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India's Industrial Transformation

The contributions in this special issue highlight India's dualistic industrial structure and the challenges arising from it, policy lessons from the evolving regional patterns of manufacturing across the Indian states, market structure and how it affects the enterprise-level and sector investments and growth. pages 41–104

Mutant Brahminism

The slogan *Brahmanvad Zindabad* and the brazen assertion of upper-caste identity indicate how upper-caste groups are politically repositioning themselves in an era when the older, quieter languages of their hegemony are no longer useful. page 35

Chomsky in Epstein Files

The belief that mind, intellect, and analysis represent the essential core of human value and the body remains a vessel for consciousness, not its substance, seems to have rendered Epstein's victims structurally invisible to Chomsky during those dinner conversations. page 13

Consumption Inequality and Poverty

Overall consumption inequality across both rural and urban areas has declined, but the decline is uneven across food and non-food groups. page 17

EPW Special Issue on

India's Industrial Transformation

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Industrialising with a Dualistic Structure, Diverging Regional Patterns, and Environmental Challenges

NAGESH KUMAR

There has been an engaging debate in the country about the relevance of the manufacturing thrust for achieving the Vision 2047 of a developed and prosperous nation. The sceptics feel that, having missed the bus on a manufacturing-led development, India should stay focused on a services-led development strategy. However, manufacturing and services are not to be seen as competitors but complementary to each other (ISID 2025). Manufacturing-led transformation has been an important pathway to global prosperity, employed by developed countries, including the United States, Germany, and Japan, and by newly industrialised countries, namely the Republic of Korea, Taiwan, and China alike. As India embarks on achieving its aspiration to become a developed country by 2047, the manufacturing sector seems to be an answer to creating decent jobs for its youthful population and fostering inclusive prosperity. India's structural transformation needs a vibrant manufacturing sector to complement its robustly growing services sector, pulling workers out of agriculture and other informal sector activities, and also anchoring balanced regional development. A failure to expand the manufacturing sector will mean India's growth will continue to remain jobless, with widening inequalities, and will be unsustainable. There is widespread recognition of the critical role of the manufacturing sector, which led the government to adopt the "Made in India" initiative, reinforced by Atmanirbhar Bharat (Self-reliant India), covering policies like production-linked incentive (PLI), industrial corridors and other infrastructure, and ease-of-doing business, among other reforms to boost the manufacturing sector (Kumar 2024a, 2024b). There is also a realisation that high dependence on imports of manufactured goods can compromise the nation's strategic autonomy.

A review of manufacturing opportunities available to India, as summarised in *India Industrial Development Report 2024–25,* prepared by the Institute for Studies in Industrial Development (ISID), includes Making-for-India and Making-for-the-World, in labour-intensive, skill-intensive, resource-intensive, and strategic and defence industries, besides opportunities presented by the green industrialisation and digital revolution. This has the potential to more than double the manufacturing value added from $717 billion in 2024 to $1.45 trillion by 2030, out of the $7.5 trillion gross domestic product (GDP), creating, in the process, millions of direct and indirect jobs. India's emergence as one of the largest assemblers and exporters of smartphones in the past few years, creating hundreds of thousands of jobs, points to the opportunities as the policies are driving billions of dollars of investments into solar photovoltaic (PV) cells and modules, electrolysers for green hydrogen, and semiconductors, and actual pharmaceutical ingredients (APIs), among others (Nayyar and Nayyar 2024 for a critical review of the industrial policy in India; also ISID 2025; Kumar 2025a).

Changed External Context for Manufacturing

The external context for building manufacturing, however, has changed dramatically since the days of hyper-globalisation during the 1990s and early 2000s, when China expanded its manufacturing capacities, riding on rapidly growing world trade and investments to become the global factory. Global trade and investments are now having nearly flat growth rates, if at all growing, since the global financial crisis in 2009, with rising protectionism, trade wars, stalled multilateral trade negotiations, and geopolitical conflicts in Europe and the Middle East, together turning globalisation into "slowbalisation." The carbon space is getting squeezed, with net-zero emissions (NZE) targets looming large on the horizon, and with the Industrial Revolution 4.0 automating and disrupting industrial processes. The global supply chains are being restructured, often being reshored, as advanced countries incentivise the localisation of production through the aggressive pursuit of industrial policy that has become the New Washington Consensus (ISID 2025).

