An Analytical Study on Forecasting GST Trends in Maharashtra and Karnataka Using Linear Regression and Monte Carlo Simulation

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Abstract
Goods and Services tax (GST) was introduced in Indian economy in the year 2017 with the intention to build a simplified indirect tax regime stating as one nation one tax. It is a destination based and consumption-based tax to reduce the cascading effect on taxes and for subsuming several other taxes including VAT, Service tax, road tax etc. Further, the state of Maharashtra followed by Karnataka has been the highest in the collection (Singh, 2018)of GST revenue. This research paper analyses the trends in Goods and Services Tax (GST) collections for two Indian states, Maharashtra and Karnataka, by leveraging statistical modelling and computational simulations. The code provided serves as the analytical backbone for predicting future GST collections using linear regression and simulating ideal growth scenarios through Monte Carlo methods. This dual approach not only highlights the predicted growth patterns but also establishes an ideal growth trajectory within defined confidence intervals, thereby providing a benchmark for policy assessment and financial forecasting.

Keywords:
Goods and Services tax, Karnataka, Maharashtra, Comparative analysis, tax revenue, Monte Carlo, Regression analysis

Introduction

The goods and service tax were first introduced in the Budget Speech presented on 28th February 2006. It laid the foundation for a complete reform of India's indirect tax system. Finally implemented on 1st July 2017 as the Goods and Services Tax Act, the indirect taxation system thus went through a chain of amendments since its inception. With this tax reform, GST replaced multiple indirect taxes that were levied on different goods and services. The Central Board of Indirect Taxes and Customs (CBIC) is the regulatory body governing all changes and amendments regarding this tax. It is a destination-based, multi-stage, comprehensive tax levied at each stage of value addition. Having replaced multiple indirect taxes in the country, it has successfully helped the Indian Government achieve its *'One Nation One Tax'* agenda.

The tax is levied on goods and services sold within India's domestic boundary for consumption. Implemented by a majority of nations worldwide with respective customisations, the tax has been successful in simplifying the indirect taxation structure of India.

GST is levied on the final market price of goods and services manufactured internally, thereby reflecting the maximum retail price. Customers are required to pay this tax on a purchase of goods or services as an inclusion in their final price. Collected by the seller, it is then required to be paid to the government, thus implying the indirect incidence.

The GST rates on different goods and services are uniformly applied across the country. Goods and services have, however, been categorised under different slab rates for tax payment. While luxury and comfort goods are categorised under higher slabs, necessities have been included in lower and nil slab rates. The main aim of this classification is to ensure the uniform distribution of wealth among residents of India.

The key objectives and features of GST are-

- 'One Nation, One Tax'

GST took the place of many indirect taxes that existed before. It was introduced with a core motive and policy called the 'One Nation, One Tax'. It was introduced as so to provide set tax rates for a service/product that every state would follow. It even simplified administering taxes and compliances.

- To Subsume Indirect Taxes in India

To create a centralised and unified tax system on goods and services, GST was introduced in India. Under its laws, the majority of indirect taxes were subsumed into one to simplify administration.

- To Restrain Tax Evasion

Prior to the introduction of GST, the tax evasion rate was very high. In order to curb evasion and create a centralised tax surveillance system, GST was introduced in India. It has effectively contributed to reducing the number of tax defaulters.

- Dual Structure

Unlike a federal structure where the government collects taxes and distributes them to the states, a dual tax structure allows both the centre and the state to levy and collect taxes.

Goods and Services Tax in India carries this same dual structure, thus having two components, state as well as a central levy. The structure is applicable to all transactions related to goods and services.

- Multi-stage, destination based and value added

The comprehensive nature of the Goods and Services tax levy takes into account every stage of manufacture whereby value-added to an item is taxable. Plus, a change of destination also attracts GST.

From production/manufacture to consumption, an item is passed from one link of the supply chain to another until it is finally purchased for consumption. An indirect tax is hence, levied at every stage, to be borne ultimately by a consumer.

A destination-based levy means the item is to be taxed at a place where it is consumed and not at its origin. This means that the location where an item is consumed will rightfully collect the tax.
The concept of GST on value addition implies every addition made to an item to make it saleable to the end-user is taxable under this regime.

