TG-iPASS and Industrial Sector Performance in Telangana: Evidence from Capital Efficiency, Structural Transformation, and Output Co-movement

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1. Abstract

This study examines the impact of the Telangana Industrial Project Approval and Self-Certification System (TG-iPASS) on the state's industrial sector over nine years (2016–17 to 2024–25), using a universe of 22,571 approved industrial units representing ₹92,199 crore in active fixed capital. Employing a sequential quantitative framework comprising descriptive analysis, three macroeconomic diagnostic models — the Incremental Capital Output Ratio (ICOR), Structural Change Index (SCI), and Relative Growth Index (RGI) — and a lagged Spearman Rank-Order Correlation, the study evaluates TG-iPASS across four dimensions: capital efficiency, sectoral modernization, growth velocity, and investment-output temporal alignment. The phase-wise ICOR remained consistently below 1.0 across all computable phases, confirming that every rupee of facilitated capital generated more than one rupee of incremental industrial Gross State Value Added (GSVA). The SCI of 52.24 establishes substantive portfolio-level structural transformation, with Electrical and Electronic Products and Food Processing emerging as Champions, while traditional sectors such as Textiles, Paper and Printing, and Granite and Stone declined in relative weight. The RGI identified five Growth Engines outpacing the state portfolio CAGR of 9.86%, confirming a two-speed industrial landscape. The lagged Spearman Rank-Order Correlation yielded $\rho s = 0.738$ ($p = 0.037$), statistically validating the temporal alignment between TG-iPASS investment flows and subsequent industrial GSVA. Collectively, these findings compel rejection of the null hypothesis, establishing TG-iPASS as a structurally transformative instrument that has produced measurable gains across capital efficiency, sectoral modernization, growth velocity, and output alignment.

Keywords: *TG-iPASS, Single-Window Clearance, Industrial Policy, ICOR, Structural Change Index, Telangana, GSVA, Investment Facilitation*.

2. Introduction

Single-window clearance systems represent one of the most widely adopted instruments of contemporary industrial policy, premised on the argument that procedural simplification directly reduces the cost of doing business and thereby catalyses private investment. In India, the proliferation of state-level investment facilitation portals since 2014 has produced a rich but analytically underexplored record of policy experimentation. Among these, Telangana's TG-iPASS, launched in 2016 has emerged as a benchmark single-window system, covering project approval, self-certification, and post-approval tracking within a single digital architecture.

While approvals and projected employment figures reflect the immediate reach of a facilitation system, the ultimate criterion for policy effectiveness is whether facilitated capital generates sustained and measurable growth in the productive base of the economy. For Telangana, this requires empirical assessment of whether

TG-iPASS approvals have translated into tangible growth in industrial Gross State Value Added (GSVA), beyond the administrative outputs of sanctioned investments and projected employment. Such evidence is essential not merely for evaluating TG-iPASS retrospectively, but for informing the design of investment facilitation systems across Indian states and comparable emerging economies.

This paper addresses this gap by examining the macroeconomic impact of TG-iPASS across a nine-year panel (2016–17 to 2024–25) using a sequential analytical framework comprising descriptive analysis, three diagnostic models: the Incremental Capital Output Ratio (ICOR), Structural Change Index (SCI), and Relative Growth Index (RGI), and a lagged Spearman Rank-Order Correlation. By integrating the official TG-iPASS administrative dataset of 22,571 approved projects with Telangana's industrial GSVA records from the Directorate of Economics and Statistics, the study provides an evidence-based assessment of how effectively the single-window mechanism has strengthened Telangana's industrial economy.

3. Literature Review

The theoretical foundation for single-window investment facilitation systems derives from the institutional economics literature on transaction costs and regulatory barriers to investment. Djankov et al. (2002) established that entry regulation measured through the number of procedures, time, and cost of starting a business is negatively correlated with investment and growth, particularly in developing economies where administrative friction is concentrated at the firm-entry stage. Building on this, the World Bank's Doing Business framework operationalized these insights into comparable cross-country indicators, influencing a generation of pro-business regulatory reforms.

Within the Indian context, Kathuria et al. (2013) documented the significant heterogeneity in investment climate quality across states, finding that procedural simplification and institutional quality were stronger predictors of manufacturing growth than factor endowments alone. The introduction of state-level ease of doing business rankings by DPIIT from 2015 accelerated the race among Indian states to reform investment facilitation regimes, with Telangana's TG-iPASS emerging as a notable example of digital integration in single-window architecture (DPIIT, 2023).

