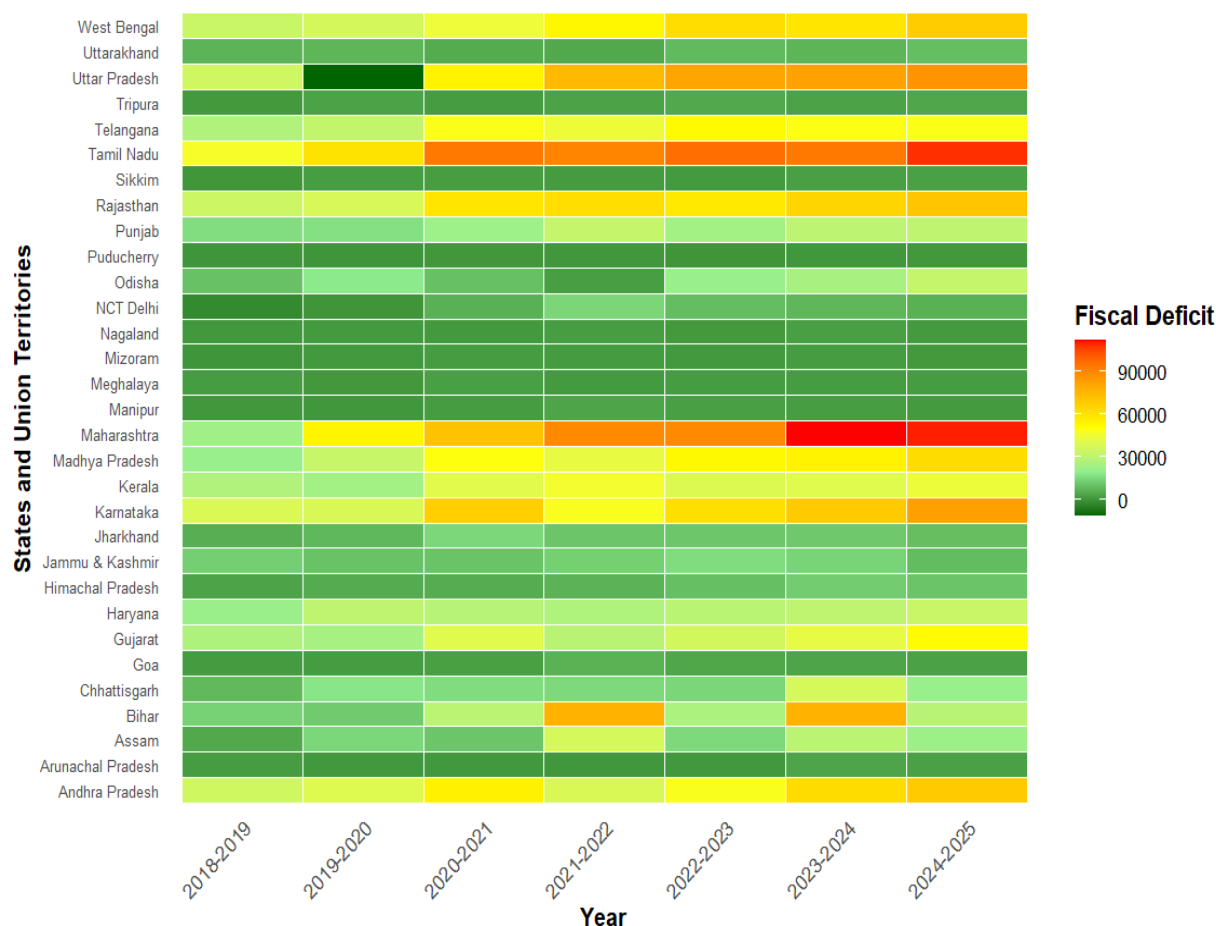


Interpretation

1. The graph shows that Fiscal Deficit increased from 2018–19 to 2024–25.
2. A large increase was observed in 2020–21 due to COVID-19. During this period, the government spent more money, which increased the Fiscal Deficit. After that, the Fiscal Deficit remained high.
3. The highest Fiscal Deficit was recorded in 2024–25, indicating higher government spending and borrowing.

Heat Map of Fiscal Deficit of All States and Union Territories (2018–19 to 2024–25)

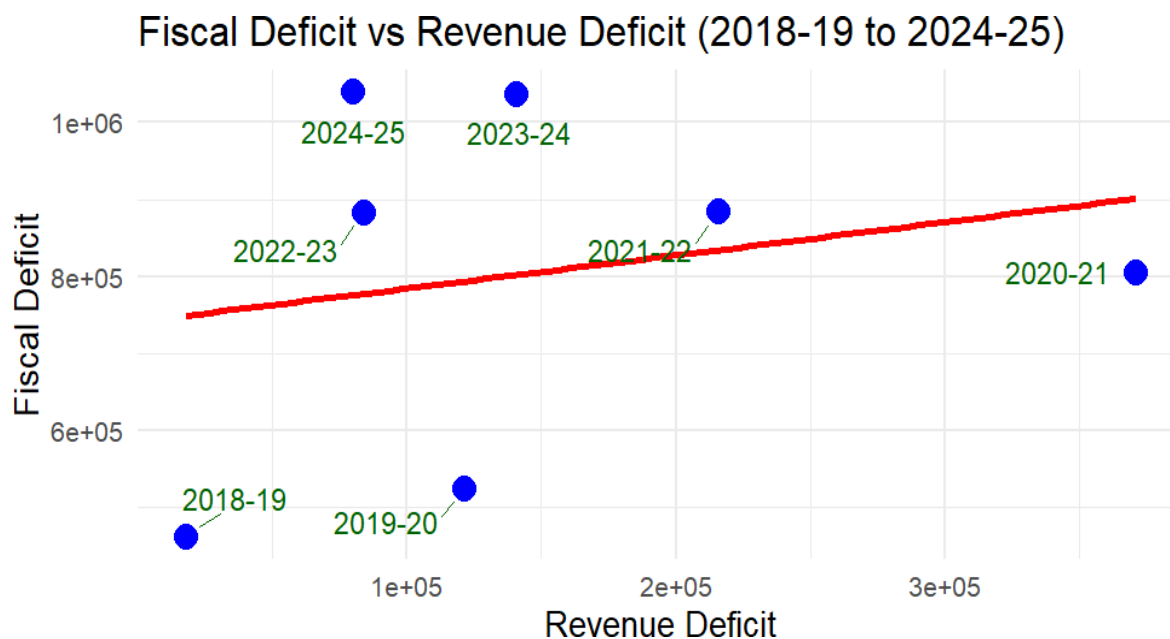
Heat Map of Fiscal Deficit of All States and Union Territories (2018–19 to 2024–25)



Interpretation

1. The heat map presents the Fiscal Deficit of all States and Union Territories from 2018–19 to 2024–25. Different colours are used to show the level of Fiscal Deficit, where green represents lower Fiscal Deficit, yellow represents moderate Fiscal Deficit, and orange to red represents higher Fiscal Deficit.
2. The graph shows that there are significant differences in Fiscal Deficit across states and over time. States such as Maharashtra, Tamil Nadu, Uttar Pradesh, Karnataka, Rajasthan and West Bengal consistently display higher Fiscal Deficit levels, as indicated by the orange and red shades. This suggests that these states experienced relatively larger fiscal gaps and higher borrowing requirements during the study period.
3. In contrast, Goa, Sikkim, Mizoram, Nagaland, Arunachal Pradesh and Puducherry show lower Fiscal Deficit levels in most years, which are represented by green shades. These states maintained comparatively smaller fiscal deficits throughout the period.
4. A noticeable increase in Fiscal Deficit can be observed in many states during 2020–21 and 2021–22, which may be attributed to the economic impact of the COVID-19 pandemic and the increase in government expenditure during that period. After the pandemic period, Fiscal Deficit remained relatively high in several states, particularly in larger states.
5. Overall, the heat map provides a clear visual comparison of Fiscal Deficit across different states and years. It highlights that larger states generally recorded higher Fiscal Deficit levels, while smaller states and Union Territories maintained lower Fiscal Deficit levels during the study period.