- Composition scheme under GST

The composition scheme under GST eases the process of indirect tax payment for small taxpayers. As per the CBIC, companies with an annual turnover within Rs. 1 Crore can opt for the scheme to pay their taxes. For North-Eastern states, the turnover limit is Rs. 75 Lakh. Registration under the scheme is, however, voluntary. The taxpayer, must, however, also meet a set of conditions to avail of the scheme. A taxpayer needs to file GST CMP-02 when opting for the scheme. They can do so at the GST online portal.

- Input Tax Credit (ITC)

An Input Tax credit means that when a business person or a trader is paying tax on output, he/she can reduce the tax already paid on input (purchase). ITC can be claimed only by businesses registered under the Goods and Services Tax Act. Also, all respective suppliers must be registered under the act for you to be eligible to avail of ITC.

Review of Literature

Amanpreet Singh Studied that GST is the main source of the indirect tax to enhance the economic growth of the country. He also proved that ITC mechanism under GST era is a backbone concept of GST. Therefore, GST law ensures the flow of credit and makes sure that the tax is paid by the end Consumer and borne liability of the supplier is being revived. The study focused the double taxation known as cascading effect is eliminated. this study has been a criterion to examine the eligibility for claiming ITC. The pre and post regime is impacted by the ITC mechanism on entire supply. The GST regime has been structured in such a way that ITC bears all the taxes of the supplier and eliminating double taxation multiple taxes etc. (Singh, 2018)

Sunil Taneja considered GST is the most transformational tax in India. This study is the elaborated study of GST works and the features of GST the manufacturing. Wholesaler and retailer reaches the end consumer the analysis verifies the payment of excess tax and utilization of input tax credit. the ITC sector as attracting the VAT and service tax in manufacturing of it products the analysis of the GST on businesses, avail ITC, redesigning business software, Taxability of installing new ERP, Export of services in IT sector. The positive impact of eliminating cascading effect from producer to consumers. (Sunil Taneja, 2018)

Varun Agarwal is a reviewer of the GST revenues performance. This research has studied the bounty of the GST revenue GST as a plan of compensation mechanism that involves central and states GST collection the result has proved that. States revenue has increased. the collections averaged around 1,00,000 crore which grew up to 1.5 lakh crore. time pattern of GST revenues considers the several changes over the

GST regime. Pre GST regime which underneath that covers Varies from state GDP steady state regime one option to abolish the cess. the collections is no more would be only for stage it is shared 50: 50 The central and states. (Varun Agarwal)

CA Dr. Marzun E Jokhi elaborates Indirect tax (GST Goods and services tax in the new era) ..The GST is a plan focused to combine all the taxes into a single tax with a consistency in levying the ITC on both goods and services, Indirect taxes such as Excise duty, custom duty, VAT, ,Service tax others are the tools in the control of the government to contribute to the economy of the country where the GST has combined all the above taxes. Indirect taxes cover a large part of overall taxes paid. (CA Urvish Patel)

Bhaivik V. Swadia Has been analysed the perception of a chartered accountant in GST adoption furtherly CGST/SGST/IGST Provided a clear picture. To segregate the GST among central and state based on the supply of goods or services. Chartered Accountants trusts on the executives who will not invest a huge budget on planning budgeting forecasting and management reporting when GST is adopted .CA believes implementation of GST will not develop major business opportunities. (Swadia)

Dr. S. V. Ramana Rao has overviewed the input tax credit in India. GST is the reform of the government of India. The final consumer has to bear the GST taxable. The author finalized that there are 17 indirect taxes and 23 types cesses. Taxes are levied at every stage of value addition in the supply chain starting from manufacturer to consumer. Pre GST came into existence cross credit of VAT against. the major benefit of GST is eliminating the cascading effect. (Rao)

According to **Dr. Himanshu Thakkar** Good And service tax is an effective way of rising revenue of the comment but also faces problem on GST input tax credit ITC fraud Most developing nations collect indirect tax from the consumers they're still developing and they want to increase their tax base by collecting taxes like goods and service tax as per the disclosure in the parliament by the finance ministry from July 2017 to February 2023 there are close to Rs 3.08 lakhs core. In the context of goods and service tax (GST) and value added tax (VAT) circular trading typically involves a series of transactions that create an artificial chain of supply it is done to claim the tax benefits such as ITC or Vat credits. GST fraud has been increasing in India an inspiring a deeper understanding of its mechanism to minimize its impact The enforcement wing of GST department should invest artificial intelligence machine learning and fraud analytical tools to identify GST fraud too early stages for better results in GST department can give internship up an opportunity to students of business senator analytics and intelligence and cyber security management. (Thakkar)

