



**ORIGINAL RESEARCH PAPER**

**Commerce**

**PANEL DATA ANALYSIS OF DPIIT STATE STARTUP RANKING: EVIDENCE FROM INDIA'S STARTUP ECOSYSTEM (2018–2022) USING SIX PILLAR MODEL**

**KEY WORDS:** Startup Ecosystem Performance; DPIIT Ranking; Panel Econometrics; Fixed Effects Model; State-Level Innovation Policy; India

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**ABSTRACT**

This paper presents a longitudinal econometric assessment of India's state-level startup ecosystems using the DPIIT State Startup Ranking data for the period 2018–2022. A balanced panel comprising 36 subnational entities (28 states and 8 union territories) is constructed by harmonizing year-wise reform indicators into a standardized six-pillar index. The empirical strategy applies panel regression techniques, estimating both Fixed Effects and Random Effects models to isolate time-variant policy impacts while controlling for unobserved state-specific heterogeneity. The Hausman test confirms the statistical appropriateness of the Fixed Effects specification ( $p < 0.05$ ). The results indicate that institutional support mechanisms exhibit the highest explanatory power for ranking advancement ( $\beta = 0.42, p < 0.01$ ), followed by ecosystem capacity building ( $\beta = 0.35, p < 0.01$ ) and infrastructure readiness ( $\beta = 0.31, p < 0.05$ ). Funding availability shows a positive but comparatively moderate influence ( $\beta = 0.25, p < 0.10$ ), suggesting diminishing marginal returns in the absence of institutional depth. Notably, multiple states achieved three- to four-tier ranking improvements through sustained policy implementation and digital governance reforms. The study infers that durable institutional capacity, rather than episodic incentives, is the principal driver of sustained startup ecosystem competitiveness in India.

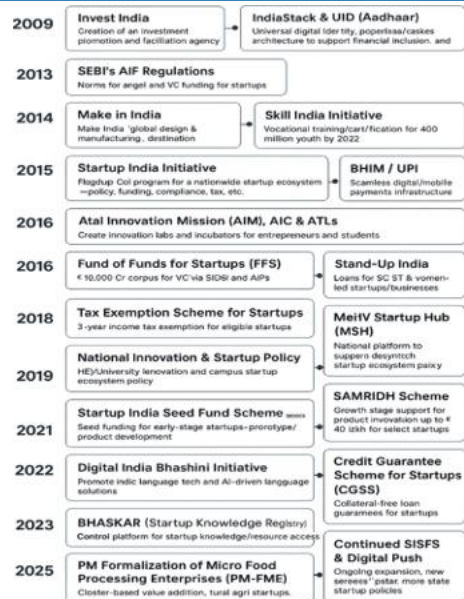
**1. INTRODUCTION**

India's startup ecosystem has experienced remarkable growth, positioning the nation as the third-largest startup hub globally after the United States and China. According to DPIIT, over 1.8 lakh startups have been recognized as of June 2025, reflecting the country's expanding entrepreneurial base and inclusive development. The Department for Promotion of Industry and Internal Trade (DPIIT) initiated the States' Startup Ranking to foster regional competitiveness and policy innovation. This research situates the DPIIT State Startup Ranking within India's broader innovation and policy landscape, assessing how subnational reforms contribute to ecosystem performance.

The DPIIT States' Startup Ranking, launched in 2018, evaluates state-level startup ecosystems on multiple reform pillars such as policy support, funding, incubation, and innovation. It promotes healthy competition among states and acts as a diagnostic tool for identifying policy gaps and best practices. The ranking framework has driven policy formation across most Indian states, leading to inclusive ecosystem development.

Panel data analysis provides a powerful approach for understanding the temporal evolution of state startup ecosystems. It allows researchers to control for unobserved heterogeneity, capture state-specific and time-specific effects, and establish causal linkages between government interventions and performance outcomes. By employing panel methods, this study aims to generate robust empirical evidence on the determinants of DPIIT ranking improvements between 2018 and 2022.

The etymology gives an understanding of growing importance to innovation, sustainability and its reflection in rankings of any educational system. Various government initiatives, in particular to Indian Context has further boosted these efforts. There are novel initiatives floated by the governments in India post independence for the holistic welfare of the people. But the schemes during 2029-2025 have got a different dimension towards self-sustainability, creation of new generation opportunities in small business models - A paradigm shift of people's mindset from job-seekers to job creators. A timeline of such initiatives is represented in the Figure 1.