On the macroeconomic side, the relationship between investment facilitation and output growth has been examined primarily through the ICOR framework. Rooted in the Harrod-Domar model, the ICOR measures the marginal capital requirements for generating unit increments in output, and has been widely applied in the Indian planning literature to assess the efficiency of capital deployment across sectors and time periods (Planning Commission, 2013). However, its application to state-level facilitated investment as distinct from aggregate capital formation remains limited.

The literature on structural transformation further informs the SCI framework employed in this study. McMillan and Rodrik (2011) demonstrated that the direction of structural change whether labour and capital move toward higher-productivity sectors is as important as the pace of growth. For Indian states, Rangarajan and Misra (2019) found that manufacturing-led structural transformation requires not just investment volume but sectoral portfolio reorientation toward technology-intensive industries, a criterion directly testable through the SCI methodology. The RGI framework, adapted from the Boston Consulting Group's growth-share matrix, provides a complementary lens for identifying differential sectoral momentum within a facilitated investment portfolio an application that has not, to the authors' knowledge, been previously applied in the context of Indian state-level industrial policy evaluation.

Finally, the co-movement analysis through lagged Spearman correlation draws on the time-series investment-output alignment literature. Bai and Perron (2003) emphasized the importance of accounting for structural breaks and gestation lags when estimating investment-output relationships, a consideration incorporated in this study through the one-year lag specification and phase-based ICOR disaggregation. The present paper contributes to this literature by providing an integrated multi-method empirical framework for assessing a specific investment facilitation policy's macroeconomic outcome at the sub-national level.

3. Objectives and Research Hypothesis

This study pursues three specific objectives:

- To evaluate the capital efficiency of TG-iPASS-facilitated investment using the phase-wise Incremental Capital Output Ratio (ICOR).
- To measure sectoral portfolio transformation across 15 industrial sub-sectors using the Structural Change Index (SCI) and Relative Growth Index (RGI).
- To empirically validate the temporal alignment between TG-iPASS investment flows and industrial GSVA growth through lagged co-movement analysis.

The study tests the following hypothesis:

H_0: The implementation of TG-iPASS has no significant impact on the industrial sector of Telangana.

H_1: The implementation of TG-iPASS has a significant positive impact on the industrial sector of Telangana.

4. Research Methodology

4.1. Data Sources and Scope

The study uses the administrative dataset obtained from the Office of the Commissioner of Industries, Government of Telangana, comprising 22,571 industrial units approved under TG-iPASS from 2016–17 to 2024–25. Industrial GSVA data are sourced from the Telangana Socio-Economic Outlook published annually by the Directorate of Economics and Statistics (DES, Telangana, 2024). The study analyses the universe of all approved units.

4.2. Analytical Framework

The study employs a sequential quantitative framework progressing from descriptive statistics to diagnostic models and co-movement analysis. All four analytical stages are described below.

4.2.1. Incremental Capital Output Ratio (ICOR)

To evaluate the systemic efficiency with which TG-iPASS-mobilised private capital translated into incremental industrial output, the ICOR is estimated as:

$$ICOR = \frac{\Delta K}{\Delta Y} \quad (5.1)$$

where ΔK is the total active fixed capital mobilized through TG-iPASS approvals in the phase, and ΔY is the absolute increase in Telangana's Industrial GSVA over the same period. To account for gestation lags and macroeconomic disruptions, the ICOR is computed across four phases: Phase I: Policy Inception (2016–18), Phase II: Pre-Pandemic Growth (2018–20), Phase III: Pandemic Shock (2020–22), and Phase IV: Post-Pandemic Recovery (2022–25). A lower ICOR indicates higher capital efficiency.

4.2.2. Structural Change Index (SCI)

To measure portfolio-level structural transformation, the SCI quantifies the aggregate absolute shift in sectoral investment shares between the base year (2016–17) and the terminal year (2024–25):

$$SCI = \frac{1}{2}\sum_{i=1}^{n} |S_{i,t} - S_{i,0}| \quad (5.2)$$

where $S_{i,t}$ and $S_{i,0}$ are the investment shares of sector i in the terminal and base years respectively, and n = 16 sub-sectors. A higher SCI indicates greater structural transformation. Results are synthesized through a Telangana Sectoral Portfolio Matrix, plotting each sector by Capital Dominance (X-axis: terminal share) and Structural Momentum (Y-axis: directional share shift), producing four quadrants: Champions, Mature Sectors, Emerging Sectors, and Declining Sectors.

