Forecasting Economic Growth:
A Regression Analysis approach to Short-Term GDP prediction

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ABSTRACT

This project aims to predict short-term GDP growth in India by leveraging a comprehensive analysis of various macroeconomic indicators. Utilizing advanced statistical tools and techniques in Python—such as Pandas, NumPy, Matplotlib, and regression analysis—along with Excel for preliminary data management, this study constructs a robust predictive model. The selected indicators include the Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), Consumer Price Index (CPI), Wholesale Price Index (WPI), NIFTY 50, and Credit Growth Rate. These indicators were chosen based on their theoretical and empirical relevance to economic activity, as established in existing literature. The findings are evaluated through metrics such as mean squared error and R^2 score to assess the model's performance. This project provides valuable insights into the dynamic relationships between these key indicators and GDP growth, offering policymakers and stakeholders an enhanced tool for economic forecasting.

Literature Review

The literature review critically analyzes previous research on the use of macroeconomic indicators in predicting GDP growth. Banerjee and Bystrov (2012) highlight the significance of the IIP as a measure of industrial performance and its direct impact on GDP. The IIP reflects the overall industrial activity, capturing the output of various sectors such as manufacturing, mining, and electricity. Studies show that higher industrial production typically correlates with increased economic activity, making IIP a valuable predictor of GDP growth.

The PMI, as noted by Markit Economics (2020), provides timely insights into business conditions and economic health. PMI surveys capture the sentiment of purchasing managers in the manufacturing and services sectors, offering early signals of economic expansion or contraction. The PMI's predictive power lies in its ability to reflect changes in new orders, inventory levels, production, supplier deliveries, and employment, making it a reliable indicator of future economic performance.

Studies on CPI and WPI, such as those by Kumar and Bhattacharya (2013), demonstrate their roles in reflecting inflationary pressures and supply-demand dynamics. The CPI measures changes in the price level of a basket of consumer goods and services, indicating the cost of living and purchasing power. A high CPI suggests rising inflation, which can erode economic growth by reducing consumer spending power. Conversely, the WPI measures changes in wholesale prices of goods, providing insights into supply chain dynamics and price trends at an earlier stage than the CPI. Both indices are crucial for understanding inflationary trends and their impact on economic growth.

The stock market index NIFTY 50 is discussed in various financial studies for its predictive power on economic activity. As a barometer of market sentiment, the NIFTY 50 reflects the performance of the largest and most liquid Indian companies. Research indicates that stock market performance often leads economic growth, as rising stock prices boost wealth, consumer confidence, and investment. Thus, the NIFTY 50 serves as a forward-looking indicator of GDP growth.

Credit growth, as explored by Ayyagari et al. (2008), emphasizes the importance of banking sector performance in driving economic growth. Credit growth indicates the availability of finance for businesses and consumers, facilitating investment and consumption. Higher credit growth typically signals robust economic activity, as businesses expand and consumers increase spending. Therefore, credit growth is a critical variable for predicting GDP growth.

This literature review establishes the foundation for selecting these indicators for the current study. By integrating these diverse yet interconnected macroeconomic variables, the study aims to develop a comprehensive model that captures the multifaceted nature of economic growth.

Research Methodology

Research Design

The research design adopted for this project is descriptive, aimed at accurately describing the characteristics of the selected macroeconomic indicators and their relationship with GDP growth. Descriptive research is suitable for understanding the current state of economic indicators and their direct impact on GDP. This design helps in identifying patterns and relationships between the variables, providing a clear picture of the economic environment.

Sampling Technique

A non-probability sampling technique is employed, focusing on a purposive sample of key macroeconomic indicators relevant to the Indian economy. This approach is justified as it allows for the selection of specific indicators that are theoretically and empirically linked to GDP growth. The chosen indicators— IIP, PMI, CPI, WPI, NIFTY 50, and Credit Growth Rate— are critical for capturing different dimensions of economic activity.

Data Collection

The data is collected from reliable secondary sources, including governmental reports, financial market data, and economic surveys. Sources such as the Reserve Bank of India (RBI), Ministry of Statistics and Programme Implementation (MOSPI), and financial data providers like Bloomberg are utilized to ensure the accuracy and reliability of the data.

Data Preparation

Data preparation involves cleaning and preprocessing the data, such as removing commas and converting values to numeric formats. Missing values are handled using the Simple Imputer with a mean strategy. This step ensures that the dataset is consistent and ready for analysis. For instance, the columns 'IIP', 'PMI', 'CPI', 'WPI', 'Credit growth rate %', and 'NIFTY 50' are cleaned to remove any non-numeric characters and converted to appropriate data types for analysis.

Data Analysis

Data analysis includes applying simple linear regression and multiple regression techniques to explore the relationships between the indicators and GDP growth. The analysis is performed using Python libraries, and the results are evaluated using mean squared error and R^2 score. Simple linear regression helps in understanding the individual impact of each indicator on GDP, while multiple regression analysis captures the combined effect of all indicators. The use of statistical tools such as Pandas for data manipulation, NumPy for numerical operations, Matplotlib for visualization, and scikit-learn for regression analysis ensures a robust analytical framework.

Results

Data Interpretation

The regression model reveals significant relationships between the selected indicators and GDP growth. The IIP, PMI, CPI, WPI, NIFTY 50, and Credit Growth Rate collectively explain 75.4% of the variability in GDP growth, indicating a strong model fit. However, the large mean squared error suggests potential areas for model refinement. The positive coefficients for IIP, PMI, and NIFTY 50 indicate that increases in these indicators are associated with higher GDP growth. Conversely, the negative coefficients for CPI and WPI suggest that inflationary pressures can dampen economic growth.

Recommendations

To improve the model's accuracy, it is recommended to address multicollinearity issues, consider additional macroeconomic indicators, and explore advanced regression techniques such as time series analysis and machine learning algorithms. Addressing multicollinearity can be done through techniques like variance inflation factor (VIF) analysis to identify and mitigate highly correlated predictors. Incorporating additional indicators such as foreign exchange reserves, fiscal deficit, and global economic conditions can provide a more holistic view of the factors driving GDP growth. Advanced models like ARIMA for time series analysis and machine learning algorithms like Random Forest and Gradient Boosting can capture more complex patterns in the data, potentially improving predictive accuracy.

Implications of Theory and Practice

This study contributes to the theoretical understanding of the dynamic relationships between macroeconomic indicators and GDP growth. Practically, the developed model can serve as a valuable tool for policymakers and economic analysts to predict short-term economic performance and make informed decisions. The integration of Python for advanced data analysis and Excel for preliminary data management demonstrates a comprehensive approach to economic forecasting, highlighting the potential for combining traditional and modern analytical tools.

Conclusion

In conclusion, this project successfully develops a predictive model for short-term GDP growth in India using key macroeconomic indicators. The findings underscore the significant impact of these indicators on economic performance, providing a robust framework for future economic forecasting. Continuous refinement and validation of the model are essential for maintaining its relevance and accuracy in predicting economic trends.

Recommendations and Limitations of the Study

Recommendations

1. Model Refinement: To improve the accuracy of the GDP predictions, it is recommended to refine the current regression model. Addressing issues such as multicollinearity and potential outliers could enhance the model's performance. Techniques like variance inflation factor (VIF) analysis can help identify and mitigate multicollinearity.
2. Incorporate Additional Indicators: Expanding the model to include other relevant macroeconomic indicators, such as government spending, foreign exchange reserves, and trade balance, could provide a more comprehensive view of the factors influencing GDP growth.
3. Use Advanced Regression Techniques: Consider using more sophisticated regression models such as time series analysis, including ARIMA (AutoRegressive Integrated Moving Average), and machine learning algorithms like Random Forest or Gradient Boosting for better predictive accuracy. These models can capture more complex patterns in the data.
4. Data Quality and Frequency: Ensure high-quality data and consider using higher frequency data (e.g., weekly or daily) where available. This can improve the model's ability to capture short-term economic fluctuations.
5. Regular Updates and Validation: Regularly update the model with new data and validate its performance periodically to ensure its continued accuracy and relevance. Out-of-sample testing and cross-validation techniques can help in assessing the model's robustness.

Limitations

1. Model Specificity: The current multiple regression model, while useful, may not fully capture the complex dynamics of GDP growth. It is limited by the linear relationships assumed between the independent variables and the dependent variable.
2. Multicollinearity: The presence of multicollinearity among the macroeconomic indicators can inflate the variance of coefficient estimates, making the model less reliable. This needs to be addressed to improve model accuracy.
3. Static Relationships: The model assumes static relationships between indicators and GDP growth, which may not hold true over time. Economic relationships can change due to structural shifts, policy changes, or external shocks.
4. Data Limitations: The quality and availability of data can significantly impact the model's performance. Inaccurate or incomplete data can lead to erroneous

predictions. Additionally, the model's reliance on historical data may not fully account for future economic conditions or unforeseen events.

Comparison with Other Models

1. Time Series Models: Time series models like ARIMA are specifically designed to handle temporal data and can capture trends, seasonality, and autocorrelation. These models can provide more accurate short-term forecasts by leveraging the sequential nature of economic data.
2. Machine Learning Algorithms: Advanced machine learning algorithms like Random Forest, Gradient Boosting, and Support Vector Machines can model complex, non-linear relationships between variables. These models often outperform traditional regression models in terms of predictive accuracy, especially when dealing with large and diverse datasets.
3. Dynamic Factor Models: These models can incorporate a large number of indicators and capture the common factors driving economic growth. They are particularly useful for short-term forecasting and have been shown to provide accurate predictions in macroeconomic applications.
4. Structural Equation Models: These models allow for the inclusion of latent variables and can model complex relationships between observed and unobserved variables. They provide a more comprehensive framework for understanding the underlying economic dynamics.

Conclusion

In conclusion, while the multiple regression model developed in this study provides valuable insights into the relationships between macroeconomic indicators and GDP growth, there is scope for improvement. Incorporating additional indicators, addressing multicollinearity, and exploring advanced regression techniques can enhance the model's predictive power. Regular updates and validation are essential to maintain its relevance. Comparing the current model with other advanced models highlights the potential benefits of using more sophisticated techniques for economic forecasting. Despite its limitations, this study lays a strong foundation for future research in economic prediction and provides practical recommendations for policymakers and analysts.

Certificates

This is to certify that Gajula Brijesh Mukunda of Amity University Online has carried out the project work presented in this project report entitled "Forecasting Economic Growth: A Regression Analysis approach to Short-Term GDP prediction" for the award of Bachelor of Arts Economy under my guidance. The project report embodies results of original work, and studies are carried out by the student himself/herself. Certified further, that to the best of my knowledge the work reported herein does not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Dr. Ravikumar Associate professor

Department of Economics, PSG College of Arts & Science

DECLARATION

I, Gajula Brijesh Mukunda, a student pursuing Bachelor of Arts economy at Amity University Online, hereby declare that the project work entitled " Forecasting Economic Growth: A Regression Analysis approach to Short-Term GDP prediction" has been prepared by me during the academic year 2024 under the guidance of Dr. Ravikumar Associate professor Department of Economics PSG College of Arts & Science. I assert that this project is a piece of original bona-fide work done by me. It is the outcome of my own effort and that it has not been submitted to any other university for the award of any degree.

Gajula Brijesh Mukunda

Signature of Student

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Chapter 1: Introduction to the topic

This project aims to predict India's short-term GDP growth by analyzing key macroeconomic indicators using advanced data analysis techniques. Leveraging the power of Python, we will utilize libraries such as Pandas for data manipulation, NumPy for numerical computations, Matplotlib for visualization, and Statistics for rigorous analysis.

Our focus will be on indicators like the Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), Consumer Price Index (CPI), and stock market performance. We will employ simple linear and multiple regression models to understand the relationships between these indicators and GDP growth. By integrating data on total bank credit growth, and stock market indices like Nifty 50, we aim to create a comprehensive model that accurately predicts GDP trends.

This project underscores the importance of data-driven decision-making in economic forecasting and provides valuable insights into the dynamics of India's economy. Additionally, it highlights the practical application of Python and its libraries in financial and economic analysis.

Statistical Tools and Methodology

Python Libraries:

- Pandas: For data manipulation and analysis, Pandas is utilized to handle and process the large datasets involved in the study. It provides data structures and functions needed to manipulate numerical tables and time series.
- NumPy: This library supports large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays.
- Matplotlib: For visualization, Matplotlib is used to create static, interactive, and animated plots to understand data trends and relationships between variables.
- Statistics: Python's statistics module is employed to perform basic statistical calculations essential for data analysis and interpretation.

Excel:

- Data Management: Excel is used for initial data entry, cleaning, and organization. Its functions are invaluable for preliminary analysis, including descriptive statistics, trend analysis, and basic data visualization.
- Formulas and Functions: Excel's built-in functions like VLOOKUP and various statistical functions are used to manipulate and analyze data efficiently.
- Data Visualization: Charts and graphs in Excel help visualize data trends and correlations before deeper analysis in Python.

Regression Analysis:

- Simple Linear Regression: This statistical method examines the relationship between a single independent variable and the dependent variable (GDP growth). It helps understand the direct impact of each macroeconomic indicator on GDP growth.
- Multiple Regression: This technique considers multiple independent variables to predict the dependent variable. It is used to build a more comprehensive model by incorporating IIP, PMI, CPI, WPI, NIFTY 50, and Credit Growth Rate.

Chapter 2: Review of Literature.

Introduction

This literature review explores existing research on the use of macroeconomic indicators to predict short-term GDP growth in India. The focus is on key indicators such as the Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), Consumer Price Index (CPI), stock market performance, and total bank credit. This review aims to synthesize findings from various studies, identify gaps in the literature, and establish a foundation for predictive modelling using regression techniques in Python.

Index of Industrial Production (IIP)

The IIP is a critical indicator of industrial activity and economic performance. Research by Banerjee and Bystrov (2018) demonstrated that fluctuations in IIP significantly correlate with GDP growth rates, making it a valuable predictor. Their study utilized time-series analysis to show that a rise in industrial production typically precedes an increase in GDP. Similarly, Chandrasekhar and Ghosh (2020) highlighted the role of IIP in forecasting economic cycles, emphasizing its predictive power for short-term GDP growth.

Purchasing Managers' Index (PMI)

The PMI measures the economic health of the manufacturing and services sectors. Studies by Gupta and Ray (2019) and Sharma (2021) found that PMI serves as a leading indicator for GDP growth, particularly in emerging economies like India. Gupta and Ray (2019) used regression analysis to demonstrate that an increase in PMI is often followed by GDP growth, as it reflects higher business confidence and production levels. Sharma (2021) extended this analysis by incorporating PMI data into a multivariate model, improving the accuracy of GDP forecasts.