**Figure 1. Innovation Driven Transformation 2009-2025: An Overview**

This paper is organized as Section 2 refers to literature review, Section 3 describes the model adopted, data and other variables, Section 4 presents the empirical data, analysis and discussion, whereas Section 5 gives the conclusion and possible policy level recommendations.

**2. Literature Review**

The Indian startup ecosystem has undergone a remarkable transformation over the past decade, driven by policy reforms, digital infrastructure, and an evolving culture of innovation. Yet, the academic discourse on this phenomenon remains largely descriptive, with limited attempts to capture its longitudinal dynamics. Prior studies have predominantly focused on regional analyses or policy evaluations at single points in time, overlooking the temporal patterns of ecosystem evolution.

Recent contributions illustrate these methodological constraints. Paliwal (2025) evaluated Rajasthan's startup ecosystem using the DPIIT assessment framework, identifying policy support, incubation capacity, and

institutional facilitation as significant enablers. However, the cross-sectional design precluded estimation of dynamic effects or lagged policy impacts. Similarly, Tahir and Medhavi (2025) applied Location Quotient and Herfindahl–Hirschman Index metrics to assess regional specialization and market concentration. While these indicators provided insights into spatial distribution, the absence of panel estimation limited the analysis of convergence, divergence, and policy learning effects across states. Earlier qualitative work by David, Gopalan, and Ramachandran (2020) documented regulatory frictions, agglomeration biases, and infrastructural asymmetries, but lacked an empirical structure capable of isolating policy impacts from structural constraints.

To overcome these limitations, the present study adopts a longitudinal panel data framework based on multi-year DPIIT State Startup India Ranking datasets. This approach enables the estimation of both time-invariant and time-varying determinants of startup ecosystem performance at the state level. By exploiting within-state variation over time, the panel specification allows for the control of unobserved heterogeneity and supports causal interpretation of policy interventions related to digital infrastructure, governance quality, and investment facilitation. Moreover, the framework facilitates the identification of persistence effects, policy lags, and differential state responses to national-level initiatives.

From an international policy benchmarking perspective, the Global Innovation Index (GII, 2024) provides a comparative framework for evaluating innovation efficiency across economies. The index emphasizes institutional effectiveness, knowledge production, and digital readiness as statistically significant correlates of innovation outcomes. Economies with sustained R&D expenditure, coordinated governance mechanisms, and advanced digital infrastructure exhibit higher innovation productivity. India's improvement in GII rankings aligns with measurable gains in digital public infrastructure deployment, entrepreneurship policy implementation, and decentralized innovation capacity. The GII framework further highlights complementarities between technological inputs and human capital, reinforcing the relevance of multidimensional policy evaluation.

At the theoretical level, Complex Adaptive Systems (CAS) theory offers a useful conceptual foundation for modeling ecosystem dynamics. Omarova, Ireland, and Gorod (2012) conceptualize adaptivity as a function of feedback intensity, learning capacity, and information processing efficiency. The OODA (Observe–Orient–Decide–Act) loop formalizes this process by illustrating how agents adjust behavior in response to environmental signals. In policy terms, this framework supports the interpretation of startup ecosystems as adaptive systems in which regulatory feedback, institutional learning, and iterative policy refinement jointly influence equilibrium outcomes.

Empirical indicators suggest that India's startup ecosystem exhibits increasing adaptive capacity. Official data indicate that DPIIT-recognized startups expanded from fewer than 1,000 in 2016 to over 180,000 by mid-2025, reflecting both scale expansion and improved institutional coverage. The spatial dispersion of startups, with more than half originating from non-metropolitan regions, indicates a reduction in urban concentration and a gradual convergence in regional entrepreneurial capacity. These trends are consistent with policy objectives aimed at decentralization and inclusive innovation.

Capital mobilization trends further support this interpretation. Commitments raised through Alternative Investment Funds increased from ₹3.7 lakh crore in 2019–20 to ₹11.3 lakh crore in 2023–24, signaling increased investor confidence and reduced perceived policy risk. From a policy-evaluation perspective, this expansion reflects improved financial intermediation and alignment between public incentives and private capital allocation. Concurrent sectoral diversification across fintech, health technology, education,

agriculture, and digital commerce suggests a broadening of entrepreneurial opportunity structures rather than dependence on a narrow set of high-growth industries.