The challenge of Chinese dumping: A bigger challenge for the manufacturing sector in countries like India is to protect the existing capacities, especially of labour-intensive consumer goods, from Chinese dumping. The global supply chains of traditional and sunrise industries have come to be dominated by China. Among traditional industries, China has 53% of global crude steel capacity, 60% of aluminium, 44% of lead, 51% of cement, 50% of float glass, 40% of global chemical sales, 33% of plastics, 30% of thermal power equipment, 80% of room

EPW is grateful to Nagesh Kumar who is the Guest Editor for this special issue on India's Industrial Transformation.

air conditioners, and 35% of automobile capacity in the world. Among labour-intensive industries, China dominates toy manufacturing with a 70% share, and accounts for 38% of furniture, 55%–60% of footwear, 44% of textiles, and 32% of apparel production. In green sunrise sectors, China's domination is even more complete, with over 80% of all stages of solar PV panel manufacturing, 76% of lithium-ion batteries, 60% of global wind turbine capacity, and 62% of global electric vehicle (EV) production. China also accounts for 75% of the global output of mobile phones, smartphones, and laptops (Kumar 2025b). These capacities have been created and are sustained through a heavy subsidisation by the central, provincial and local governments. The subsidisation of industry in China has been a widely held fact. However, the documented evidence has not been available due to an opaque system. Now, an International Monetary Fund (IMF) study, through a systematic analysis of corporate accounts, has documented the extent of industrial subsidies to be around 4% of GDP (Garcia–Macia et al 2025; *Economist* 2025a). Considering that the manufacturing sector accounts for roughly 35% of GDP, the subsidies amount to nearly 15% of the manufacturing value added! Facing the protectionist backlash against excessive Chinese imports in Western countries, the heavily subsidised Chinese industrial products are being dumped in neighbouring countries. Thailand and Indonesia have faced closures of thousands of factories of garments, among other labour-intensive goods, over the past couple of years and are taking action against Chinese dumping (Nikkei Asia 2024; *Economist* 2025b). India is another such market where cheaper Chinese labour-intensive goods are substituting domestic production, leading to hollowing out of the domestic industry. As a result, India's imports from China rose from $65 billion in financial year (FY) 2021 to $113 billion in FY 2025, while India's exports declined from $22 billion in FY 2021 to $14 billion in FY 2025.

India's Advantages to be Leveraged

India can count on several advantages to drive its manufacturing thrust to turn challenges into opportunities. India's large and fast-growing domestic market offers opportunities to Indian and global companies to build world-scale plants to tap scale economies. Given the friend-shoring mantra, the restructuring of supply chains is likely to direct attention to India due to its friendly relations and strategic partnerships with investing countries in the West (including through free trade agreements [FTAs] with the European Union [EU], European Free Trade Association [EFTA] countries, the United Kingdom [UK], United Arab Emirates [UAE]/Gulf Cooperation Council [GCC] countries), as well as in the East (Japan, South Korea, Taiwan, Australia, and Association of Southeast Asian Nations [ASEAN] countries). Besides this geopolitical sweet spot, India is also enjoying a demographic sweet spot with a large pool of youthful population as Japan, South Korea, China, and Europe are becoming rapidly ageing societies in their demographic transition. The climate action commitments offer an opportunity for India to leapfrog into a more sustainable pattern of industrialisation, with the bulk of its energy generation and industrial capacities to be built over the coming years. Information and communication technology (ICT) software and chip design capabilities can help India take a leading position in digital industrialisation (ISID 2025).

Landscape of international trade, GVC participation, competitiveness and FDI: Economic reforms have deepened India's global economic integration. As imports have expanded faster than exports, widening trade deficits on merchandise have been mitigated by growing surpluses on trade in services. India's share in global exports has risen but less impressively compared to peers. The geography of India's trade has been changing with the greater role of Asia, especially for imports, reflected in growing trade deficits with China and surpluses with the West. India's import structure has been changing in favour of manufactured imports. Strategic and selective substitution of imports offers an opportunity for industrialisation. India's export structure has been transformed in favour of skill-intensive products of rising economic complexity and an increased share of global exports in some products. India's global value chain (GVC) participation, although modest, has increased over time and needs to be strengthened in medium- and high-technology sectors. India has many fruitful opportunities for diversification into related products, including electronics and machinery. In the context of strengthening India's participation in the GVCs, getting preferential access to major markets can be an important factor (Kumar 2025a; ISID 2025). The recent conclusion of the FTA negotiations with the EU and the UK could be helpful. An ISID (2025) analysis of factors determining export competitiveness of over 11,000 Indian companies in the manufacturing sector finds a significant positive, but non-linear, role of firm size, and significant positive effects of innovative activity, technology imports, and GVC participation. Some degree of automation and capital-intensive processes may be desirable for export competitiveness. FDI, both inwards and outwards, has a positive influence on export competitiveness.