According to **Dr.N. Ramalingam** the Goods and service tax Asian is the second-generation reforms in indirect tax in India GST operates under the principle and the system of value added tax The right system becomes attractive worldwide because of fits in irritate advantage that is input tax credit ITC the taxpayer will get the credit for the tax paid on in these are our product of goods or service. Central government under this system form this series transactions the total tax revenue derived is rupees 138 remitted Has exercise duty by the manufacturer only. state comment on the seams state comments on tax revenue of collected at two stages that is tax remitted by raw materials suppliers and the manufacturers. (Ramalingam)

According to **Prof. Dr Rupa Khanna Malhotra, Rakesh Kumar** the Composition came under goods and service tax reduce the burden for compliance and to small taxpayers This game is applicable up to the 1.5 crore an 75 LAX in special states in the preceding financial year composition scheme limits number of benefits like input tax credit is not applicable under this scheme However compositions key person can count of will input tax credit and can't shift burden of GST on the customers However under the composition scheme there was no input tax credit facility available to the dealers composition scheme can be opt only by those person was turn over 1.5 gross and 75 relax in special case category states for manufacture goods and 50 lacs for services composition scheme can't be v availed Bye Interstate supply casual taxpayers e-commerce an non-resident person tobacco find masala and ice cream businesses Composition scheme is mainly meant for small businesses. (Dr. Rupa Khanna Malhotra)

According to **Ms. Priti Jadhav, Ms. Manjushree Yewale, Ms. Trupti Kalyankar, Mrs. Vandana Nemane** the Commerce as anything that involves an online transaction he almost provides multiple benefits to the customers in the form of availability of goods at a lower cost wider choice and saves their time Goods and service tax or GST as it is known is all set to be a game changer for the Indian economy power all it is known to be beneficial to both the consumer and business and the government Indian e-commerce market is estimated to have could I strip is 211005 crore in December 2016 as per the study conducted by the Internet and mobile association of India the report further claimed that India is expected to generate $100 billion online retail revenue by the year 2020 All the businesses carrying out e-commerce activity are required to generate under GST irrespective of their turnover no benefit under composition scheme GST that impacted the e-commerce sector is as follows

1. No trade barriers one nation one tax
2. Tax collection at sources
3. Increase in compliance is for e-commerce operators
4. Mandatory registration for sellers an unavailability for composition scheme
5. Increase in credits

As we can see the GST law may have a negative impact on the e-commerce sector given that the common sector in India is one of the most rapidly advancing sector Andy government is promoting the economy The GST law should provide an enabling environment that encourages e-commerce operators and suppliers. (Nemane)

6. The manufacturing sector might be revived under the focused efforts of regime and by an implementation of GST regime that could even lead to experience a paradigm shift from an agrarian economy to manufacture and accommodation predicated economy. An intricate tax structure, inadequate infrastructure, and bureaucracy diminishing its capability to perform well on an ecumenical scale engulf the

manufacturing sector in India. The manufacturing sector of any country is a major economic driver for the developing economies across the globe. The implementation of goods and accommodations tax (GST) is consequently critical and compulsory to give a boost to an already flagging sector. Our first update on the impact of GST in the e-commerce sector can be accessed from here**. Dr. Pawan Kumar Singh, Sunil Kumar Agrahari** have made a study on the following industry's Cement industry, automobile industry, IT industry, telecom sector, banking and financial sector, Pharmacy industry, textile and garment industry, automobile and battery industry etc. The advantages of having GST is removal of multiple tax, entry tax sub summation will reduce cost of production, Improved cash flow and etc. In the world every country has the sum of financial or aid to the manufacturing industry. Be that as it may, concerns stay on particular issues, for example, the extra 1% cause impose, expanded income issues by virtue of GST payable on stock exchanges, and expanded costs attributable to prohibition of oil powers from the ambit of GST. The Government should look into these issues in more detail if it's keen to promote its 'Make in India' initiatives. However, concerns remain on specific issues such as the additional 1% origin tax, increased cash flow issues on account of GST payable on stock transfers, and increased costs owing to exclusion of petroleum fuels from the ambit of GST. (Agrahari, 2017)