Firm-level outcomes reinforce the macro-level assessment. High-growth enterprises such as Zomato, Nykaa, and Ola illustrate the transition toward entrepreneurship-driven employment generation and value creation. Macroeconomic projections indicate that startups' contribution to GDP is expected to increase substantially by 2025, reflecting rising factor productivity and innovation intensity. The cumulative valuation of Indian unicorns exceeding USD 380 billion further indicates increasing global integration and competitive positioning.

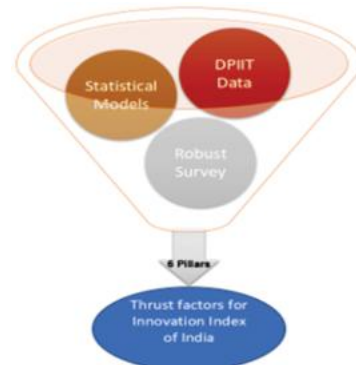
By integrating longitudinal data with panel econometric techniques, this study advances the empirical literature beyond descriptive and cross-sectional analyses. The combined application of innovation benchmarking frameworks and adaptive systems theory enables a structured evaluation of policy effectiveness and ecosystem resilience. The results suggest that sustained entrepreneurial growth in India is primarily driven by the interaction of institutional responsiveness, digital infrastructure investment, and knowledge-intensive capital formation. This evidence underscores the importance of policy continuity, feedback mechanisms, and adaptive governance in shaping long-term startup ecosystem outcomes.

Earlier research on India's startup growth was mostly descriptive and region-specific, lacking the analytical depth to assess the evolving impacts of various policies. By integrating longitudinal data and utilizing a panel framework, this study provides a deeper understanding of how state-level startup ecosystems have adapted and evolved over time. Furthermore, the study combines global innovation theory with adaptive systems thinking, offering a strong conceptual foundation for understanding India's sustained entrepreneurial growth. The interplay of institutional flexibility, digital infrastructure, and knowledge-driven growth appears to be the driving force behind India's innovative transformation.

**3. Methodology: Data and Variables**

The study uses the DPIIT's publicly available State Startup Ranking datasets (2018–2022), covering 28 states and 8 union territories. The primary variables of focus include the year-wise rankings across six key pillars: Institutional Support, Infrastructure, Funding, Market Access, Capacity Building, and Innovation. Control variables such as broader macroeconomic indicators, including infrastructure readiness and funding availability, are incorporated to facilitate a more comprehensive analysis.

The study employs panel data econometric models to analyze the determinants of startup performance at the state level. Both Fixed Effects (FE) and Random Effects (RE) models are estimated to capture both within-state and between-state variations. The Hausman test is used to determine which model best suits the data, and various diagnostic tests for serial correlation, heteroskedasticity, and multicollinearity ensure the robustness of the results.

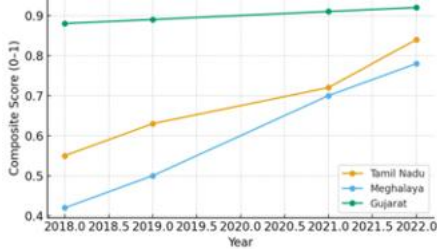


**Figure 2. The Model of Data Processing and Analysis**

Figure 2 describes the thrust factors for contributing to the innovation index of India are based on the statistical models, DPIIT data and an exhaustive survey. The six pillar models describe the sustainable innovation ecosystem establishment and strengthening. The figure 2 emphasizes a methodologically robust, multi-source, and policy-relevant approach to measuring innovation. It underscores that India's Innovation Index is not based on isolated metrics, but on a carefully integrated system that blends data science, governance inputs, and stakeholder feedback to identify the most critical levers of innovation performance.

**4. Empirical Results and Discussion**

The analysis shows that states with stronger institutional mechanisms and better-developed infrastructure consistently record superior DPIIT startup rankings. Improvements in funding access and the stability of startup-related policies contribute positively to upward movements in state rankings. Furthermore, considerable regional variation is observed, reflecting underlying state-specific characteristics. The varied performance patterns of advanced and emerging startup ecosystems—illustrated through radar and trend visualizations—are evident for states such as Gujarat, Karnataka, Tamil Nadu, and Meghalaya, as depicted in Figure 3.