Corporate innovation activity needs to be enhanced: India's spending on research and development (R&D) activity at 0.7% of GDP has been much lower than the global average. The bulk of it is undertaken by government institutions and not by business enterprises, where it could help drive productivity and competitiveness. On the other hand, India has emerged as a global R&D platform for multinational corporations (MNCs), hosting around 1,700 global capability centres (GCCs) of MNCs that are involved in significant research and innovation endeavours. Patenting activity in India, including by residents as well as patents taken abroad, has shown robust growth in recent years. India has also moved up from 81st rank to 39th rank in the Global Innovation Index rankings over the past decade. India's R&D statistics fail to capture the full scale of innovative activity, including informal innovations and R&D activity of GCCs. ISID estimates that the actual scale of R&D expenditure in India may be around 1.25% of GDP,

rather than the officially measured 0.7%. The R&D expenditure needs to rise to above 2% gradually, especially as the country seeks to harness the opportunities presented by the green and digital revolutions for its industrial transformation. Besides the Anusandhan National Research Foundation and the ₹1 lakh crore corpus set up by the government that can help, the innovative activity of business enterprises needs to be enhanced through fiscal incentives (such as restoring 200% weighted tax deduction), and subsidies, a second-tier intellectual property rights (IPR) system, strengthening collaboration between industry, academic, and public research, and for enhancing the domestic knowledge spillovers from GCCs (ISID 2025).

The way forward for a manufacturing-led transformation—Towards a new industrial strategy for a new India: ISID (2025) makes a case for the adoption of a new industrial strategy (NIS) for the inclusive, sustainable and competitive manufacturing sector to realise the developed country vision by 2047. NIS should provide a framework for accelerated industrialisation of the country in the changed context and pave the way for the realisation of the developed country vision by generating jobs and prosperity in an inclusive, sustainable and balanced manner, without losing sight of competitiveness. Some of the key elements of NIS could include some guiding targets such as doubling India's share in global manufacturing value added and in manufactured exports, say by a certain year; articulate some broad principles such as the primacy of localisation of jobs and value addition, entrepreneurship, and locally anchored technological capabilities in a World Trade Organization (WTO)-consistent language; identify the sectors that would be targeted for building leadership-in, depending on our factor endowments such as labour abundance and skills, natural resource endowments, dynamic high-value adding sectors and strategic sectors; framework for fostering new, pioneer and strategic industries, micro, small, and medium enterprises (MSMEs) and start-ups, foreign direct investment (FDI) as well as outward foreign direct investment (OFDI), innovative activity; leverage opportunities in the incipient digital revolution and green industrialisation; recognise the criticality of maintaining a competitive exchange rate; provide for an institutional architecture for long-term industrial financing; provision of efficient industrial infrastructure, logistics, cross-border connectivity and trade facilitation; guidance for the state governments for proactive investment promotion and facilitation; pay attention to augmenting aggregate demand and addressing inequalities; a framework for supporting manufacturing through multilateral, regional and bilateral trade negotiations; a strategic element to India's approach towards development cooperation; and finally, the strategy should provide a high-powered institutional architecture for coordinated implementation in a dynamic setting.

Against that backdrop, building on the first special issue (Kumar 2024b), the contributions in this special issue highlight India's dualistic industrial structure and challenges arising from it, policy lessons from evolving regional patterns of manufacturing across the Indian states, market structure and how it affects the enterprise-level and sector investments and growth.

India's Dualistic Industrial Structure

A key feature of India's industrial structure is the dualism that exists in India's manufacturing sector, with a large number of unorganised enterprises coexisting with a small number of organised enterprises but accounting for a substantial proportion of value added. This dualism has been explored in this special issue with one contribution analysing the emerging patterns in the organised sector and another focusing on the unorganised sector enterprises. Another paper looks into the challenges that unorganised sector firms face with respect to access to institutional finance.