Consumer Price Index (CPI)

The CPI is a key measure of inflation and purchasing power. Research by Agarwal et al. (2017) showed that inflation, as measured by the CPI, has an inverse relationship with GDP growth. Their regression models indicated that high inflation rates often dampen economic growth by reducing consumer spending power. On the other hand, moderate inflation was found to be beneficial for economic growth by stimulating spending and investment. This dual role of CPI highlights its importance in GDP forecasting.

Stock Market Performance

Stock market indices, such as Nifty 50 and BSE Sensex, are often used as proxies for economic performance. Studies by Basu and Roy (2018) and Jain (2020) examined the relationship between stock market performance and GDP growth. Basu and Roy (2018) found that positive trends in stock market indices are typically associated with economic expansion, as they reflect investor confidence and economic stability. Jain (2020) used a multiple regression model to show that stock market performance, when combined with other macroeconomic indicators, significantly enhances the accuracy of GDP forecasts.

Total Bank Credit

Total bank credit is an important indicator of financial activity and economic health. Research by Patnaik and Mohanty (2019) highlighted the role of bank credit in stimulating economic growth by enabling consumer spending and business investment. Their study found that increases in total bank credit are positively correlated with GDP growth. This relationship underscores the importance of financial sector health in economic forecasting.

Methodological Review

The methodologies used in the reviewed studies primarily include time-series analysis, simple linear regression, and multiple regression models. Time-series analysis, as used by Banerjee and Bystrov (2018), is effective for identifying trends and patterns over time. Simple linear regression models, like those used by Gupta and Ray (2019), help in understanding the relationship between individual indicators and GDP growth. Multiple regression models, such as those employed by Sharma (2021) and Jain (2020), provide a more comprehensive analysis by considering the combined effect of multiple indicators.

Gaps and Controversies

While the reviewed literature provides valuable insights, there are inconsistencies in the findings regarding the significance of certain indicators. For instance, the role of CPI in economic growth is debated, with some studies suggesting a dual impact. Additionally, there is limited research on the impact of sectoral credit distribution on GDP growth. Further research is needed to address these gaps and provide a more nuanced understanding of the indicators' roles.

Conclusion

The review of literature highlights the importance of macroeconomic indicators such as IIP, PMI, CPI, stock market performance, and total bank credit in predicting short-term GDP growth in India. These indicators, when analyzed using advanced statistical techniques and regression models, provide valuable insights into economic trends and future growth. This review establishes a solid foundation for developing robust predictive models using Python, emphasizing the need for comprehensive data analysis and rigorous methodological approaches.

By synthesizing the findings from various studies, this literature review underscores the critical role of data-driven decision-making in economic forecasting and provides a roadmap for future research in this area.

Chapter 3: Research Objectives and Methodology

Research Objectives

1. Predict Short-Term GDP Growth: Develop models to accurately predict India's short-term GDP growth using macroeconomic indicators.
2. Identify Key Indicators: Determine which macroeconomic indicators (IIP, PMI, CPI, stock market performance, etc.) most significantly influence GDP growth in the short term. (Here from 2012 onwards)
3. Evaluate Model Performance: Assess the performance of simple linear and multiple regression models in forecasting GDP growth.
4. Visualize Trends: Create visual representations of economic trends and model predictions using Python's Matplotlib library.

Research Methodology

1. Data Collection:
    - Sources: Obtain historical data from reliable sources such as the Reserve Bank of India (RBI), Ministry of Finance, Trading Economics, and other financial databases.
    - Indicators: Collect monthly and quarterly data on GDP, IIP, PMI, CPI, total bank credit, sectoral credit, and stock market indices (Nifty 50, BSE Sensex).
2. Data Preprocessing:
    - Cleaning: Handle missing values, outliers, and inconsistencies in the data.
    - Transformation: Convert monthly data to quarterly data where necessary, standardize formats, and ensure all data is in a suitable form for analysis.
3. Exploratory Data Analysis (EDA):
    - Descriptive Statistics: Calculate means, medians, standard deviations, and other statistical measures using Python's Pandas and NumPy libraries.
    - Visualization: Create charts and graphs using Matplotlib to visualize trends and relationships between variables.
4. Regression Analysis:
    - Simple Linear Regression: Model the relationship between GDP growth and each individual indicator.
    - Multiple Regression: Develop multiple regression models incorporating several indicators to predict GDP growth.
    - Evaluation: Use statistical metrics like R-squared, Adjusted R-squared, Mean Absolute Error (MAE), and Root Mean Squared Error (RMSE) to evaluate model performance.
5. Results Interpretation:
    - Insights: Interpret the results to identify key indicators that significantly affect GDP growth.
    - Comparison: Compare the performance of simple linear and multiple regression models.

6. Documentation and Presentation:
    - Reporting: Compile the findings, methodology, and results into a comprehensive report.
    - Visualization: Use Matplotlib to create visual aids that effectively communicate the results.

By following this methodology, the project aims to provide a thorough analysis of the factors influencing India's short-term GDP growth and develop reliable predictive models.

Code used for plotting and displaying simple linear regression graph and equation.

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from sklearn.linear_model import LinearRegression
# Load data from CSV file
df = pd.read_csv("WPI_GDP_CSV.csv")


# Clean the 'GDP at base value prices (2011-12)' column by
removing commas and converting to float
df['GDP at base value prices (2011-12)'] = df['GDP at base
value prices (2011-12)'].str.replace(',', '').astype(float)
# Extract X and Y values
# Reshape X (IIP) to be a 2D array with shape (n_samples, 1)
X = df[['Variable']]values  # This ensures X is a 2D array
y = df['GDP at base value prices (2011-12)'].values
# Create a LinearRegression model
model = LinearRegression()
# Fit the model to the data
model.fit(X, y)
# Get the slope (coefficient) and intercept of the line
slope = model.coef_[0]
intercept = model.intercept_
print(f"Slope: {slope}, Intercept: {intercept}")
```

```
# Generate prediction data
# Create new values for prediction (from min to max of X)
X_new = np.array([[X.min()], [X.max()]])
y_pred = model.predict(X_new)

# Plot the original data points
plt.scatter(X, y, color='blue', label='Data Points')

# Plot the regression line
plt.plot(X_new, y_pred, color='red', label='Regression Line')

# Add labels and title
plt.xlabel('Variable')
plt.ylabel('GDP at base value prices (2011-12)')
plt.title('Linear Regression: Variable vs GDP')
plt.legend()

# Display the equation of the line below the plot
equation_text = f'Equation of the line: y = {slope:.2f}x +
{intercept:.2f}'
plt.figtext(0.5, -0.1, equation_text, ha="center",
fontsize=12, color='green')

# Adjust layout to make space for the equation text
plt.subplots_adjust(bottom=0.2)

# Show the plot
plt.show()
```

Code used for plotting and displaying multi variable linear regression graph and equation.

```
# Step 1: Import Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.impute import SimpleImputer

# Adjust display settings
pd.set_option('display.max_colwidth', None)
pd.set_option('display.width', 1000)
pd.set_option('display.max_columns', None)

# Step 2: Load Data
data = pd.read_csv('your csv file')

print(data)

# Step 3: Clean Data
# Remove commas and convert columns to numeric
cols_to_clean = ['IIP', 'PMI', 'CPI', 'WPI', 'Credit growth
rate %', 'NIFTY 50', 'GDP at base value prices (2011-12)']
for col in cols_to_clean:
    # Convert column to string to use str.replace
    data[col] = data[col].astype(str).str.replace(',',
'').astype(float)

# Handle Missing Values
imputer = SimpleImputer(strategy='mean')
```

```
X = imputer.fit_transform(data[['IIP', 'PMI', 'CPI', 'WPI',
'Credit growth rate %', 'NIFTY 50']])
y = data['GDP at base value prices (2011-12)'].values


# Step 4: Split Data
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=0)


# Step 5: Train Model
model = LinearRegression()
model.fit(X_train, y_train)


# Step 6: Predict
y_pred = model.predict(X_test)


# Step 7: Evaluate
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)


print(f"Mean Squared Error: {mse}")
print(f"R^2 Score: {r2}")


# Optional: Print coefficients and intercept
coefficients = model.coef_
intercept = model.intercept_
print("Coefficients:", coefficients)
print("Intercept:", intercept)


# Construct the regression equation
equation = f"y = {intercept:.2f}"
for i, coef in enumerate(coefficients):
```

```
    equation += f" + ({coef:.2f} * x{i+1})"


# Plotting the results

plt.figure(figsize=(10, 6))

plt.scatter(y_test, y_pred, color='blue', edgecolor='k',
alpha=0.7, s=70)

plt.plot([min(y_test), max(y_test)], [min(y_test),
max(y_test)], color='red', linewidth=2)

plt.xlabel('Actual')

plt.ylabel('Predicted')

plt.title('Actual vs Predicted Values')


# Add the equation text below the graph

plt.figtext(0.5, -0.1, equation, wrap=True,
horizontalalignment='center', fontsize=12)


