SJIF Impact Factor (2025): 8.539 |Journal DOI: 10.36713/epra0212 ISSN: 2277–3142
International Journal of Indian Economic Light (JIEL) - Peer-Reviewed Journal
Volume: 13 | Issue: 3 | April 2025

DEBT SUSTAINABILITY, OPTIMUM ECONOMIC GROWTH AND OPTIMUM LEVEL DEBT: A CASE STUDY OF ODISHA STATE FINANCES

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Article DOI: https://doi.org/10.36713/epra21329
DOI No: 10.36713/epra21329

ABSTRACT

This study examines, sustainability of public debt, its threshold, and its relationship with economic growth in Odisha, India, and, using data from 2005-06 to 2023-24. Employing traditional methods (Domar model, Indicator Approach), and econometric methods (unit root and cointegration tests), and nonlinear regression techniques for the study and the analysis identifies a debt-to-GSDP threshold of 29.65%, confirming Odisha's debt sustainability. The findings highlight the state's successful fiscal reforms, achieving macroeconomic stability, debt sustainability, and economic growth. However, challenges in developmental expenditure management, particularly in capital outlay, underscore the need for strategic debt management to sustain growth while maintaining fiscal stability.

KEYWORDS: *Debt Sustainability, Public Debt, Fiscal Deficit, Economic Growth, FRBM, Debt Threshold*
***JEL Codes**: Q54, H63, C23, D72, H68, F43*

1. INTRODUCTION

In the post-globalization era, India's fiscal policy has increasingly centred on macroeconomic stabilization to foster international competitiveness and long-term economic resilience. Among the critical institutional reforms introduced in this context, the Fiscal Responsibility and Budget Management (FRBM) Act—guided by the 12th Finance Commission—has played a foundational role in institutionalizing fiscal discipline across both the central and state governments. By setting credible targets for deficit reduction and debt containment, the FRBM framework aims to promote sustainable growth while maintaining fiscal solvency and macroeconomic stability.

At the heart of this discourse lies the dynamic interplay between fiscal deficits, public debt, and economic growth. While a well-managed fiscal deficit—particularly one directed towards productive capital investments—can catalyse growth and support debt sustainability, unchecked expansionary fiscal policies in demand-constrained conditions risk escalating the debt-to-GDP ratio, increasing interest burdens, and crowding out private investment. These macroeconomic risks underscore the importance of aligning fiscal strategies with long-term sustainability goals.

For Indian states like Odisha, achieving this delicate balance is particularly critical. As a resource-rich state with a history of economic volatility and exposure to both global shocks and recurrent natural disasters (e.g., the global financial crisis of 2007–08, Cyclones Phailin and Fani, and the COVID-19 pandemic), Odisha's ability to maintain fiscal prudence while driving developmental expenditure exemplifies both the challenges and opportunities of sub-national fiscal management in India. Moreover, given the state's reliance on intergovernmental transfers and its varied fiscal capacity, crafting an optimal fiscal policy tailored to Odisha's structural and economic characteristics becomes imperative.

This study aims to critically examine the nexus between fiscal deficit stability, debt sustainability, and optimal economic growth within the specific context of Odisha from FY 2005–06 to FY 2024–25. It seeks to address three pivotal questions:
1. What is the empirical relationship between public debt and economic growth in Odisha?
2. What constitutes an optimal debt threshold that ensures sustainable and maximise economic growth?
3. Should Odisha prioritize fiscal consolidation to meet FRBM mandates or emphasize growth-enhancing public investment?

Employing a multi-method approach, this research integrates theoretical frameworks—including the Domar sustainability model, intertemporal budget constraint analysis, and indicator-based assessments—with robust

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empirical techniques. These include descriptive analysis of fiscal indicators, time series econometrics (ADF unit root and Johansen/Engle-Granger cointegration tests), and regression modelling (linear, quadratic, semi-log, and nonlinear models). A nonlinear regression is used to estimate the optimal debt-to-GSDP ratio using the formula: $= -\frac{\beta_1}{2\beta_2}$, β_1 and β_2 are coefficients of the debt-to-GSDP ratio and its squared term, respectively. All econometric analyses are conducted in E-Views 11.

Through this rigorous framework, the study offers a comprehensive understanding of Odisha's fiscal dynamics and provides evidence-based policy recommendations to reinforce deficit stability, ensure long-term debt sustainability, and maximize economic growth potential. The findings aim to contribute to the broader discourse on sub-national fiscal governance in India, offering insights for policymakers seeking to balance fiscal prudence with developmental imperatives.

2. LITERATURE REVIEW

The literature on public debt sustainability is divided into theoretical and empirical perspectives, with no universal consensus on its economic impacts or assessment methods.

2.1 Theoretical Perspectives

1. **Classical (Ricardian Equivalence)**: Argues that deficits have minimal economic impact as households save to offset future tax burdens (Barro, 1974).
2. **Keynesian**: Views deficits as growth-enhancing through demand stimulation, though rapid debt accumulation raises sustainability concerns (Keynes, 1936).
3. **Neo-classical**: Suggests deficits reduce savings, increase interest rates, and crowd out private investment, hindering growth (Elmendorf & Mankiw, 1999).

Empirical studies reflect these theoretical divides. The Keynesian approach fuelled debt increases in the 1970s, but when debt-to-GDP ratios rose, concerns about sustainability grew. Hamilton and Flavin's (1986) seminal work sparked research into debt sustainability, yet no consensus among economists on whether deficit financing is good or bad or neutral (Rangarajan and Srivastava, 2005). It needs to be resolved empirically, i.e., it is necessary to examine whether public debt is beneficial or not and if beneficial, then up to what level? However, on the empirical front also, there is no universal agreement on how public debt sustainability can be assessed. (Akhmadev et al.,2018)

2.2 Literature on Empirical Approaches

Empirical studies employ varied methodologies to assess debt sustainability:

- **Traditional Domar Model**:

Debt is sustainable if the growth rate of debt (k) is less than the interest rate (r), which is less than the economic growth rate (g), i.e., k < r < g (Domar, 1944).

The Domar stability condition that is solvency or no ponzi game condition implies that the initial debt stock equates the present discounted value of primary surplus in the future. That is the Inter temporal budget constraint follows.