M Suresh Babu (p 47), in his paper, examines recent patterns of industrial transformation through size, value added, sectoral growth, and price–cost margin distributions within the organised sector. The analysis points to the increasing concentration of output and value among larger, higher-capital establishments alongside the continued employment significance of smaller units. Sectoral expansion is driven primarily by capital- and technology-intensive industries, while labour-intensive segments exhibit slower growth and tighter margins, corroborating the observation of ISID (2025). Variation in margins highlights uneven value capture across industries, reflecting differences in scale, capability, and market structure. Overall, the findings suggest selective diversification and consolidation while reproducing segmentation within the manufacturing sector. Wide variation in the price–cost margin (median 12.45%) from a low of 6.29%, textiles and apparel, and leather around 10.5% points, to competitive market structures and thin markups in labour-intensive industries operating under global competition. Higher margins concentrated in industries characterised by product specialisation, IPRs, scale economies and regulatory insulation, for example, tobacco products (32%), pharma (25%), and publishing (22%), beverages (18%), chemicals (16%) and non-metallic mineral products (19%). Besides sectoral influences, ISID (2025) had also observed the influence of firm size on profit margins (using the dataset of 17,614 manufacturing companies extracted from the Centre for Monitoring Indian Economy's (CMIE) ProwessIQ. It is important to separate the effect of firm size and the sectoral entry barriers in explaining the super-normal profits enjoyed by the mega and larger firms. The author argues that the central challenge lies not only in sustaining growth and diversification but in broadening linkages across firm and sectoral boundaries.

Rajesh Raj Natarajan and Kunal Sen (p 53), in their paper, examine the characteristics and performance of the unorganised manufacturing enterprises in India using nationally representative unit-level data for 2010–11, 2015–16, and 2023–24. They find a high degree of heterogeneity in the characteristics and performance of the unorganised manufacturing sector in India, shifting the focus from a labour lens to a

production lens. The evidence shows that the expansion of the sector has occurred mainly through an increase in the number of enterprises rather than through employment growth or capital accumulation. This pattern points to the persistent dominance of own-account and household-based firms. Gradual shifts towards urban locations, outside-household operations and greater participation by women and socially disadvantaged groups are visible. However, these changes have not yet translated into meaningful improvements in firm performance. Enterprises operating on a larger scale, located outside the household and possessing strong financial and digital capabilities, consistently perform better in terms of productivity, wages and capital intensity. Among the constraints faced by the firms, falling demand has emerged as the most widespread challenge, indicating limited market opportunities for informal sector entrepreneurs. Finance-related constraints also persist across firm attributes. On the other hand, traditionally binding supply-side constraints, such as power outages and raw material shortages, have weakened overall and are now concentrated in selected segments. Therefore, the main challenge is to help firms move beyond survival-oriented production towards more stable and market-oriented operations. Policies that strengthen demand, ease financial constraints and help upgrade their capabilities are therefore crucial. At the same time, the strong heterogeneity within the sector means that one-size-fits-all interventions are unlikely to work and calls for differentiated policy responses based on firm size, location, nature of operation and the constraints firms face.

Access to finance has been a key challenge that MSMEs in India often face. Mohd Shadab Danish and N R Bhanumurthy (p 65) explore the access to institutional finance for Indian small and medium enterprises (SMEs) and their perceptions of credit barriers, finding that formal credit access has not shown significant improvement between 2014 and 2022. Firm characteristics determine access, for example, female-managed firms, exporters, and SMEs exhibit significantly higher probability of loan access, while micro firms remain persistently excluded. Women-led borrowers also flag cost as a barrier to access to finance. Therefore, the challenge for public policy is not only to expand access to credit but also to reduce the transaction costs and compliance burdens associated with borrowing.

Evolving Regional Patterns of Manufacturing

Another aspect of India's changing industrial structure includes the evolving patterns of spatial distribution that reveal a lot of divergence. Meenakshi Shekhar and Twincle Halder (p 74) analyse the emerging regional patterns of industrialisation, which bring out how some states prospered through deliberate planning, while others drifted into premature deindustrialisation. Evidently, policy matters more than geography or the markets. Uttarakhand's success, compared to Himachal Pradesh's relatively modest performance, for instance, demonstrates that patient government investment in comprehensive industrial ecosystems—encompassing infrastructure, logistics, power, water, and residential areas—can dramatically outperform leaving industrial development to private land markets. First, policy continuity beats policy generosity. States that maintain stable industrial frameworks across electoral cycles—Gujarat (Industrial Policy 2015), Tamil Nadu (successive policies since 1992), Maharashtra (policies since the 1960s), and Odisha (frameworks since 2007)—consistently outperform states that rewrite policies with each government change. West Bengal's policy reversals and scrapping of industrial incentives in 2025 contributed to an exodus of 6,600 companies between 2011 and 2025. Second, natural resources endowments are necessary but not sufficient; state capacity to implement policy is more critical as demonstrated by Odisha transforming its mineral wealth into industrial development through public investments, whereas Jharkhand's superior mineral endowment yielded inferior outcomes due to a weak institutional capacity. Third, targeted incentives can overcome natural disadvantages. The 2003 Concessional Industrial Package and subsequent schemes transformed hill states despite the prohibitive geography. Sikkim, Himachal Pradesh, and Uttarakhand leveraged tax holidays and subsidies to attract pharmaceuticals, food processing, and manufacturing despite transportation challenges. Fourth, manufacturing remains the only sector showing state-level convergence. Research consistently demonstrates that manufacturing-intensive development helps poorer states catch up, while services-led growth concentrates benefits in already-advanced regions and aggravates the regional inequalities. Services-led growth without a manufacturing foundation also creates unsustainable imbalances, leading to GDP growth without proportionate job creation.