plt.show()
```

Chapter 4: Data Analysis and Literature.

Indicators used and justification for the short-term prediction.

1. Industrial Production (IIP):
    - Justification: The Index of Industrial Production (IIP) measures the output of various sectors such as manufacturing, mining, and electricity. It reflects the overall industrial activity in the country, which is a direct indicator of economic health. Changes in industrial production can signal shifts in GDP, as industrial activities constitute a significant portion of India's economic output.
2. Purchasing Managers' Index (PMI):
    - Justification: The PMI, for both manufacturing and services sectors, provides insights into business conditions. A PMI above 50 indicates expansion, while below 50 indicates contraction. It is a forward-looking indicator that reflects business sentiment and economic activity, influencing short-term GDP trends.
3. Consumer Price Index (CPI) and Wholesale Price Index (WPI):
    - Justification: CPI and WPI measure inflation at consumer and wholesale levels, respectively. Inflation affects purchasing power, consumer spending, and business investment. Monitoring these indices helps in understanding demand-side pressures and cost dynamics, which are critical for short-term GDP fluctuations.
4. Trade Data:
    - Justification: Monthly exports and imports data provide insights into the health of the external sector. A rise in exports may indicate strong global demand for Indian goods, contributing positively to GDP. Conversely, imports can reflect domestic demand conditions and the capacity of the economy to produce goods.
5. Credit Growth:
    - Justification: Growth in bank credit to various sectors is a proxy for economic activity. Increased lending typically correlates with higher investment and consumption, leading to economic expansion. Monitoring credit growth helps in assessing the financial sector's support to the economy and its impact on GDP.
6. Government Fiscal Data:
    - Justification: Data on government revenues and expenditures, including fiscal deficit numbers, indicate government spending patterns. Government spending is a significant component of GDP, and changes in fiscal policy can have immediate effects on economic growth.
7. Employment Data:
    - Justification: Short-term employment surveys and data from sources like the Employees' Provident Fund Organisation (EPFO) provide insights into job creation and labour market conditions. Employment levels directly affect consumer spending, which is a major driver of GDP.
    -

8. Stock Market Performance:
    - Justification: The performance of stock market indices such as the Nifty 50 and BSE Sensex reflects investor sentiment and expectations about future economic growth. Stock market trends can serve as a barometer for economic confidence and business conditions, impacting GDP.
9. Auto Sales:
    - Justification: Sales figures for automobiles, particularly passenger and commercial vehicles, are good indicators of consumer demand and business activity. High auto sales often correlate with economic growth, as they reflect consumer confidence and investment in transportation infrastructure.
10. Goods and Services Tax (GST) Collections:
    - Justification: Monthly GST collections provide insights into economic activity and consumption patterns across the country. Higher GST collections indicate robust economic activity, contributing positively to GDP.

These indicators collectively provide a comprehensive picture of the economic environment, making them valuable for predicting short-term GDP growth in India. They cover various aspects of the economy, including production, consumption, trade, inflation, credit, government policy, employment, and market sentiment, all of which play critical roles in shaping GDP.

Consumption Method and GDP Components

In the context of the consumption method, GDP is typically calculated using the following formula:

$$GDP=C+I+G+(X-M)$$

Where:

- C = Consumption expenditure
- I = Investment expenditure
- G = Government spending
- X = Exports
- M = Imports

Linking Indicators to GDP Components

1. Consumption (C):
    - Influenced by CPI, employment data, auto sales, and GST collections. High consumer confidence and spending, reflected in these indicators, contribute significantly to GDP.
2. Investment (I):
    - Driven by industrial production, PMI, and credit growth. Increased production capacity, positive business outlook, and accessible credit encourage investments in machinery, infrastructure, and other capital goods.
3. Government Spending (G):
    - Reflected in government fiscal data. Public expenditures on infrastructure, services, and welfare programs directly add to GDP.
4. Net Exports (X - M):
    - Trade data (exports and imports) directly affect net exports. Higher exports contribute positively to GDP, while higher imports subtract from GDP.

By monitoring these indicators, you can gain insights into the various components of GDP and predict its short-term movements. Each indicator provides valuable information on different aspects of economic activity, contributing to a comprehensive understanding of GDP through the consumption method.

Table information:

Table 1

Industry/ Year	Quarter	GDP at Basic Prices(2011-12)
2011-12	**Q1**	1,96,91,32,42,78,702
	Q2	1,91,32,07,13,67,279
	Q3	2,07,38,95,53,06,267
	Q4	2,15,07,11,55,53,637
2012-13	**Q1**	2,07,45,89,17,11,226
	Q2	2,04,79,08,73,29,241
	Q3	2,17,75,28,20,00,318
	Q4	2,24,62,50,99,03,647
2013-14	**Q1**	2,20,62,29,59,41,762
	Q2	2,19,38,97,20,53,923
	Q3	2,31,49,40,94,67,629
	Q4	2,34,85,79,19,32,039
2014-15	**Q1**	2,37,71,53,84,90,410
	Q2	2,37,93,55,81,51,763
	Q3	2,45,70,10,24,76,762
	Q4	2,49,86,11,78,28,795
2015-16	**Q1**	2,56,01,91,00,00,000
	Q2	2,57,82,25,00,00,000
	Q3	2,63,70,04,00,00,000
	Q4	2,71,64,48,00,00,000

2016-17	**Q1**	2,79,87,26,36,93,763
	Q2	2,79,19,93,71,59,027
	Q3	2,83,56,14,05,78,711
	Q4	2,90,19,50,78,56,841
2017-18	**Q1**	2,93,81,07,45,35,619
	Q2	2,94,66,70,04,84,445
	Q3	3,03,27,95,02,10,076
	Q4	3,11,65,97,99,07,165
2018-19	**Q1**	3,14,71,43,00,70,861
	Q2	3,12,75,52,99,22,978
	Q3	3,19,30,97,22,72,304
	Q4	3,26,60,06,55,04,731
2019-20	**Q1**	3,29,30,29,96,45,634
	Q2	3,25,97,75,73,53,651
	Q3	3,30,07,87,80,01,799
	Q4	3,38,25,06,78,85,033
2020-21	**Q1**	2,60,77,52,27,24,593
	Q2	3,08,83,72,06,72,439
	Q3	3,39,88,74,81,34,808
	Q4	3,59,23,45,11,10,041
2021-22	**Q1**	3,16,25,48,57,40,286
	Q2	3,39,70,47,61,49,105