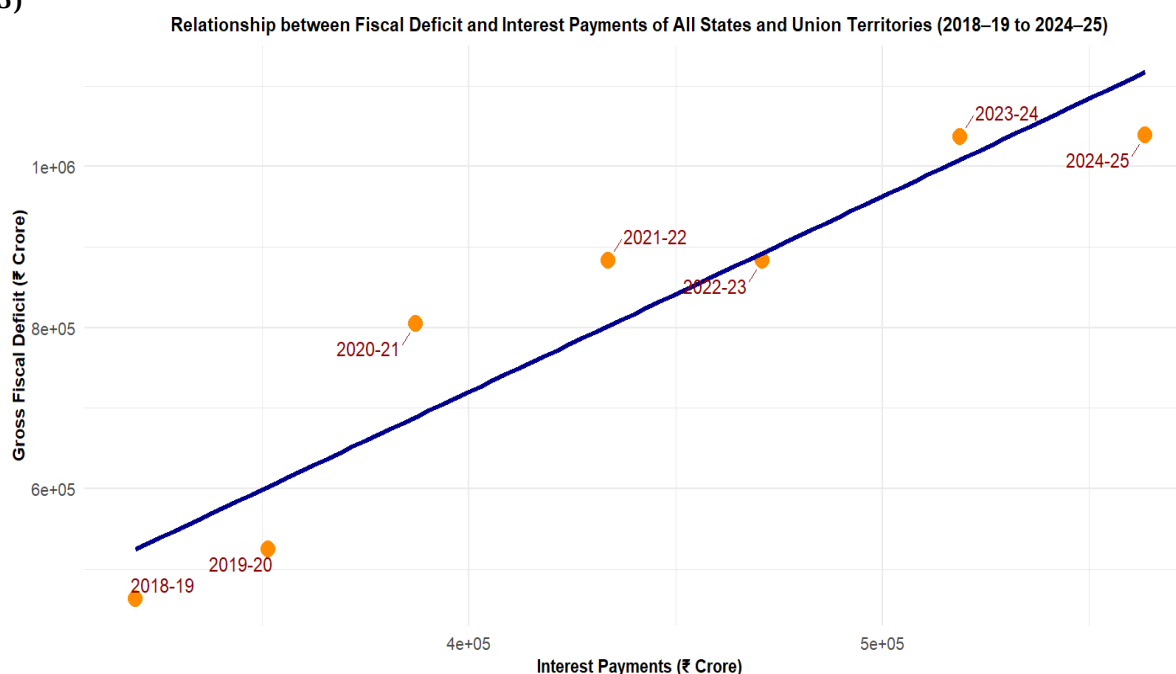
Relationship between Fiscal Deficit and Revenue Deficit (2018–19 to 2024–25)



Interpretation

1. The scatter plot shows the relationship between Fiscal Deficit and Revenue Deficit during the period 2018–19 to 2024–25.
2. The upward sloping trend line indicates a positive relationship between the two variables. This suggests that years with higher Revenue Deficit generally tend to have higher Fiscal Deficit. A noticeable increase is observed in 2020–21, which may be attributed to the COVID-19 pandemic and the resulting increase in government expenditure.
3. However, the data points are not perfectly aligned with the trend line, indicating that Fiscal Deficit is also influenced by other factors such as GSDP, Interest Payments, Capital Expenditure, and Social Sector Expenditure. Overall, the graph suggests that Revenue Deficit is an important contributor to Fiscal Deficit.

Relationship between Fiscal Deficit and Interest Payments of All States and Union Territories (2018–19 to 2024–25)



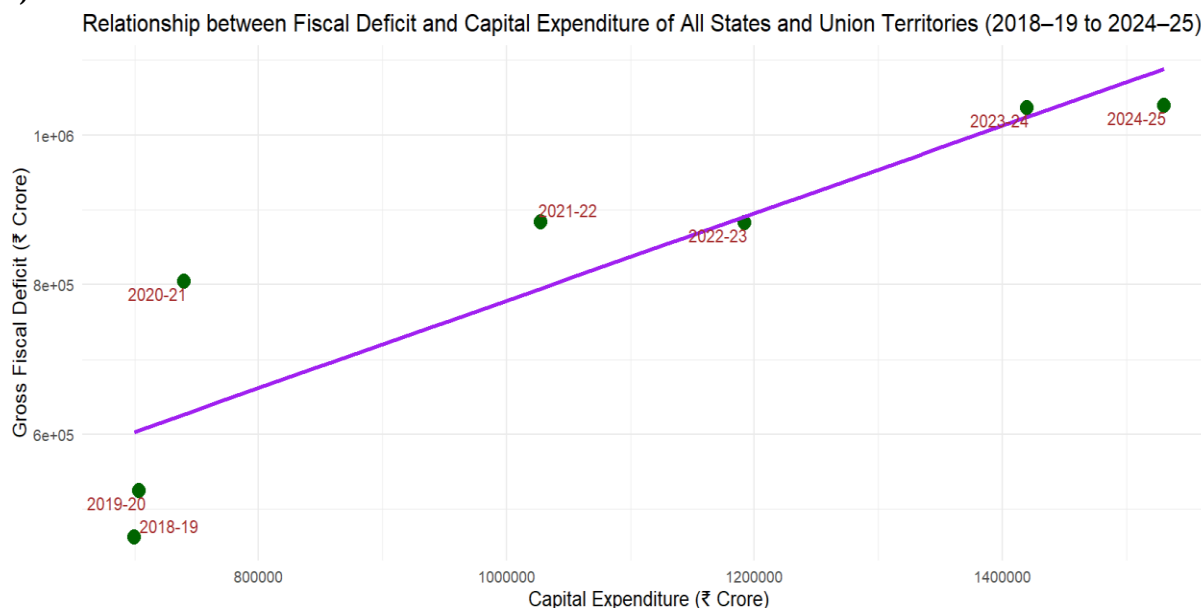
Interpretation

1. The graph shows the relationship between Interest Payments and Fiscal Deficit of all States and Union Territories from 2018–19 to 2024–25.
2. The trend line moves upward, indicating a positive relationship between the two variables. This means that as Interest Payments increase, Fiscal Deficit also tends to increase.

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3. The points are generally close to the trend line, showing a strong relationship between Interest Payments and Fiscal Deficit.
4. The highest values of both Interest Payments and Fiscal Deficit are observed during 2023–24 and 2024–25. Overall, the graph suggests that higher Interest Payments are associated with a higher Fiscal Deficit.

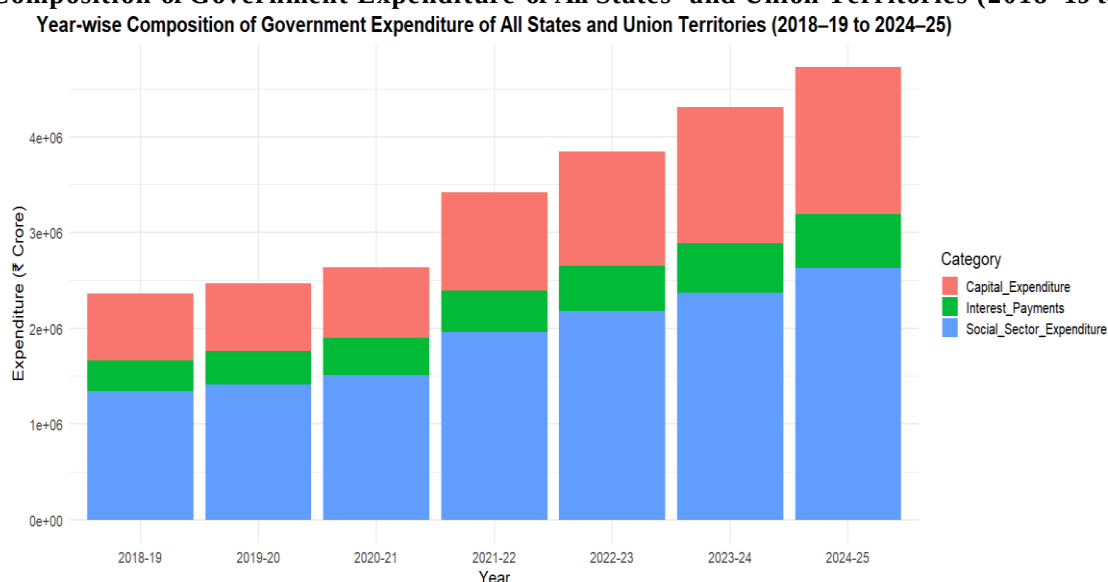
Relationship between Fiscal Deficit and Capital Expenditure of All States and Union Territories (2018–19 to 2024–25)



Interpretation

1. The graph shows that Capital Expenditure and Fiscal Deficit move in the same direction. When Capital Expenditure increases, Fiscal Deficit also increases.
2. A noticeable rise is seen in 2020–21 due to COVID-19, when the government spent more money.
3. Most of the points are close to the trend line, which shows a strong relationship between the two variables. Overall, higher development spending is associated with a higher Fiscal Deficit.

