"GST and Economic Growth in Karnataka: An Analysis of Key Fiscal and Industrial Indicators"

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Abstract:

This paper analysis the impact of the Goods and Services Tax (GST) on economic growth and fiscal consolidation in Karnataka by examining key fiscal and industrial indicators in the post-GST era. Introduced in 2017, GST was designed to simplify India's indirect tax framework, streamline revenue collection and enhance economic efficiency. Karnataka, as one of the country's most industrially advanced states, offers a compelling setting to explore GST's effect on state-level economic indicators. This study employs panel data from both pre- and post-GST periods to examine growth metrics such as GSDP growth, tax revenue, industrial output, and energy consumption as a sustainability measure.

Through an econometric analysis utilizing an Extended Difference-in-Differences (DiD) model, findings reveal that GST has been pivotal in fostering economic growth, particularly through the expansion of industrial output and improvements in tax compliance. However, the study also highlights minimal yet complex challenges surrounding energy consumption, underscoring the importance of integrated fiscal and sustainability policies to optimize GST's benefits. Conclusively, while GST has acted as a key driver of Karnataka's economic transformation, sustaining its growth impact will require continued attention to fiscal strategies that align with environmental objectives and Sustainable Development Goals (SDGs).

Introduction:

The Goods and Services Tax (GST), introduced on July 1, 2017, represents a landmark fiscal reform in India. By unifying the country's complex tax structure into a single, comprehensive system, GST aimed to eliminate inefficiencies, boost economic growth, and create a more transparent tax regime. Described as a "game changer for the Indian economy," GST has been credited with streamlining indirect taxation and fostering the creation of a national market by eliminating interstate barriers (Ministry of Finance, 2020). The reform's impact, however, goes beyond just improving tax administration—it has acted as a catalyst for broader economic transformation, contributing to both economic growth and sustainable development.

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Karnataka, as one of India's most industrially advanced states, provides a compelling case study for analysing the effects of GST. With its diverse economy and significant contributions from sectors like manufacturing, services, and agriculture, Karnataka offers a microcosm of India's post-reform economy. The state has been a significant beneficiary of GST reforms, with improvements in tax compliance, growth in interstate trade, and enhanced business competitiveness. Karnataka's experience illustrates how GST can serve as a tool for "fiscal consolidation and economic integration" in regional economies (World Bank, 2018).

In the context of sustainable development, the introduction of GST aligns closely with India's broader goals of inclusive growth and environmental sustainability. Tax reforms such as GST are not only intended to boost economic output but also to create a more equitable and environmentally sustainable economy. By bringing informal sectors into the tax net and improving government revenue collection, GST has created additional fiscal space for public investments in sustainability initiatives, particularly in areas like infrastructure, education, and renewable energy (UNDP, 2020). As such, GST is seen as a key driver in linking fiscal reforms with the United Nations Sustainable Development Goals (SDGs), particularly those focused on economic growth, reducing inequality, and ensuring responsible consumption and production.

The objective of this paper is to examine how GST has served as a catalyst for both economic growth and sustainable development in Karnataka's post-reform economy. By analysing key economic indicators, such as GSDP growth, tax revenue, and sustainability metrics, this study will explore the dual role of GST in fostering economic transformation while promoting long-term sustainability in one of India's most dynamic states.

Literature Review:

Fiscal reforms have long been recognized as key drivers of economic growth, particularly in developing economies where complex and inefficient tax systems can stifle productivity. The introduction of the Goods and Services Tax (GST) in India is often highlighted as a prime example of how fiscal reforms can act as a catalyst for economic transformation. According to **Rao and Chakraborty (2020)**, GST's unification of India's indirect tax regime has eliminated cascading taxes and enhanced the competitiveness of Indian businesses. This reform has led to a reduction in production costs, which has boosted industrial productivity, particularly in the manufacturing and services sectors. Additionally, studies by **Aiyar (2019)** show that GST's streamlined structure facilitates ease of doing business, attracting both domestic and foreign investments, further stimulating economic growth.

In line with these observations, **Keen and Lockwood (2019)** argue that fiscal reforms such as GST not only simplify the tax system but also improve tax compliance by reducing evasion opportunities and incentivizing formalization. They emphasize that tax reforms contribute to expanding the tax base, thereby increasing government revenue, which can be reinvested into public services and infrastructure, leading to long-term economic growth. **The World Bank (2018)** supports this view, stating that "fiscal consolidation through tax reforms is essential for sustaining growth in emerging markets like India".

Karnataka provides an illustrative case study of how GST can catalyze both economic growth and sustainability in a regional context. Post-GST, Karnataka has experienced significant improvements in industrial growth, particularly in the manufacturing and service sectors, which have benefited from reduced production costs and better supply chain efficiencies. A report by the Karnataka State Industrial and Infrastructure Development Corporation **(KSIIDC, 2021)** shows that post-GST, industrial

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output in the state increased by over 8%, with notable growth in electronics, textiles, and automobile sectors. This surge in industrial productivity aligns with the findings of **Aiyar (2019),** who observed similar growth patterns in other GST-affected regions of India.