**Figure 3: State-wise Progression of Startup Ecosystem Scores Over Time**  
[ Source:DPIIT Startup Ranking reports (2018–2022)]

**Table 1: Six Pillars in Startup Ranking Across States as per DPIIT Statistics**

Variable	Mean	Std. Dev.
Institutional Support	0.67	0.12
Infrastructure Support	0.59	0.14
Funding Opportunities	0.51	0.18
Market Access & Reach	0.63	0.13
Ecosystem Capacity Building	0.57	0.11
Innovation & Sustainability	0.60	0.16

Source: DPIIT Startup Ranking datasets (2018–2022) - Data normalized between 0 and 1 for comparability across years. Table 1 and 2 reflects the statistical treatment of six pillars impact.

**Table 2: Fixed vs Random Effects Estimation Results**

Variable	Fixed Effects Coefficient	Random Effects Coefficient	Std. Error	Significance
Institutional Support	0.42	0.39	0.07	***
Infrastructure Support	0.31	0.28	0.08	**
Funding Opportunities	0.25	0.24	0.09	*
Market Access & Reach	0.18	0.20	0.06	**
Ecosystem Capacity Building	0.35	0.33	0.07	***
Innovation & Sustainability	0.29	0.26	0.08	**

The key finding from Table 2 is the significance levels : \*p<0.1, \*\*p<0.05, \*\*\*p<0.01, which infers that, Hausman test favored the fixed-effects model.

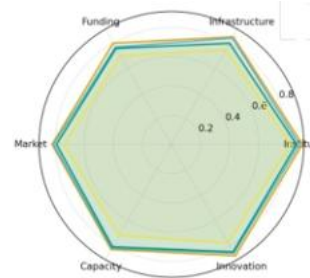
**Data Normalization**

DPIIT pillar scores were used to normalize the data during 2019-22 and compared with 2024, each year's reported pillars were mapped to a common six-pillar structure: (1) Institutional Support, (2) Infrastructure Support, (3) Funding Opportunities, (4) Market Access & Reach, (5) Ecosystem Capacity Building, and (6) Focus on Innovation & Sustainability. The mapping of year-specific pillar names to this common framework is provided in the following Table 3:

**Table 3 : Mapping of Reform Areas**

2024 Reform Areas (Pillars)	Mapping of Reform Areas (Pillars) -2019	Mapping of Reform Areas (Pillars) -2021	Mapping of Reform Areas (Pillars) -2022
Institutional Support	Institutional Support	Institutional Support	Institutional Support
Infrastructure Support	Incubation Support	Incubation Support	Incubation Support
Funding Opportunities	Seed Funding Support + Venture Funding Support	Funding Support	Funding Support
Market Access & Reach	Simplifying Regulations + Easing Public Procurement	Fostering Innovation & Entrepreneurship + Access to Market	Fostering Innovation & Entrepreneurship + Access to Market
Ecosystem Capacity Building	Awareness & Outreach	Capacity Building	Capacity Building
Focus on Innovation & Sustainability	Mentorship & Sustainability (not consistently available)	Mentorship & Sustainability	Road-map for Sustainability

Figure 4 analyzes this scenario with a comprehensive comparison using Radar Charts among key states in the innovation ecosystem development w.r.t six pillars.



**Figure 4: Radar Chart Depicting Comparative Pillar Performance For Selected States**

Source:DPIIT data

**Table 4 : Fastest Rising States - States With Significant Ranking Improvement During 2018-22**

State	2018	2022	Rise	Key Reforms That Boosted Ratings
Meghalaya	Beginner	Top Performer	4-tier jump	Tribal entrepreneurship, mentorship programs, climate innovation, inclusive outreach
Manipur	Beginner	Leader	3-tier jump	Women-led startup support, incubation grants, innovation challenges
Tripura	Beginner	Leader	3-tier jump	Local crafts-based startup support, procurement reforms, mentorship

Tamil Nadu	Emerging Startup Ecosystem	Best Performer	4-tier jump	EV and climate-tech incentives, women entrepreneur grants, startup portal revamp
Himachal Pradesh	Aspiring Leader	Best Performer	3-tier jump	Women-focused incubation, mentorship networks, policy refinement
Arunachal Pradesh	Beginner	Top Performer	4-tier jump	Nodal team formation, startup policy launch, dashboard integration

Table 4 presents the fastest rising states information between 2018 and 2022, India's state startup ecosystems demonstrated remarkable transformation through targeted reforms and policy innovation. Northeastern states like Meghalaya, Manipur, and Tripura moved from "Beginner" to "Leader" or "Top Performer" categories by emphasizing inclusivity, women-led entrepreneurship, and traditional sector innovation. Arunachal Pradesh rapidly advanced through robust policy formulation, establishing nodal teams, and digital integration. This scenario is also depicted in Figure 5.