4.2.3. Relative Growth Index (RGI)

The RGI benchmarks each sector's investment growth velocity against the state portfolio's overall CAGR:

$$RGIi = \frac{CAGR_i}{CAGR_{total}} \quad (5.3)$$

An RGI > 1.0 identifies a Growth Engine; an RGI < 1.0 classifies a Laggard. Results are synthesized through a Telangana Sectoral Growth Velocity Matrix — adapted from the BCG framework — with four quadrants: Stars (high share, high velocity), Question Marks (low share, high velocity), Cash Cows (high share, low velocity), and Underperformers (low share, low velocity).

4.2.4. Spearman Rank-Order Correlation (Co-movement Analysis)

To assess the temporal alignment between investment flows and industrial output, the Spearman Rank-Order Correlation is computed between TG-iPASS investment in year (t−1) and industrial GSVA in year (t), using a one-year lag specification consistent with the gestation period implicit in the phased ICOR framework:

$$\rho_s = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} \quad (5.4)$$

where d_i is the difference in ranks of lagged investment and corresponding GSVA for observation i, and n = 8 paired observations. Statistical significance is evaluated at the 5% level ($p < 0.05$).

5. Results

5.1. Descriptive Analysis: Investment and Output Trends

Over the nine-year study period (2016–17 to 2024–25), TG-iPASS mobilised ₹92,199 crore in active fixed capital across 22,571 approved industrial units. Correspondingly, state-level Industrial GSVA expanded from ₹1,29,295 crore to ₹2,81,411 crore, an absolute increase of ₹1,52,116 crore (Table 1). The data reveal four structurally distinct phases of performance.

Phase I (2016–18): TG-iPASS registered its first macroeconomic dividend as GSVA grew by 16.62% in 2017–18, with the removal of procedural bottlenecks rapidly accelerating investment disbursals from ₹4,031 crore to ₹9,312 crore. Phase II (2018–20): The strongest single-year output response in the study period occurred in 2018–19, with GSVA surging 20.95%, before a marginal contraction of 0.60% in 2019–20 driven by the national credit slowdown and delayed project commissioning. Phase III (2020–22): Despite the COVID-19 pandemic inducing a 1.85% GSVA contraction in 2020–21, TG-iPASS approvals of ₹9,106 crore sustained private investment momentum; the robust rebound of 14.64% in 2021–22 confirmed TG-iPASS's role as a stabilizing anchor for private sector confidence. Phase IV (2022–25): Consistent double-digit GSVA

growth across all three years, anchored by ₹20,247 crore — the highest single-year investment in the policy's history — in 2023–24.

Table 1: Year-on-Year Investment and Industrial GSVA Growth (2016–2025)

Phase	Financial Year	TG-iPASS Inv. (₹ Cr)	Cumulative Inv. (₹ Cr)	Industrial GSVA (₹ Cr)	YoY GSVA Growth (%)
Phase I	2016–17	4,030.57	4,030.57	1,29,295	—
	2017–18	9,311.67	13,342.24	1,50,790	16.62%
Phase II	2018–19	5,242.35	18,584.59	1,82,373	20.95%
	2019–20	11,382.01	29,966.60	1,81,276	−0.60%
Phase III	2020–21	9,105.64	39,072.24	1,77,929	−1.85%
	2021–22	10,356.47	49,428.71	2,03,977	14.64%
Phase IV	2022–23	13,972.83	63,401.54	2,25,664	10.63%
	2023–24	20,246.71	83,648.25	2,48,505	10.12%
	2024–25	8,551.01	92,199.26	2,81,411	13.24%

Source: Compiled from TG-iPASS Database and State Industrial GSVA Records (DES, Telangana, 2024).

5.2. Capital Efficiency: Incremental Capital Output Ratio

Table 2 presents the phase-wise ICOR analysis. Across the full nine-year span, the overall ICOR of 0.61 confirms that ₹0.61 of TG-iPASS-mobilised fixed capital was associated with every ₹1 of incremental industrial GSVA establishing sustained and directionally consistent co-movement between investment flows and state industrial output.