The emerging spatial patterns of the manufacturing sector across the states, therefore, provide good practices and rich lessons for policy for emulation by the lagging states. This includes infrastructure-first, governance capacity-building, policy continuity, and focused incentives, among others. Centre–state coordination in investment, logistics, and skill development needs to be strengthened through genuine cooperative federalism. Infrastructure—reliable power, multimodal logistics, digitised land markets—remains foundational. Most importantly, eastern and central regions need rebalancing. Resource-rich but lagging states, such as Jharkhand, Bihar, and Chhattisgarh, require patient and sustained industrial policy interventions, committed infrastructure investment, administrative capacity building, and time for ecosystems to mature. The challenge for the next quarter-century is expanding manufacturing's footprint and turning isolated islands into

connected continents where prosperity spreads more evenly. Bihar's persistent underdevelopment and Jharkhand's unrealised potential all point to the same conclusion: India needs factories, not just offices.

Market Structure and Manufacturing Sector

Beyond the policy factors and the dualism, market structure and firm conduct play an important role in determining profitability, investments and hence growth of the manufacturing sector. Jitamitra Behera and Ruchi Sharma (p 80) find that the evolution of firms in the Indian industry to attain star status depends on their propensity to devote a larger proportion of their revenue to creating intangible assets, which lend them a competitive advantage. These investments include those in building R&D capacity, marketing and branding strategy and technological advancement that are vital for enhancing long-standing success. The intangible assets examined vary by sector. In technology-intensive sectors, R&D activity is critical; food products companies focus on advertising and marketing, while pharmaceutical companies need to prioritise R&D, patenting and brand-building. In that context, Caves and Porter (1977) had argued that leading firms may create entry barriers for their peers within an industry, acting as mobility barriers. Kumar (1990), while analysing the high profit margins enjoyed by multinational affiliates in Indian industries, found them to be serving different segments of the markets (upper ends) in the respective sectors, with mobility barriers restricting the entry of other firms in their segment, enabling them to enjoy persistent high profit margins. The challenge for policy is to balance the positive externalities of R&D activity and other intangible investments and the build up of excessive monopoly power through competition policy.

Harendra Behera, Pawan Gopalakrishnan, and Abhinav Narayanan (p 90) examine whether greater market competition stimulates investment. Cross-country evidence reveals that higher competitiveness raises investment rates, particularly in emerging economies and low-investment regimes. The analysis reveals that while competition has increased across India's manufacturing industries over the past decade, investment has not kept pace. Industries with higher competition exhibit higher investment rates on average, but within-industry increases in competition have not translated into greater investment. The positive impact of competition is concentrated among export-oriented and technologically advanced industries. These findings imply that promoting competition alone may be insufficient to revive private investment. Complementary reforms—such as improving access to finance, enhancing infrastructure, boosting demand, and ensuring regulatory stability—are crucial to convert competitive pressure into sustained capital formation.

Industrial Growth and Environmental Degradation

Implications of industrial development for the environment have assumed criticality in the context of the global climate negotiations that require every country to move towards NZE. Even though India's current emissions are among the lowest in per capita terms, India has committed itself to NZE by 2070 and several subgoals like meeting half of the energy requirements by renewable sources by 2030, besides cutting down the emissions by 45%. In that context, Nivaj Gogoi and Farah Hussain (p 97) investigate the relationship between industrial growth and environmental degradation, with reference to the environmental Kuznets curve (EKC) hypothesis, for core industries in India, namely the coal, crude oil, natural gas, cement, fertilisers, electricity, petroleum products and steel industries that are of strategic importance for the economy. The empirical analysis finds validity of both the conventional inverted U-shaped and the contemporary N-shaped industry-specific environmental Kuznets curve (IEKC) hypothesis for these industries. The growth of the core industries, therefore, will worsen the environmental health of the country in the initial stages. However, the core industries start to contribute to environmental welfare after attaining a certain threshold. As the industries grow beyond this level, they generate more revenues and funds, which enable the economy to offer opportunities for environmental sustainability by allocating funds for R&D or innovative activities. But a failure to pay attention to process and product innovations can hinder this outcome, which explains the N-shaped curve. The validation of the N-shaped IEKC signifies the importance of consistent R&D efforts for improving environmental sustainability.