Year-wise Composition of Government Expenditure of All States and Union Territories (2018–19 to 2024–25)



Interpretation

1. The stacked bar chart shows the year-wise composition of government expenditure of all States and Union Territories from 2018–19 to 2024–25. The total expenditure is divided into three components: Social Sector Expenditure, Interest Payments, and Capital Expenditure.
2. The graph indicates that Social Sector Expenditure accounts for the largest share of total government expenditure in every year, followed by Capital Expenditure and Interest Payments. This shows that governments allocate a major portion of their

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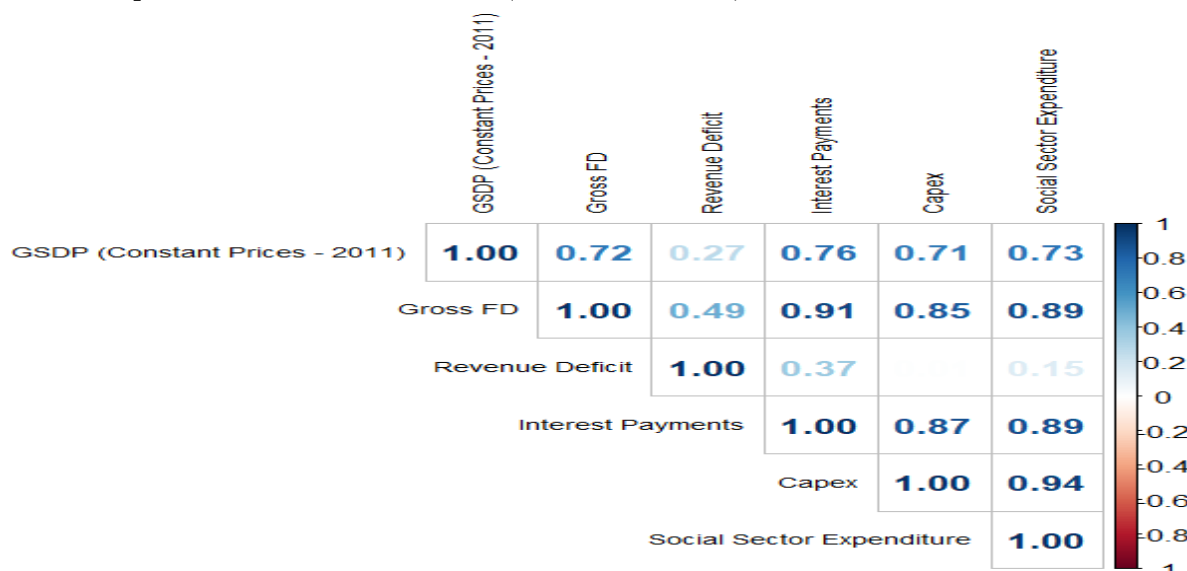
expenditure towards social welfare, education, health, and other development-related activities.

3. A significant increase in total expenditure can be observed from 2021–22 onwards. This increase is mainly due to the rise in Social Sector Expenditure and Capital Expenditure. The increase may be associated with higher government spending for economic recovery and development after the COVID-19 period.
4. Interest Payments also show a gradual increase throughout the study period, indicating a rise in debt servicing obligations of governments. Capital Expenditure increases steadily over time, reflecting greater investment in infrastructure and development projects.
5. Overall, the graph shows that total government expenditure increased continuously during the study period, with Social Sector Expenditure remaining the largest component of expenditure in all years.

Pearson Correlation Matrix of GSDP and Fiscal Indicators (2018–19 to 2024–25)

Variable	GSDP	GFD	RD	IP	CAPEX	SSE
GSDP	1	0.718	0.266	0.759	0.709	0.73
GFD	0.718	1	0.49	0.913	0.845	0.891
RD	0.266	0.49	1	0.37	0.005	0.145
IP	0.759	0.913	0.37	1	0.874	0.887
CAPEX	0.709	0.845	0.005	0.874	1	0.942
SSE	0.73	0.891	0.145	0.887	0.942	1

Correlation Heatmap of GSDP and Fiscal Indicators (2018–19 to 2024–25)



Interpretation:

1. The Pearson correlation analysis was conducted to examine the relationship between GSDP and selected fiscal indicators across Indian States and Union Territories during 2018–19 to 2024–25. The results revealed strong positive correlations between GSDP and Gross Fiscal Deficit ($r = 0.718$), Interest Payments ($r = 0.759$), Capital Expenditure ($r = 0.709$), and Social Sector Expenditure ($r = 0.730$). These findings indicate that economically larger states tend to have higher levels of fiscal expenditure and public investment.
2. Revenue Deficit exhibited a relatively weak positive correlation with GSDP ($r = 0.266$), suggesting that economic size has only a limited association with revenue deficit levels. Among the fiscal indicators, the strongest positive relationship was observed between Capital Expenditure and Social Sector Expenditure ($r = 0.942$), followed by Gross Fiscal Deficit and Interest Payments ($r = 0.913$). This indicates that states with higher developmental and social spending generally maintain larger fiscal operations.
3. Overall, the correlation structure suggests that expenditure-related fiscal indicators are closely associated with economic performance, whereas revenue deficit demonstrates a comparatively weaker relationship with GSDP.
4. The statistical significance test indicated that most correlation coefficients were significant at the 1% level ($p < 0.01$), confirming the existence of meaningful associations among the fiscal indicators. However, the relationship between Revenue Deficit and Capital Expenditure was not statistically significant ($p = 0.939$), suggesting the absence of a meaningful linear association between these variables.

CONCLUSION

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The correlation analysis confirmed the existence of strong positive associations between GSDP and major fiscal indicators. States with higher economic output generally exhibited higher fiscal expenditure, capital investment, and social sector spending. The findings highlight the interdependence between economic growth and fiscal performance across Indian States and Union Territories

K-MEANS Clustering

K-Means Clustering was employed to classify Indian States and Union Territories into homogeneous groups based on their fiscal and economic characteristics. Since the objective was to classify States and Union Territories rather than individual state-year observations, the mean value of each variable over the period 2018–19 to 2024–25 was calculated for every State and Union Territory.

Thus, the clustering analysis was based on 31 observations representing the average fiscal and economic characteristics of the States and Union Territories during the study period.

Data Standardization

Since the variables included in the clustering analysis were measured on different scales, standardization was performed before applying the K-Means algorithm. Standardization transforms the variables to a common scale with mean zero and standard deviation one, thereby preventing variables with larger magnitudes from dominating the clustering process.

The standardized value was computed using the formula:

$$Z = (X - \bar{X}) / s$$

where:

- X = Original observation
- $\bar{X}$ = Mean of the variable
- s = Standard deviation of the variable
- Z = Standardized value

After standardization, all variables had a mean of 0 and a standard deviation of 1, making them comparable for clustering analysis.

Preparation of State-Level Dataset

Since the objective was to classify States and Union Territories rather than state-year observations, the average value of each fiscal and economic indicator over the period 2018–19 to 2024–25 was computed for every State and Union Territory. This resulted in a dataset consisting of 31 observations representing the long-term fiscal and economic characteristics of the States and Union Territories.

Why Standardization was Necessary

The dataset contained variables measured on substantially different scales. For example, GSDP values were much larger than Revenue Deficit or Interest Payments. Without standardization, variables with larger numerical values would have exerted a greater influence on the Euclidean distance calculations used in K-Means clustering. Therefore, standardization was performed to ensure that each variable contributed equally to the cluster formation process.

K-Means Clustering Algorithm

K-Means is an unsupervised machine learning technique used to partition observations into a predefined number of clusters. The algorithm assigns observations to clusters such that observations within the same cluster are as similar as possible, while observations belonging to different clusters are as dissimilar as possible. This is achieved by minimizing the Within-Cluster Sum of Squares (WSS).

Within-Cluster Sum of Squares (WSS)

The squared Euclidean distance between an observation and its cluster centroid is calculated as:

$$d_{ij}^2 = \sum (x_{ijm} - c_{im})^2$$

where:

- x_{ijm} = Value of the m^{th} variable for the j^{th} observation in cluster i
- c_{im} = Centroid value of the m^{th} variable in cluster i
- p = Number of variables

The Within-Cluster Sum of Squares is obtained by summing these squared distances over all observations and clusters:

$$WSS = \sum \sum d_{ij}^2 \text{ where:}$$

- K = Number of clusters
- n_i = Number of observations in cluster i

A lower WSS indicates that observations are closer to their respective cluster centroids and hence form more compact clusters.