Table 2: Phase-wise ICOR Analysis (2016–17 to 2024–25)

Phase	Period	TG-iPASS Inv. (₹ Cr)	GSVA Start (₹ Cr)	GSVA End (₹ Cr)	ICOR
Phase I	2016–17 to 2017–18	13,342	1,29,295	1,50,790	0.62
Phase II	2018–19 to 2019–20	16,624	1,82,373	1,81,276	N/A
Phase III	2020–21 to 2021–22	19,462	1,77,929	2,03,977	0.75
Phase IV	2022–23 to 2024–25	42,771	2,25,664	2,81,411	0.77
Overall	**2016–17 to 2024–25**	**92,199**	**1,29,295**	**2,81,411**	**0.61**

Source: Computed from TG-iPASS Database and State Industrial GSVA Records.

Phase I registered the lowest ICOR of 0.62, reflecting the strongest per-unit GSVA response as early high-output sector approvals rapidly translated into industrial activity. Phase II ICOR is not computable as GSVA contracted marginally by ₹1,097 crore despite ₹16,624 crore in investment, attributable to the national pre-pandemic deceleration rather than policy failure. Phase III's ICOR of 0.75 is the most analytically significant result: despite severe COVID-19 disruption, GSVA expanded by ₹26,048 crore, underscoring TG-iPASS's role as an investment anchor in adverse conditions. Phase IV's ICOR of 0.77 reflects the natural structural shift toward capital-intensive Mega projects in Electrical and Electronics and Automobile manufacturing with longer gestation periods — a portfolio maturation effect rather than declining efficiency. All computable phase ICORs remain below 1.0, confirming that private capital mobilised through TG-iPASS consistently generated more than one rupee of incremental GSVA per rupee invested.

5.3. Sectoral Modernization: Structural Change Index

The SCI across 15 industrial sub-sectors is computed at 52.24 (Table 3), confirming that more than half of the total investment portfolio composition shifted over the nine-year period. This represents substantive portfolio-level structural transformation.

Table 3: Structural Change Index — Sectoral Share Shift (2016–17 to 2024–25)

No.	Sector	Category	Base 2016–17	Term 2024–25	Shift (pp)	Quadrant
1	Electrical & Electronic	Value Engine	2.90%	38.47%	**+35.57**	Champion
2	Food Processing	Volume Engine	8.15%	14.40%	**+6.25**	Champion
3	Engineering	Volume Engine	8.73%	8.29%	**−0.44**	Mature Sector
4	Pharmaceuticals	Value Engine	16.10%	7.37%	**−8.74**	Mature Sector
5	Plastic & Rubber	Volume Engine	8.87%	6.49%	**−2.37**	Mature Sector
6	R&D	Value Engine	11.48%	3.37%	**−8.11**	Mature Sector
7	Agro & Cold Storage	Volume Engine	2.26%	2.31%	**+0.05**	Champion
8	Automobile	Value Engine	0.07%	2.28%	**+2.21**	Champion
9	Beverages	Value Engine	4.90%	2.14%	**−2.76**	Declining
10	Paper & Printing	Volume Engine	16.80%	2.11%	**−14.69**	Declining
11	Granite & Stone	Volume Engine	5.28%	0.96%	**−4.32**	Declining
12	Cement & Concrete	Volume Engine	1.02%	0.90%	**−0.12**	Declining
13	Wood & Leather	Volume Engine	0.17%	0.55%	**+0.39**	Emerging
14	Textiles	Value Engine	9.81%	0.40%	**−9.41**	Declining
15	Fertilizers Organic	Value Engine	1.42%	0.14%	**−1.27**	Declining
	SCI					**= 52.24**

Source: Computed from TG-iPASS Database. Note: pp = percentage points. SCI excluding 'Others' = 48.35.

Among Champions, Electrical and Electronic Products recorded the most dramatic transformation (+35.57 pp), though substantially concentrated in a single ₹2,774.80 crore Mega project; the adjusted shift excluding this project is +3.12 pp. Nonetheless, its commencement signals Telangana's emergence as a high-value electronics manufacturing destination. Food Processing delivered the most organically sustained gain (+6.25 pp), driven by consistent approvals across all nine years without Mega-project dependence. Automobile and Agro-based industries registered positive shifts at threshold margins.

The four Mature Sectors - Pharmaceuticals (−8.74 pp), R&D (−8.11 pp), Engineering (−0.44 pp), and Plastic and Rubber (−2.37 pp) retain high terminal portfolio weight but declining relative momentum, reflecting capital diversification toward newer sectors rather than absolute retreat. Declining Sectors include Textiles (−9.41 pp) and Paper and Printing (−14.69 pp, adjusted −2.79 pp excluding a base-year Mega project), confirming the structural retreat of extraction-based and traditional manufacturing from the investment frontier. The residual 'Others' category (+7.77 pp) is driven by a single ₹9,528 crore Mega project and is excluded from quadrant classification; the SCI of 48.35 excluding this category confirms that structural transformation is independent of this unclassified residual.