7. According to **Dr. Laksh Kaushik Dattatraya Puri** integrating goods and services taxation is a world class tax system as it increases tax revenue in major economies like India. It is a significant breakthrough towards comprehensive indirect tax reform in India. GST is a tax on goods and services with continuous and comprehensive set-off benefits from the producer's point to the service provider's point, all the way to the retailer. It is a tax on the value added at each stage. Therefore, the final consumer bears only the GST charged by the last dealer in the supply chain, with set-off benefits at all previous stages. For small businesses, GST compliance involves greater time, costs and energy as compared to larger companies. This impacts them much more as compared to the bigger companies. Therefore, some relaxation benefits are necessary in order to help them cope with sudden increase / change in compliance challenges. Impact of GST is starting a business is now easy, single market, Service Provider's High Tax Rate Burden, Reduced Logistics Overhead, and etc. GST has made the MSMEs more competitive and the playing arena level between big enterprises and them. Additionally, the Indian MSMEs are now be able to compete with the international market goods and competition coming from cheap price epicentres such as China, Philippines, and Bangladesh and actually thrive in the world market scenario. (Puri, 2022)

8. **Anant Bapurao** As discussed, the aspects and pitfalls of SEZ on rural economy of Maharashtra the special economic zone is a region that consists of economic laws that are liberal compared to than other countries economic laws. He has been. analysed about the aspects of SEZ on rural economy that detailed about the direct employment generation and indirect employment generation and the employment generation for

women and technology upgrading effects and their living condition. The impact on local employment and the generation of the job opportunities for the regional population. He has analysed the investment in SEZ's That the most economics are motivated to bring in foreign multinational enterprises. he also explains in brief about the regional development displacement compensation and rehabilitation land acquisition and corruption and Direct tax code (DTC) impact. (Salave)

9. **Amanjot Kaur** Has stated that the country's major national income has been Tax. He also analysed that the goods and services which are applicable to the old country which is known as one nation one tax which is being combined into single Tax. He has also been analysed that the benefits of GST that is being reducing the cascading of various taxes and providing a universal national market and to restrain tax evasion and reducing the overall prices that helps in protecting the domestic industry. his analysis and researches elaborate about the E way bills and the graphical representation of the collections of GSTs over the period of 2020 -2024 and also the precise data of the domestic i.e State wise contribution for the financial year 2023-24. (Salave)

10. Jerome Joseph Has been briefed the GST which was implemented on 1st July 2017, most significant Indirect tax. He has analysed the statewide revenue performance of GST from the past six years. he also includes the composition of GST revenue collection across states and includes the SGST and the settlement of IGST by the central Government. Exactly produced the data of the pre and post GST revenue growth and the rate of each state among the country and also the pre and post GST tax to GST You have beautiful bags to the GDP ratio of states. He also analysed the tax buoyancy that measures the response of the income both to difference in the national income and to difference in tax policies over time. The policymakers and the government are paid the revenue that is interest as the major component of Tax system. (Jerome Joseph, 2023)

GST in the state of Maharashtra and Karnataka

Maharashtra, with a 19.6 per cent share in all-India Goods and Services Tax (GST) collection in fiscal 2024 (April-February), is the top contributor to the GST pool, as per latest data on collections across Indian states, cementing its position as the country's economic powerhouse. A Crisil report released on April 11, 2024 reveals that after Maharashtra, Karnataka was the second biggest contributor to the GST pool. "Maharashtra's dominance is not just in terms of absolute GST collection, but also when looked at from a per capita perspective," said the report, titled Quickonomics by Crisil. "Normalized for population size, Maharashtra tops the ranking, indicating the intensity of consumption spending in the state."

In the fiscal year 2023–24, Maharashtra's GST collection surpassed Rs 3 lakh crore, marking the first time this milestone has been reached since the introduction of the Goods and Services Tax system. As per the Deputy Commissioner of Taxation in Mumbai, the state's Goods and Services Tax (SGST) collection for the year amounted to Rs 3.2 lakh crore, reflecting a notable 18% surge compared to the previous year.