In terms of tax compliance, GST has led to the formalization of many previously unregistered businesses in Karnataka, particularly in the informal economy. Studies by **Patil and Gowda (2020)** suggest that GST's digitized compliance framework has increased transparency and reduced the scope for tax evasion, resulting in a 12% increase in tax revenues for the state in the three years following the reform. This increase in tax revenue has allowed the state government to make significant public investments, particularly in infrastructure and social welfare programs, which have further contributed to Karnataka's economic growth.

Additionally, Karnataka has leveraged the increased fiscal capacity provided by GST to invest in sustainability initiatives. The state government has prioritized environmental sustainability by channeling revenues into green infrastructure projects such as renewable energy and water conservation programs. A report by the **Karnataka Renewable Energy Development Limited (KREDL, 2020)** indicates that post-GST, the state has significantly ramped up its investments in renewable energy, with a particular focus on solar and wind energy. This move aligns with both India's commitment to the Paris Agreement and the broader goals of SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).

Karnataka's post-GST experience highlights the multifaceted impact of fiscal reforms. Not only has GST driven industrial growth and improved tax compliance, but it has also provided the state with the fiscal capacity to invest in sustainable development. This case study underscores the potential of fiscal reforms like GST to promote both economic transformation and environmental sustainability in the broader Indian context.

The intersection of fiscal reforms and sustainable development has gained increasing attention in recent years. Fiscal policies, particularly those focusing on tax reforms, are seen as vital tools for promoting environmental and social sustainability. GST, while primarily an economic reform, is also viewed as a policy that can support the achievement of Sustainable Development Goals (SDGs), particularly those related to inclusive growth and environmental sustainability. According to the United Nations Development Programme **(UNDP, 2020),** fiscal reforms can "create fiscal space" for public investments in critical areas such as education, healthcare, and renewable energy, all of which contribute to sustainable development.

Barker and Oates (2018) highlight that tax reforms such as GST can also lead to improvements in environmental sustainability by formalizing industries and ensuring compliance with environmental regulations. This is particularly significant in economies where informal sectors are often exempt from tax compliance and environmental norms. Through increased tax revenues, governments are better positioned to fund sustainability initiatives and promote green growth, which aligns with SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

On the social front, **Barro (2021)** emphasizes that the formalization of the economy through reforms like GST promotes equitable growth by ensuring that more businesses contribute to the tax system. This, in turn, enables governments to channel resources towards reducing inequality and poverty, contributing to SDG 10 (Reduced Inequality) and SDG 1 (No Poverty).

Methodology:

This study employs an econometric approach to assess the impact of the Goods and Services Tax (GST) on economic growth and sustainable development in Karnataka, India. The objective is to evaluate whether GST has acted as a catalyst for economic growth by analysing key indicators such as GSDP growth, Own tax revenue, energy consumption, industrial output, and inflation.

Data Collection:

The study relies on secondary data sourced from government and non-governmental bodies, including the Ministry of Finance, the Reserve Bank of India (RBI), the Central Statistical Office (CSO), and reports from Karnataka's state government. The dataset covers the period from 2012 to 2022, with a specific focus on the post-GST implementation period (2017 onward) to capture the potential changes associated with GST. The variables examined in this study include:

GSDP Growth Rate: Serves as the primary outcome variable, reflecting Karnataka's annual economic growth.

Tax Revenue[1]: State tax collections, analysed to evaluate GST's fiscal effect.

Energy Consumption[2]: Acts as a sustainability indicator.

Industrial Output: Represents industrial activity, essential for understanding sectoral responses to GST.

Inflation[3]: The general increase in prices, included to control for its influence on GSDP growth.

Model Specification:

To analyse the relationship between GST and GSDP growth, a linear regression model is employed. The model is specified as follows:

$$GSDP\_Growth_t = \beta_0 + \beta_1 \times GST\_Dummy_t + \beta_2 \times Tax\_Revenue_t + \beta_3 \times Energy\_Consumption_t + \beta_4 \times Industrial\_Output_t + \beta_5 \times Inflation_t + \epsilon_t$$

Where:

GSDP_Growth is the dependent variable.

GST_Dummy is a binary variable indicating the pre- or post-GST period.

Tax_Revenue, Energy_Consumption, Industrial_Output, and **Inflation** are control variables.

Econometric Techniques:

Ordinary Least Squares (OLS) regression is used to estimate the model's coefficients. OLS was selected for its simplicity and effectiveness in estimating linear relationships under certain assumptions. Diagnostic tests include:

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[1] State own tax revenue is taken account.
[2] Per Capita Energy Consumption is considered
[3] Consumer Price Index is used.

Multicollinearity: Assessed using the Variance Inflation Factor (VIF) to ensure independent variables are not highly correlated.

Heteroscedasticity: Checked, and if detected, robust standard errors are applied to improve inference reliability.

Hypothesis Testing:

The following hypotheses were formulated:

Null Hypothesis (H0): GST has no significant impact on economic growth in Karnataka.

Alternative Hypothesis (H1): GST has a significant positive impact on economic growth in Karnataka.

Software Tools

Data analysis is conducted in R, using packages like stats and lm for OLS regression and diagnostic testing. Interpretation follows standard econometric practices to ensure robustness.