Determination of Optimal Number of Clusters

The Elbow Method was used to determine the optimal number of clusters. The WSS values were computed for different values of K and plotted against the corresponding number of clusters.

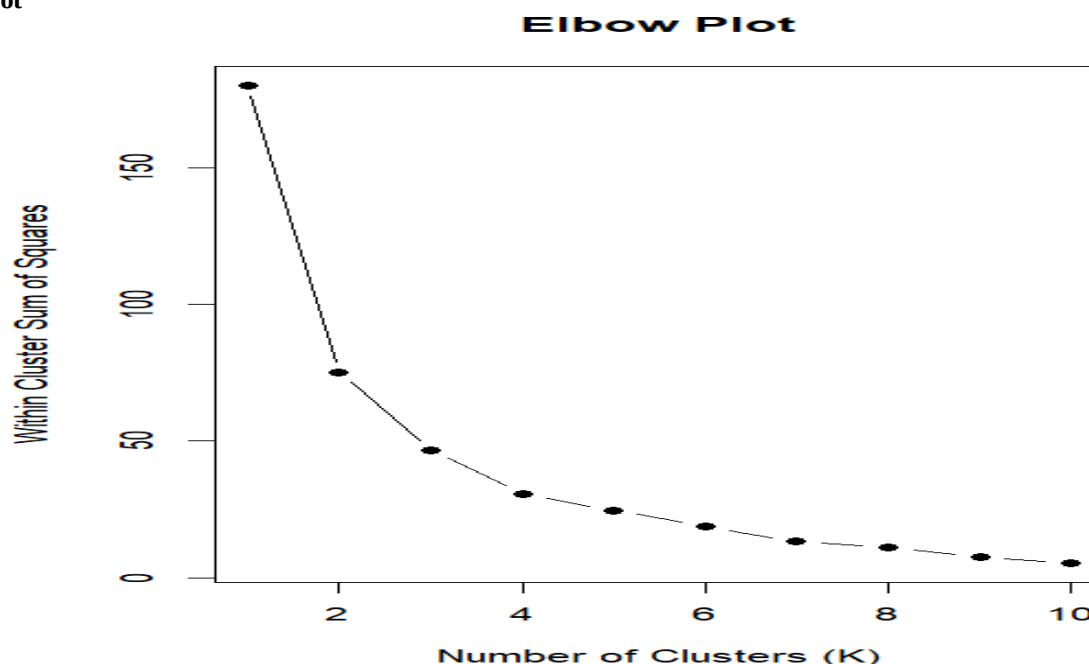
Table: Within-Cluster Sum of Squares (WSS)

Number of Clusters (K)	WSS
1	180
2	75.13
3	46.61
4	30.7
5	24.64
6	18.73
7	13.19
8	11.02
9	7.46
10	5.26

Interpretation of WSS Table

The Within-Cluster Sum of Squares (WSS) decreased continuously as the number of clusters increased, indicating improved cluster compactness. A substantial reduction in WSS was observed from $K = 1$ to $K = 4$. After four clusters, the decrease in WSS became comparatively smaller, suggesting diminishing improvements in cluster homogeneity. Therefore, four clusters were selected as the optimal clustering solution.

Elbow Plot



Interpretation

The Elbow Plot showed a substantial reduction in WSS up to $K = 4$. Beyond this point, the decrease in WSS became relatively smaller, indicating diminishing returns from adding additional clusters. Therefore, four clusters were selected as the optimal clustering solution.

K-Means Clustering Results

After selecting $K = 4$, the K-Means algorithm was applied to the standardized dataset of 31 States and Union Territories.

Cluster Distribution –

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Cluster	Number of States/UTs
Cluster 1	1
Cluster 2	17
Cluster 3	11
Cluster 4	2

Interpretation

Cluster 2 was the largest cluster containing 17 States and Union Territories, while Cluster 1 and Cluster 4 contained a small number of observations representing unique fiscal and economic profiles.

Mean Fiscal and Economic Indicators by Cluster:

Cluster	GSDP	Gross FD	Revenue Deficit	Interest Payments	Capex	Social Sector Expenditure
1	107,304.842	57,587.43	-43,324.00	42,257.71	128,898.57	197,482.14
2	20,230.620	6,882.56	-2,410.40	3,224.12	12,478.97	23,422.39
3	72,950.712	42,479.16	15,020.29	22,915.83	48,073.17	91,217.73
4	172,281.147	81,509.86	33,205.57	42,889.57	87,439.93	157,188.57

The cluster profile table presents the average values of fiscal and economic indicators for each cluster. The results indicate substantial differences among the clusters. Cluster 2 recorded the lowest average values for most indicators, whereas Cluster 4 exhibited the highest average GSDP and fiscal activity. Cluster

1 represented a unique group characterized by exceptionally high Capital Expenditure and Social Sector Expenditure. These differences suggest that the clusters capture distinct fiscal and economic characteristics of States and Union Territories.

Cluster	States and Union Territories
Cluster 1	Uttar Pradesh
Cluster 2	Arunachal Pradesh, Assam, Chhattisgarh, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Manipur, Meghalaya, Mizoram, Nagaland, NCT Delhi, Odisha, Puducherry, Sikkim, Tripura and Uttarakhand
Cluster 3	Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Punjab, Rajasthan, Telangana and West Bengal
Cluster 4	Maharashtra and Tamil Nadu

The composition of the clusters indicates that States and Union Territories with similar fiscal and economic characteristics were grouped together. The clustering results reveal considerable diversity in fiscal performance across the country.

Interpretation of Clusters

Cluster 1 – High Investment and Development Expenditure Group

Cluster 1 contained only Uttar Pradesh, indicating that its fiscal and economic characteristics were sufficiently distinct from those of the other States and Union Territories. The state recorded exceptionally high Capital Expenditure and Social Sector Expenditure along with high Gross Fiscal Deficit and Interest Payments. Consequently, the K-Means algorithm identified Uttar Pradesh as a

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unique fiscal group.

Cluster 2 – Low Fiscal Activity Group

Cluster 2 contained 17 States and Union Territories and recorded the lowest average values for GSDP, Gross Fiscal Deficit, Interest Payments, Capital Expenditure and Social Sector Expenditure. Therefore, this cluster represents states with relatively lower economic output and lower fiscal activity during the study period.

Cluster 3 – Moderate to High Fiscal Activity Group

Cluster 3 consisted of 11 States and Union Territories and exhibited moderate to high values for all fiscal and economic indicators. Compared to Cluster 2, these states showed substantially higher economic output, expenditure and borrowing levels. This cluster represents states with relatively strong fiscal activity and moderate economic scale.

Cluster 4 – Very High Economic Output Group

Cluster 4 consisted of Maharashtra and Tamil Nadu, which recorded the highest average GSDP and among the highest values of fiscal expenditure indicators. Their large economic size and extensive fiscal operations distinguished them from the remaining States and Union Territories.

Overall Conclusion

The K-Means clustering analysis classified the 31 States and Union Territories into four distinct groups based on their average fiscal and economic characteristics during 2018–19 to 2024–25. The results revealed substantial heterogeneity among States and Union Territories. Cluster 2 represented states with comparatively lower fiscal activity, whereas Cluster 3 consisted of states with moderate to high fiscal activity. Cluster 4 contained economically dominant states with extensive fiscal operations, while Cluster 1 represented a unique case characterized by exceptionally high developmental and social sector expenditure. Overall, the clustering approach successfully identified meaningful groups of States and Union Territories with similar fiscal and economic profiles, thereby providing useful insights for comparative fiscal assessment and policy formulation.

pRINCIPAL COMPONENT ANALYSIS (pCA)

Principal Component Analysis (PCA) was employed to reduce the dimensionality of the dataset and identify the major underlying dimensions governing fiscal and economic performance among Indian States and Union Territories. Since the objective was to examine the overall fiscal and economic characteristics of States and Union Territories rather than individual state-year observations, the mean value of each indicator over the period 2018–19 to 2024–25 was calculated for every State and Union Territory.