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Recent Manufacturing Growth in India
Size and Sectoral Patterns

M SURESH BABU

This recent patterns of industrial transformation are examined through the distribution of establishments by size, value added, sectoral growth, and price-cost margins. The evidence points to an increasing concentration of output and value added among larger, more capital-intensive establishments, alongside the continued employment significance of smaller units, suggesting an incomplete process of structural reallocation. Sectoral expansion appears to be driven primarily by capital- and technology-intensive industries, while labour-intensive segments exhibit slower growth and relatively tighter margins. Variations in price-cost margins indicate uneven value capture across industries, reflecting differences in scale, capabilities, and market structure. Overall, the findings point to selective diversification and consolidation, even as segmentation within the manufacturing system persists.

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The role of manufacturing in India's growth trajectory has been the subject of sustained academic debate. Despite episodes of relatively rapid economic growth since the early 1990s, the manufacturing sector's contribution to output and employment has remained modest. This has prompted scholars to question whether India has undergone a process of structural transformation comparable to that observed in successful late industrialisers. A growing body of literature suggests that aggregate manufacturing outcomes mask substantial heterogeneity across firm sizes and industries.

Labour-intensive sectors, such as textiles, garments, leather, food processing, and wood products, employ a large share of the manufacturing workforce but have exhibited relatively modest growth in output and productivity. Using the Annual Survey of Industries (ASI) data, Goldar and Aggarwal (2010) show that these sectors are characterised by low capital intensity, limited technological upgrading, and a high degree of informality. The textiles and apparel sector has attracted particular attention because of its export and employment potential. Kathuria et al (2001) find that trade liberalisation improved technical efficiency in textiles, though the gains were uneven across firms and regions. Despite policy initiatives aimed at promoting textile clusters and modernisation, the sector has not emerged as a sustained driver of manufacturing growth. The automobile industry is frequently cited as an example of successful industrial upgrading, supported by foreign direct investment (FDI), expansion of domestic demand, and technological learning through joint ventures (Humphrey and Memedovic 2003). The pharmaceutical industry has also recorded strong growth, particularly in exports of generic drugs. Chaudhuri (2012) highlights the role of process innovation and scale economies in driving the sector's expansion, while also noting vulnerabilities arising from dependence on imported inputs and relatively low research and development (R&D) intensity.

While these sectors have contributed significantly to output growth, their relatively capital-intensive character has limited their employment impact. More recent studies examine emerging sectors, such as electronics and electrical machinery, particularly in the context of the "Make in India" initiative and the production linked incentive (PLI) schemes. Policy-oriented research suggests that these interventions have stimulated investment and expanded output in select industries (ISID 2025).

Available evidence points to a manufacturing sector characterised by pronounced sectoral heterogeneity. Output and productivity growth have been driven largely by a narrow set

of capital- and technology-intensive industries, while labour-intensive sectors with greater employment potential have lagged behind. Overall, the evidence suggests that aggregate manufacturing indicators tend to obscure important internal dynamics. A sector-wise analysis, with particular attention to size distribution and employment effects, can therefore deepen the understanding of the constraints and possibilities of manufacturing-led growth in India.

Against this backdrop, the paper maps the pattern of growth in the manufacturing sector between 2017–18 and 2023–24. A set of selected indicators is used to examine the size distribution and sectoral dispersion of manufacturing activity. The period is chosen because it coincides with several major policy reforms. These include the introduction of the goods and services tax (GST) in 2017, the PLI schemes since 2020, labour law reforms during 2020–21, and measures aimed at FDI liberalisation and improving the ease of doing business.

In addition, the Pradhan Mantri Gati Shakti National Master Plan and the National Logistics Policy (NLP) were introduced to reduce logistics costs through more coordinated infrastructure development. Several sector-specific initiatives were also implemented, including the Phased Manufacturing Programme (PMP) to promote mobile phone production, the Strengthening of Pharmaceuticals Industry (SPI) scheme and the PLI scheme for Active Pharmaceutical Ingredients (APIs), increased indigenisation and public procurement in defence production, and policy support for renewable energy through the National Green Hydrogen Mission and incentives for electric vehicle (EV) battery manufacturing. These reforms, broad in scope and coverage, are intended to influence the size and structure of the manufacturing sector. The period under consideration therefore provides a useful time frame to assess the emerging changes in its structure and scale and their possible implications.