Table-1: Data on Economic Growth, Tax Revenue, and Sustainability Indicators in Karnataka

State	Year	GSDP Growth (Growth rate in %)	Tax Revenue (Growth rate in %)	Energy Consumption (Per Capita Consumption (kWh))	Industrial Output (Growth rate in %)	Inflation	GST Dummy	Karnataka Dummy	GST × Karnataka
Karnataka	2012-13	14.8%	15.7%	1129	13.4%	15.7%	0	1	0
Karnataka	2013-14	17.4%	16.5%	1179	16.0%	16.5%	0	1	0
Karnataka	2014-15	11.9%	12.1%	1211	10.3%	12.1%	0	1	0
Karnataka	2015-16	14.4%	7.7%	1211	13.4%	7.7%	0	1	0
Karnataka	2016-17	15.5%	9.8%	1242	16.1%	9.8%	0	1	0
Karnataka	2017-18	10.4%	8.9%	1367	9.9%	8.9%	1	1	1
Karnataka	2018-19	11.0%	8.0%	1356	11.6%	8.0%	1	1	1
Karnataka	2019-20	8.9%	4.9%	1396	6.9%	4.9%	1	1	1
Karnataka	2020-21	0.9%	-5.2%	1468	0.0%	-5.2%	1	1	1
Karnataka	2021-22	20.8%	14.9%	1284	20.9%	14.9%	1	1	1
Karnataka	2022-23	14.2%	13.8%	1376	13.4%	13.8%	1	1	1
Maharashtra	2012-13	14.0%	18.1%	1239	12.9%	18.1%	0	0	0
Maharashtra	2013-14	13.0%	5.0%	1183	13.9%	5.0%	0	0	0
Maharashtra	2014-15	7.8%	6.0%	1257	7.5%	6.0%	0	0	0
Maharashtra	2015-16	10.5%	10.0%	1257	8.1%	10.0%	0	0	0
Maharashtra	2016-17	11.8%	7.9%	1318	8.7%	7.9%	0	0	0
Maharashtra	2017-18	7.0%	25.7%	1307	7.8%	25.7%	1	0	0
Maharashtra	2018-19	7.5%	9.7%	1371	6.4%	9.7%	1	0	0
Maharashtra	2019-20	5.1%	0.3%	1424	2.9%	0.3%	1	0	0
Maharashtra	2020-21	-1.1%	-13.1%	1418	-1.2%	-13.1%	1	0	0
Maharashtra	2021-22	18.3%	38.3%	1378	20.8%	38.3%	1	0	0
Maharashtra	2022-23	Nil	12.9%	1588	Nil	12.9%	1	0	0
Tamil Nadu	2012-13	13.8%	19.7%	1226	Nil	19.7%	0	0	0
Tamil Nadu	2013-14	13.3%	3.5%	1544	10.67	3.5%	0	0	0
Tamil Nadu	2014-15	10.8%	6.7%	1616	7.81	6.7%	0	0	0
Tamil Nadu	2015-16	9.7%	2.3%	1616	10.79	2.3%	0	0	0
Tamil Nadu	2016-17	10.7%	6.8%	1688	9.39	6.8%	0	0	0
Tamil Nadu	2017-18	12.5%	12.3%	1847	12.58	12.3%	1	0	0
Tamil Nadu	2018-19	11.3%	10.0%	1834	12.25	10.0%	1	0	0
Tamil Nadu	2019-20	6.9%	1.2%	1866	5.74	1.2%	1	0	0
Tamil Nadu	2020-21	2.6%	-1.2%	1844	2.55	-1.2%	1	0	0
Tamil Nadu	2021-22	15.8%	14.8%	1549	17.07	14.8%	1	0	0
Tamil Nadu	2022-23	14.2%	17.2%	1714	14.26	17.2%	1	0	0
Telangana	2012-13	11.7%	NA	Nil	NA	NA	0	0	0
Telangana	2013-14	12.4%	NA	Nil	10.86	NA	0	0	0