Month Year	National Gross Revenue Collected (Rs. In crores)	Maharashtra Rs. In crores	Karnataka Rs. In crores
Sep-23	1,62,712	72,741	36,162
Oct-23	1,72,003	84,712	42,657
Nov-23	1,67,929	96,551	48,766
Dec-23	1,64,882	1,08,887	54,881
Jan-24	1,72,129	28,342	13,320
Feb-24	1,68,337	27,065	12,812
Mar-24	1,78,000	27,688	13,014
Apr-24	2,10,267	37,671	15,978
May-24	1,72,739	26,854	11,889
Jun-24	1,73,812	28,881	12,389
Jul-24	1,82,075	28,970	13,051
Aug-24	1,74,962	26,367	12,344
Sep-24	1,73,240	26,369	12,642

Source: www.pib.gov.in

Data analysis and interpretation

Month-Year	**National Gross Revenue Collected (Rs. In crores)**	**Growth Rate %**	**Maharashtra (Rs. In crores)**	**Growth Rate %**	**Karnataka (Rs. In crores)**	**Growth Rate %**
Sep-23	162712	5.71%	72741	16.46%	36162	17.961 %
Oct-23	172003	-2.37%	84712	13.98%	42657	14.321 %
Nov-23	167929	-1.81%	96551	12.78%	48766	12.539 %
Dec-23	164882	4.40%	108887	-73.97%	54881	-75.729 %
Jan-24	172129	-2.20%	28342	-4.51%	13320	-3.814%
Feb-24	168337	5.74%	27065	2.30%	12812	1.577%

Mar-24	178000	17.98%	27688	36.06%	13014	22.775 %
Apr-24	210000	- 31.27%	37671	- 28.71%	15978	- 25.591 %
May-24	144329	6.61%	26854	7.55%	11889	4.206%
Jun-24	153867	7.75%	28881	0.31%	12389	5.343%
Jul-24	165793	-9.22%	28970	-8.99%	13051	-5.417%
Aug-24	150501	1.52%	26367	0.01%	12344	2.414%
Sep-24	152782		26369		12642	
Standard Deviation	16341.49095		30927.81997		16181.91628	
Average	166404.9231		47776.76923		23069.61538	
Variance	246502455.1		882950813.9		241711767.3	

Analysing Growth Rates: A Visualization of National and State Trends

In today's data-driven environment, visualizing economic indicators is crucial for understanding trends and making informed decisions. The provided Python code in the reference section utilizes the Pandas library for data manipulation and Matplotlib for data visualization, focusing on the growth rates of three key regions: the national level, Maharashtra, and Karnataka. This analysis aims to present a clear picture of growth trends over time, facilitating better comprehension of economic performance across these regions.

Data Preparation

The initial step in the analysis involves preparing the dataset. The code extracts the "Month-Year" index from the Data Frame, which is already in a datetime format. This conversion is essential as it allows for accurate plotting of time series data. Following this, the growth rates for the national level, Maharashtra, and Karnataka are extracted into separate NumPy arrays after dropping any missing values. This ensures that only complete data points are considered in the analysis, enhancing the reliability of the results.

Visualization of Growth Rates

The core of the analysis lies in visualizing these growth rates over time. A figure with a specified size is created to ensure clarity and readability. Each growth rate is plotted as a line graph with distinct markers to represent different regions:

- National Growth Rate: Represented with a specific colour from Matplotlib's Set2 colormap.
- Maharashtra Growth Rate: Plotted alongside the national rate, using a different colour for differentiation.
- Karnataka Growth Rate: Similarly represented with its unique colour.

This multi-line plot allows for an immediate visual comparison of growth trends across these regions.

Adding Trendlines

To provide further insights into the data, trendlines are added to each growth rate series. Using NumPy's polyfit function, linear regression is applied to calculate the best-fit line for each dataset. The resulting polynomial functions are then plotted as dashed lines on the same graph. These trendlines serve to highlight overall growth patterns and can indicate whether a region's growth is accelerating or decelerating over time.

Enhancing Clarity

To improve the interpretability of the graph, several enhancements are made:

- Axis Labels: Clear labels for both axes are included to specify what is being measured.
- Title: A descriptive title summarizes the content of the graph.
- Legend: A legend differentiates between the various growth rates, ensuring viewers can easily identify each line.
- Grid Lines: The addition of grid lines aids in reading values more accurately from the graph.
- X-axis Rotation: The month-year labels on the x-axis are rotated for better visibility and to prevent overlap.