5.4. Sectoral Growth Velocity: Relative Growth Index

The RGI, benchmarked against the portfolio CAGR of 9.86%, identifies five Growth Engines (RGI > 1.0) and ten Laggards (RGI < 1.0) within the TG-iPASS portfolio (Table 4).

Table 4: Relative Growth Index — Sectoral Growth Velocity (2016–17 to 2024–25)

No.	Sector	Category	CAGR (%)	Total CAGR (%)	RGI	Quadrant
1	Electrical & Electronic	Value Engine	51.78	9.86	**5.25**	Star
2	Automobile	Value Engine	68.50	9.86	**6.95**	Question Mark
3	Food Processing	Volume Engine	17.96	9.86	**1.82**	Star
4	Wood & Leather	Volume Engine	27.51	9.86	**2.79**	Question Mark
5	Agro & Cold Storage	Volume Engine	10.18	9.86	**1.03**	Question Mark
6	Engineering	Volume Engine	9.15	9.86	**0.93**	Cash Cow
7	Pharmaceuticals	Value Engine	−0.37	9.86	**−0.04**	Cash Cow
8	Cement & Concrete	Volume Engine	8.22	9.86	**0.83**	Underperformer
9	Plastic & Rubber	Volume Engine	5.66	9.86	**0.57**	Underperformer
10	Beverages	Value Engine	−0.97	9.86	**−0.10**	Underperformer
11	R&D	Value Engine	−5.75	9.86	**−0.58**	Underperformer
12	Granite & Stone	Volume Engine	−11.25	9.86	**−1.14**	Underperformer
13	Paper & Printing	Volume Engine	−15.25	9.86	**−1.55**	Underperformer
14	Fertilizers Organic	Value Engine	−17.44	9.86	**−1.77**	Underperformer
15	Textiles	Value Engine	−26.37	9.86	**−2.68**	Underperformer

Source: Computed from TG-iPASS Database. CAGR total = 9.86% across all 16 sectors, 2016–17 to 2024–25.

Stars: Electrical and Electronic Products (RGI 5.25) and Food Processing (RGI 1.82) confirm the Champions identified by the SCI. Food Processing is the more structurally significant, as its growth is organically broad-based across all project size categories. Question Marks: Automobile (RGI 6.95), Wood and Leather (RGI 2.79), and Agro and Cold Storage (RGI 1.03) surpass the growth benchmark but remain small in portfolio size, indicating early-stage momentum without structural scale. Cash Cows: Engineering (RGI 0.93) and Pharmaceuticals (RGI −0.04) retain the highest terminal shares among laggards, confirming their role as stable volume anchors. Eight Underperformers, led by Textiles (RGI −2.68), Paper and Printing (RGI −1.55), and Fertilizers Organic (RGI −1.77), confirm the structural retreat of traditional sub-sectors from the active investment frontier. Together, the RGI results reveal a two-speed industrial landscape under TG-iPASS: a small cluster of fast-growing sectors pulling ahead while most traditional sub-sectors fall behind the portfolio average, reinforcing the SCI finding of 52.24.

5.5. Co-movement Analysis: Spearman Rank-Order Correlation

Table 5 presents the rank-order computation across eight paired observations.

Table 5: Spearman Rank-Order Correlation — Lagged Investment and GSVA (2016–25)

Obs.	Inv Year (t−1)	GSVA Year (t)	TG-iPASS Inv (₹ Cr)	Industrial GSVA (₹ Cr)	Rank (Inv)	Rank (GSVA)	d	d^2
1	2016–17	2017–18	4,030.57	1,50,790	1	1	0	0
2	2017–18	2018–19	9,311.67	1,82,373	4	4	0	0
3	2018–19	2019–20	5,242.35	1,81,276	2	3	−1	1
4	2019–20	2020–21	11,382.01	1,77,929	6	2	+4	16
5	2020–21	2021–22	9,105.64	2,03,977	3	5	−2	4
6	2021–22	2022–23	10,356.47	2,25,664	5	6	−1	1
7	2022–23	2023–24	13,972.83	2,48,505	7	7	0	0
8	2023–24	2024–25	20,246.71	2,81,411	8	8	0	0
				Σd^2				**22**

Source: Computed from TG-iPASS Database and State Industrial GSVA Records.