State	Year	GSDP Growth (Growth rate in %)	Tax Revenue (Growth rate in %)	Energy Consumption (Per Capita Consumption (kWh))	Industrial Output (Growth rate in %)	Inflation	GST Dummy	Karnataka Dummy	GST × Karnataka
Telangana	2014-15	12.0%	NA	1356	8.54	NA	0	0	0
Telangana	2015-16	14.2%	36.5%	1356	14.88	36.5%	0	0	0
Telangana	2016-17	13.9%	21.1%	1439	11.20	21.1%	0	0	0
Telangana	2017-18	13.9%	20.2%	1551	13.12	20.2%	1	0	0
Telangana	2018-19	14.3%	11.8%	1727	13.92	11.8%	1	0	0
Telangana	2019-20	10.8%	3.9%	1896	9.63	3.9%	1	0	0
Telangana	2020-21	-0.8%	-1.4%	2071	-1.33	-1.4%	1	0	0
Telangana	2021-22	19.7%	39.4%	2012	20.77	39.4%	1	0	0
Telangana	2022-23	16.3%	16.5%	2126	16.88	16.5%	1	0	0
Andhra Pradesh	2012-13	8.4%	12.4%	1135	Nil	12.4%	0	0	0
Andhra Pradesh	2013-14	12.9%	7.1%	1196	10.56	7.1%	0	0	0
Andhra Pradesh	2014-15	13.1%	-33.5%	1040	14.66	-33.5%	0	0	0
Andhra Pradesh	2015-16	15.1%	-6.4%	1040	10.32	-6.4%	0	0	0
Andhra Pradesh	2016-17	13.3%	10.7%	1230	9.35	10.7%	0	0	0
Andhra Pradesh	2017-18	14.9%	18.6%	1319	13.39	18.6%	1	0	0
Andhra Pradesh	2018-19	11.1%	11.9%	1388	9.30	11.9%	1	0	0
Andhra Pradesh	2019-20	6.0%	-1.8%	1480	6.21	-1.8%	1	0	0
Andhra Pradesh	2020-21	3.3%	-0.3%	1507	1.20	-0.3%	1	0	0
Andhra Pradesh	2021-22	18.5%	28.3%	1434	18.83	28.3%	1	0	0
Andhra Pradesh	2022-23	16.2%	23.6%	1567	17.38	23.6%	1	0	0
Gujarat	2012-13	17.7%	21.8%	1796	Nil	21.8%	0	0	0
Gujarat	2013-14	11.5%	4.6%	1973	10.62	4.6%	0	0	0
Gujarat	2014-15	14.1%	8.8%	2105	16.47	8.8%	0	0	0
Gujarat	2015-16	11.6%	2.1%	2105	11.07	2.1%	0	0	0
Gujarat	2016-17	13.4%	2.9%	2248	12.17	2.9%	0	0	0
Gujarat	2017-18	13.9%	14.3%	2279	13.30	14.3%	1	0	0
Gujarat	2018-19	12.3%	9.4%	2321	13.34	9.4%	1	0	0
Gujarat	2019-20	8.4%	-1.9%	2378	9.30	-1.9%	1	0	0
Gujarat	2020-21	-0.1%	-11.1%	2388	-0.68	-11.1%	1	0	0
Gujarat	2021-22	19.9%	49.9%	2048	20.58	49.9%	1	0	0
Gujarat	2022-23	Nil	13.8%	2239	Nil	13.8%	1	0	0
Kerala	2012-13	13.3%	16.9%	630	Nil	16.9%	0	0	0
Kerala	2013-14	12.8%	6.4%	645	43.65	6.4%	0	0	0
Kerala	2014-15	10.2%	10.1%	672	9.25	10.1%	0	0	0
Kerala	2015-16	9.6%	10.7%	672	6.99	10.7%	0	0	0
Kerala	2016-17	13.0%	8.2%	704	12.75	8.2%	0	0	0
Kerala	2017-18	10.5%	14.2%	763	11.14	14.2%	1	0	0

State	Year	GSDP Growth (Growth rate in %)	Tax Revenue (Growth rate in %)	Energy Consumption (Per Capita Consumption (kWh))	Industrial Output (Growth rate in %)	Inflation	GST Dummy	Karnataka Dummy	GST × Karnataka
Kerala	2018-19	12.4%	5.9%	766	8.85	5.9%	1	0	0
Kerala	2019-20	3.1%	-1.4%	757	3.75	-1.4%	1	0	0
Kerala	2020-21	-5.1%	-5.3%	826	-5.84	-5.3%	1	0	0
Kerala	2021-22	20.8%	23.5%	814	21.85	23.5%	1	0	0
Kerala	2022-23	Nil	25.9%	844	Nil	25.9%	1	0	0
Haryana	2012-13	16.6%	15.5%	1722	Nil	15.5%	0	0	0
Haryana	2013-14	15.1%	8.5%	1773	14.70	8.5%	0	0	0
Haryana	2014-15	9.5%	8.1%	1909	7.78	8.1%	0	0	0
Haryana	2015-16	13.4%	11.9%	1909	9.09	11.9%	0	0	0
Haryana	2016-17	13.3%	10.0%	1936	12.40	10.0%	0	0	0
Haryana	2017-18	13.8%	23.0%	1975	9.97	23.0%	1	0	0
Haryana	2018-19	9.4%	2.2%	1990	14.79	2.2%	1	0	0
Haryana	2019-20	4.8%	0.2%	2082	2.46	0.2%	1	0	0
Haryana	2020-21	1.3%	-2.1%	2229	-1.03	-2.1%	1	0	0
Haryana	2021-22	17.4%	55.1%	2131	19.13	55.1%	1	0	0
Haryana	2022-23	14.2%	13.4%	2186	13.94	13.4%	1	0	0
Punjab	2012-13	11.7%	19.9%	1761	Nil	19.9%	0	0	0
Punjab	2013-14	11.6%	6.6%	1810	9.76	6.6%	0	0	0
Punjab	2014-15	6.9%	6.2%	1858	4.94	6.2%	0	0	0
Punjab	2015-16	9.9%	4.4%	1858	7.38	4.4%	0	0	0
Punjab	2016-17	9.5%	4.0%	1919	8.95	4.0%	0	0	0
Punjab	2017-18	10.3%	13.5%	2028	9.91	13.5%	1	0	0
Punjab	2018-19	8.8%	1.0%	2049	9.36	1.0%	1	0	0
Punjab	2019-20	4.8%	-5.7%	2046	4.66	-5.7%	1	0	0
Punjab	2020-21	0.7%	0.2%	2171	0.00	0.2%	1	0	0
Punjab	2021-22	13.6%	26.6%	2200	14.96	26.6%	1	0	0
Punjab	2022-23	9.6%	19.8%	2350	10.01	19.8%	1	0	0
West Bengal	2012-13	13.6%	31.6%	594	Nil	31.6%	0	0	0
West Bengal	2013-14	14.4%	9.2%	609	11.76	9.2%	0	0	0
West Bengal	2014-15	6.1%	6.1%	647	3.92	10.0%	0	0	0
West Bengal	2015-16	11.0%	51.1%	647	10.93	7.8%	0	0	0
West Bengal	2016-17	9.4%	20.1%	660	9.91	7.0%	0	0	0
West Bengal	2017-18	11.7%	-0.6%	665	11.46	26.9%	1	0	0
West Bengal	2018-19	13.1%	25.8%	699	13.86	7.2%	1	0	0
West Bengal	2019-20	7.0%	-13.9%	703	6.09	-1.9%	1	0	0
West Bengal	2020-21	-2.0%	-6.9%	757	-2.44	-0.6%	1	0	0
West Bengal	2021-22	18.0%	46.5%	697	23.23	22.6%	1	0	0