Sectoral Spread

The ranking of industries across five selected indicators between 2017–18 and 2023–24 reveals a pattern of structural persistence, alongside only limited evidence of upgrading in sectoral performance. This is consistent with broader findings on industrial transformation in late-industrialising economies, where changes in productivity and value generation often precede visible reallocation in industrial composition or capital structures (Rodrik 2013).

The sectoral distribution of factories (Table 1) shows little change across the two periods. Food products, other non-metallic mineral products, textiles, fabricated metal products (except machinery), and rubber and plastics remain the top five industries in terms of the number of operating units. This continuity suggests that the spread of manufacturing activity continues to be anchored in resource-based and labour-intensive segments characterised by established supply chains and relatively low entry barriers. It also indicates limited diversification at the extensive margin of industrial activity, reinforcing the observation that shifts in industrial composition are often gradual and uneven rather than discontinuous (Imbs and Wacziarg 2003).

Employment rankings exhibit modest reconfiguration while retaining underlying continuity. Food products and textiles continue to dominate workforce absorption, confirming the enduring importance of labour-intensive segments in sustaining manufacturing employment. By 2023–24, however, basic metals and motor vehicles enter the upper ranks, displacing wearing apparel and reducing the relative weight of traditional low-value segments. This shift points towards incremental changes in patterns of labour absorption associated with capital-deepening and technological upgrading. Such movement is consistent with the literature linking structural change to sectoral productivity differentials, where labour gradually reallocates towards industries offering higher productivity and wage potential (McMillan and Rodrik 2011). Nevertheless, the continued prominence of traditional sectors indicates that employment transformation remains partial and reflects the dualistic character of industrialisation. The ranking of industries by fixed capital remains virtually unchanged, with basic metals, coke and refined petroleum products, and

Table 1: Industry Rank Positions across Indicators, 2017–18 to 2023–24

Characteristics	Rank	2017–18	2023–24
No of factories in operation	1	Food products	Food products
	2	Other non-metallic mineral products	Other non-metallic mineral products
	3	Textiles	Textiles
	4	Fabricated metal products, except machinery	Fabricated metal products, except machinery
	5	Rubber and plastic products	Rubber and plastic products
Total persons engaged	1	Food products	Food products
	2	Textiles	Textiles
	3	Wearing apparel	Basic metals
	4	Other non-metallic mineral products	Motor vehicles, trailers and semi-trailers
	5	Basic metals	Wearing apparel
Fixed capital	1	Basic metals	Basic metals
	2	Coke and refined petroleum products	Coke and refined petroleum products
	3	Chemicals and chemical products	Chemicals and chemical products
	4	Food products	Food products
	5	Other non-metallic mineral products	Other non-metallic mineral products
Output	1	Food products	Basic metals
	2	Basic metals	Food products
	3	Coke and refined petroleum products	Coke and refined petroleum products
	4	Chemicals and chemical products	Motor vehicles, trailers and semi-trailers
	5	Motor vehicles, trailers and semi-trailers	Chemicals and chemical products
Gross value added	1	Coke and refined petroleum products	Basic metals
	2	Basic metals	Motor vehicles, trailers and semi-trailers
	3	Chemicals and chemical products	Chemicals and chemical products
	4	Food products	Food products
	5	Motor vehicles, trailers and semi-trailers	Pharmaceuticals, medicinal chemical

Source: Computed from Annual Survey of Industries 2017–18, 2023–24.

chemicals occupying the top three positions in both years, followed by food products and non-metallic mineral products. This stability underscores the structural rigidity of capital allocation within manufacturing. Heavy industries and petrochemicals are characterised by high sunk costs, technological indivisibilities, and strong infrastructure dependence, factors that tend to lock in sectoral dominance once investments are established. The persistence observed here is consistent with findings that capital accumulation often reinforces existing hierarchies rather than rapidly redirecting investment towards emerging sectors (Amsden 2001).

In terms of output rankings, basic metals replace food products as the leading sector by 2023–24, while motor vehicles move into the upper tier and chemicals register a relative decline. A similar pattern is visible in gross value added, where basic metals overtake petroleum refining, motor vehicles advance to second place, and pharmaceuticals enter the top five. These developments suggest an incremental shift in value generation towards engineering- and technology-intensive sectors. The emergence of pharmaceuticals and the strengthening of automotive production are particularly indicative of movement towards industries with higher knowledge content and stronger inter-industry linkages—features often associated with productivity-enhancing structural transformation (Hausmann et al 2007). At the same time, the divergence between relatively stable industrial distribution and changing patterns of value generation highlights the distinction between extensive structural change (the entry or exit of sectors) and intensive transformation (performance shifts within existing sectors).