The visualization produced by this code effectively conveys important information regarding economic growth trends at both national and state levels. By leveraging Python’s powerful libraries, analysts can create insightful graphics that facilitate understanding of complex data sets. This approach not only aids stakeholders in making informed decisions but also enhances communication regarding economic performance across different regions. As businesses and policymakers navigate economic landscapes, such visualizations will continue to play a pivotal role in strategy formulation and performance assessment.

Exploring GST Revenue Trends: An Analysis of National and State Data

Introduction to the conceptual data

In the context of India's economic landscape, the Goods and Services Tax (GST) has emerged as a significant reform aimed at simplifying the tax structure and enhancing revenue collection. The analysis of GST revenue trends over time provides valuable insights into the economic health of the nation and its individual states. This essay delves into the data produced by a Python script that visualizes GST revenue collections and growth rates for the national level, as well as for the states of Maharashtra and Karnataka, over a one-year period from September 2023 to August 2024.The data analysis is conducted using Python libraries such as Pandas for data manipulation, Matplotlib for basic plotting, and Seaborn for more sophisticated visualizations. The focus will be on understanding revenue trends, growth rates, and comparative analysis between the national figures and those of Maharashtra and Karnataka.

Data Overview

The dataset comprises monthly GST revenue figures and growth rates for three entities:

- National Gross Revenue
- Maharashtra Revenue
- Karnataka Revenue

Month-Year	National Gross Revenue	Maharashtra Revenue	Karnataka Revenue	National Growth Rate (%)	Maharashtra Growth Rate (%)	Karnataka Growth Rate (%)
Sep-23	162712	72741	36162	5.71	16.46	17.96
Oct-23	172003	84712	42657	-2.37	13.98	14.32
Nov-23	167929	96551	48766	-1.81	12.78	12.54
Dec-23	164882	108887	54881	4.40	-73.97	-75.73
Jan-24	172129	28342	13320	-2.20	-4.51	-3.81

Feb-24	168337	27065	12812	5.74	2.30	1.58
Mar-24	178000	27688	13014	17.98	36.06	22.78
Apr-24	210000	37671	15978	-31.27	-28.71	-25.59
May-24	144329	26854	11889	6.61	7.55	4.21
Jun-24	153867	28881	12389	7.75	0.31	5.34
Jul-24	165793	28970	13051	-9.22	-8.99	-5.42
Aug-24	150501	26367	12344	1.52	0.01	2.41

Data Cleaning
Before visualizing the data, it is essential to clean it by removing any rows with missing values in the growth rate columns to ensure accurate analysis.

Visualization of Revenue Trends
National vs State Revenue Collections

The first step in our analysis is to visualize the revenue collections over time for each entity using line graphs.

National Gross Revenue
The national gross revenue shows a generally upward trend with fluctuations throughout the year:
- Starting at **Rs.162712 crores** in September, it peaks at **Rs.210000 crores** in April.
- The revenue dips significantly in May to **Rs.144329 crores**, indicating potential seasonal effects or economic downturns.

Maharashtra Revenue
Maharashtra's revenue exhibits a more volatile pattern:

- The state starts strong with **Rs.72741 crores** in September but experiences a dramatic drop to **Rs.28342 crores** in January.
- A recovery occurs in March with **Rs.27688 crores**, followed by another peak in April at **Rs.37671 crores**.

Karnataka Revenue

Karnataka's revenue also shows fluctuations but remains lower than that of Maharashtra:

- Beginning at **Rs.36,162 crores**, it reaches a high of **Rs.15,978 crores** in April.
- The state's revenue remains relatively stable compared to Maharashtra, with minor variations.

Comparative Analysis of Growth Rates

Visualizing growth rates provides insights into how each region's revenue is changing relative to previous periods.

National Growth Rate

The national growth rate fluctuates significantly:

- It starts positively at **5.71%** but experiences negative growth in October and November.
- A notable spike occurs in March at **17.98%**, indicating strong recovery, followed by a sharp decline of **-31.27%** in April.

Maharashtra Growth Rate

Maharashtra's growth rate illustrates extreme volatility:

- The state begins with a robust growth rate of **16.46%**, but this plummets to **-73.97%** in December.
- A recovery is noted in March with a growth rate of **36.06%**, which is impressive but followed by another decline.