For solvency growth rate of public debt (k) must be less than rate of interest (r), and

Debt /GSDP ratio converges to a steady value when r (rate of interest) < g (growth rate of GSDP)

The ultimate condition for solvency and Sustainability should be

- k (growth rate of debt) <r (rate of interest) < g (growth rate of GSDP)

(Rath (2005), "Fiscal deficit and its Sustainability Perspective for a Backward State in India: A case study of Odisha").

This debt dynamic equation is given as:

$$d_t = p_t + d_{t-1}\left[\frac{1+r}{1+g}\right] = f_t + d_{t-1}\left[\frac{1}{1+g}\right] \quad (1)$$

where:

dt is the debt-GDP ratio at year t,

pt is the primary balance relative to GDP, and

ft is the fiscal deficit-GDP ratio.

When the primary deficit is zero and r=g, the debt-GDP ratio remains constant; if r>g, the debt/GDP ratio will rise and is unsustainable.

- **Indicator Approach**

This approach was later expanded to include the **inter-temporal budget constraint (IBC)** of the government, which states that the current debt must equal the present value of future primary surpluses (Blanchard et al., 1991). Additional factors such as growth, liquidity, creditworthiness, fiscal burden, and fiscal space were also

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incorporated, and the method became known as the "Indicator Approach" (Blanchard et al., 1991; Pattnaik et al., 2003; Kaur et al., 2018).
Nonetheless, it has been criticized for applying the sustainability criterion on a year-to-year basis without adequately considering the long-term validity of the intertemporal budget constraint.

- **Modern Time Series Approach**

The time series approach employs econometric and statistical methods to assess the sustainability of public debt. A key condition for sustainability under this method is that the first difference of the debt-to-GDP ratio must be stationary (i.e., integrated of order zero), indicating that the debt series does not exhibit explosive behaviour over time (Hamilton, 1986). Stationarity is commonly tested using the Augmented Dickey-Fuller (ADF) test.

An important development within this approach involves testing for co-integration between government revenues and expenditures. If these series are co-integrated, it suggests that fiscal policy is sustainable in the long run. Trehan and Walsh (1991) introduced a method to test whether the quasi-difference of public debt [$(d_t - {}_v d_{t-1})$ with $0 \leq v < 1 + r$, where r is the interest rate], is stationary and whether debt and primary surpluses are co-integrated. Similar co-integration-based sustainability tests have been employed in subsequent studies (e.g., Greiner and Fincke, 2009; Jha and Sharma, 2004; Krishanu Pradhan, 2014).

Bohn (2007) proposed an alternative approach in which the existence of a positive and significant relationship between lagged debt levels and the primary surplus serves as evidence of sustainability. Likewise, Canzoneri et al. (2012) suggested that if increases in debt levels lead to proportional increases in future primary surpluses, then fiscal policy may be deemed sustainable.

Despite the robustness of these techniques, several criticisms persist. Unit root tests are highly sensitive to structural breaks, making inference difficult (Uctum et al., 2006).

Moreover, rejecting the unit root hypothesis in real debt or debt ratios is statistically challenging. Lastly, the satisfaction of the IBC does not necessarily require co-integration among budgetary components (Bohn, 2007).

- **Debt-Growth Threshold**

Nonlinear regression models identify a debt threshold beyond which debt negatively impacts growth (Reinhart & Rogoff, 2010; Ghosh et al., 2013).

To analyse the relationship between debt levels and economic growth, researchers employ non-linear regression models in which the growth rate is regressed on the debt-to-GDP ratio and its squared term. The model is expressed as: -(Coefficient of Debt/GDP)/ (2 x Coefficient of Debt-GDP^2). Here, the coefficient of the debt-to-GDP ratio is expected to be positive, while the coefficient of its squared term should be negative. This non-linear model helps identify a debt threshold where levels of debt up to this ratio foster growth, but beyond which the impact becomes detrimental.

Subsequent studies (e.g., Ghosh, 1998; Greiner and Fincke, 2015) argue that debt can potentially enhance growth and welfare, provided it is allocated towards productive investments. These analyses utilize non-linear models such as threshold regression, quadratic specifications, and spline regression to capture the complex debt-growth dynamics.

(i) Determining Sustainable Debt Thresholds via the Deficit-Debt-Growth Relationship

A sustainable debt-to-GDP ratio can be inferred by establishing its linkage with the fiscal deficit. The fiscal deficit necessary to stabilize the debt-to-GDP ratio over time is given by:

$f^* = b^* . \frac{g}{1+g}$

Where f^* is the debt stabilizing fiscal deficit-GDP ratio, b^* is stabilized debt-GDP ratio and g is the nominal GDP growth. This formulation provides a benchmark for policymakers to assess the upper bound of public borrowing while maintaining fiscal stability. Rangarajan and Srivastava (2005), Srivastava et. al. (2021)

(ii) Econometric estimation of debt sustainability and debt threshold:

The alternative to this approach is to utilize an econometric method (threshold regression) for determining the sustainability threshold.

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Table 2.1: Summary Results of Important (Selective) Studies on Debt Sustainability

Author of the Study	Data Period	Variables/ methodology	Issue covered	Result of the study
		(i)Unit root approach		
Hamilton and Flavin (1986)	Annual; 1992- 84	Public Debt, Deficit	Debt sustainability for national level (USA)	Sustainable
Trehan and Walsh (1991)	Annual; 1890- 1983	Deficit, Public Debt	Debt sustainability for national level (USA)	Sustainable
Misra and Khundrakpm (2009)	1991–1992 to 2007–2008	IBC approach (unit root test)	For national level (India)	Not Sustainable
		(ii) Co-integration approach		
Hukkio and Rush (1991)	Quarterly; 1950: II to1988: IV	Revenue and expenditure	Debt sustainability for national level (US)	Not sustainable
M Tronzono (2013)	Annual; 1950- 2010	Revenue and expenditure	Debt sustainability for India	Weakly sustainable
Jha and Sharma (2001)	1871-1921 and 1950-1997	Revenue and expenditure series stationary with structural breaks	if these are I(1) and not cointegrated or have a cointegrating vector different from [1, -1] the Indian public debt is unsustainable	Not sustainable
Kaur et. al. (2014)	Annual; 1980- 13	Revenue, Expenditure and Debt (Panel test)	For state level (20 Indian States)	Sustainable
Bohn (1998)	1916–1995	ordinary least squares (OLS)	Debt sustainability for national level (US)	Sustainable
Tiwari (2012)	1970–2009	p-spline	National level (India)	Not Sustainable
Renjith and Shanmugam (2018)	2004–05 to 2014–15	fixed effects	National level (India)	Sustainable
Fincke and Greiner (2011)	Annual; 1971- 09	p-spline	For Euro Countries	Sustainable (Except Greece and Italy)
		(iii) Threshold regression approach		
D K Srivastava et.al, 2021	1991-92 to 2018-19	ARDL and threshold regression	59% for both central and state government of India	Not sustainable
K. R. Shanmugam & K. Shanmugam (2022)	1996-97 to 2020-21	threshold regression and nonlinear regression	18.36% at debt threshold regression and 18.82 at nonlinear regression of India	Not sustainable for Tamil Nadu
Ngan Tran (2018)	1999–2016	non-linear relationship between government debt and sovereign risk premium	threshold bounds of 40–55% of GDP for 14 emerging economies	non-Latin American economies are sustainable in the short run
Omotosho, Bawa and Doguwa (2016)	using quarterly data from 2005 – 2015	Khan and Senhadji (2001) type of model (Threshold regression)	73.7 per cent (external and domestic debts were 49.4% and 30.9%) threshold for Nigeria	Sustainable for long run