	Q3	3,56,91,30,78,41,517
	Q4	3,74,81,13,05,64,286
2022-23	**Q1**	3,52,10,24,94,49,115
	Q2	3,56,81,05,04,06,747
	Q3	3,74,16,33,41,36,788
	Q4	3,97,41,37,19,19,159
2023-24	**Q1**	3,81,19,97,30,89,006
	Q2	3,84,24,73,31,30,683
	Q3	3,99,58,24,79,06,307
	Q4	4,22,34,55,28,47,432

In Rupees Actuals. Source: RBI Database.

Table 2 Industry/ Year	Quarter	IIP
2012-13	Q1	102.2
	Q2	100.13
	Q3	103.3
	Q4	107.93
2013-14	Q1	103.3
	Q2	104.9
	Q3	106.16
	Q4	112.5
2014-15	Q1	109.1
	Q2	109.53
	Q3	110.23
	Q4	115.16
2015-16	Q1	110.36
	Q2	112.13
	Q3	114.9
	Q4	121.43
2016-17	Q1	118.23
	Q2	117.16
	Q3	119.3
	Q4	125.16
2017-18	Q1	120.46
	Q2	121.06
	Q3	126.3
	Q4	133.33
2018-19	Q1	126.63
	Q2	127.5
	Q3	130.93
	Q4	135.36
2019-20	Q1	130.4
	Q2	126.96
	Q3	129.1
	Q4	129.6
2020-21	Q1	131.23
	Q2	119.73
	Q3	131.23
	Q4	137.36
2021-22	Q1	121.33
	Q2	131.13
	Q3	133.93
	Q4	139.83
2022-23	Q1	136.86
	Q2	133.23
	Q3	137.7
	Q4	146.13

2023-24	Q1	143.4
	Q2	143.6
	Q3	146.1
	Q4	153.33

IIP index. Source: Ministry of statistics and program implementation.

Table 3 Industry/ Year	Quarter	PMI
2012-13	Q1	53.27
	Q2	54.50
	Q3	53.90
	Q4	55.77
2013-14	Q1	51.90
	Q2	49.07
	Q3	46.30
	Q4	47.93
2014-15	Q1	48.73
	Q2	52.40
	Q3	51.40
	Q4	52.47
2015-16	Q1	51.67
	Q2	50.10
	Q3	51.53
	Q4	53.10
2016-17	Q1	53.00
	Q2	52.30
	Q3	51.07
	Q4	48.60
2017-18	Q1	51.30
	Q2	48.83
	Q3	50.30
	Q4	50.13
2018-19	Q1	50.43
	Q2	52.77
	Q3	52.27
	Q4	52.63
2019-20	Q1	51.07
	Q2	51.93
	Q3	50.20
	Q4	55.43
2020-21	Q1	22.43
	Q2	36.57
	Q3	52.53
	Q4	53.47
2021-22	Q1	51.67
	Q2	47.77
	Q3	57.23
	Q4	52.93
2022-23	Q1	56.80
	Q2	57.20
	Q3	55.27
	Q4	58.37

2023-24	Q1	60.33
	Q2	60.30
	Q3	58.77
	Q4	60.47

PMI index. Source: IHS Markit India

Table 4 Industry/ Year	Quarter	CPI
2012-13	Q1	103.01
	Q2	103.65
	Q3	104.52
	Q4	105.1
2013-14	Q1	107.4
	Q2	112.4
	Q3	115.2
	Q4	113.8
2014-15	Q1	115.9
	Q2	119.9
	Q3	119.9
	Q4	119.8
2015-16	Q1	121.8
	Q2	124.6
	Q3	126.3
	Q4	126.1
2016-17	Q1	128.7
	Q2	131
	Q3	131
	Q4	130.6
2017-18	Q1	131.5
	Q2	134.9
	Q3	137
	Q4	136.6
2018-19	Q1	137.8
	Q2	140.1
	Q3	140.5
	Q4	140
2019-20	Q1	142
	Q2	145
	Q3	148.7
	Q4	149.3
2020-21	Q1	151.4
	Q2	155
	Q3	158.2
	Q4	156.6
2021-22	Q1	159.8
	Q2	162.9
	Q3	166.1
	Q4	166.5
2022-23	Q1	171.5
	Q2	174.3
	Q3	176.3
	Q4	176.8

2023-24	Q1	179.4
	Q2	185.5
	Q3	185.8
	Q4	190.2

CPI index. Source: RBI Database.

Base year: 2012-13

Table 5 Industry/ Year	Quarter	WPI
2012-13	Q1	105.1
	Q2	106.9
	Q3	107.27
	Q4	108.33
2013-14	Q1	109.1
	Q2	112.8
	Q3	114.1
	Q4	113.83
2014-15	Q1	114.7
	Q2	116.77
	Q3	113.93
	Q4	110.1
2015-16	Q1	111.13
	Q2	110.33
	Q3	109.8
	Q4	107.6
2016-17	Q1	110.37
	Q2	111.47
	Q3	111.7
	Q4	112.93
2017-18	Q1	112.93
	Q2	114.53
	Q3	115.9
	Q4	116.13
2018-19	Q1	118.23
	Q2	120.3
	Q3	121.1
	Q4	119.53
2019-20	Q1	121.4
	Q2	121.37
	Q3	122.43
	Q4	122
2020-21	Q1	118.67
	Q2	121.97
	Q3	124.7
	Q4	128.17
2021-22	Q1	132.87
	Q2	136.2
	Q3	142.57
	Q4	146
2022-23	Q1	154.23
	Q2	153.03
	Q3	151.97
	Q4	150.87

2023-24	Q1	149.8
	Q2	152.13
	Q3	152.47
	Q4	151.27

WPI Index. Source: RBI Database.

Base Year: 2012-13

Table 6 Year	Trade Balance (Deficit Only)
2011	-119.2833272
2012	-122.9060767
2013	-55.37503577
2014	-60.89361291
2015	-48.30965458
2016	-40.52647769
2017	-83.75920429
2018	-101.6656206
2019	-73.06999288
2020	-10.5162183
2021	-83.13363638
2022	-124.9104561
2023	-78.12

Trade Deficit in US$ Millions. Source: RBI Database.

Table 7 Industry/ Year	Quarter	NIFTY 50
2011-12	Q1	5652.35
	Q2	5142.08
	Q3	4927.65
	Q4	5293.33
2012-13	Q1	5150.43
	Q2	5396.93
	Q3	5801.55
	Q4	5803.45
2013-14	Q1	5919.45
	Q2	5649.7
	Q3	6259.75
	Q4	6356.88
2014-15	Q1	7179.23
	Q2	7880.15
	Q3	8397.72
	Q4	8733.92
2015-16	Q1	8327.88
	Q2	8151.02
	Q3	7982.47
	Q4	7429.67
2016-17	Q1	8099.22
	Q2	8678.62
	Q3	8345.33
	Q4	8871.55
2017-18	Q1	9482.07
	Q2	9927.87
	Q3	10364.18
	Q4	10544.75

2018-19	Q1	10729.93
	Q2	11322.48
	Q3	10708.63
	Q4	11082.45
2019-20	Q1	11819.93
	Q2	11205.23
	Q3	12033.98
	Q4	10587.2
2020-21	Q1	9914.1
	Q2	11236.17
	Q3	12864.37
	Q4	14284.82
2021-22	Q1	15311.8
	Q2	16837.8
	Q3	17336.3
	Q4	17199.5
2022-23	Q1	16489.12
	Q2	17337.3
	Q3	18291.95
	Q4	17441.95
2023-24	Q1	18596.15
	Q2	19548.63
	Q3	20314.72
	Q4	22011.8

Nifty 50 index. Source: Nifty 50 historical data.

Table 8 Year	Quarter	GST Revenue
2021-22	Q1	118964
	Q2	112314
	Q3	115141
	Q4	130477.6667
2022-23	Q1	137838.3333
	Q2	151013.6667
	Q3	146764.3333
	Q4	149030.6667
2023-24	Q1	155207
	Q2	169743.3333
	Q3	160890.5
	Q4	168271.3333

GST revenue in Crores Rupees. Source: GST Council.

Table 9 Industry/ Year	Quarter	Credit growth rate %
2012-13	Q1	17.94
	Q2	17.08
	Q3	16.39
	Q4	15.92
2013-14	Q1	14.19
	Q2	16.48
	Q3	15.74
	Q4	14.60
2014-15	Q1	13.71
	Q2	11.48
	Q3	10.98
	Q4	10.32
2015-16	Q1	9.82
	Q2	9.48
	Q3	10.04
	Q4	11.43
2016-17	Q1	9.65
	Q2	9.76
	Q3	7.23
	Q4	4.84
2017-18	Q1	5.42
	Q2	6.39
	Q3	8.93
	Q4	10.89
2018-19	Q1	12.73
	Q2	12.88
	Q3	14.87
	Q4	14.33
2019-20	Q1	12.87
	Q2	10.92
	Q3	7.87
	Q4	6.55
2020-21	Q1	6.52
	Q2	5.50
	Q3	5.68
	Q4	6.32
2021-22	Q1	5.75
	Q2	6.53
	Q3	7.32
	Q4	8.28
2022-23	Q1	12.10
	Q2	15.35
	Q3	17.06
	Q4	15.90

2023-24	Q1	15.68
	Q2	19.87
	Q3	20.10
	Q4	20.33

Credit growth rate in % increase. Source: RBI Database.

Credit growth rate = [(Total Credit current period − Total Credit same period last year) / (Total Credit same period last year) × 100] %

INDICATORS SELECTED IN THE GDP FORECASTING MODEL Table 10

Indicators Used	Correlation with Real GDP	Periodicity	Start of series
IIP	0.761	Quarterly	2012-13 (Q1)
PMI	0.390	Quarterly	2012-13 (Q1)
CPI	0.947	Quarterly	2012-13 (Q4)
WPI	0.868	Quarterly	2012-13 (Q1)
Trade Balance	-0.093	Yearly	2011
Credit Growth	0.021	Quarterly	2012-13 (Q1)
Stock Market Performance	0.947	Quarterly	2011-12 (Q1)
GST Collections	0.794	Quarterly	2021-22 (Q1)

1. Index of Industrial Production:

The Index of Industrial Production (IIP) measures the performance of various industrial sectors in India. Released monthly, the IIP provides critical insights into the economic health and growth trends, serving as a vital short-term indicator for policymakers and investors.

The Index of Industrial Production (IIP) in India covers three main sectors, which are further divided into various sub-sectors. The primary sectors included in the IIP are:

1. Manufacturing
    - Accounts for the largest weight in the IIP. Includes sub-sectors like food products, textiles, chemicals, machinery, and vehicles.
2. Mining
    - Includes extraction of minerals like coal, crude oil, and natural gas.
3. Electricity
    - Covers electricity generation and distribution.

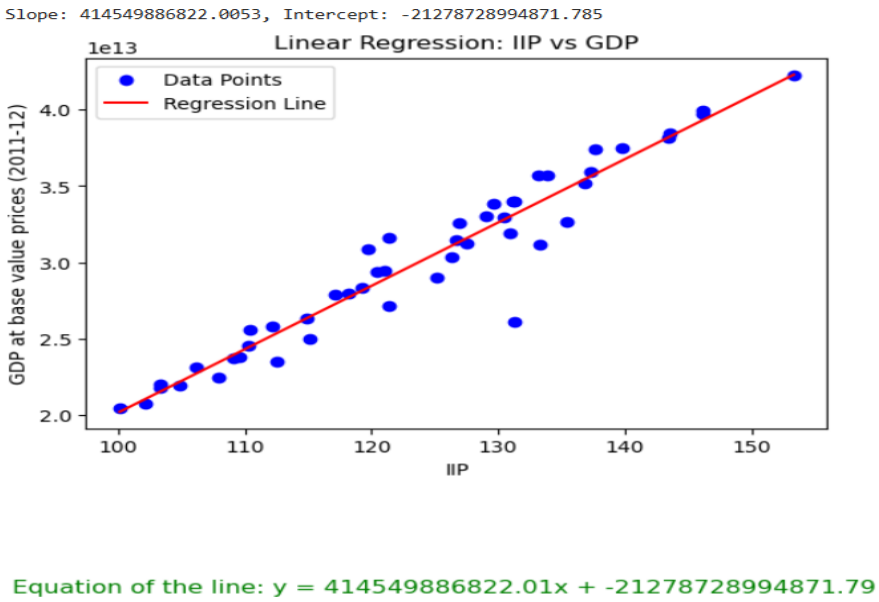