Karnataka Growth Rate

Karnataka's growth rate follows a similar pattern but is less extreme:

- It starts at **17.96%** and experiences a significant drop to **-75.73%** in December.
- The state shows resilience with positive growth rates returning by March (**22.78%**) before declining again.

Heatmap Analysis

To further analyse the comparative performance across regions, a heatmap visualization can be employed.

Heatmap Insights

The heatmap provides an immediate visual representation of revenue trends:

- Darker shades indicate higher revenues, while lighter shades represent lower revenues.
- The heatmap clearly illustrates that while national revenues are generally higher, Maharashtra's revenues fluctuate significantly, indicating periods of both high performance and severe downturns.

Factors Influencing Revenue Trends

Understanding the underlying factors that influence these trends is crucial for interpreting the data effectively.

Economic Factors

1. **Seasonality**: Certain months may naturally see fluctuations due to seasonal business cycles or holiday spending patterns.
2. **Policy Changes**: Changes in tax policy or implementation of new regulations can impact revenue collections significantly.
3. **Economic Conditions**: Broader economic conditions such as inflation, employment rates, and consumer confidence can directly affect GST collections.

Regional Factors

1. **Business Activity**: Variations in business activity levels between states can lead to differences in GST collections; states with more robust industrial sectors might show higher revenues.
2. **Population Density**: States like Maharashtra, with high population density, may generate higher revenues due to increased consumption compared to less populated states like Karnataka.
3. **Infrastructure Development**: States investing heavily in infrastructure may experience higher economic activity leading to increased GST collections.

Introduction based on regression-based forecasting and monte Carlo simulation

GST collections serve as a critical indicator of a state's economic performance and fiscal health. By analysing historical data and predicting future trends, policymakers can make informed decisions to optimize revenue streams and assess economic resilience. This study employs machine learning-based regression modelling to predict GST collections for Maharashtra and Karnataka from 2024 to 2027, complemented by Monte Carlo simulations to establish ideal growth patterns. The simulation accounts for variability in economic conditions, reflecting realistic growth scenarios within specified ranges.

Methodology

The methodology involves two key stages: regression-based forecasting and Monte Carlo simulation.

1. **Regression-Based Forecasting**: Using historical data from 2017 to 2023, linear regression models predict GST collections for the years 2024 to 2027. The simplicity of linear regression ensures computational efficiency while capturing overall trends.
   - **Input Data**: The dataset consists of GST collections from 2017 to 2023 for Maharashtra and Karnataka.
   - **Regression Modelling**: Separate regression models for each state train on the historical data, generating predictions based on trends.
2. **Monte Carlo Simulation**: Monte Carlo simulations model the ideal growth trajectory by incorporating variability in annual growth rates. This approach provides a probabilistic distribution of possible outcomes, creating a more robust framework to compare actual and predicted data.
   - **Growth Rate Ranges**: Annual growth rate ranges are predefined (e.g., 8%-12% for Maharashtra and 7%-11% for Karnataka) to simulate plausible economic conditions.
   - **Simulated Scenarios**: Over 10,000 simulations generate distributions of potential GST collections, calculating means and confidence intervals for a realistic ideal trajectory.

Results and Analysis

1. **Predicted GST Collections**: The regression models provide baseline predictions for future GST collections. Both Maharashtra and Karnataka exhibit upward trends, with Maharashtra showing slightly higher growth due to its larger economic base.
2. **Ideal Growth Trajectories**: Monte Carlo simulations reveal the ideal mean growth trajectory for each state. Confidence intervals (90%) offer a range of possible outcomes, providing insight into expected variability.
   - **Maharashtra**: The ideal trajectory closely aligns with historical trends, suggesting sustained economic performance.
   - **Karnataka**: Slightly lower growth rates reflect Karnataka's smaller base but still demonstrate significant upward momentum.
3. **Comparative Insights**: Overlaying actual, predicted, and ideal trajectories highlights discrepancies and potential areas for policy intervention. Deviations from ideal growth could indicate economic slowdowns, policy inefficiencies, or external shocks.