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2.3 Studies on India and Odisha

Indian studies suggest debt sustainability at the national level but highlight state-level variations. Kaur and Mukherjee (2012) estimated a 61% debt-to-GDP threshold for India, while Shanmugam and Renjith (2023) found a 22% threshold for Indian states. India's central debt is sustainable long-term due to cointegrated revenues-expenditures and fiscal adjustments, but post-COVID spikes and state-level variations (e.g., Tamil Nadu's 26.94% unsustainable debt) demand ongoing corrections (Kaur & Mukherjee, 2012; Pradhan, 2014; Shanmugam & Shanmugam, 2022; Srivastava et al., 2021).

For Odisha, Rath (2005) noted historical fiscal challenges, with a debt-to-GSDP ratio of 58.87% in the early 2000s, but recent reforms have improved fiscal health (Odisha Economic Survey, 2023). It reflects unsustainable debt growth and structural deficiencies, requiring central transfers, debt relief, and reforms akin to India's broader state-level strategies (Rajaraman et al., 2005; Rangarajan & Prasad, 2012).

3. OVERVIEW OF PUBLIC DEBT

Government borrowing refers to the funds raised by a government to cover budget deficits, meet expenditure commitments, and finance development projects.

3.1 Debt Trends of Odisha

Table No.3.1

Year	DEBT STOCK	dt%
2005-06	36456.45	42.84
2006-07	37249.51	36.58
2007-08	36311.61	28.09
2008-09	36430.54	24.53
2009-10	37730.04	23.15
2010-11	39136.91	19.81
2011-12	38589.37	16.71
2012-13	37980.14	14.51
2013-14	38666.24	13.04
2014-15	43273.38	13.77
2015-16	52017.35	15.83
2016-17	62135.45	15.82
2017-18	73864.66	16.77
2018-19	81675.32	16.38
2019-20	92775.81	17.26
2020-21	104452.26	19.34
2021-22	97205.03	14.66
2022-23	88164.82	11.71
2023-24	103265.96	11.56
2024-25(BE)	125500	13.56

Source: Budget at a Glance (2005–06 to 2024–25), Finance Department of Odisha.

Debt rose from ₹36,456 crore in 2005-06 to ₹1,25,550 crore in 2024-25, but Debt/GSDP fell from 42.8% to 13.5%, reflecting stronger fiscal management

3.2 Impact of borrowing on Economic Growth and Development

1. Impact of Debt and Revenue Growth on Odisha's Economic Development

The growth of debt to GSDP (Gross State Domestic Product) and the growth of total revenue receipts (TRR) to GSDP have significant implications for economic growth and development.

Fluctuations in debt growth, especially spikes like in 2016–17 or dips in 2021–22, reflect varying borrowing needs and economic conditions. TRR to GSDP growth, marked by sharp variations (e.g., high in 2021–22), signals changes in revenue performance due to economic revival, non-tax gains, or temporary measures. Strong revenue growth supports fiscal sustainability and reduces borrowing needs. However, volatility in TRR suggests the need for stable, diversified revenue sources. Debt grows faster than revenue in the year 2016-17, 2017-18, 2019-20, 2021-22 it increases fiscal burden and limits funds for development. However, when debt is used productively for capital investment, it can support long-term growth.

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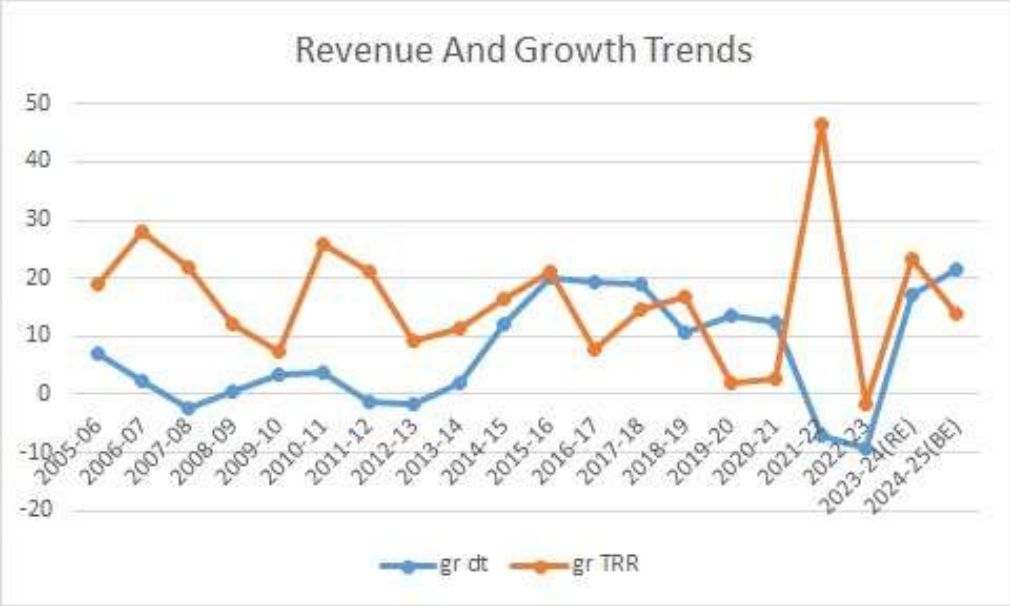

The growth of debt to GSDP and total revenue receipts (TRR) to GSDP significantly influence fiscal health and development.