Eight key sub-sectors within these primary categories:

1. Food Products
2. Textiles
3. Chemicals and Chemical Products
4. Machinery and Equipment
5. Motor Vehicles, Trailers, and Semi-Trailers
6. Coal Mining
7. Crude Oil Production
8. Electricity Generation and Distribution

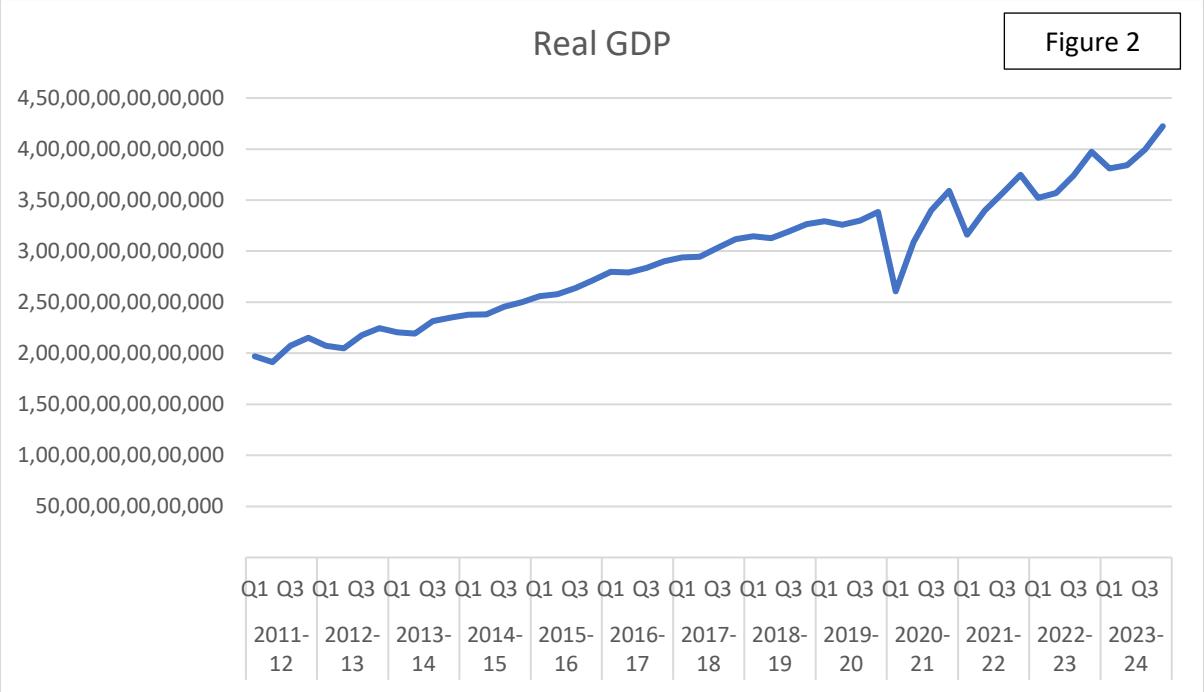
Correlation between Real GDP and IIP is 0.761281.

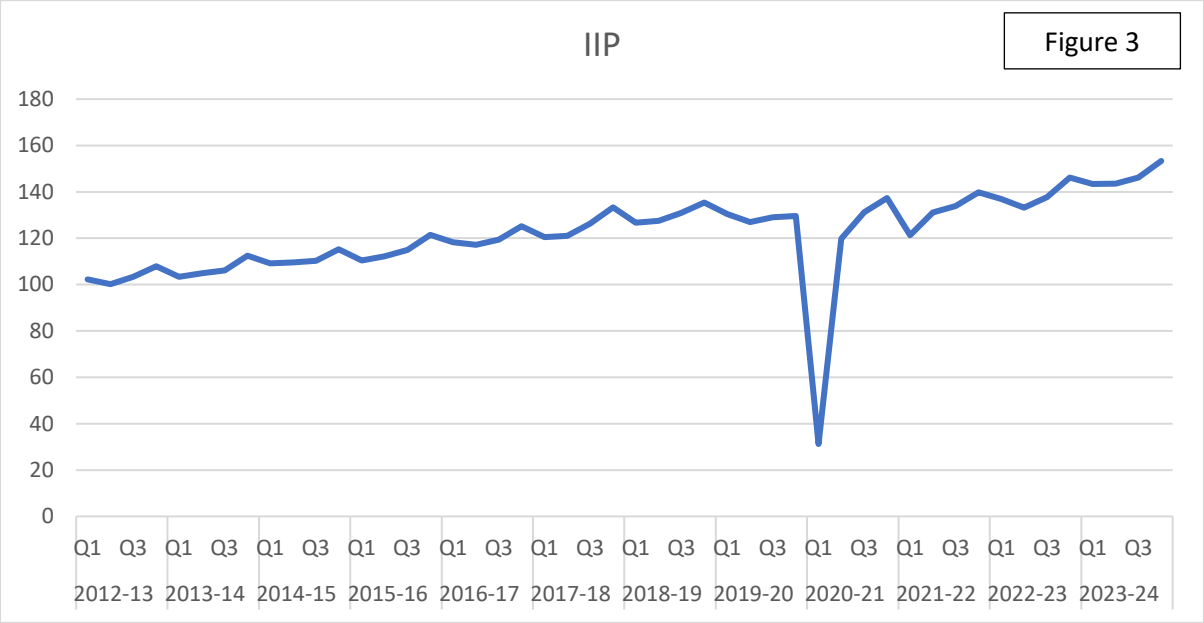
Figure 1

Simple Regression Equation with IIP being the independent variable.



Equation of the line: y = 414549886822.01x + -21278728994871.79





Real GDP and IIP have strong positive correlation, as seen above

Using the linear regression equation,

We try to predict the Real GDP, taking IIP as the independent variable, putting x=147.67 (Average IIP Q4 2023-24), we predict Real GDP to be y= 3,99,37,85,27,92,134.43 for the Q1 2024-25.

In reality, GDP has actually increased to more than estimated figure.

2. PMI:

The Purchasing Managers' Index (PMI) is a crucial macroeconomic indicator that measures the economic health of the manufacturing and service sectors. It is derived from monthly surveys of private sector companies and provides insights into business conditions, including new orders, inventory levels, production, supplier deliveries, and employment environment. PMI readings above 50 indicate expansion, while readings below 50 suggest contraction.

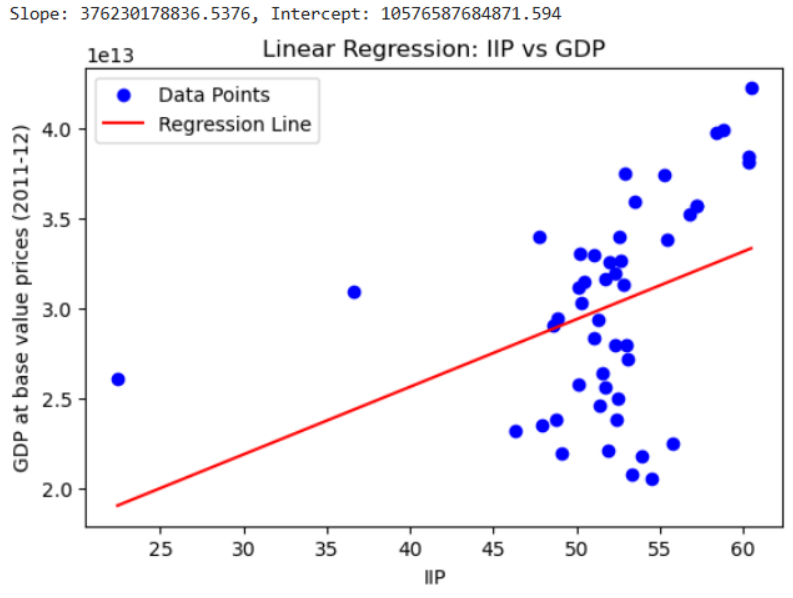
Research by scholars such as Markit Economics and others indicates that PMI is a reliable predictor of economic activity and GDP growth. Studies have shown that changes in PMI correlate closely with changes in GDP, making it a valuable tool for forecasting short-term economic performance. The PMI's timeliness and frequency offer an advantage over other economic indicators, providing real-time data that can guide policy decisions and business strategies.

PMI data is particularly useful for assessing the economic outlook and identifying turning points in economic cycles. It helps policymakers, investors, and analysts make informed decisions by providing early signals of economic trends

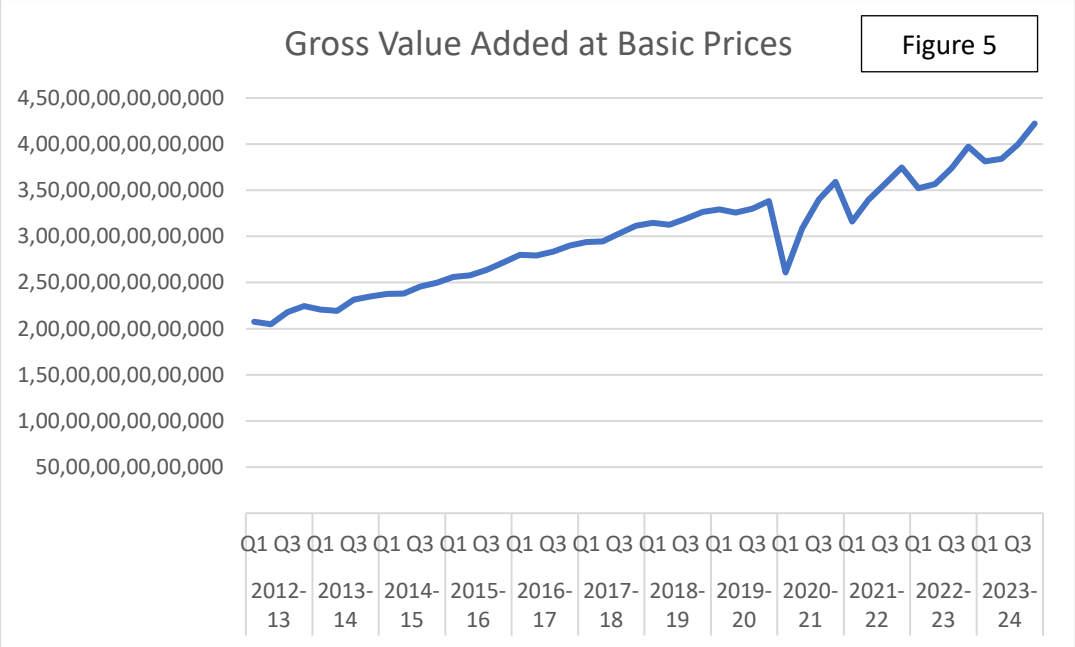
Correlation between Real GDP and PMI is 0.390822

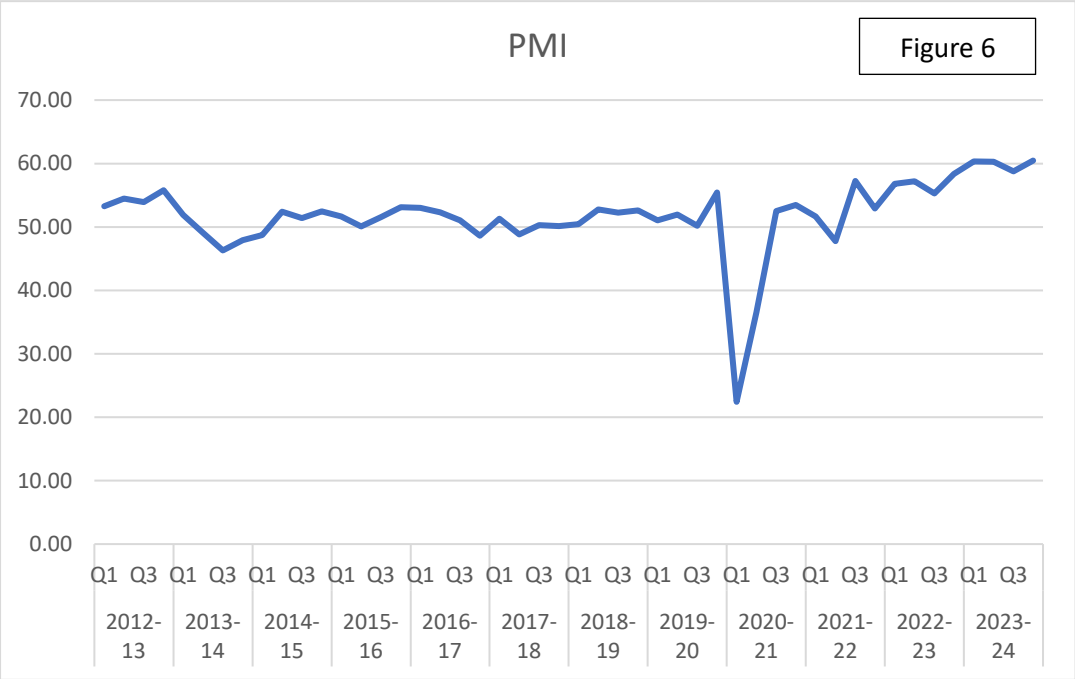
Figure 4

Simple Regression Equation with PMI being the independent variable



Equation of the line: y = 376230178836.54x + 10576587684871.59





Real GDP and PMI have a weak positive correlation.

Using the linear regression equation,

We try to predict the Real GDP, taking IIP as the independent variable, putting x=59.97 (Average IIP Q4 2023-24), we predict Real GDP to be y= 3,31,39,11,15,09,698.89 for the Q1 2024-25.

We observe PMI and Real GDP simple linear regression are not a good fit since the predicted Real GDP. So, PMI alone is not a good predictor of Real GDP in the short term.

3. Consumer Price Index (CPI):

The Consumer Price Index (CPI) is a vital economic indicator that measures inflation by tracking changes in the prices of a basket of consumer goods and services. It reflects the cost of living and purchasing power of a country's currency. Studies have shown that CPI significantly impacts economic growth, with inflation influencing consumer spending, investment decisions, and overall economic stability.

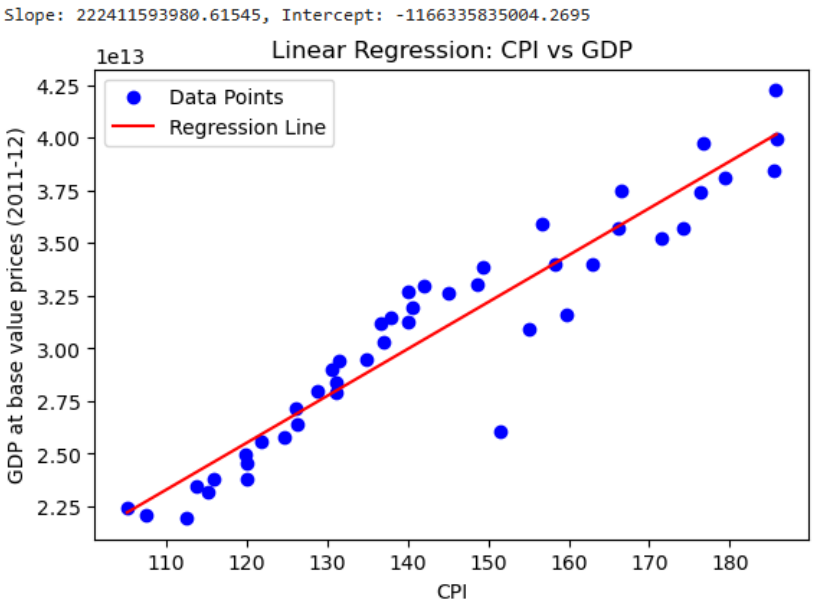
Research by Agarwal et al. (2017) and other economists highlights the dual role of CPI in economic forecasting. High inflation, indicated by a rising CPI, can dampen economic growth by eroding consumer purchasing power and increasing the cost of borrowing. Conversely, moderate inflation can stimulate economic activity by encouraging spending and investment. Their regression models indicate that CPI is a strong predictor of GDP growth, with both direct and indirect effects on economic performance.

The literature also emphasizes the importance of considering CPI alongside other macroeconomic indicators for a comprehensive understanding of economic trends. By integrating CPI data with indicators such as IIP and PMI, researchers can enhance the accuracy of GDP forecasts and better understand the dynamics of economic growth.

Correlation between Real GDP and CPI is 0.947462.

Figure 7

Simple Regression Equation with CPI being the independent variable



Equation of the line: y = 222411593980.62x + -1166335835004.27

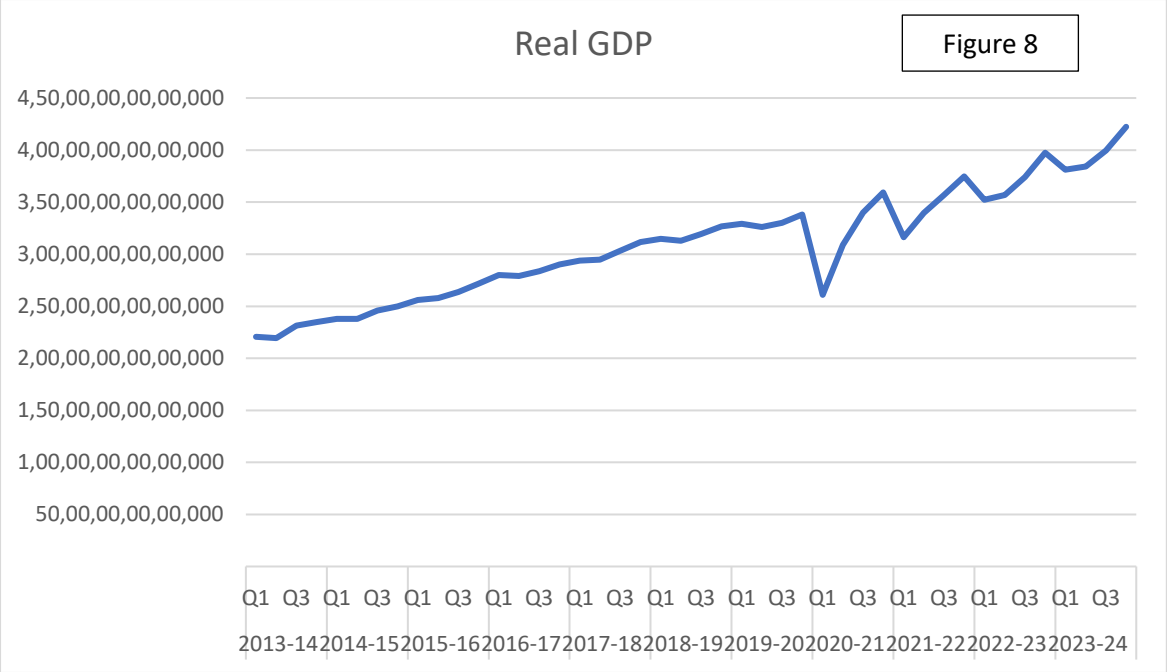


Figure 8

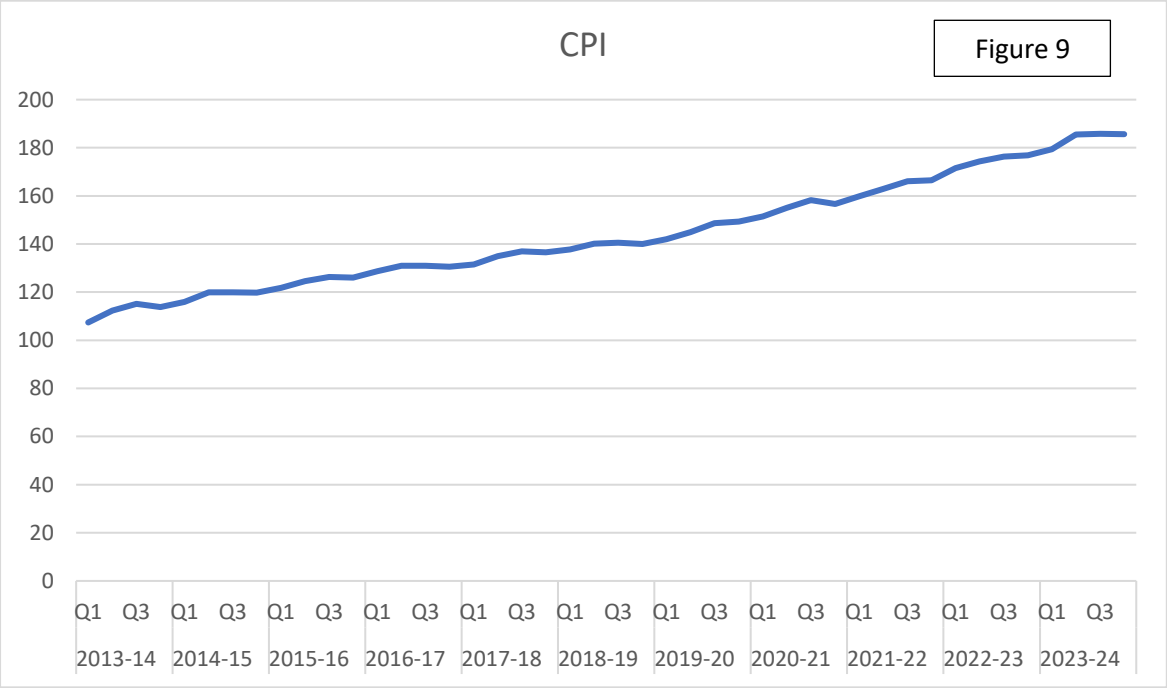


Figure 9

Real GDP and CPI have very strong positive correlation of 0.947462

Using the linear regression equation,

We try to predict the Real GDP, taking CPI as the independent variable, putting x=185.7 (Average CPI Q4 2023-24), we predict Real GDP to be y=4,01,35,49,71,67,197.13 for the Q1 2024-25.

This figure is very close to the actual Q1 2024-25 figure. Thus, CPI seems to be a good indicator for predicting GDP, relative to IIP.

4. Wholesale Price Index (WPI):

The Wholesale Price Index (WPI) is a crucial macroeconomic indicator that measures the average change in the prices of goods at the wholesale level. It reflects the supply and demand dynamics in the economy and is an essential tool for understanding inflationary trends. Unlike the Consumer Price Index (CPI), which measures retail inflation, the WPI tracks price changes before they reach the consumer, making it a valuable predictor of future consumer price movements and economic conditions.

Research shows that WPI is a significant predictor of GDP growth, particularly in emerging economies like India. Studies by Bhoi and Madhusudhana (1997) and more recent analyses by the Reserve Bank of India suggest that WPI movements have a direct impact on the cost of production and, consequently, on the pricing of final consumer goods. High WPI indicates rising input costs, which can lead to higher retail prices and reduced consumer spending, ultimately affecting GDP growth.

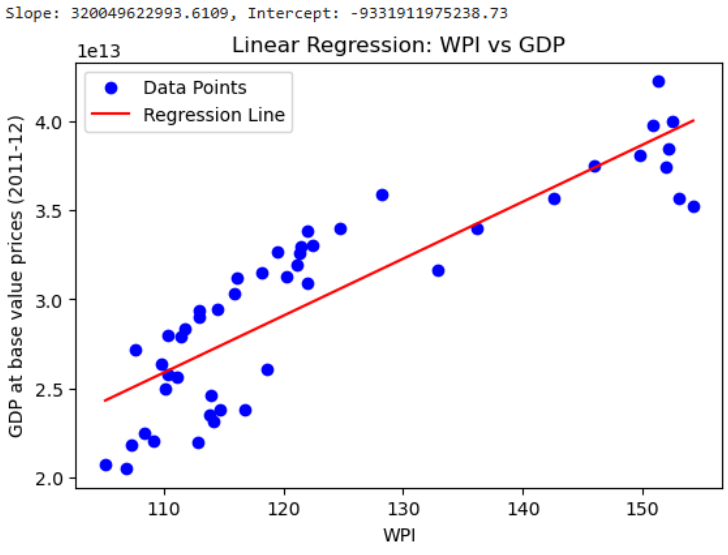
Integrating WPI data into economic forecasting models can enhance the accuracy of GDP predictions. For instance, incorporating WPI with other indicators such as CPI, IIP, and PMI allows for a more comprehensive analysis of inflationary pressures and economic performance. This multidimensional approach helps in understanding the complex interplay between wholesale prices, consumer prices, and overall economic growth.