The analysis was carried out using six variables, namely Gross State Domestic Product (GSDP), Gross Fiscal Deficit (GFD), Revenue Deficit (RD), Interest Payments (IP), Capital Expenditure (CAPEX), and Social Sector Expenditure (SSE). Thus, PCA was performed on a dataset consisting of 31 observations representing the average fiscal and economic profile of each State and Union Territory during the study period.

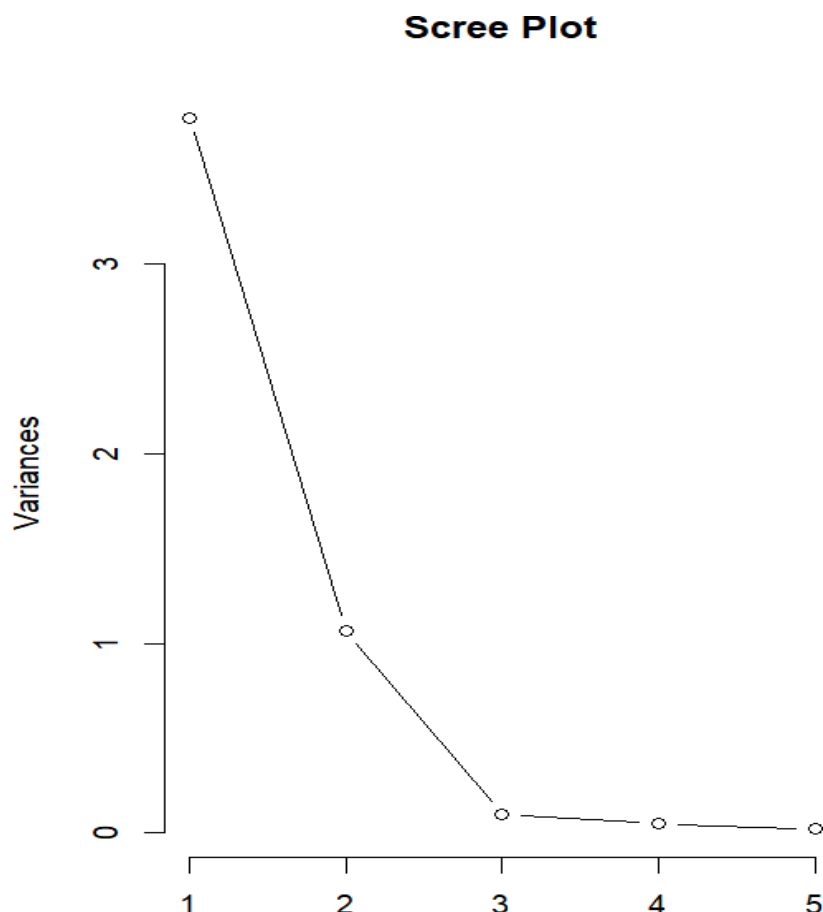
Principal Components and Variance Explained

The eigenvalues and proportion of variance explained by each principal component are presented below.

Table: Eigenvalues and Variance Explained:

Principal Component	Eigenvalue	Variance Explained (%)	Cumulative Variance (%)
PC1	3.770	75.41	75.41
PC2	1.066	21.32	96.73
PC3	0.095	1.91	98.64
PC4	0.048	0.96	99.60
PC5	0.021	0.41	100.00

Scree Plot -

**Interpretation:**

The scree plot showed a sharp decline in eigenvalues from the first to the second principal component, followed by a gradual flattening of the curve. The elbow occurred after the second principal component, confirming that retaining two principal components was appropriate.

Principal Component Loadings

Predictor Variable	PC1	PC2
Gross Fiscal Deficit	-0.500	0.157
Revenue Deficit	-0.181	0.905
Interest Payments	-0.497	0.037
Capital Expenditure	-0.477	-0.338
Social Sector Expenditure	-0.492	-0.203

Interpretation:

- 1) The first principal component (PC1) exhibited relatively high loadings for Gross Fiscal Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure, indicating that it primarily represents the overall fiscal expenditure dimension.
- 2) The second principal component (PC2) was dominated by Revenue Deficit, suggesting that it captures variations related to the revenue deficit dimension.

Contribution of Variables to Principal Components Contribution to PC1

Predictor Variable	Loading	Contribution
Gross Fiscal Deficit	-0.500	Very High
Interest Payments	-0.497	Very High
Social Sector Expenditure	-0.492	Very High

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Capital Expenditure	-0.477	High
Revenue Deficit	-0.181	Low

Interpretation of Contribution to PC1

The first principal component (PC1) is mainly influenced by **Gross Fiscal Deficit, Interest Payments, Social Sector Expenditure, and Capital Expenditure**, as these variables have the largest absolute loadings. Revenue Deficit contributes relatively little to PC1. Therefore, **PC1 may be interpreted as the "Overall Fiscal Expenditure Component."**

Contribution to PC2

Predictor Variable	Loading	Contribution
Revenue Deficit	0.905	Very High
Capital Expenditure	-0.338	Moderate
Social Sector Expenditure	-0.203	Low
Gross Fiscal Deficit	0.157	Low
Interest Payments	0.037	Negligible

Interpretation of Contribution to PC2

The second principal component (PC2) is dominated by **Revenue Deficit**, which has the highest loading (0.905). The contributions of the remaining variables are comparatively small. Hence, **PC2 primarily represents the "Revenue Deficit Component."**

Overall Conclusion:

1. The application of Principal Component Analysis reduced the original five predictor variables to **two principal components**, explaining **96.73%** of the total variance. Based on Kaiser's criterion and the scree plot, only the first two principal components were retained. Therefore, PCA successfully transformed the correlated fiscal indicators into a smaller set of uncorrelated components, facilitating easier interpretation while preserving nearly all of the variability in the original data.
2. Overall, the PCA successfully reduced the complexity of the dataset and demonstrated that variations in economic size, government expenditure, and fiscal activity were the primary factors distinguishing Indian States and Union Territories during the study period, while Revenue Deficit represented a separate dimension of fiscal performance.

Methodology

The ranking of States and Union Territories was carried out using the results obtained from Principal Component Analysis (PCA). The first principal component (PC1) explained the largest proportion of total variation (78.71%) and was therefore considered an appropriate summary measure of overall fiscal and economic scale.

The mean values of six fiscal and economic indicators, namely Gross State Domestic Product (GSDP), Gross Fiscal Deficit (GFD), Revenue Deficit (RD), Interest Payments (IP), Capital Expenditure (CAPEX), and Social Sector Expenditure (SSE), were calculated for each State and Union Territory over the study period. PCA was then performed on the standardized data.

The scores of the first principal component were used to construct a Composite Fiscal and Economic Index. Since the direction of principal components is arbitrary, the sign of the PC1 scores was reversed to facilitate interpretation. Consequently, higher composite index values indicate relatively larger fiscal and economic scale.

The composite index was calculated as:

Composite Index = – (PC1 Score)

The States and Union Territories were then ranked in descending order of the composite index values.

	States	
1	Andhra Pradesh	1.58666230
2	Arunachal Pradesh	-2.21346895
3	Assam	-0.85788713
4	Bihar	0.74202412
5	Chhattisgarh	-0.86833296
6	Goa	-2.09980864
7	Gujarat	1.64644548
8	Haryana	0.34902919
9	Himachal Pradesh	-1.68341440