Corelation analysis of growth of debt to GSDP (gr dt) and growth of total revenue receipts to GSDP (gr TRR):

Table No. 3.2

corelation	*gr dt*	*gr TRR*
gr dt	1	
gr TRR	-0.1837	1

The correlation between debt and TRR growth (-0.183) shows a weak negative relationship—higher revenue growth slightly reduces debt growth but is not decisive. This highlights that revenue growth alone is insufficient; effective fiscal policies and prudent debt management are essential to ensure stable and inclusive economic development.

1. Debt Productivity Analysis

Debt productivity is a key indicator of how effectively government borrowing translates into economic growth. Debt productivity (%) is a measure of how effectively debt is contributing to economic growth. It is calculated as:
Debt Productivity = (Change in GSDP / Change in Debt) *100

A higher debt productivity more than 100 % indicates that the borrowed funds are being used efficiently to generate economic growth, while a lower or negative debt productivity suggests inefficiencies or excessive borrowing without sufficient economic returns.

Table No. 3.3

Year	GSDP	change in GSDP	DEBT	Change in Debt	DEBT PRODUCTIVITY	in %
2005-06	85096		5927.5			
2006-07	101839	16743	36456.45	30528.95	0.54843026	54.84303
2007-08	129274	27435	37249.51	793.06	34.59385166	3459.385
2008-09	148491	19217	36311.61	-937.9	-20.48939119	-2048.94
2009-10	162946	14455	36430.54	118.93	121.5420836	12154.21
2010-11	197530	34584	37730.04	1299.5	26.61331281	2661.331
2011-12	230987	33457	39136.91	1406.87	23.7811596	2378.116
2012-13	261700	30713	38589.37	-547.54	-56.09270556	-5609.27
2013-14	296475	34775	37980.14	-609.23	-57.08024884	-5708.02
2014-15	314250	17775	38666.24	686.1	25.90730214	2590.73
2015-16	328590	14340	43273.38	4607.14	3.11256007	311.256
2016-17	392804	64214	52017.35	8743.97	7.343803787	734.3804

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2017-18	440395	47591	62135.45	10118.1	4.703551062	470.3551
2018-19	498611	58216	73864.66	11729.21	4.963335127	496.3335
2019-20	537502	38891	81675.32	7810.66	4.979220706	497.9221
2020-21	540150	2648	92775.81	11100.49	0.238548028	23.8548
2021-22	662886	122736	104452.26	11676.45	10.511414	1051.141
2022-23	753177	90291	97205.03	-7247.23	-12.45869111	-1245.87
2023-24(RE)	832790	79613	97037	-168.03	-473.8022972	-47380.2
2024-25(BE)	926000	93210	112882	15845	5.882612812	588.2613

Source: Budget at a Glance (2005–06 to 2024–25), Finance Department of Odisha.
High productivity (e.g., 12,154% in 2009-10 and 3,459% in 2007–08) saw small increases in debt leading to large GSDP gains, indicating efficient borrowing. indicated efficient borrowing, Similarly, in 2021–22 (1,051%), post-COVID stimulus effectively supported growth. Though 2024–25 (588%) shows improvement, it remains below peak levels.
while negative productivity (2012-14) reflected inefficient debt use, where GSDP grew despite falling debt, indicating fiscal consolidation rather than debt-driven growth.

3. Regression Analysis
Regression of the growth rate of GSDP on Capital expenditure to GSDP, debt to GSDP ratio and total revenue to GSDP.

Table No.3.4

Year	Yt(%)	CAP/GSDP	Dt(%)	TOTAL TAX
2005-06	9.47	2.51814421	42.84156	11.60894754
2006-07	19.67543	3.50943155	36.57686	12.06357093
2007-08	26.93958	3.96139982	28.08887	11.37312994
2008-09	14.86532	3.86066496	24.53384	10.96023328
2009-10	9.734597	3.22134327	23.15493	10.74015318
2010-11	21.22421	3.38347593	19.81315	10.98053966
2011-12	16.93768	3.2230645	16.7063	11.11410166
2012-13	13.29642	3.4459572	14.51285	11.08101261
2013-14	13.28812	3.54605616	13.04199	13.66639008
2014-15	5.995446	4.94640573	13.77037	11.45887669
2015-16	4.563246	6.18046197	15.8324	14.02987005
2016-17	19.54229	5.56569434	15.81844	13.02784086
2017-18	12.11571	5.82980733	16.77237	13.43926929
2018-19	13.21904	5.73434802	16.38057	13.17100104
2019-20	7.799868	4.84283407	17.26055	11.67780585
2020-21	0.492649	5.33153568	19.33764	11.05577895
2021-22	22.72258	6.66923423	14.66391	11.90139783
2022-23	13.62089	6.56337621	11.70572	11.88873266
2023-24(RE)	10.57029	8.0345081	12.4	12.48954358
2024-25(BE)	11.1925	8.79449028	13.55292	12.44403456

Source: Budget at a Glance (2005–06 to 2024–25), Finance Department of Odisha.

Table No. 3.5 Regression Result:

R^2= 0.19	β value	P value	Result	Implication
CAP/GSDP	2.46	0.23	SIGNIFICANT	higher investment boost growth
DT	0.25	0.31	SIGNIFICANT	higher debt increase growth
T Rev	-1.37	0.1	SIGNIFICANT	higher revenue decrease growth

Regression Analysis Interpretation and Implications:

- A regression with capital expenditure (Table 5.17) showed Debt/GSDP positively impacting growth (β = 0.25), emphasizing the role of productive investments.
-

3.3 Empirical analyses of debt sustainability and debt threshold

(i) Traditional Domar model approach

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Traditional studies employed the Domar (1944) stability condition: k (growth rate of debt) < r (Average interest rate) < g (growth rate of GSDP).

To measure the growth rate over a longer period for 2005-06 to 2024-25 of time series can base on a semi log regression model. We found the equation from this model is

$$Y_t=Y_0 (1+r)^t \ldots\ldots\ldots (1)$$

Where Y_t is dependent variable at period t, Y_0 is initial value of Y_t and r is the average annual growth rate

By taking logarithm of both sides of the equation (1), we have found

$\text{Log } Y_t = \log Y_0 + \log (1+r)$..... (2)

$\text{Log } Y_t = \alpha+\beta_t$ …… (3)

Here, α and β are parameters of the model, 't' represents the time and it is an independent variable, and Y is the dependent variable.