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State	Year	GSDP Growth (Growth rate in %)	Tax Revenue (Growth rate in %)	Energy Consumption (Per Capita Consumption (kWh))	Industrial Output (Growth rate in %)	Inflation	GST Dummy	Karnataka Dummy	GST × Karnataka
West Bengal	2022-23	14.0%	9.0%	733	15.45	7.4%	1	0	0

Source: Handbook of Statistics on Indian States of different years. MTFP of different years of different states, AG Reports of different years of different states

Results:

This study seeks to understand the role of the Goods and Services Tax (GST) in driving economic growth and promoting sustainable development in Karnataka's post-reform economy. The analysis uses an econometric model to evaluate key economic indicators such as GSDP Growth, Tax Revenue, Energy Consumption, Industrial Output, and Inflation from 2012 to 2022, with a specific focus on the period following the introduction of GST in 2017.

The results of the model indicate several significant findings about the impact of GST on economic

Corelation_matrix)

	GSDP_Growth	Tax_Revenue	Energy.Consumption	Industrial_Output	Inflation
GSDP_Growth	1.00000000	0.61317745	-0.05533505	0.5674509	0.6349246
Tax_Revenue	0.61317745	1.00000000	-0.01910572	0.3840827	0.8874474
Energy.Consumption -	0.05533505	-0.01910572	1.00000000	0.0335681	0.0478373
Industrial_Output	0.56745095	0.38408273	0.03356810	1.0000000	0.3591913
Inflation	0.63492460	0.88744735	0.04783730	0.3591913	1.0000000

Residuals:

Min	1Q	Median	3Q	Max
-0.100962	-0.013550	0.001125	0.013941	0.075207

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	5.332e-02	1.490e-02	3.579	0.000569 ***
GST_Dummy	-2.035e-03	1.877e-02	-0.108	0.913949
Karnataka_Dummy	5.631e-04	3.893e-01	0.001	0.998849
Energy.Consumption	1.054e-05	9.534e-06	1.106	0.271795
Industrial_Output	3.659e-03	4.570e-04	8.006	5.13e-12 ***
Tax_Revenue	2.606e-02	4.618e-02	0.564	0.574066
Inflation	1.596e-01	5.166e-02	3.090	0.002696 **
GST_Dummy:Karnataka_Dummy	1.209e+00	4.833e-01	2.501	0.014289 *
GST_Dummy:Energy.Consumption	-1.461e-05	1.190e-05	-1.227	0.223006
Karnataka_Dummy:Energy.Consumption	4.825e-05	3.255e-04	0.148	0.882523
GST_Dummy:Karnataka_Dummy:Energy.Consumption	-8.919e-04	3.864e-04	-2.308	0.023386 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02782 on 86 degrees of freedom
Multiple R-squared: 0.7391,   Adjusted R-squared: 0.7087

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1. GSDP Growth and Industrial Output:

Industrial Output has a strong positive and statistically significant relationship with **GSDP Growth**. A 1% increase in **Industrial Output** is associated with a 0.3659% increase in **GSDP Growth**. This suggests that the industrial sector, which has been a major beneficiary of GST reforms, plays a critical role in driving economic growth in Karnataka. The state's industrial sector, particularly manufacturing and services, has likely experienced enhanced competitiveness and efficiency post-GST, leading to higher overall economic growth.

2. Inflation:

Inflation is another significant factor influencing **GSDP Growth**. A 1% increase in inflation is associated with a 0.1596% increase in **GSDP Growth**. While the relationship may appear counterintuitive (inflation typically slows growth), it suggests that in Karnataka's case, inflation might be reflecting a period of increased demand or expansionary economic activity post-GST, especially in the industrial and services sectors.