The Spearman coefficient is computed as: $\rho s = 1 - [6 \times 22] / [8(64-1)] = 1 - 132/504 = 0.738$.

The analysis yields $\rho s = 0.738$, statistically significant at the 5% level ($t = 2.68$, $df = 6$, $p = 0.037$), confirming a strong positive monotonic relationship between lagged TG-iPASS investment and subsequent industrial GSVA. The largest rank discrepancy, Observation 4 (2019–20 investment ranked 6th; 2020–21 GSVA ranked 2nd) is attributable to the COVID-19 pandemic suppressing industrial output, an exogenous shock wholly external to the TG-iPASS framework. Near-perfect rank alignment across Observations 1, 2, 7, and 8 particularly in high-investment terminal years further reinforces the directional consistency of the investment-GSVA relationship under the policy.

6. Hypothesis Validation

The empirical evidence compels rejection of H_0 on four independent grounds. First, the phase-wise ICOR remained below 1.0 across all three computable phases, confirming that every rupee of mobilised capital generated more than one rupee of incremental industrial output. Second, the SCI of 52.24 establishes that more than half of the total sectoral investment composition shifted over the nine-year period, reflecting substantive policy-driven structural transformation. Third, the RGI analysis identifies five sectors as Growth Engines outpacing the state portfolio average, affirming measurable and differential sectoral acceleration under TG-iPASS. Fourth, the Spearman Rank-Order Correlation of $\rho s = 0.738$ ($p = 0.037$) statistically confirms that higher investment years were reliably followed by higher industrial output in the succeeding year.

Consequently, the study rejects H_0 and accepts H_1: TG-iPASS has had a significant positive impact on the industrial sector of Telangana. The policy has functioned not merely as an administrative facilitation mechanism, but as a structurally transformative instrument producing measurable gains in capital efficiency, sectoral modernization, growth velocity, and output alignment across the nine-year study period.

7. Conclusion and Policy Implications

7.1. Conclusion

This study provides multi-dimensional empirical evidence of TG-iPASS's macroeconomic impact on Telangana's industrial sector across 2016–17 to 2024–25. The policy mobilised ₹92,199 crore across 22,571 units, with industrial GSVA expanding from ₹1,29,295 crore to ₹2,81,411 crore. The phase-wise ICOR,

consistently below 1.0, established high capital-to-output efficiency; the SCI of 52.24 confirmed substantive portfolio reorientation; the RGI revealed a two-speed industrial landscape with five Growth Engines; and the lagged Spearman Correlation of $\rho s = 0.738$ ($p = 0.037$) statistically validated investment-output co-movement. Together, these results establish that TG-iPASS has served as both an administrative enabler and a structural transformation instrument, accelerating investment into emerging high-value sectors while providing stability to the broader industrial base.

7.2. Policy Implications

Three policy-actionable findings emerge from this analysis. First, the Mega-project concentration risk in the Champions quadrant (where Electrical and Electronic Products' SCI gain is driven by a single project) underscores the need for portfolio diversification strategies within the TG-iPASS approval pipeline. Sectoral investment caps or incentive tapering for dominant projects could help distribute structural momentum more broadly.

Second, the ten Underperformer sectors, including Textiles, Granite and Stone, and Fertilizers Organic, represent both a structural challenge and a strategic opportunity. Telangana could deploy targeted sector-specific facilitation windows, technology upgrade incentives, or cluster development schemes for these sectors, rather than applying the uniform TG-iPASS template. The generic single-window model may require sector-sensitive overlays for capital-light and resource-intensive industries.

Third, the rising Phase IV ICOR (0.77), reflecting the longer gestation of capital-intensive Mega projects, suggests that GSVA benefits from the largest recent approvals are yet to be fully realized. Policymakers should track commissioning timelines of large-scale projects approved in 2022–25 as a leading indicator of medium-term industrial output performance.

7.3. Limitations and Future Research

This study acknowledges several limitations. The one-year lag specification in the co-movement analysis, while theoretically grounded, is a simplification; sector-specific gestation periods vary and could be modelled more precisely with project-level commissioning data. The GSVA series captures all industrial activity in the state, not exclusively TG-iPASS-facilitated activity, implying that the estimated ICOR is a conservative lower bound on the policy's direct contribution. Future research could disaggregate GSVA by approval cohort using firm-level data, apply panel ARDL or VECM methods to address potential non-stationarity, and extend the comparative analysis to other state-level single-window systems to assess whether TG-iPASS outcomes are replicable in different institutional contexts.

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