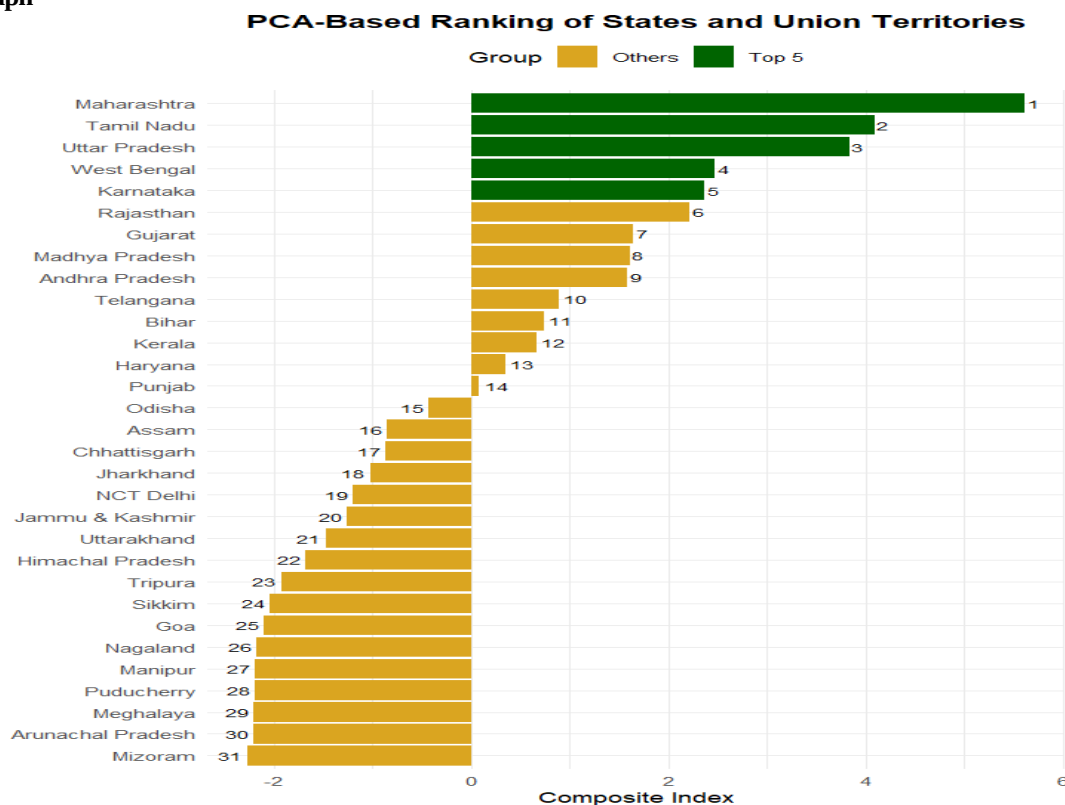
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	States	Composite_Index
1	Andhra Pradesh	1.58666230
2	Arunachal Pradesh	-2.21346895
3	Assam	-0.85788713
4	Bihar	0.74202412
5	Chhattisgarh	-0.86833296
6	Goa	-2.09980864
7	Gujarat	1.64644548
8.	Haryana	0.34902919
9	Himachal Pradesh	-1.68341440
10	Jammu & Kashmir	-1.25990670
11	Jharkhand	-1.02721921
12	Karnataka	2.36724601
13	Kerala	0.65701437
14	Madhya Pradesh	1.60399624
15	Maharashtra	5.61375477
16	Manipur	-2.19201571
17	Meghalaya	-2.20861551
18	Mizoram	-2.27546929
19	Nagaland	-2.17643201
20	NCT Delhi	-1.20005434
21	Odisha	-0.43449023
22	Puducherry	-2.19783035
23	Punjab	0.08215549
24	Rajasthan	2.21779207
25	Sikkim	-2.04035900
26	Tamil Nadu	4.08817533
27	Telangana	0.88345398

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28	Tripura	-1.93123224
29	Uttar Pradesh	3.83395375
30	Uttarakhand	-1.48038953
31	West Bengal	2.47522309

Ranking Graph



Interpretation of Ranking Graph

1. The PCA-based ranking graph presents the relative fiscal and economic standing of Indian States and Union Territories based on the Composite Fiscal and Economic Index derived from the first principal component. Since the first principal component explained **78.71% of the total variation**, the ranking provides a comprehensive summary of the fiscal and economic characteristics of the States and Union Territories.
2. The graph indicates substantial variation across States and Union Territories. **Maharashtra** achieved the highest composite index value and ranked first, followed by **Tamil Nadu** and **Uttar Pradesh**. These States are characterized by relatively high levels of GSDP, Gross Fiscal Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure, reflecting their large economic scale and extensive fiscal operations.
3. States such as **West Bengal, Karnataka, Rajasthan, and Gujarat** also recorded relatively high composite index values, indicating strong fiscal and economic activity during the study period. In contrast, **Mizoram, Arunachal Pradesh, Meghalaya, Puducherry, and Manipur** occupied the lower end of the ranking due to their comparatively smaller economic size and fiscal expenditure levels.

Table: Ranking of States and Union Territories Based on Composite Fiscal and Economic Index

Rank	State/UT	Composite Index
1	Maharashtra	5.614
2	Tamil Nadu	4.088
3	Uttar Pradesh	3.834

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4	West Bengal	2.475
5	Karnataka	2.367
6	Rajasthan	2.218
7	Gujarat	1.646
8	Madhya Pradesh	1.604
9	Andhra Pradesh	1.587
10	Telangana	0.883
11	Bihar	0.742
12	Kerala	0.657
13	Haryana	0.349
14	Punjab	0.082
15	Odisha	-0.434
16	Assam	-0.858
17	Chhattisgarh	-0.868
18	Jharkhand	-1.027
19	NCT Delhi	-1.2
20	Jammu & Kashmir	-1.26
21	Uttarakhand	-1.48
22	Himachal Pradesh	-1.683
23	Tripura	-1.931
24	Sikkim	-2.04
25	Goa	-2.1
26	Nagaland	-2.176
27	Manipur	-2.192
28	Puducherry	-2.198
29	Meghalaya	-2.209
30	Arunachal Pradesh	-2.213
31	Mizoram	-2.275

Interpretation:

1. The ranking based on the Composite Fiscal and Economic Index revealed substantial differences among Indian States and Union Territories. Maharashtra obtained the highest composite index score and ranked first, followed by Tamil Nadu and Uttar Pradesh. These States exhibited relatively high values of GSDP, Capital Expenditure, Social Sector Expenditure, Gross Fiscal Deficit, and Interest Payments, reflecting their large economic scale and fiscal activity during the study period.
2. Other highly ranked States included West Bengal, Karnataka, Rajasthan, and Gujarat, indicating comparatively strong fiscal and economic profiles. In contrast, Mizoram, Arunachal Pradesh, Meghalaya, Puducherry, and Manipur recorded the lowest composite index values. These lower rankings primarily reflect differences in economic and fiscal scale rather than administrative performance or development outcomes.
3. Overall, the ranking highlights significant variation in fiscal and economic characteristics across Indian States and Union Territories during 2018–19 to 2024–25.

Overall Conclusion

The PCA-based Composite Fiscal and Economic Index successfully summarized six fiscal and economic indicators into a single measure representing the overall fiscal and economic scale of States and Union Territories. The ranking revealed considerable variation across States, with Maharashtra, Tamil Nadu, and Uttar Pradesh occupying the highest positions. The results provide a useful framework for comparing fiscal and economic characteristics across States and Union Territories and offer valuable insights for fiscal assessment and policy analysis.

TREND ANALYSIS OF MEAN GSDP

A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

Methodology

Trend analysis was conducted to examine the changes in fiscal and economic indicators over the study period from 2018–19 to 2024–25. The analysis was performed using annual mean values of six indicators, namely GSDP, Gross Fiscal Deficit, Revenue Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure.

Since the dataset consisted of 31 States and Union Territories observed over seven years, annual mean values were calculated for each indicator. The use of annual means provided a representative measure of the overall fiscal and economic position of Indian States and Union Territories in each year and reduced the influence of state-specific variations.

Line plots were constructed using the annual mean values to visualize the movement of each indicator over time. In addition, the Compound Annual Growth Rate (CAGR) was calculated to measure the average annual growth achieved by each indicator during the study period.

Compound Annual Growth Rate (CAGR) Definition

The Compound Annual Growth Rate (CAGR) is a measure used to determine the average annual rate of growth of a variable over a specified period, assuming that the growth occurred at a constant compounded rate.

Formula

$$CAGR = \left(\frac{V_f}{V_i} \right)^{\frac{1}{n}} - 1$$

Where:

- V_f = Final Value
- V_i = Initial Value
- n = Number of years

Why CAGR was Used

CAGR was used because it provides a single summary measure of long-term growth over the study period. Unlike simple percentage change, CAGR accounts for the compounding effect of growth and allows comparison of growth rates across different indicators. It helps in understanding the average annual increase or decrease in fiscal and economic indicators between 2018–19 and 2024–25.

Why Annual Mean Values Were Used

The dataset contained observations for 31 States and Union Territories across seven years, resulting in 217 observations.

Using raw data would have reflected individual state-level variations and produced highly cluttered visualizations. The objective of this analysis was to study the overall fiscal and economic trend of Indian States and Union Territories rather than state-specific movements.

Therefore, annual mean values were calculated to obtain a representative measure of the average fiscal and economic position across all States and Union Territories for each year.