$\alpha = \log Y_0$ …….. (4)

$\beta = \log (1+r)$..... (5)

$1+r$ = antilog of β…… (6)

r = antilog of β-1…... (7)

Then, the growth rate can be found out from the estimated parameters that is

% growth rate (r) = [antilog of (β)-1] *100

The equation (3) is called a semi log model because only dependent variable is in the logarithm form.

As per the model β = 0.11882

$\Longrightarrow 0.11882 = \log (1+r)$

⟹Antilog of 0.11882 = 1.126167

⟹1+r = 1.126167

⟹r = 0.126167

%Annual average growth rate of GSDP (g) =12.62%

Similarly, we can find out the growth rate of Debt (k)

So, β = 0.06933

$\Longrightarrow 0.06933 = \log (1+r)$

⟹Antilog of 0.06933 = 1.07179

⟹1+r = 1.07179

⟹r = 0.07179

% growth rate of Debt (k) = 7.18%

The average interest rate is the calculation of the interest rate (Interest Payment on Outstanding Debt) from the year 2005-06 to 2024-25 by adopting the simple formula $r = r_1/D_{t-1}*100$ (S.S. Rath, 2005)

r_t =rate of interest of period (t)

D_{t-1} = debt stock of period (t-1)

Table. No.3.6

Year	It pay	Dt-1	r=It/Dt-1*100
2005-06	3697.1	34051.18	10.857
2006-07	3188.43	36456.45	8.745
2007-08	3169.48	37249.51	8.508
2008-09	2889.81	36311.61	7.958
2009-10	3044.17	36430.54	8.356
2010-11	3061.46	37730.04	8.114
2011-12	2576.43	39136.91	6.583
2012-13	2807.23	38589.37	7.274
2013-14	2888.22	37980.14	7.604
2014-15	2810.27	38666.24	7.268
2015-16	3343.24	43273.38	7.725
2016-17	4650	52017.33	8.939
2017-18	5000	62135.45	8.046
2018-19	5800.37	73864.66	7.852
2019-20	6062.56	81675.32	7.422
2020-21	6643.79	92775.81	7.161
2021-22	8342.45	104452.3	7.986
2022-23	6996.46	97205.03	7.197
2023-24	7240.85	97037	7.461

Source: various budget at a glance, finance department Odisha

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	INDICATORS	symbolic representation	PHASE 1 (2005-06 to 2009-10) 12th FC	PHASE 2 (2010-11 to 2014-15) 13th FC	PHASE 3 (2015-16 to 2019-20) 14th FC	PHASE 4 (2020-21 to 2023-24) 15th FC	TOTAL (2005-06 to 2023-24) 12th to 15th
1	Rate of nominal growth of GDP (G) should be more than rate of growth of debt (D)	D-G<0	-17.78	-10.4541	1.999682	-17.3069	-5.43773
2	Real output growth (G) should be higher than real interest rate (r)	r-g<0	-1.67	1.669301	-0.00935	-1.07042	0.708244
3.A	Primary balance (PB) to GSDP should be in surplus	PB/GSDP>0	-0.02	-0.01795	-0.03274	-0.03784	-0.02614
3.B	Primary revenue balance to GSDP should be in surplus	PRB/GSDP>0	0.01	-0.00879	-0.02337	-0.03105	-0.03105
3.C	adequate to meet interest payments (IP)	PRB/IP>0	0.20	-0.94175	-2.14457	-4.04778	-1.7334
4.A	Interest Burden to GDP ratio should decline over time	IP/GSDP ↓↓	0.027	0.011213	0.010898	0.010542	0.015034
4.B	Interest payment as a proportion of revenue expenditure should decline overtime	IP/RExp ↓↓	0.18	0.074053	0.063489	0.054056	0.093374
4.C	Interest payment as a proportion of revenue receipts should fall over time	IP/RR ↓↓	16.32	6.563792	5.58623	4.561122	8.2587
5A	Revenue Receipt to GSDP should decline overtime	RR/GSDP↓↓	0.16	0.17143	0.195549	0.213394	0.187269
5.B	Debt stock to Revenue Receipt should decline overtime	D/RR ↓↓	184.29	90.9612	83.83254	67.12594	106.5544
6	Buoyancy of Own Tax Revenue should be greater than 1	BUOYANCY of OTR >1	0.87	-1.39262	0.767621	0.910058	1.058034

The average interest rate $\bar{r}$ = 7.95 %

Therefore, we found that k < r < g, the condition of solvency and sustainability of public debt is satisfied. In other words, in last 20 years from 2005-06 to 2024-25 there are debt solvency and sustainability in Odisha state finances.

(ii) Table 3. Inter temporal Budged Constraint approach which is renamed as Indicator approach and this table is derived from Pattnaik et al., 2003.

Table. No. 3.7 Indicator approach

Source: calculated from the Odisha finance data of various budget at a glance.

The fiscal sustainability of states, as reflected in key indicators like Debt/GSDP and Interest Payments to Total Revenue Receipts (IP/TRR), has shown improvement, with declining ratios indicating enhanced debt management (Table 3). However, persistent primary revenue deficits across the 13th to 15th Finance Commission (FC) periods highlight a continued reliance on borrowing to meet interest obligations, posing risks to long-term fiscal health. Analysing the phases, the 12th FC period exhibited strong sustainability, driven by prudent fiscal policies. This weakened during the 14th FC, as debt growth outpaced GSDP growth, indicating strained fiscal capacity. A recovery was observed in the 15th FC period, supported by robust revenue performance, though the ongoing primary revenue balance deficit underscores the need for structural reforms to ensure sustainable fiscal consolidation.

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(iii) Unit Root Test

In the debt sustainability literature, fiscal sustainability requires that the first difference of the government debt-to-GDP ratio be stationary, implying it is integrated of order zero. The empirical analysis conducted in this study utilized E-Views 11 software.

The null hypothesis of the test assumes the presence of the unit root against the alternative hypothesis that the time series is stationary. The Akaike criterion is used to estimate the optimal lag length for debt to GSDP ratio. The results obtained from the ADF test indicate that the null hypothesis is rejected at level.

Table 3.8 Stationarity test (ADF test): results for DT

Test statistic	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.148123	0.008
Test critical values: 1% level	-3.88671	
5% level	-3.052169	
10% level	-2.666593	

*MacKinnon (1996) one-sided p-values Source (basic data): Authors' estimates Notes: DT = change in government debt to GDP ratio.