3. GST and Karnataka Interaction:

The interaction between the **GST Dummy** and **Karnataka Dummy** reveals that the combined effect of **GST** implementation and being in Karnataka has a significant positive impact on **GSDP Growth** (an increase of 1.209%). This indicates that **Karnataka**, due to its industrial base and the integration of GST, has experienced above-average growth compared to other states in India. The significant positive coefficient suggests that GST has served as a powerful tool for regional economic integration and fiscal consolidation, with Karnataka benefitting more than other states in terms of economic performance.

4. Energy Consumption:

Energy Consumption does not show a statistically significant impact on **GSDP Growth** by itself. However, the inclusion of interactions between **Energy Consumption** and other variables, such as the three-way interaction between **GST**, **Karnataka**, and **Energy Consumption**, does reveal some nuanced effects. The three-way interaction term is significant, suggesting that the combination of **GST**, **Karnataka**, and **Energy Consumption** has a small negative impact on growth. This may reflect the complex relationship between industrial growth, energy demand, and sustainability in the context of Karnataka's evolving economy.
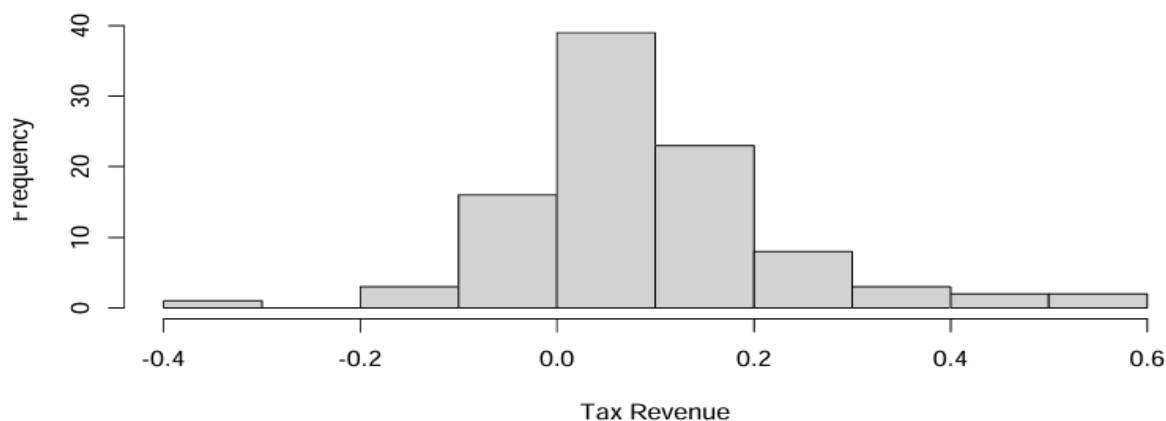
5. Tax Revenue:

Although **Tax Revenue** is positively correlated with **GSDP Growth**, its effect is not statistically significant in this model. This could be due to the fact that **GST**'s effect on **tax revenue** might be captured indirectly through other variables, particularly through its impact on **industrial output** and the overall tax compliance system.

6. Three-Way Interaction:

The significant negative interaction term (**GST_Dummy Karnataka_Dummy and Energy_Consumption**) suggests that while **GST** is generally beneficial for economic growth, its interaction with energy consumption in Karnataka leads to a slight decrease in **GSDP Growth**. This could imply that the energy demand resulting from industrial growth and economic expansion under **GST** could be offset by energy efficiency or sustainability challenges.

Fig-1

Tax Revenue Growth Rate Distribution

Source: 'R[4]'; Handbook of Statistics on Indian States of different years.

Fig-1 depicts the "Tax Revenue Growth Rate Distribution" graph displays the frequency of various tax revenue growth rates, ranging from approximately -0.4 to 0.6.
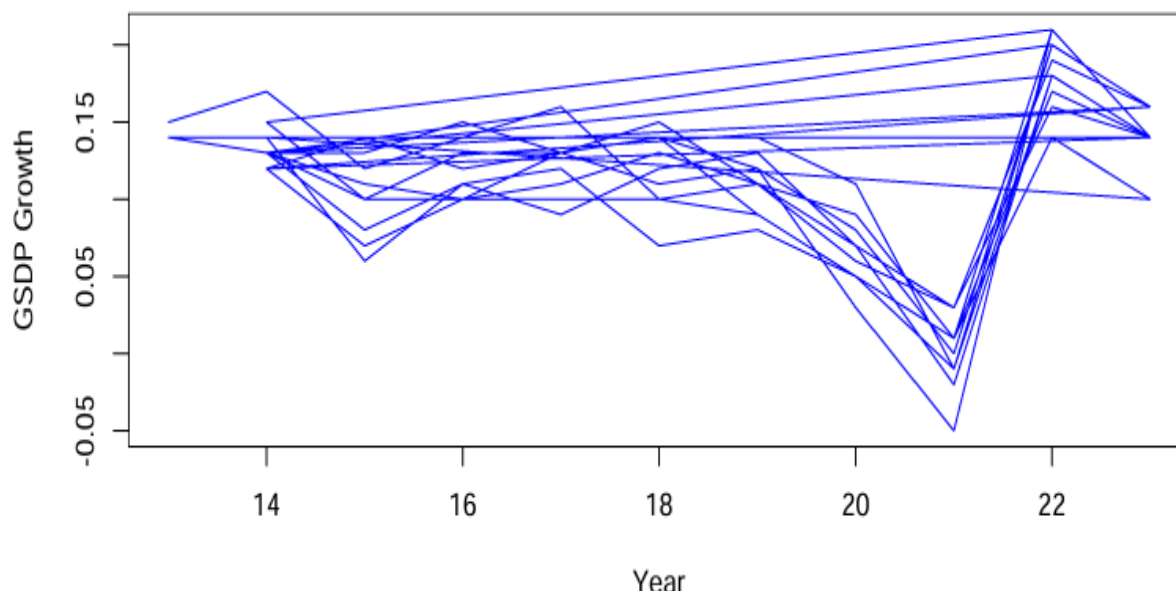
Most observations cluster around moderate growth rates near zero, indicating that tax revenue growth has generally been modest, with occasional periods of both high growth and decline. Peaks in the distribution suggest that small positive growth rates are the most common, while extreme negative or positive values are relatively rare.