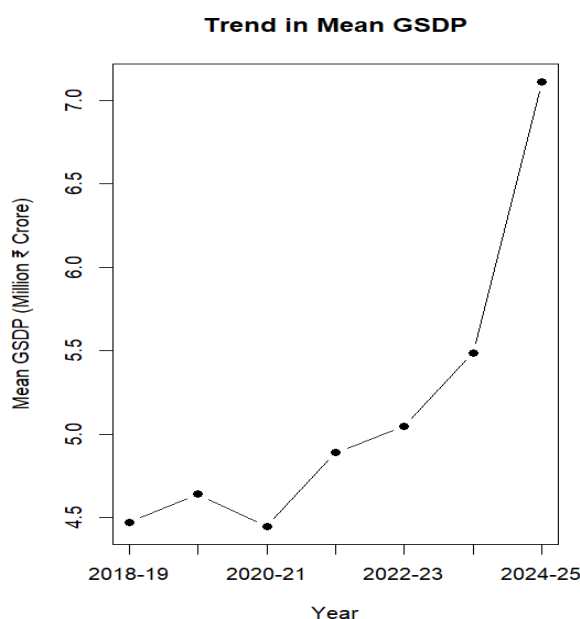


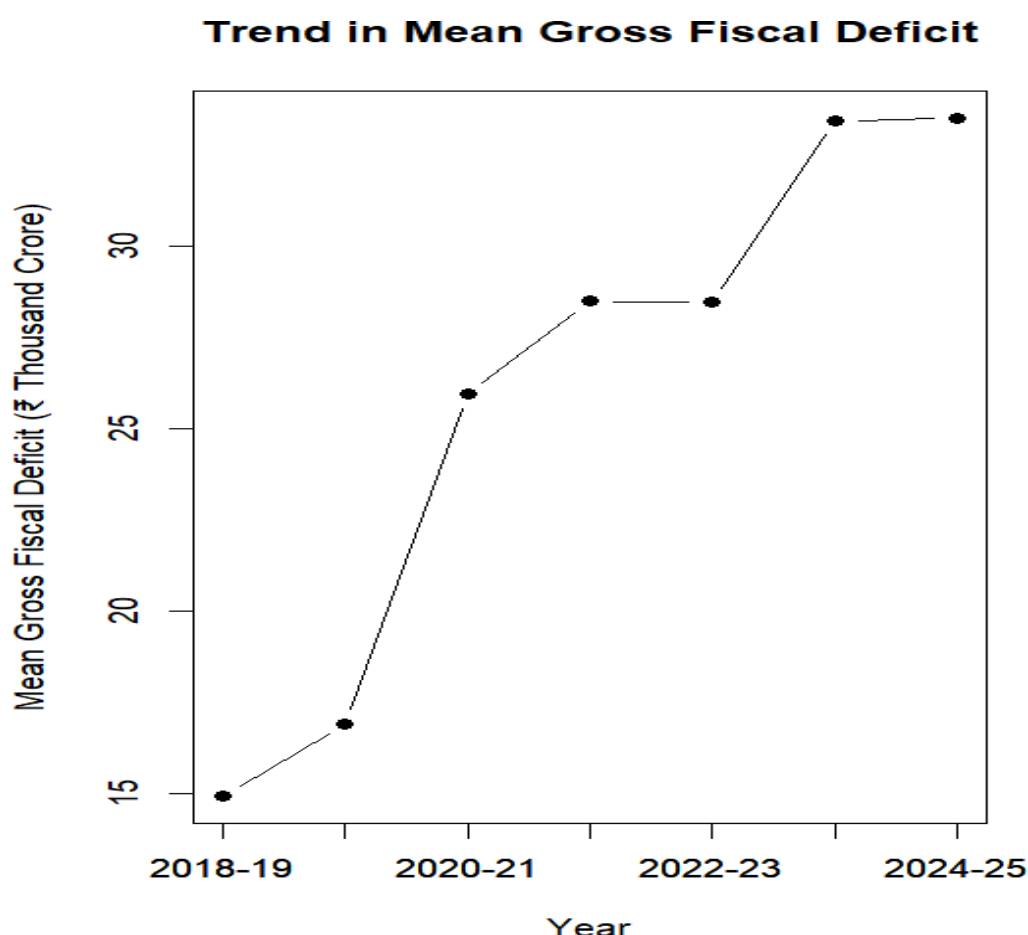
Figure : Trend in Mean GSDP

A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

Interpretation

1. The mean Gross State Domestic Product (GSDP) showed an overall increasing trend during the study period.
2. The average GSDP increased from ₹44.69 lakh crore in 2018–19 to ₹71.12 lakh crore in 2024–25 (BE).
3. A slight decline was observed in 2020–21, which may be associated with the economic disruptions caused by the COVID-19 pandemic.
4. However, from 2021–22 onwards, GSDP increased steadily and reached its highest value in 2024–25.
5. The estimated CAGR of 8.05% indicates sustained economic growth across Indian States and Union Territories during the study period.

Trend Analysis of Mean Gross Fiscal Deficit Figure: Trend in Mean Gross Fiscal Deficit



Interpretation

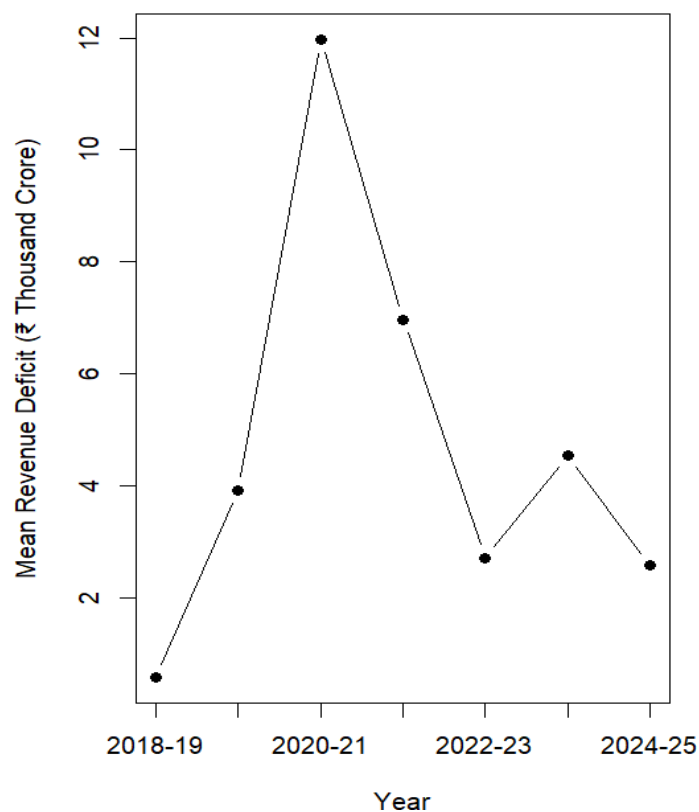
1. The mean Gross Fiscal Deficit exhibited a consistent upward trend over the study period. It increased from ₹14.93 thousand crore in 2018–19 to ₹33.52 thousand crore in 2024–25 (BE).
2. The sharp rise observed during 2020–21 and 2021–22 suggests increased government borrowing and fiscal support measures during and after the pandemic period.
3. The CAGR of 14.43% indicates that fiscal deficits grew at a relatively faster rate than economic output during the study period.

Trend Analysis of Mean Revenue Deficit. Figure : Trend in Mean Revenue Deficit.

Interpretation

1. The mean Revenue Deficit displayed considerable fluctuations throughout the study period. It increased sharply from ₹0.57 thousand crore in 2018–19 to ₹11.98 thousand crore in 2020–21, indicating a substantial gap between revenue expenditure and revenue receipts during the pandemic period.
2. Thereafter, the deficit declined in most years, although some fluctuations were observed.
3. The irregular pattern suggests that Revenue Deficit was highly sensitive to changing fiscal conditions and government policy responses. Therefore, no clear long-term trend can be observed for this indicator.