Visualization

The analysis incorporates 2D and 3D visualizations:

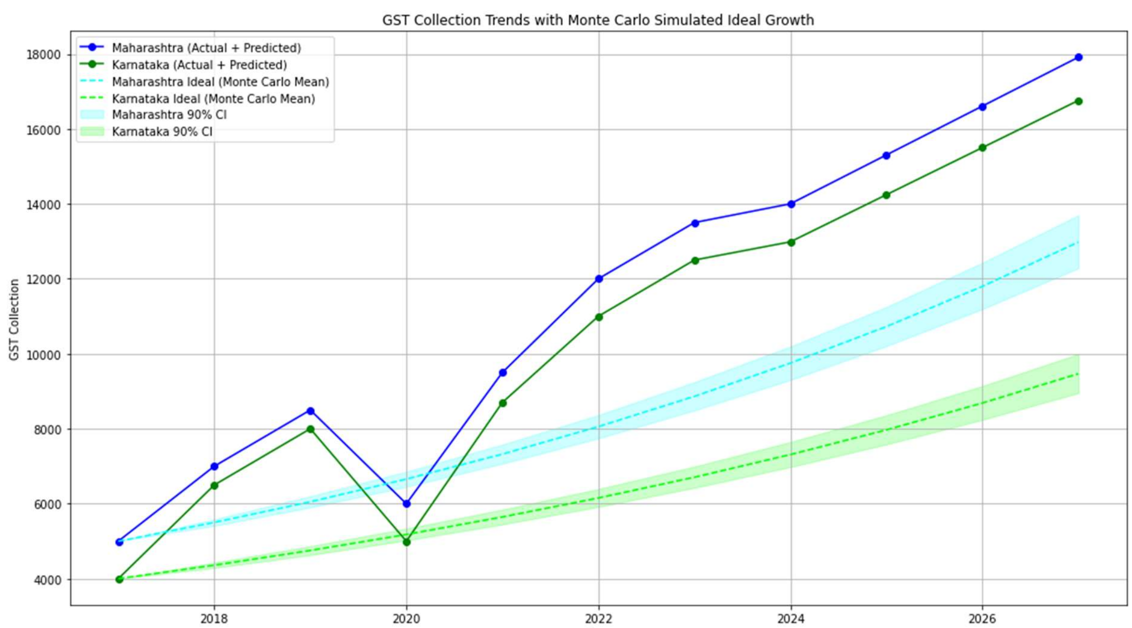
- Line plots compare actual, predicted, and simulated ideal trends.
- Confidence intervals for simulated data emphasize the robustness of the Monte Carlo approach.
- Surface plots illustrate GST trends for both states, adding dimensionality to the comparative analysis.

This study successfully demonstrates a combined approach of linear regression and Monte Carlo simulation to analyze and forecast GST collections. While regression provides deterministic forecasts, the Monte Carlo method introduces stochasticity, yielding a nuanced understanding of potential growth trajectories. This dual framework is invaluable for policymakers to evaluate fiscal strategies and address deviations from expected performance.

Future research could enhance the model by incorporating external variables such as inflation rates, GDP growth, and policy changes. Additionally, advanced machine learning techniques like time-series forecasting models could provide more granular predictions.

Implications

The insights from this research can guide state governments in Maharashtra and Karnataka in setting realistic revenue targets and crafting adaptive economic policies. The approach serves as a template for similar analyses in other regions or fiscal metrics, advancing data-driven governance. (Benedict S. M., 2024) (Benedict S. M.) (Benedict S. M., 2024) (Benedict S. M., GST Collections in Karnataka and Maharashtra India, 2024)



Final Conclusion

The analysis of GST revenue trends from September 2023 to August 2024 reveals significant insights into the economic performance at both national and state levels within India, particularly focusing on Maharashtra and Karnataka. Through effective use of Python's data visualization libraries—Pandas for data handling, Matplotlib for basic plotting, and Seaborn for advanced visualizations—we have illustrated how revenues fluctuate over time and how growth rates can vary dramatically based on numerous factors. This exploratory essay highlights not only the importance of data visualization in understanding complex economic indicators but also emphasizes the need for continuous monitoring and analysis to inform policy decisions effectively. In conclusion, understanding these trends provides stakeholders—including policymakers, businesses, and economists—with critical insights necessary for strategic planning and economic forecasting moving forward into an increasingly complex financial landscape influenced by both domestic and global factors.

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