Clearly, the first difference in the debt-GDP ratio in Odisha's case from 2005-06 to 2023-24 has no unit-root, that is it is stationary at level 0. The related estimation results of the ADF test equation are given in Appendix Table 3. It is indicating that the public debt of Odisha state is sustainable.

(iv) Co-integration Test:

Another approach proposed in the literature is to assess whether government revenue and expenditure series exhibit a long-run relationship such that their combination yields a stationary series (Hamilton, 1986; RBI, 2020). This involves testing for the presence of cointegration between government revenues and expenditures. In this study, both variables are expressed as ratios to GDP.

Johanson cointegration test

Cointegration test between the 2 series Total Expenditure to GSDP ratio and Total Revenue Receipt to GSDP ratio from 2005-06 to 2023-24.

Table 3.9 Cointegration Rank Test (Johanson cointegration test): results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.742295	24.40791	15.49471	0.0009
At most 1	5.41E-05	0.000974	3.841465	0.9754

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level denotes rejections of the Null hypothesis at the 0.05 level, *MacKinnon-Haug-Michelis (1999) p-values Source (basic data): Authors' estimates Notes: TRR-GSDP = government revenues relative to GSDP, TEX-GSDP = government total expenditure to GSDP ratio

In both the trace statistics and maximum eigenvalue report that there are one cointegrating equations present in this model at 5% level of significance. We reject the null hypothesis means both series are cointegrated in long run.

These results also imply that the debt is sustainable in the case of Odisha state finances. The results of the unrestricted cointegrated rank test are given in Appendix Table 4.

(v) Debt Threshold Analysis:

Threshold Analysis to find the debt-to-GSDP level where negative effects begin. We can determine this using regression analysis or an analytical approach.

Review of many studies about Armey curve and calculate the optimum level of public debt, these studies analysed nonlinear regression methods to estimate the optimal debt level.

We have a regression model where Debt-to-GSDP has a negative beta value.

The optimum level occurs at the turning point of the quadratic equation:

Growth rate of GSDP = $\beta_0 + \beta_1$ (Debt /GSDP) + β_2 (Debt / GSDP)^2 + ε

β_1 is the linear effect of debt on growth.

β_2 is the quadratic effect (to check for a U-shaped relationship).

Optimal Debt-to-GSDP = $-\frac{\beta_1}{2\beta_2}$ This gives the optimum debt level where growth is maximized.

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Table. No. 3.10

Year	Yt (%)	Dt(%)	Dt^2
2005-06	9.47	42.84156	1835.399
2006-07	19.67543	36.57686	1337.867
2007-08	26.93958	28.08887	788.9848
2008-09	14.86532	24.53384	601.9092
2009-10	9.734597	23.15493	536.151
2010-11	21.22421	19.81315	392.5608
2011-12	16.93768	16.7063	279.1003
2012-13	13.29642	14.51285	210.6229
2013-14	13.28812	13.04199	170.0935
2014-15	5.995446	13.77037	189.623
2015-16	4.563246	15.8324	250.6649
2016-17	19.54229	15.81844	250.2229
2017-18	12.11571	16.77237	281.3123
2018-19	13.21904	16.38057	268.323
2019-20	7.799868	17.26055	297.9266
2020-21	0.492649	19.3764	373.9443
2021-22	22.72258	14.66391	215.0304
2022-23	13.62089	11.70572	137.024
2023-24(RE)	10.57029	12.4	153.76

Source: Various budget at a glance, Finance department of Odisha

Regression Analysis Table. No. 3.11

variables	Coefficients	Standard Error	t Stat	P-value	result (<0.05)
Intercept	-0.181	13.359	-0.01358	0.989331	significant
Dt (%)	1.134	1.168	0.971293	0.345858	significant
Dt^2	-0.019	0.0219	-0.87031	0.397	significant

A quadratic regression (Table 3.11) showed an inverted U-shaped relationship between Debt/GSDP and growth:

- **Debt/GSDP**: $\beta_1 = 1.134$, $\beta_2 = -0.019$, indicating debt supports growth up to a threshold, beyond which it reduces growth.
- **Optimal Debt/GSDP**: $-\beta_1/(2\beta_2)$ = **29.65%,** higher than Odisha's current 13.5%, suggesting room for productive borrowing.

29.65 % for the state Odisha which is higher than the debt sustainability threshold level of 25% given by the FRBM committee, Since Odisha's Debt-to-GSDP is below 20%, this is significantly lower than the optimal level (29.65%) estimated from the model. Current debt to GSDP ratio (12.4 %) is below optimum level (29.65 %) So, Odisha has room for safely borrow for productive investments.

4. DEFICIT STABILITY, DEBT SUSTAINABILITY, AND OPTIMUM ECONOMIC GROWTH: A BALANCE THEORY APPROACH

In the context of Odisha's fiscal policy, achieving a balance among deficit stability, debt sustainability, and optimum economic growth is critical for long-term macroeconomic stability. This section applies the canonical framework proposed by Rangarajan and Srivastava (2005) to analyse Odisha's fiscal performance across the 12th to 15th Finance Commission (FC) periods (2005–06 to 2024–25). The framework emphasizes the interplay between fiscal deficits, debt levels, and economic growth, providing a structured approach to assess whether Odisha's fiscal strategies align with the objectives of the Fiscal Responsibility and Budget Management (FRBM) Act.

4.1 Theoretical Framework

The balance theory posits that fiscal policy must harmonize three interconnected goals:

1. **Deficit Stability**: Maintaining fiscal deficits within sustainable limits to avoid excessive borrowing.

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2. **Debt Sustainability**: Ensuring that public debt remains manageable relative to economic output (Gross State Domestic Product, GSDP).
3. **Optimum Economic Growth**: Maximizing growth through productive public expenditure while avoiding adverse effects from high debt or deficits.

Rangarajan and Srivastava (2005) provide a canonical framework to quantify this balance, defining the debt-stabilizing fiscal deficit as a function of the debt-to-GSDP ratio and nominal GSDP growth rate: $f^* = b^* . \frac{g}{1+g}$

This equation determines the fiscal deficit required to stabilize the debt-to-GSDP ratio at a given growth rate. Conversely, the framework allows estimation of the achievable growth rate given target fiscal deficit and debt levels:

$g = \frac{1}{\frac{b^*}{f^*} - 1}$

The framework assumes that growth (g) and interest rates (r) are nonlinear functions of the fiscal deficit, advocating for lower borrowing to boost growth and reduce interest burdens. This approach distinguishes between stability (maintaining fiscal discipline), sustainability (ensuring debt solvency), and optimality (maximizing growth without compromising fiscal health).