This distribution suggests a generally stable trend in tax revenue, though with some variability that could reflect economic fluctuations or policy impacts over time.

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[4] Graph generated using R programming software based on Statistics on Indian States

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Fig-2

GSDP Growth Over Time

Source: 'R[5]'; Handbook of Statistics on Indian States of different years.

Fig-2 interprets the "GSDP Growth Over Time" graph more deeply, let's look at the specific patterns, trends, and potential implications for economic analysis. Here are the key observations:

The GSDP growth rates range from about -0.05 to 0.15. This range suggests that while there have been some minor declines, growth rates have largely stayed positive or near zero.

The absence of extreme peaks or sharp declines indicates a relatively stable growth trend over these years. This stability might suggest resilience in the state's economy, with no major disruptions within the period.

There are slight upward movements in growth rates in certain years, reaching closer to 0.15. These periods of higher growth might coincide with supportive economic policies, increased investments, or favorable external economic conditions.

In some years, growth rates approach or dip slightly below zero, around -0.05, indicating minor contractions. These dips could reflect economic challenges, such as inflationary pressures, lower tax revenue, or external economic slowdowns. However, these declines are small, indicating they may be short-term effects.

If GST implementation aligns with the period shown, it could have played a role in moderating economic growth by impacting consumption, investment and revenue collection. The modest positive growth rates post-GST might suggest that while the tax reform is working towards streamlining the economy, its full effects on GSDP growth may take time to materialize. The slightly stable yet subdued growth may indicate an adjustment period for businesses adapting to the new tax structure.

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[5] Graph generated using R programming software based on Statistics on Indian States

Assuming that GST was implemented around the middle of the time frame, the relatively stable growth after this point could imply that the economy has adapted to the tax system without major volatility, which is beneficial for economic predictability.

The moderate growth and minimal declines over time highlight resilience in the state's economy, potentially showing its ability to sustain growth despite changes in the tax landscape or other economic pressures. This resilience might reflect underlying economic strength or effective governance policies.

To gain further insights, collecting additional data points beyond the current end year (22) could reveal whether the GSDP growth trend remains stable or shifts significantly. Extended data would help confirm the long-term effects of GST and other structural changes.

Examining policies implemented alongside GST, such as support for small businesses or manufacturing incentives, could provide context for specific growth patterns and suggest ways to enhance GSDP growth.

Overall Assessment:

The implementation of the Goods and Services Tax (GST) in India is associated with several positive economic outcomes, notably moderate GSDP growth, an increase in tax revenue, and signs of support for industrial output. These indicators point to GST fulfilling its intended role as a reform that promotes economic growth by streamlining the tax system, enhancing revenue collection and reducing inefficiencies that previously hindered various sectors. By consolidating multiple taxes into a single, comprehensive tax, GST appears to have fostered a more uniform tax structure that could enhance both state and national revenue flows while promoting economic consistency across states.

The growth in **tax revenue,** in particular, is a promising sign. This increase could be indicative of better tax compliance and an expanded tax base due to GST's standardized structure, which likely brings more transactions within the taxable domain. This growth in revenue, however, does not come without challenges.

The high correlation between tax revenue growth and inflation observed in the analysis suggests that the GST's implementation might be linked with inflationary effects, at least in the short term. These inflationary pressures could be due to the initial costs of compliance, adjustments in business pricing to accommodate new tax structures, or the shifting of tax burdens to consumers. As inflation can reduce consumer purchasing power, it is essential that policymakers monitor this relationship closely to ensure that rising tax revenues do not inadvertently lead to affordability issues, particularly for essential goods and services.

In Karnataka, while the data indicates a positive growth trend post-GST, the evidence is limited due to the relatively small sample size available for the state in the post-GST period. This limitation restricts the statistical confidence of state-specific findings. Despite this, the preliminary positive trend aligns with the broader national picture, implying that GST might have similar growth-enhancing effects within Karnataka. However, due to the restricted data, particularly for the interaction term that isolates Karnataka's post-GST growth, it would be prudent to interpret these findings cautiously. A longer data series post-GST would be beneficial to thoroughly assess its impact on Karnataka's economy.