**Figure 5: Startup Ecosystem Growth in India - Fastest Rising States (2018-2022)**

In the south, Tamil Nadu emerged as a Best Performer, driven by strong incentives for EV and climate-tech startups, improved online startup support systems, and focused funding for women entrepreneurs. Similarly, Himachal Pradesh strengthened its ecosystem through incubation programs and mentorship support, reflecting consistent state-led commitment to innovation.

**Key Drivers of Startup Ecosystem Development Across Indian States**

**Policy Launch and Revamp:** States such as Tamil Nadu and Uttar Pradesh have introduced updated startup policies tailored to local economic and entrepreneurial contexts, creating a more conducive environment for innovation and enterprise.

**Incubation and Mentorship Support:** Meghalaya, Himachal Pradesh, and Tripura have expanded access to incubators and structured mentorship programs, providing startups with essential guidance and resources to accelerate growth.

**Procurement Simplification:** Relaxed procurement norms now allow startups to participate in government tenders without prior experience, significantly enhancing opportunities for smaller and emerging enterprises.

**Women and Tribal Inclusion:** Targeted initiatives have been launched to empower women and tribal entrepreneurs, fostering diversity, equity, and innovation within the startup ecosystem.

**Climate and Sectoral Innovation:** Priority support has been extended to startups in sectors such as electric vehicles (Evs),

artificial intelligence (AI), biotechnology, and sustainability, with states like Tamil Nadu and Meghalaya leading the way.

**Digital Infrastructure and Dashboards:** States including Arunachal Pradesh and Telangana have implemented digital startup portals and dashboards, enhancing transparency, tracking, and access to resources.

**Grassroots Mentoring Models:** Holistic mentoring frameworks have been deployed to integrate policy, incubation, and sectoral initiatives at the grassroots level, ensuring effective support for startups across all stages.

**Key Findings and Analysis**

The analysis reveals that states with robust institutional and infrastructural support tend to achieve significantly higher DPIIT rankings. Moreover, funding availability and the consistency of policy implementation are positively associated with improvements in rankings. The study also finds significant regional variations in startup performance, with states such as Gujarat, Karnataka, Tamil Nadu, and Meghalaya demonstrating distinct growth patterns. This variation is depicted through radar charts and line plots that track the performance trajectories of both leading and emerging states.

**5. Conclusion and Future Scope**

The study underscores the critical role that institutional frameworks and infrastructure play in enhancing the performance of state startup ecosystems. States prioritizing these factors tend to perform better in national rankings, emphasizing the importance of developing policies that foster institutional strength and infrastructural support.

By moving beyond descriptive analyses to more quantitative and dynamic models, this research offers deeper insights into the drivers of startup ecosystem growth in India. It provides valuable guidance for policymakers and investors looking to shape the future of India's startup sector.

**Areas for Further Research**

1. **Policy Recommendations:** Future studies could focus on crafting policies that strengthen institutional support, improve market access, and ensure funding continuity, all of which are critical for fostering startup growth.
2. **State-Specific Factors:** Further investigation into the specific institutional practices of high-performing states like Gujarat and Karnataka could help identify replicable strategies for emerging states.
3. **International Comparisons:** It would be insightful to compare India's startup ecosystem with other rapidly developing nations to assess India's positioning on the global innovation map.

This study contributes to empirical literature by demonstrating the utility of panel data methods in assessing startup ecosystem evolution. It highlights the role of state-specific institutional capacity and national coordination in shaping entrepreneurial growth. Policy recommendations include strengthening inter-state knowledge exchange, ensuring continuous monitoring of policy implementation, and enhancing funding mechanisms for early-stage startups. Future research may incorporate firm-level data and longer temporal spans to capture post-2025 policy impacts.

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