4.2 Empirical Analysis

Using data from Odisha's Budget at a Glance (2005–06 to 2024–25), this section evaluates the relationship between fiscal deficits, debt-to-GSDP ratios, and GSDP growth across four FC periods. The analysis compares actual fiscal outcomes with FRBM targets and theoretical growth rates derived from the canonical framework.

4.2.1 Optimal Fiscal Deficit Calculation

The study previously estimated an optimal debt-to-GSDP ratio of 29.65 and an average GSDP growth rate of 12.62% Applying the canonical framework: $f^* = b^* . \frac{g}{1+g}$

This suggests that a fiscal deficit of **3.32%** of GSDP is required to stabilize the debt-to-GSDP ratio at 29.65% given a 12.62% growth rate. The value (3.32%) aligns with FRBM targets (3% fiscal deficit) and reflects Odisha's fiscal capacity.

4.2.2 Fiscal Performance Across Finance Commission Periods

Table 6.1 summarizes Odisha's fiscal parameters across the 12th to 15th FC periods, comparing actual outcomes with FRBM targets and theoretical growth rates derived from the canonical framework.

Table 4.1: Fiscal Parameters Across Finance Commission Periods (2005–06 to 2024–25)

Parameter (%)	**12th FC (2005–10)**	**13th FC (2010–15)**	**14th FC (2015–20)**	**15th FC (2020–25)**
Average GSDP Growth	18.25	12.50	13.38	13.95
Average Fiscal Deficit/GSDP	0.05	0.67	2.44	1.34
Average Debt/GSDP	31.03	15.61	16.41	11.72
FRBM Targets				
-Fiscal Deficit/GSDP	3.0	3.0	≤3.0 (+0.25 if debt < 25%)	≤3.0 (+0.5 with reforms)
- Debt/GSDP	28.0	25.0	25.0	25.0
Targeted Growth (%)	12.00	13.63	13.48	13.60
Theoretical Growth (%)	0.16	4.48	17.46	12.90

***Source*: Author's calculations based on Odisha Budget at a Glance, Finance Department, Government of Odisha.**

12th FC Period (2005–06 to 2009–10)

- **FRBM Targets**: Fiscal deficit ≤ 3%, debt-to-GSDP ≤ 28%.

Targeted Growth $g = \frac{1}{\frac{b^*}{f^*} - 1}$

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$\Longrightarrow g = 1/ [(b^*/f^*) -1] *100$
$\Longrightarrow g = 1/ [(28/3) -1] *100$
$\Longrightarrow g = 12\%$

- **Actual Outcomes**: Fiscal deficit = 0.05%, debt-to-GSDP = 31.03%, GSDP growth = 18.25%.
- **Theoretical Growth**: $\Longrightarrow g = 1/ [(31.03/0.05)-1] *100$
  $\Longrightarrow g = 0.16\%$
- **Implications**: Despite exceeding the debt target, the extremely low fiscal deficit enabled high growth, indicating efficient resource utilization. However, high debt levels suggest a need for improved debt management.

13th FC Period (2010–11 to 2014–15)

- **FRBM Targets**: Fiscal deficit ≤ 3%, debt-to-GSDP ≤ 25%.
- **Targeted Growth**: 13.63%
- **Actual Outcomes**: Fiscal deficit = 0.67%, debt-to-GSDP = 15.61%, GSDP growth = 12.50%.
- **Theoretical Growth**: 4.48%,
- **Implications**: Both fiscal deficit and debt were well below FRBM targets, ensuring stability. However, growth was slightly below the targeted level, suggesting underutilization of fiscal space.

14th FC Period (2015–16 to 2019–20)

- **FRBM Targets**: Fiscal deficit ≤ 3% (+0.25% if debt < 25%), debt-to-GSDP ≤ 25%.
- **Targeted Growth**: 13.48%
- **Actual Outcomes**: Fiscal deficit = 2.44%, debt-to-GSDP = 16.41%, GSDP growth = 13.38%.
- **Theoretical Growth**: 17.46%
- **Implications**: Fiscal discipline improved, with deficits and debt below targets. Growth closely aligned with FRBM goals, but the theoretical growth suggests potential for higher growth through productive expenditure.

15th FC Period (2020–21 to 2024–25)

- **FRBM Targets**: Fiscal deficit ≤ 3% (+0.5% with reforms), debt-to-GSDP ≤ 25%.
- **Targeted Growth**: 13.60%
- **Actual Outcomes**: Fiscal deficit = 1.34%, debt-to-GSDP = 11.72%, GSDP growth = 13.95%.
- **Theoretical Growth**: 12.90%
- **Implications**: Strong fiscal management and low debt levels supported high growth, exceeding the theoretical optimum. Emphasis on developmental spending (e.g., capital outlay) drove growth while maintaining stability.

4.3 Discussion

Odisha's fiscal performance demonstrates a successful balance of deficit stability, debt sustainability, and economic growth. Across all FC periods, fiscal deficits remained below FRBM targets, and debt-to-GSDP ratios declined significantly, from 31.03% in the 12th FC to 11.72% in the 15th FC. Actual GSDP growth consistently exceeded theoretical levels, particularly in the 12th FC (18.25% vs. 0.16%) and 15th FC (13.95% vs. 12.90%), reflecting efficient use of fiscal resources. However, the 13th FC period's lower growth (12.50% vs. 13.63% targeted) suggests missed opportunities for leveraging fiscal space.

The fiscal deficit calculation (3.32%) aligns with FRBM targets and indicates that Odisha has room to increase deficits for productive investments without compromising sustainability. The emphasis on capital expenditure, particularly in the 15th FC period, has been pivotal in achieving high growth while maintaining low debt levels.

5. IMPLICATIONS FOR POLICY

1. Leverage Fiscal Space: Odisha should utilize its low debt-to-GSDP ratio (11.72%) to increase borrowing up to the optimal threshold (29.65%), focusing on high-return capital investments.
2. Enhance Developmental Expenditure: Prioritize capital outlay to sustain high growth, ensuring efficient allocation to maximize debt productivity.
3. Maintain Fiscal Discipline: Continue adhering to FRBM targets to ensure long-term deficit and debt sustainability.
4. Monitor Growth Dynamics: Regularly assess the interplay between deficits, debt, and growth to adapt fiscal strategies to economic conditions.