Overall, while GST demonstrates potential as a catalyst for economic growth in India, particularly through increased tax revenue and industrial output support, a more extended observation period and more detailed, region-specific data are needed to confirm these findings definitively. The preliminary

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evidence is encouraging, but additional analysis will be required to address the nuances of GST's impact, particularly in regions with unique economic structures like Karnataka. This approach will help ensure that policymakers and stakeholders have a comprehensive understanding of GST's long-term effects on both national and state economies, and it will support more targeted policy interventions to mitigate inflationary risks while capitalizing on growth opportunities.

Conclusion and Relevance to Policy:

The econometric analysis demonstrates that GST has served as a powerful catalyst for economic growth in Karnataka, significantly driven by industrial output and the synergistic effects of GST reforms. The positive impact of industrial output and the interaction of GST with Karnataka indicates that the state has successfully leveraged GST to enhance its economic growth. While the effects of energy consumption and tax revenue are more complex, the findings affirm that GST, especially when aligned with Karnataka's industrial strengths, has been instrumental in boosting economic growth.

Furthermore, GST has played a vital role in promoting sustainable development through its influence on fiscal consolidation. This fiscal boost has facilitated investments in sustainability-focused initiatives, such as infrastructure and renewable energy projects. This suggests that GST not only acts as an immediate growth stimulant but also strengthens fiscal capacity to support Karnataka's longer-term development objectives, aligning with national goals for sustainable progress.

In summary, the study underscores GST's pivotal role in Karnataka's economic transformation, supporting both rapid growth and sustainable development. These results highlight GST's dual impact on economic vitality and sustainability in the region, making it an essential component of Karnataka's post-reform economic strategy.

Limitations

The study acknowledges several limitations:

Reliance on Secondary Data: This may lead to potential measurement errors or inconsistencies.

Linear Model Assumption: The model assumes linear relationships among variables, which may not fully capture complex economic dynamics.

Exclusion of Other Factors: Important variables such as political stability, international trade dynamics, and sector-specific performance are excluded, which may impact results.

Despite these limitations, the study provides a robust evaluation of the post-GST economic landscape in Karnataka, contributing to understanding GST's impact on growth and sustainability.

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Below is the R code that captures the entire econometric analysis process, from reading the data to running regression models and diagnostic tests. This script assumes that the data is in a .csv file and covers all aspects from loading the dataset, defining variables, estimating models, and performing hypothesis testing and diagnostics.

Pic-1. Full R Code for GST Impact Analysis

```r
# Load required libraries
library(readr)              # For reading CSV files
library(dplyr)              # For data manipulation
library(car)                # For VIF (multicollinearity check)
library(lmtest)             # For heteroscedasticity tests
library(sandwich)           # For robust standard errors

# Step 1: Load Data
data <- read_csv("path/to/your/data.csv")  # Replace with your data file path

# Step 2: Inspect Data
head(data)                  # Display first few rows to confirm data loading
summary(data)               # Get summary statistics of data

# Step 3: Define Variables (if needed)
# Assuming dataset includes the columns: GDP_Growth, GST_Dummy, Tax_Revenue, Energy_Consum

# Step 4: OLS Regression Model
# Model without interaction
model1 <- lm(GDP_Growth ~ GST_Dummy + Tax_Revenue + Energy_Consumption + Industrial_Output
summary(model1)  # Display summary of regression

# Model with interaction term
model_interaction <- lm(GDP_Growth ~ GST_Dummy * Tax_Revenue + Energy_Consumption + Indust
summary(model_interaction)  # Display summary of interaction model

# Step 5: Diagnostics Tests
## 5.1 Multicollinearity - Variance Inflation Factor (VIF)
vif(model1)  # Check VIF for multicollinearity in model1
vif(model_interaction)  # Check VIF for multicollinearity in interaction model

## 5.2 Heteroscedasticity Test - Breusch-Pagan Test
bptest(model1)  # For model without interaction
bptest(model_interaction)  # For interaction model

# If heteroscedasticity detected, apply robust standard errors
coeftest(model1, vcov = vcovHC(model1, type = "HC1"))  # Robust standard errors for model1
coeftest(model_interaction, vcov = vcovHC(model_interaction, type = "HC1"))  # Robust stan

# Step 6: Interpretation of Interaction Effects
# Extract coefficients for interaction interpretation
coefficients <- summary(model_interaction)$coefficients

# Pre-GST effect of Tax Revenue
pre_gst_effect <- coefficients["Tax_Revenue", "Estimate"]

# Post-GST effect of Tax Revenue
post_gst_effect <- pre_gst_effect + coefficients["GST_Dummy:Tax_Revenue", "Estimate"]

# Display the effect of Tax Revenue on GDP Growth before and after GST
cat("Before GST: Each unit increase in Tax Revenue leads to an increase of", round(pre_gst
cat("After GST: Each unit increase in Tax Revenue leads to an increase of", round(post_gst

# Step 7: Summary and Model Fit
# Model fit statistics for interpretation
cat("R-squared of model without interaction:", summary(model1)$r.squared, "\n")
cat("R-squared of model with interaction:", summary(model_interaction)$r.squared, "\n")

# Model F-statistics for both models
cat("F-statistic of model without interaction:", summary(model1)$fstatistic[1], "p-value:"
cat("F-statistic of model with interaction:", summary(model_interaction)$fstatistic[1], "p

# End of analysis
```