Trend in Mean Revenue Deficit

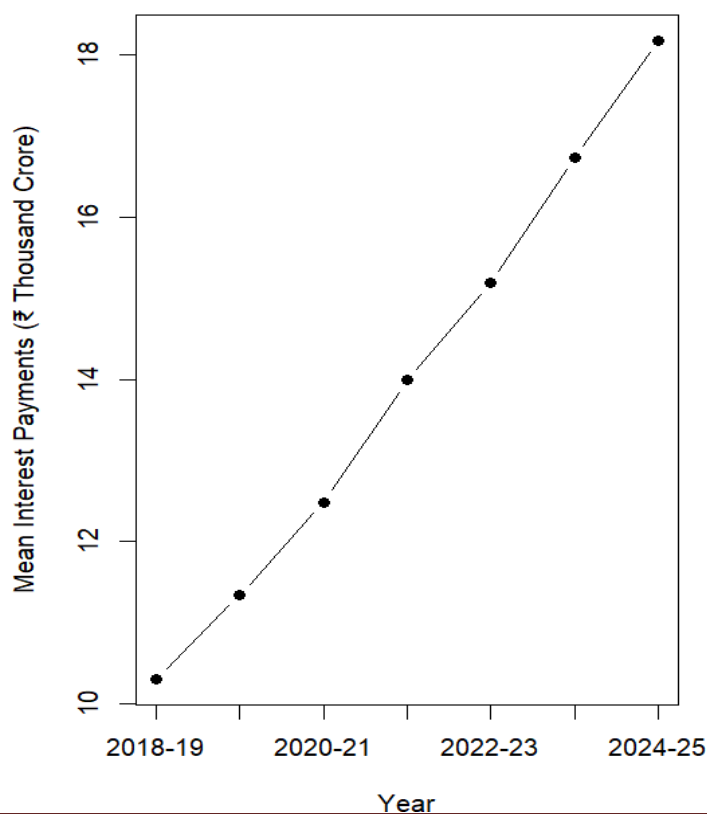


Trend Analysis of Mean Interest Payments Figure 7.4: Trend in Mean Interest Payments

Interpretation

1. The mean Interest Payments increased steadily throughout the study period, rising from ₹10.30 thousand crore in 2018–19 to ₹18.18 thousand crore in 2024–25 (BE).
2. The absence of major fluctuations indicates a gradual increase in debt servicing obligations of States and Union Territories.

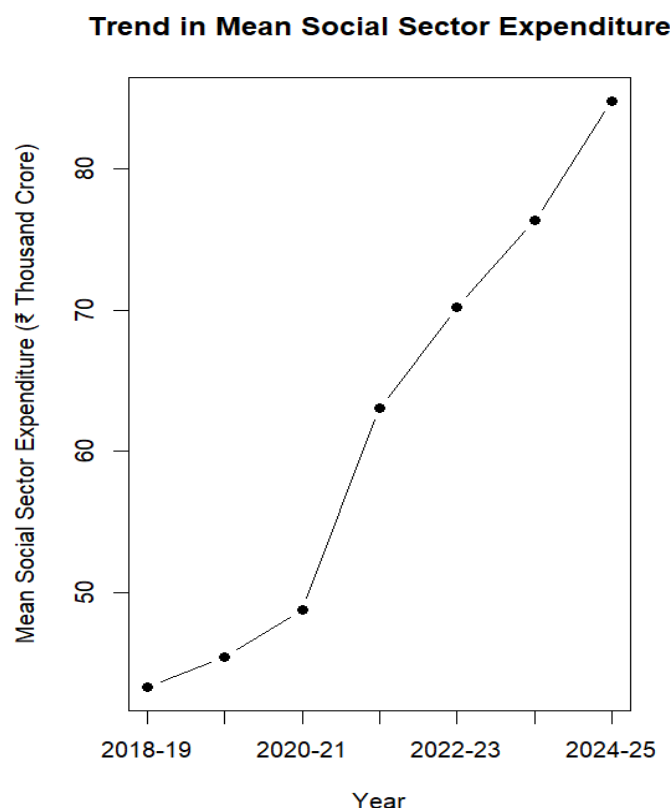
Trend in Mean Interest Payments



A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

3. The CAGR of 9.93% reflects a continuous rise in interest expenditure, which may be associated with increased borrowing over the years.

Trend Analysis of Mean Capital Expenditure Figure 7.5: Trend in Mean Capital Expenditure



Interpretation

1. The mean Capital Expenditure showed a strong increasing trend during the study period. It increased from ₹22.57 thousand crore in 2018–19 to ₹49.37 thousand crore in 2024–25 (BE).
2. The increase became particularly pronounced after 2020–21, indicating greater emphasis on infrastructure development and capital investment by State Governments.
3. The CAGR of 13.94% demonstrates substantial growth in developmental expenditure over the study period.

Trend Analysis of Mean Social Sector Expenditure Figure 7.6: Trend in Mean Social Sector Expenditure

Interpretation

1. The mean Social Sector Expenditure increased continuously throughout the study period. It rose from ₹43.31 thousand crore in 2018–19 to ₹84.81 thousand crore in 2024–25 (BE).
2. The steady increase reflects greater government spending on social sectors such as education, health, welfare, and related public services.
3. The CAGR of 11.85% indicates sustained growth in social sector investment across States and Union Territories.

Overall Interpretation of Trend Analysis

1. The trend analysis revealed that most fiscal and economic indicators experienced growth during the study period.
2. Mean GSDP showed a positive long-term trend, indicating overall economic expansion across States and Union Territories.
3. Capital Expenditure and Social Sector Expenditure recorded substantial increases, suggesting enhanced investment in infrastructure and welfare activities.
4. Gross Fiscal Deficit and Interest Payments also increased over time, reflecting greater fiscal commitments and borrowing requirements. In contrast, Revenue Deficit exhibited significant fluctuations and did not follow a consistent trend.
5. Overall, the findings indicate that economic growth during the study period was accompanied by increased public expenditure and fiscal responsibilities.

6. MuLTIvARIATE ANALysIs OF vARIANCE (MANOvA)

To examine whether significant differences exist among Indian States and Union Territories with respect to multiple fiscal and economic indicators, a **one-way Multivariate Analysis of Variance (MANOVA)** was performed.

A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

Unlike separate ANOVA tests, MANOVA simultaneously compares the mean vectors of several dependent variables while accounting for the correlation among them.

The dependent variables considered were:

- Gross State Domestic Product (GSDP)
- Gross Fiscal Deficit
- Revenue Deficit
- Interest Payments
- Capital Expenditure
- Social Sector Expenditure

The grouping factor consisted of the different States and Union Territories.

Objective of MANOVA

The objectives of the MANOVA

- To determine whether fiscal and economic performance differs significantly among States and Union Territories.
- To evaluate the combined effect of multiple fiscal indicators.
- To identify whether States exhibit statistically distinct fiscal profiles.

Hypotheses

Null Hypothesis (H_0):

The mean vectors of all fiscal and economic indicators are equal across the States and Union Territories.

$$H_0: \mu_1 = \mu_2 = \dots = \mu_k$$

Alternative Hypothesis (H_1):

At least one State or Union Territory differs significantly in its multivariate mean vector.

Multivariate Test Results

Test Statistic Value Approx. F Numerator df Denominator df p-value

Pillai's Trace 3.6379 9.4976 180 1110 <0.001

Since the p-value is less than 0.001, the null hypothesis is rejected at the 5% level of significance. This indicates that there is a statistically significant difference in the combined economic and fiscal performance among the Indian states.

Univariate ANOVA Results

Following the significant MANOVA result, individual ANOVA tests were examined for each response variable.

Variable	F-value	p-value	Decision
GSDP	20.407	<0.001	Significant
Gross Fiscal Deficit	25.160	<0.001	Significant
Revenue Deficit	21.272	<0.001	Significant
Interest Payments	73.444	<0.001	Significant
Capital Expenditure	25.752	<0.001	Significant
Social Sector Expenditure	38.558	<0.001	Significant

The results indicate that each of the six variables differs significantly across the states.

Interpretation

1. The MANOVA results reveal significant differences in the overall economic and fiscal performance of the Indian states. The significant Pillai's Trace statistic confirms that the combined mean vectors of the selected indicators are not identical across states.
2. Furthermore, the follow-up univariate ANOVA results show that all six indicators—GSDP, Gross Fiscal Deficit, Revenue

A Statistical Analysis of Gross State Domestic Product and Fiscal Indicators (2018–19 To 2024–25)

Deficit, Interest Payments, Capital Expenditure, and Social Sector Expenditure—vary significantly among the states.

3. These findings suggest that Indian states exhibit distinct fiscal and economic characteristics, reflecting differences in their economic size, fiscal management, expenditure priorities, and financial performance.

CONCLUSION

The null hypothesis was rejected, indicating that the selected fiscal and economic indicators differ significantly across Indian states. Hence, the overall fiscal and economic performance is not the same for all states. The significant MANOVA result justifies further multivariate analyses, such as Principal Component Analysis, to summarize the underlying structure of these indicators.

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