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6. SUMMERY AND CONCLUSION

This research paper investigates Odisha's fiscal management, debt sustainability, and economic growth over the period from 2005-06 to 2024-25. Odisha has demonstrated prudent fiscal management by consistently keeping its fiscal deficit below the limits set by the Fiscal Responsibility and Budget Management (FRBM) Act. This prudent approach has allowed the state to effectively utilize fiscal space during economic downturns and for developmental initiatives, bolstering macroeconomic stability.

The analysis of borrowing's impact on Odisha's economic growth and development from 2005–06 to 2024–25, Odisha's economic growth was significantly influenced by debt-to-GSDP and total revenue receipts (TRR). A weak negative correlation (-0.1837) between debt and TRR growth highlights the need for diversified revenue sources to counter TRR volatility and reduce borrowing reliance. Debt productivity peaked in 2009–10 (12,154%) and 2021–22 (1,051%), reflecting efficient borrowing, but negative productivity in 2012–14 and 2023–24 indicated fiscal consolidation. Regression analysis ($R^2 = 0.19$) shows capital expenditure ($\beta = 2.46$) and debt-to-GSDP ($\beta = 0.25$) drive growth, while higher revenue-to-GSDP ($\beta = -1.37$) unexpectedly reduces it. Sustainable growth requires productive debt allocation and revenue stabilization.

The sustainability of Odisha's public debt was rigorously evaluated using multiple methodologies. The traditional Domar model affirmed sustainability, with the state's GSDP growth rate (g) exceeding the interest rate (r), which in turn surpassed the debt growth rate (k), i.e., ($g > r > k$). The intertemporal budget constraint approach largely supported debt sustainability across various Finance Commission periods, though some necessary conditions were unmet during the 13th Finance Commission period and the ongoing fiscal reform phase. Modern econometric techniques, such as the unit root test (indicating a stationary debt-to-GSDP ratio) and the Johansen cointegration test (showing cointegration between total expenditure and revenue receipts relative to GSDP), further reinforced these findings leads to debt sustainability.

The study determined an optimal debt-to-GSDP threshold of 29.65%, a level Odisha remains comfortably below, suggesting room for productive borrowing. Economic growth has been impressive, particularly during the 14th Finance Commission period, often exceeding expectations and reflecting efficient resource use. However, there is untapped potential to enhance the productivity of borrowed funds. Recommendations include optimizing borrowing for high-return projects, boosting revenue through tax reforms, prioritizing capital expenditure, and vigilant debt monitoring—strategies vital for sustaining growth in the post-pandemic era.

Odisha's fiscal management exemplifies a balanced approach to maintaining deficit stability, ensuring debt sustainability, and fostering robust economic growth. This study confirms the sustainability of the state's public debt through both traditional and modern analytical frameworks, with an optimal debt-to-GSDP threshold of 29.65% providing a clear guide for future borrowing. The state's ability to maintain fiscal deficits below FRBM targets and strategically deploy fiscal resources has been instrumental in driving high growth rates

Looking ahead, Odisha must focus on enhancing the efficiency of public expenditure, particularly through capital investments, to maximize economic returns while keeping debt manageable. In the post-pandemic recovery phase, leveraging fiscal space for counter-cyclical measures and targeted sectoral investments will be key to sustaining momentum. The empirical validation of theoretical models in this research highlights their adaptability to Odisha's unique context, emphasizing the critical role of effective debt management in transforming public debt into a growth enabler rather than a liability. Future efforts could refine these strategies by exploring sector-specific investments or advanced debt management techniques to further strengthen Odisha's fiscal resilience and economic trajectory.

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APPENDICES

Appendix 1. Regression Analysis of growth rate of GSDP. Dependent variable is year from 2005-06 to 2024-25 and independent variable is GSDP data for the same year.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.99388
R Square	0.987797
Adjusted R Square	0.987119
Standard Error	0.080274
Observations	20

b	0.11882
antilog b	1.126167
-1	0.126167
gr total Y	12.61672

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	9.388783	9.388783	1457.008	1.12E-18
Residual	18	0.115994	0.006444		
Total	19	9.504773			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-226.703	6.270929	-36.1515	2.94E-18	-239.878	-213.529	-239.878	-213.529
year	0.118821	0.003113	38.17077	1.12E-18	0.112281	0.125361	0.112281	0.125361

Appendix 2. Regression Analysis of growth rate of Debt. Dependent variable is year from 2005-06 to 2024-25 and independent variable is Debt stock data for the same year.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.929525
R Square	0.864016
Adjusted R Square	0.856017
Standard Error	0.159266
Observations	19

b	0.06933
	1.07179
	0.07179
gr of dt	7.178984

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ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.739871	2.739871	108.0151	8.77E-09
Residual	17	0.431216	0.025366		
Total	18	3.171087			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-128.725	13.43527	-9.58112	2.89E-08	-157.071	-100.379	-157.071	-100.379
year	0.069331	0.006671	10.39303	8.77E-09	0.055257	0.083405	0.055257	0.083405

Appendix 3.

Null Hypothesis: DT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.148123	0.0008
Test critical values:	1% level	-3.886751	
	5% level	-3.052169	
	10% level	-2.666593	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations
and may not be accurate for a sample size of 17

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DT)
Method: Least Squares
Date: 04/04/24 Time: 17:51
Sample (adjusted): 2006 2022
Included observations: 17 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DT(-1)	-0.282645	0.054902	-5.148123	0.0001
C	0.040321	0.012121	3.326556	0.0046

R-squared	0.638582	Mean dependent var	-0.017749
Adjusted R-squared	0.614487	S.D. dependent var	0.029461
S.E. of regression	0.018292	Akaike info criterion	-5.054526
Sum squared resid	0.005019	Schwarz criterion	-4.956501
Log likelihood	44.96347	Hannan-Quinn criter.	-5.044782
F-statistic	26.50317	Durbin-Watson stat	1.728010
Prob(F-statistic)	0.000119		

Appendix 4.

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Date: 08/03/24 Time: 09:13
Sample (adjusted): 2007 2024
Included observations: 18 after adjustments
Trend assumption: Linear deterministic trend
Series: TEX GSDP TRR GSDP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.742295	24.40791	15.49471	0.0018
At most 1	5.41E-05	0.000974	3.841465	0.9754

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.742295	24.40694	14.26460	0.0009
At most 1	5.41E-05	0.000974	3.841465	0.9754

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values