In conclusion, WPI serves as a leading indicator of inflation and economic activity, offering critical insights for predicting short-term GDP growth. Its inclusion in regression models, alongside other macroeconomic indicators, provides a robust framework for economic forecasting and policy-making

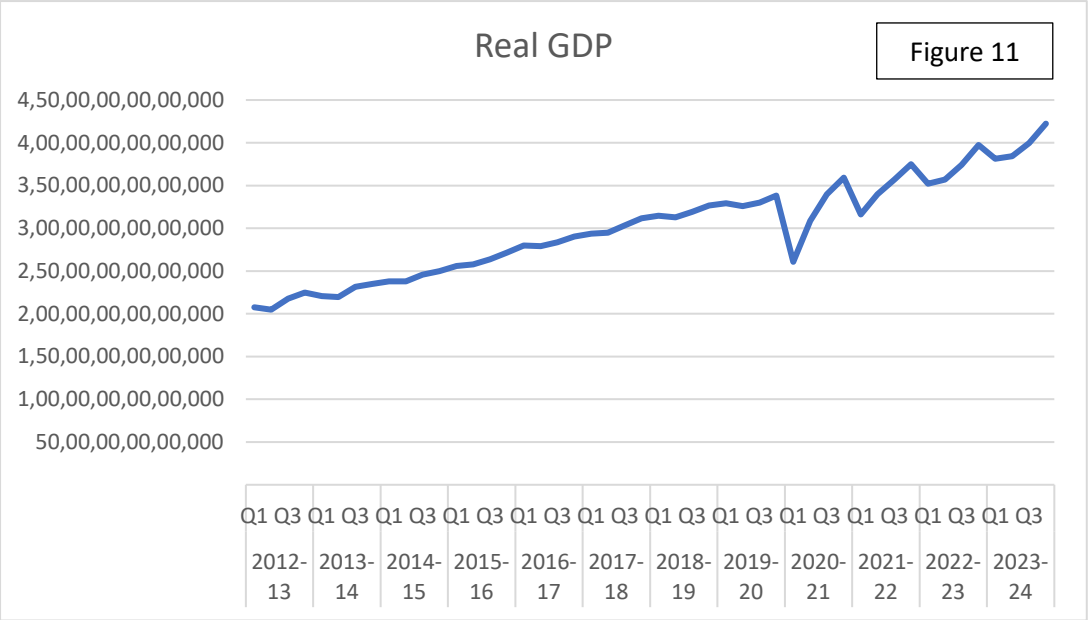
Correlation between Real GDP and WPI is 0.8685

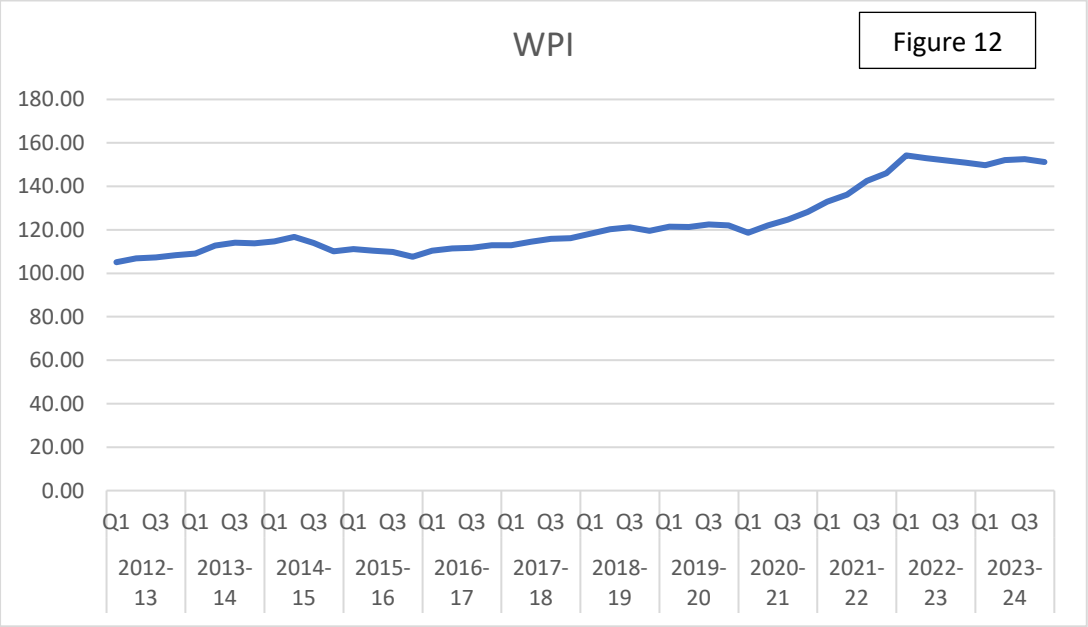
Figure 10

Simple Regression Equation with WPI being the independent variable



Equation of the line: y = 320049622993.61x + -9331911975238.73





Real GDP and WPI have strong positive correlation of 0.86

Using the linear regression equation,

We try to predict the Real GDP, taking WPI as the independent variable, putting x=151.4 (Average WPI 2023-24), we predict Real GDP to be y=4,86,36,06,83,985.446 for the Q1 2024-25.

This figure is far to the actual Q1 2024-25 figure. Thus, WPI, unlike CPI, does not seem to be a good indicator for predicting GDP, relative CPI, but better than IIP and PMI.

5. Trade Balance:

The trade balance, defined as the difference between a country's exports and imports of goods and services, is a crucial macroeconomic indicator. It reflects the economic health and competitiveness of a nation in the global market. A positive trade balance (trade surplus) indicates that exports exceed imports, contributing positively to GDP growth. Conversely, a negative trade balance (trade deficit) suggests higher imports than exports, which can be a drag on GDP.

Research by economists such as Krugman (1991) and more recent studies by the International Monetary Fund (IMF) highlight the significant impact of the trade balance on GDP growth. A trade surplus enhances GDP by generating higher income from foreign markets, leading to increased production and employment domestically. On the other hand, a persistent trade deficit can lead to external borrowing and economic vulnerabilities.

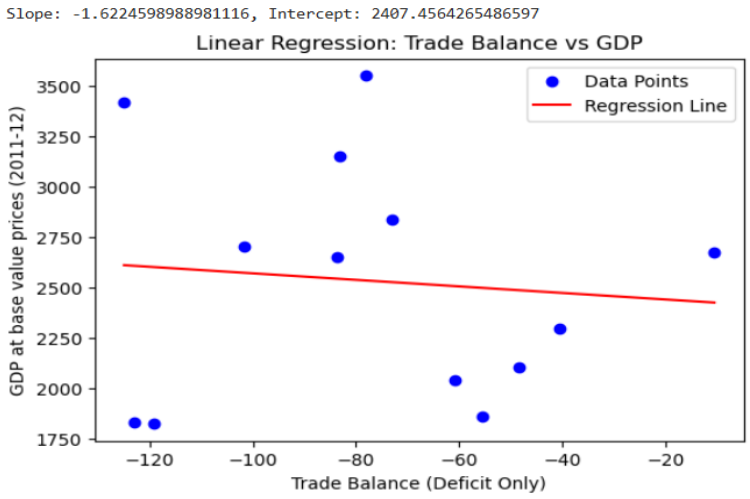
In the context of India's economy, studies by Kumar and Dhawan (2017) have shown that trade balance fluctuations are closely linked to economic cycles. Their regression analyses indicate that trade balance improvements contribute to economic expansion by boosting industrial output and overall economic activity. Conversely, trade deficits have been associated with slower economic growth and increased fiscal pressures.

For predicting short-term GDP growth, incorporating trade balance data into regression models provides valuable insights. The trade balance, when analyzed alongside other indicators like the Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), Consumer Price Index (CPI), and Wholesale Price Index (WPI), offers a comprehensive view of economic trends. This multi-indicator approach enhances the robustness and accuracy of economic forecasts.

Correlation between Real GDP and Trade Balance is -0.093303083

Figure 13

Simple Regression Equation with BOT being the independent variable



Equation of the line: y = -1.62x + 2407.46

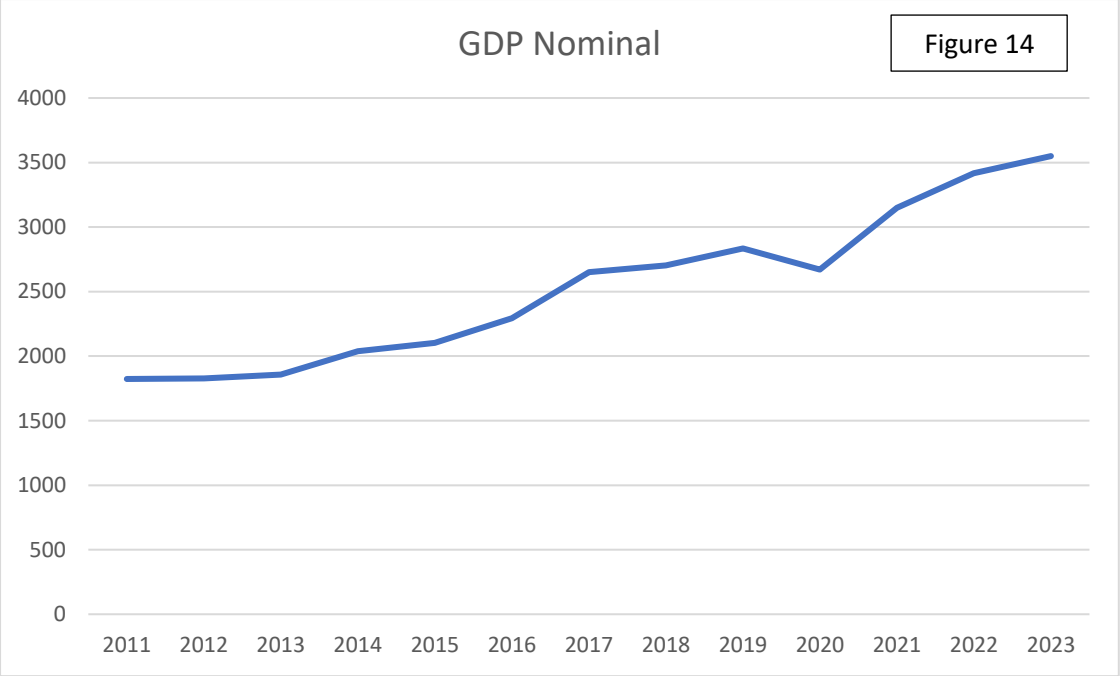


Figure 14

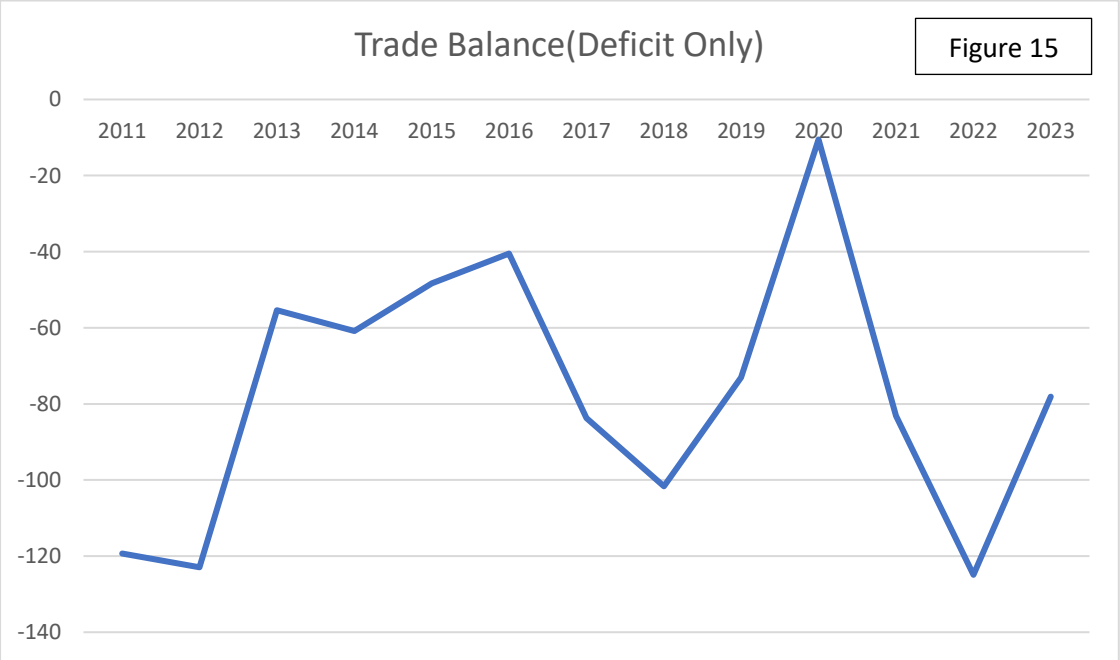


Figure 15

Real GDP and Trade Balance have negative correlation of -0.09

Using the linear regression equation,

We try to predict the Real GDP, taking BOT as the independent variable, putting x=95 (Average BOT 2023-24), we predict Real GDP to be y=-2253.55 for the 2024-25.

It's not a good fit. We will also ignore Balance of trade in the multi regression due to lack of further understanding in finding GDP through linear regression.

6. Stock Market Performance:

Stock market performance is a critical macroeconomic indicator that reflects the overall economic health and investor sentiment of a country. Stock indices such as the Nifty 50 and BSE Sensex in India provide real-time snapshots of market dynamics and are closely monitored by policymakers, investors, and economists. A growing body of research has established the link between stock market performance and GDP growth.

Studies by Basu and Roy (2018) highlight that stock market indices are leading indicators of economic activity. Their analysis suggests that a rising stock market generally precedes periods of economic expansion, as it reflects increased investor confidence, higher corporate earnings, and improved business conditions. Conversely, a declining stock market often signals economic downturns, as it may indicate reduced investor confidence and weaker economic fundamentals.

Further research by Jain (2020) demonstrates that stock market performance, when used in conjunction with other macroeconomic indicators like the Index of Industrial Production (IIP), Consumer Price Index (CPI), and Purchasing Managers' Index (PMI), enhances the accuracy of GDP forecasts. Jain's multiple regression models show that stock market trends provide valuable insights into future economic conditions, making them indispensable for short-term GDP prediction.

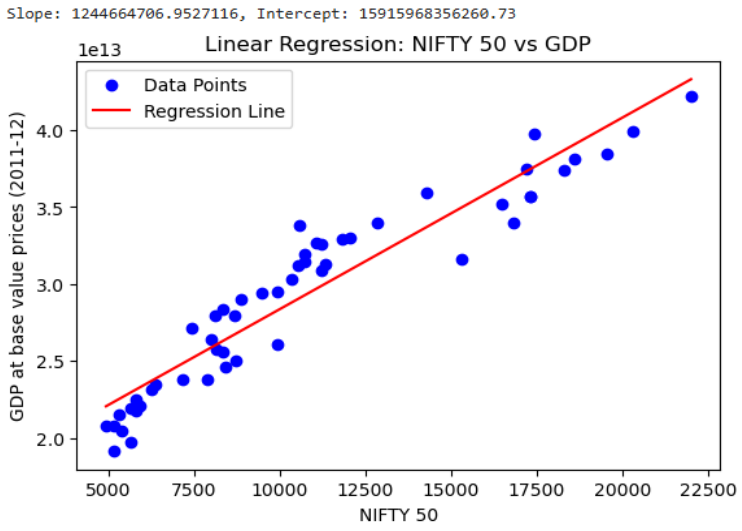
In the context of India, the stock market's reaction to policy changes, economic reforms, and global economic trends provides early signals of economic shifts. Studies by Sharma (2021) have underscored the importance of incorporating stock market data into economic forecasting models. Sharma's work reveals that stock market performance, reflecting the collective behavior of investors, captures the impact of various economic shocks and policy measures more quickly than traditional macroeconomic indicators.

Overall, stock market performance is a vital component of GDP prediction models. Its ability to capture real-time economic sentiment and forecast future economic trends makes it an essential indicator for analyzing and predicting short-term economic performance in India

Correlation between Real GDP and NIFTY 50 is 0.947528

Figure 16

Simple Regression Equation with NIFTY 50 being the independent variable

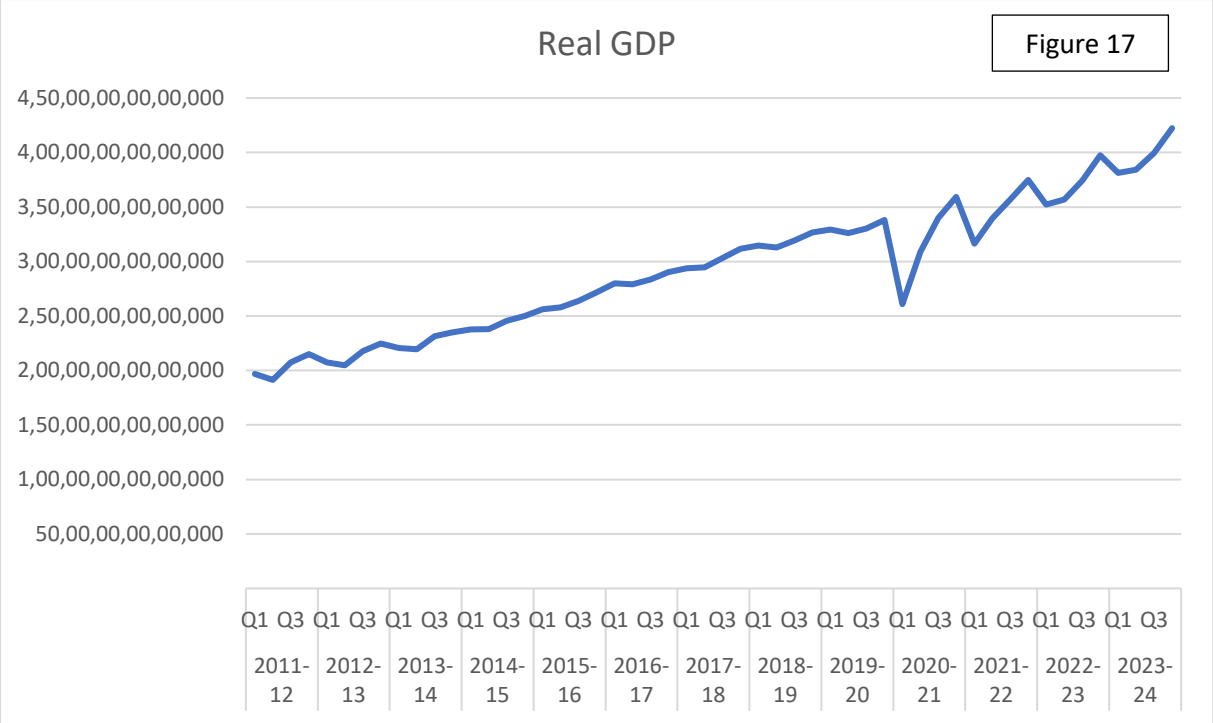


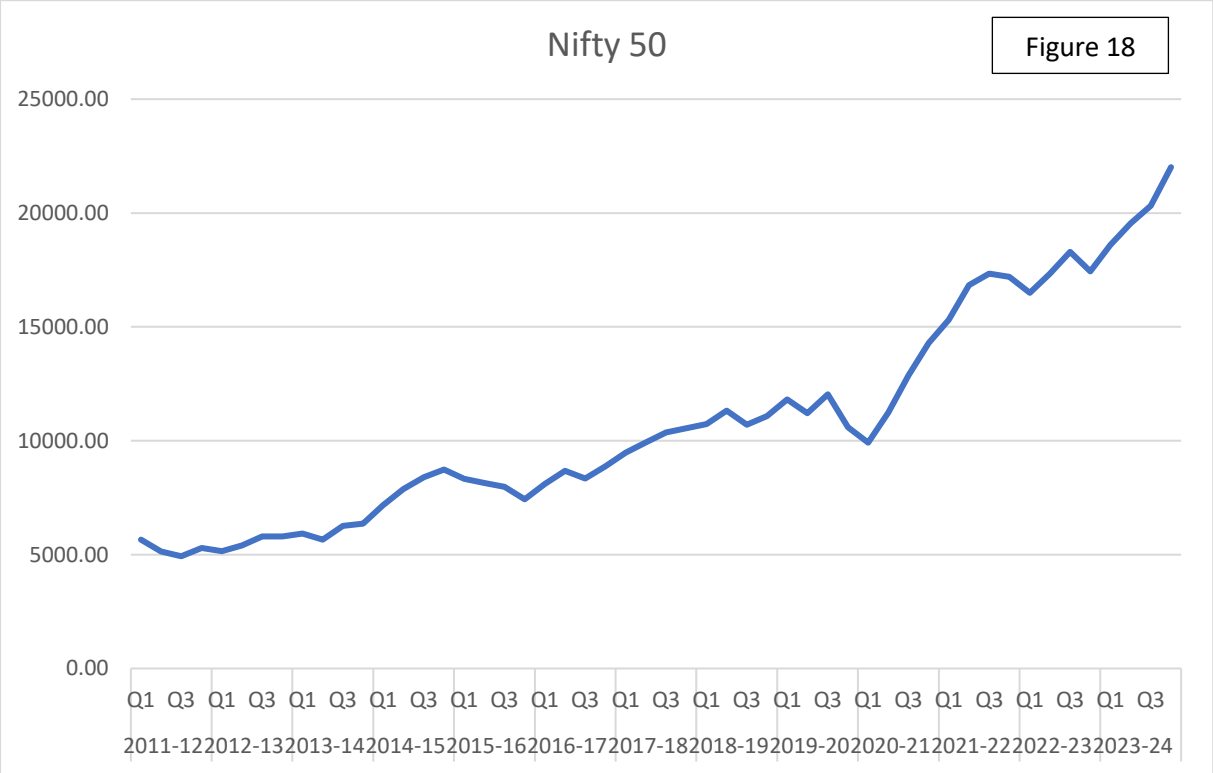
Equation of the line: y = 1244664706.95x + 15915968356260.73

Using the linear regression equation,

We try to predict the Real GDP, taking NIFTY 50 as the independent variable, putting x=20117.825 (Average NIFTY 50 2023-24), we predict Real GDP to be y=4,09,58,43,55,60,388.69 crore rupees for the Q1 2024-25.

This is a very good fit and predicts the GDP close to the actual estimate.





Real GDP and Stock Market have very strong correlation of 0.9

7. GST REVENUE:

Goods and Services Tax (GST) revenue is a vital macroeconomic indicator reflecting the overall health of a nation's economy. Introduced in India in July 2017, GST replaced multiple indirect taxes, aiming to create a unified tax structure. It significantly impacts economic activity by influencing consumption, investment, and government finances. Research on GST revenue's relationship with GDP growth reveals crucial insights into its role as a predictor of economic performance.

Studies by Bhattacharya and Rao (2018) demonstrate that GST revenue is a reliable indicator of economic activity. Their analysis shows that higher GST collections are associated with robust economic growth, as they indicate increased production and consumption of goods and services. The study uses regression models to correlate GST revenue with GDP growth, highlighting its predictive power.

Further research by the National Institute of Public Finance and Policy (NIPFP) (2019) emphasizes the importance of GST in improving tax compliance and broadening the tax base. This has positive implications for GDP growth, as increased tax revenues enable higher public investment in infrastructure and social programs, which in turn stimulate economic activity.

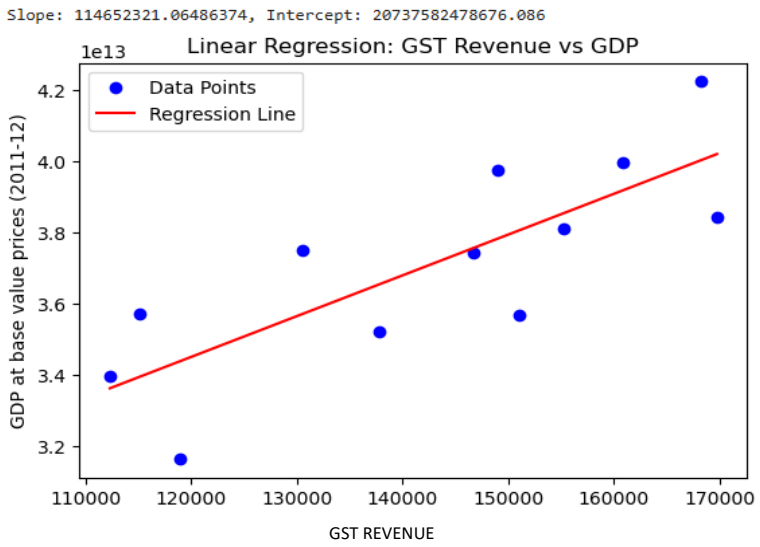
Moreover, Garg and Goyal (2020) analyzed the monthly GST revenue data to forecast short-term GDP growth. Their findings suggest that fluctuations in GST collections provide early signals of economic trends, making it a valuable tool for policymakers and economists. The study integrates GST revenue with other macroeconomic indicators, such as the Index of Industrial Production (IIP) and Purchasing Managers' Index (PMI), to enhance the accuracy of GDP forecasts.

In conclusion, GST revenue is a crucial indicator for predicting short-term GDP growth in India. Its impact on economic activity and government finances makes it an essential component of economic forecasting models. By incorporating GST revenue data with other macroeconomic indicators, researchers can develop robust models to predict economic trends and inform policy decisions.

Correlation between Real GDP and GST Revenue is 0.794936767

Figure 19

Simple Regression Equation with GST Revenue being the independent variable

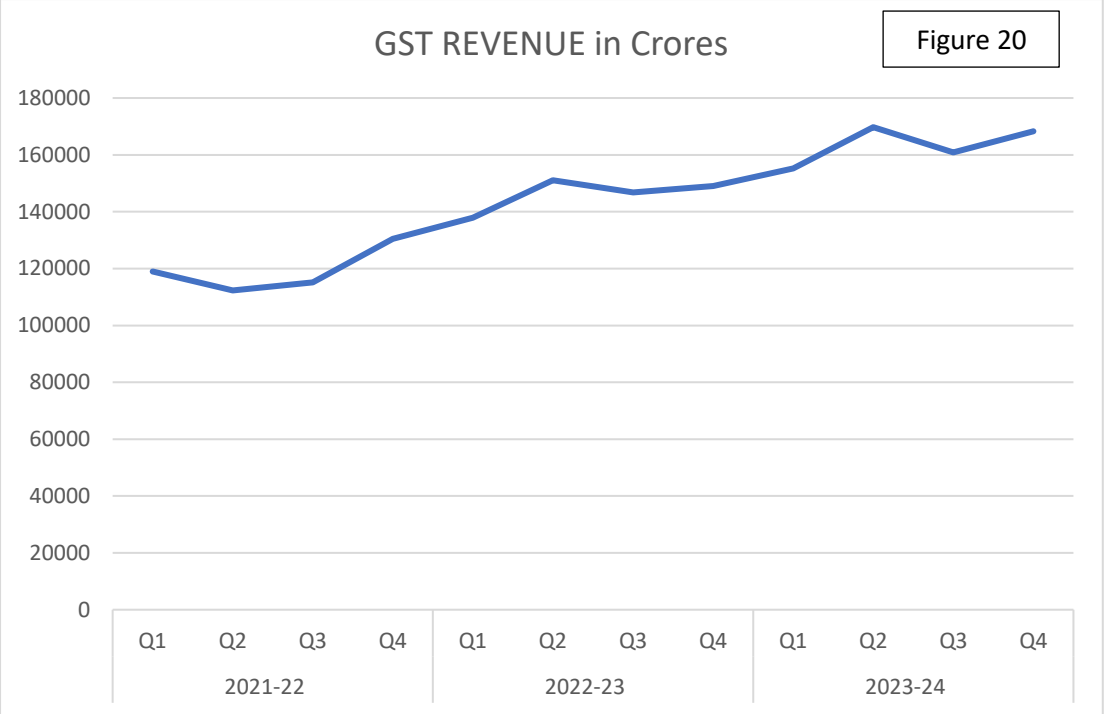


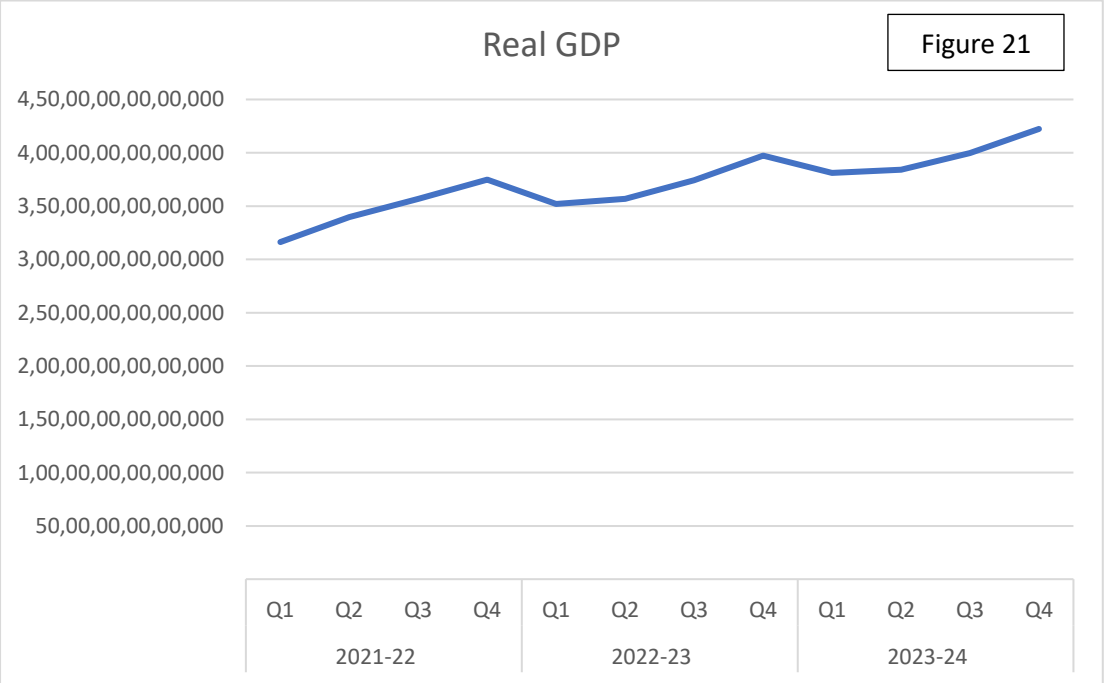
Equation of the line: y = 114652321.06x + 20737582478676.09

Using the linear regression equation,

We try to predict the Real GDP, taking GST Revenue as the independent variable, putting x=163528.0417 (Average GST Revenue 2023-24), we predict Real GDP to be y=3,94,86,45,20,17,977.558202 for the Q1 2024-25.

This is a good fit and close to the actual estimates.





Real GDP and GST Revenue have strong correlation of 0.7

8. Credit Growth in %:

Credit growth, defined as the increase in the amount of loans provided by the banking sector to various sectors of the economy, is a crucial macroeconomic indicator. It plays a significant role in driving economic activity by facilitating consumer spending, business investment, and overall economic expansion. Research has consistently highlighted the strong relationship between credit growth and GDP growth, particularly in emerging economies like India.

Studies by Patnaik and Mohanty (2019) demonstrate that credit growth is a leading indicator of economic performance. Their research shows that an increase in bank credit is associated with higher GDP growth rates. The availability of credit stimulates consumption and investment, leading to enhanced production and economic expansion. Patnaik and Mohanty's regression models indicate a positive correlation between credit growth and GDP, emphasizing the importance of a robust banking sector for sustained economic growth.

Further research by the Reserve Bank of India (RBI) supports these findings, indicating that credit growth is critical for the overall health of the economy. The RBI's analyses show that periods of strong credit growth are typically followed by increased economic activity, as businesses expand and consumers spend more. Conversely, periods of credit contraction often precede economic slowdowns, highlighting the sensitivity of GDP to credit availability.

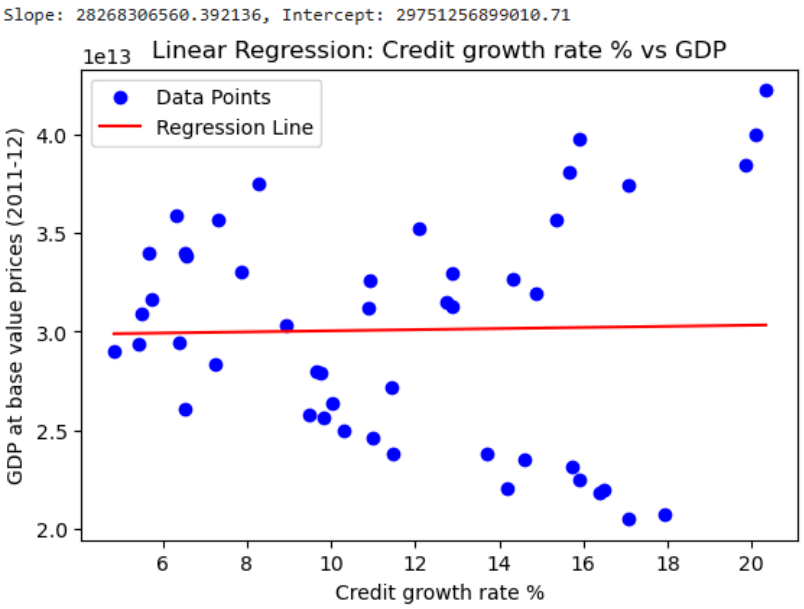
In the context of short-term GDP prediction, integrating credit growth data into economic forecasting models can enhance their accuracy. Studies by Subbarao (2018) and Singh (2020) have shown that combining credit growth with other macroeconomic indicators such as the Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), and Consumer Price Index (CPI) provides a comprehensive view of economic trends. This multi-indicator approach helps in capturing the complex dynamics of economic growth and improving the robustness of GDP forecasts.

In conclusion, credit growth is a vital indicator for predicting short-term GDP growth. Its impact on consumption and investment underscores its significance in economic forecasting models. By incorporating credit growth data alongside other macroeconomic indicators, researchers and policymakers can develop more accurate and reliable predictions of economic performance

Correlation between Real GDP and Credit Growth rate is 0.02155

Figure 22

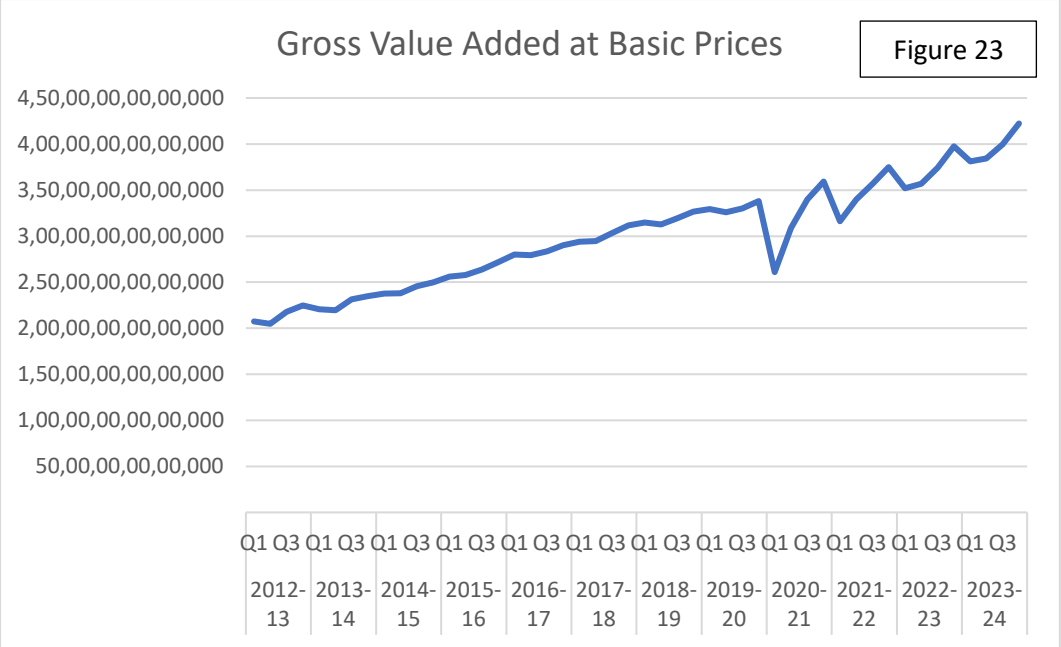
Simple Regression Equation with Credit Growth rate being the independent variable

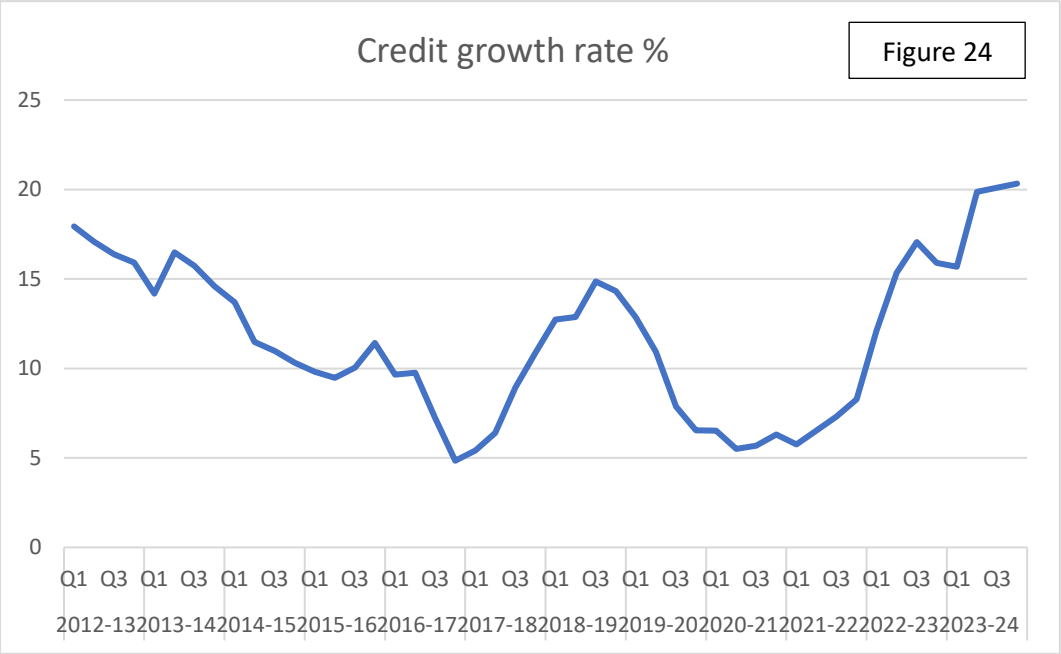


Equation of the line: y = 28268306560.39x + 29751256899010.71

Using the linear regression equation,

We try to predict the Real GDP, taking Credit growth rate as the independent variable, putting x=18.99 (Average Credit growth rate 2023-24), we predict Real GDP to be y=3,02,88,07,20,40,592.5161 for the Q1 2024-25.
This is not a good fit.





Real GDP and Credit growth rate have strong correlation of 0.7

9. Multi correlation:

Here the coefficients taken are IIP, PMI, CPI, WPI, Nifty 50, GST revenue. We are not going to use Balance of trade data to calculate Multi correlation.

Mean Squared Error: 5.596565856839302e+24
R^2 score: 0.7542105896649214
Coefficients: [2.46083315e+11, 6.42533953e+09, 9.83728546e+10, -7.46018367e+08
-6.19791410e+10, 3.61749156e+07]
Intercept: -14001274617240.297

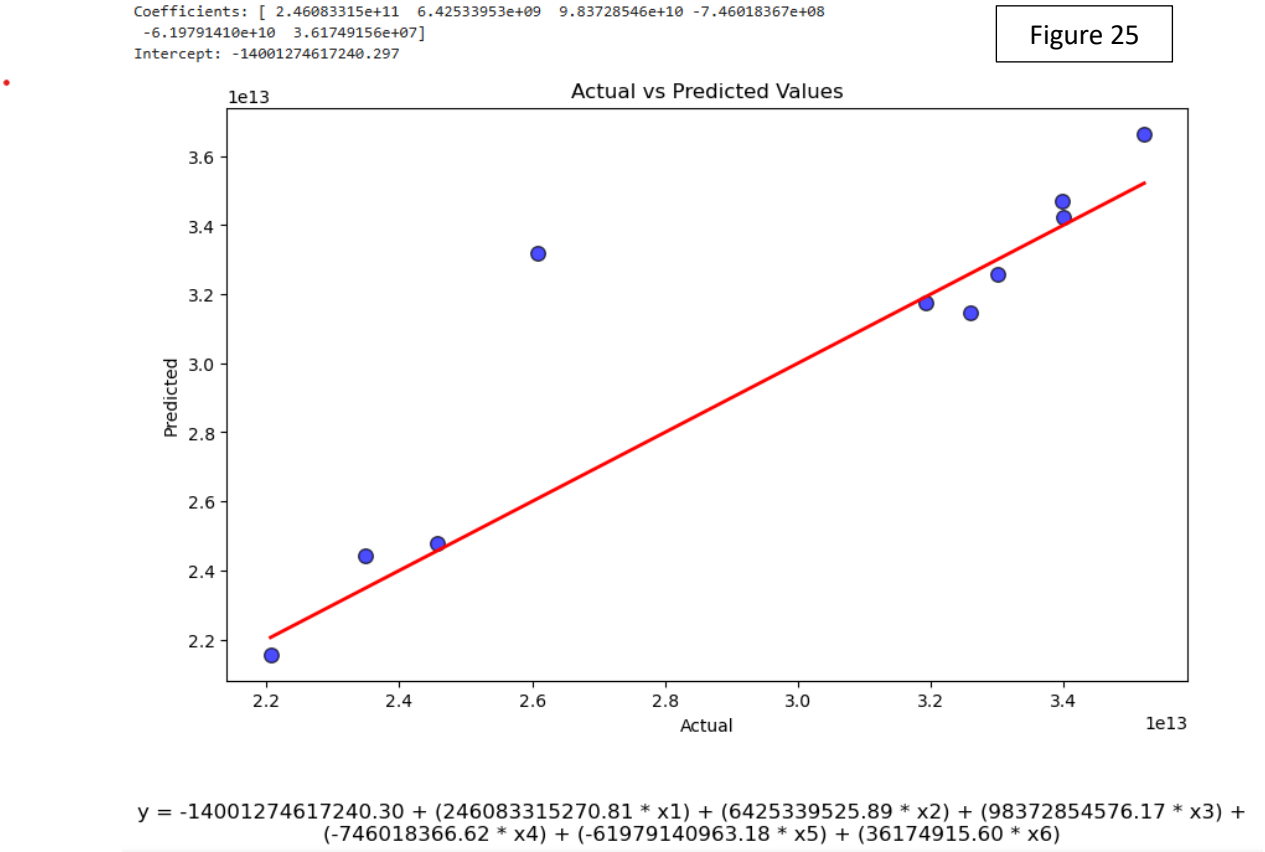


Figure 25

y = -14001274617240.30 + (246083315270.81 * x1) + (6425339525.89 * x2) + (98372854576.17 * x3) + (-746018366.62 * x4) + (-61979140963.18 * x5) + (36174915.60 * x6)

We try to predict the Real GDP, taking Credit growth rate as the independent variable, putting x1(IIP) = 147.67, x2(PMI) = 59.97, x3(CPI) = 185.7, x4(WPI) = 151.4, x5(Credit growth in %) = 18.99, x6(NIFTY 50) = 20117.825, we predict Real GDP to be y= 40,428,844,808,796.11 for the Q1 2024-25.

This prediction is actually a very good model fit and a strong one too and is very close to the actual 2024-25 Q1 figure.

Chapter 5: Findings and Conclusion

Multiple macroeconomic indicators—Index of Industrial Production (IIP), Purchasing Managers' Index (PMI), Consumer Price Index (CPI), Wholesale Price Index (WPI), NIFTY 50, and Credit Growth Rate—to predict short-term GDP growth. The regression model yielded a Mean Squared Error (MSE) of 5.596565856839302e+24 and an R^2 score of 0.7542105896649214.

The high R^2 score of 0.754 indicates that 75.4% of the variability in GDP growth can be explained by these indicators, suggesting a strong model fit. This underscores the significant impact of these macroeconomic variables on GDP growth. However, the large MSE suggests there might be some issues with the model's predictions, indicating potential data outliers or multicollinearity among the predictors.

These results highlight the importance of these indicators in economic forecasting. IIP and PMI reflect industrial and business activity, CPI and WPI measure inflation, NIFTY 50 indicates market sentiment, and credit growth shows financial sector health. This combination provides a comprehensive view of the economic landscape, crucial for accurate GDP predictions. Further refinement of the model, such as addressing multicollinearity and improving data quality, could enhance its predictive power.

Individually, the indicators and their how they fit into the simple regression model, in prediction of Real GDP.

Indicators conclusion **Table 11**

Indicators Used	Correlation with Real GDP	Fit
IIP	0.761	Strong Fit
PMI	0.390	Good Fit
CPI	0.947	Very Strong Fit
WPI	0.868	Strong Fit
Trade Balance	-0.093	Weak Fit, Null
Credit Growth	0.021	Good Fit
Stock Market Performance	0.947	Very Strong Fit
GST Collections	0.794	Strong Fit

Chapter 6: Recommendations and Limitations of the study

Recommendations and Limitations of the Study

Recommendations

1. Model Refinement: To improve the accuracy of the GDP predictions, it is recommended to refine the current regression model. Addressing issues such as multicollinearity and potential outliers could enhance the model's performance. Techniques like variance inflation factor (VIF) analysis can help identify and mitigate multicollinearity.
2. Incorporate Additional Indicators: Expanding the model to include other relevant macroeconomic indicators, such as government spending, foreign exchange reserves, and trade balance, could provide a more comprehensive view of the factors influencing GDP growth.
3. Use Advanced Regression Techniques: Consider using more sophisticated regression models such as time series analysis, including ARIMA (Autoregressive Integrated Moving Average), and machine learning algorithms like Random Forest or Gradient Boosting for better predictive accuracy. These models can capture more complex patterns in the data.
4. Data Quality and Frequency: Ensure high-quality data and consider using higher frequency data (e.g., weekly or daily) where available. This can improve the model's ability to capture short-term economic fluctuations.
5. Regular Updates and Validation: Regularly update the model with new data and validate its performance periodically to ensure its continued accuracy and relevance. Out-of-sample testing and cross-validation techniques can help in assessing the model's robustness.

Limitations

1. Model Specificity: The current multiple regression model, while useful, may not fully capture the complex dynamics of GDP growth. It is limited by the linear relationships assumed between the independent variables and the dependent variable.
2. Multicollinearity: The presence of multicollinearity among the macroeconomic indicators can inflate the variance of coefficient estimates, making the model less reliable. This needs to be addressed to improve model accuracy.
3. Static Relationships: The model assumes static relationships between indicators and GDP growth, which may not hold true over time. Economic relationships can change due to structural shifts, policy changes, or external shocks.
4. Data Limitations: The quality and availability of data can significantly impact the model's performance. Inaccurate or incomplete data can lead to erroneous

predictions. Additionally, the model's reliance on historical data may not fully account for future economic conditions or unforeseen events.

5.

Comparison with Other Models

1. Time Series Models: Time series models like ARIMA can capture temporal dependencies and trends in GDP data better than static regression models. They are particularly effective for short-term forecasting as they account for the time-dependent structure of the data.
2. Machine Learning Models: Algorithms such as Random Forest, Gradient Boosting, and Neural Networks can handle complex, non-linear relationships between variables. They are more flexible and can improve prediction accuracy by learning from large datasets. However, these models require more data and computational resources.
3. Vector Autoregression (VAR): VAR models consider the interdependencies among multiple time series, making them suitable for understanding the dynamic relationship between macroeconomic indicators and GDP. They can provide insights into how shocks to one variable affect others.

In conclusion, while the current multiple regression model provides valuable insights into the relationship between macroeconomic indicators and GDP growth, there are significant opportunities for improvement. Incorporating advanced statistical techniques, expanding the range of indicators, and ensuring high-quality data can enhance the model's predictive power. Exploring time series models and machine learning algorithms can offer more accurate and robust forecasts, better capturing the complex dynamics of economic growth. Regular updates and validation are essential to maintaining the model's relevance and accuracy in predicting short-term GDP growth.

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These references provide the foundation for the macroeconomic indicators used in this study and support the theoretical framework and empirical analysis undertaken in the project.