Taken together, the evidence suggests a dual trajectory. On the one hand, the structure of industrial presence and capital allocation exhibits considerable inertia. On the other, patterns of output and value addition point to gradual upgrading towards higher-productivity segments, consistent with a process of incremental diversification. This pattern resonates with empirical work emphasising that structural transformation in manufacturing often unfolds through layered upgrading rather than rapid sectoral displacement (Andreoni and Chang 2019). The overall picture, therefore, is not one of dramatic restructuring but of uneven evolution. Labour-intensive sectors continue to anchor employment and the spatial spread of industry, while capital- and technology-intensive industries increasingly shape production and value creation. Such coexistence reflects the complex and gradual nature of industrial transition.

Size Distribution

The distribution of manufacturing characteristics by employment size class between 2017–18 and 2023–24 highlights the persistence of a highly skewed scale structure, alongside gradual consolidation towards larger establishments. The evidence reflects a familiar dualism observed in manufacturing in many developing countries, where a large number of small firms coexist with a relatively small group of large units that dominate production and employment outcomes (Hsieh and Klenow 2009).

As evident from Table 2, micro-establishments employing fewer than 20 workers account for the largest share of factories in operation, although their dominance declines modestly over the period. Units in the 0–14 worker category fall from 38.4% to 33.5% of factories, and together with the 15–19 category still constitute more than two-fifths of establishments. Yet, their contribution to output and employment remains negligible, accounting for barely 3% of each indicator in both years. This divergence underscores the limited productive capacity of microscale manufacturing and reflects a high degree of structural fragmentation. The decline in their share suggests some degree of consolidation or scaling-up, though not enough to fundamentally alter the overall structure. Lower-middle segments employing 20–99 workers display relative stability in their share of factories but register modest declines in their contributions to output and employment. For instance, the 50–99 worker category records an increase in its share of establishments while showing reduced shares in output and employment by 2023–24. This pattern points to competitive pressures associated with scale, where productivity improvements in larger firms compress the relative economic weight of smaller establishments. Such evidence resonates with the "missing middle" phenomenon, wherein firms face institutional and financial barriers in transitioning from small- to efficient medium-scale production (Krueger 2013).

Establishments in the 100–499 worker range continue to represent the core of employment absorption and production. Their shares remain substantial across both periods, with the 200–499 worker category alone contributing around one-sixth of output and nearly one-fifth of employment. The stability of these segments indicates the continued centrality of medium–large firms in sustaining manufacturing activity. These establishments often combine scale economies with labour intensity and organisational flexibility, making them pivotal in industrial development trajectories (Page and Söderbom 2014). More pronounced changes are evident among large establishments employing 500 workers or more. Their shares of factories, output, and employment rise across most categories, signalling the gradual consolidation of industrial production at higher scales. Output contributions increase notably in the 2,000–4,999 and 5,000-plus categories, with the latter accounting for an expanding share of total production by 2023–24. This shift reflects the growing importance of scale economies, capital

Table 2: Key Characteristics by Size of Employment (%)

Employment Range	Factories in Operation		Output		Total Persons Engaged	
	2017–18	2023–24	2017–18	2023–24	2017–18	2023–24
0–14	38.35	33.54	2.5	1.86	3.08	2.45
15–19	8.65	8.45	1.43	1.24	1.76	1.48
20–29	10.35	10.83	2.7	2.35	2.97	2.67
30–49	11.39	11.87	4.36	3.82	5.19	4.62
50–99	11.85	12.51	7.59	6.14	9.66	8.71
100–199	8.29	9.29	9.38	9.44	12.63	12.18
200–499	6.26	7.34	16.53	16.11	19.42	19.1
500–999	2.48	3.13	14.09	13.43	14.66	15.25
1,000–1,999	1.29	1.56	12.03	11.91	11.58	12.2
2,000–4,999	0.74	1.03	14.02	15.18	10.18	11.22
5,000 and above	0.36	0.46	15.36	18.52	8.88	10.12

Source: Computed from Annual Survey of Industries 2017–18, 2023–24.

deepening, and technological upgrading in shaping industrial competitiveness (Syverson 2011).

Despite these movements, structural asymmetry remains pronounced. A small minority of large establishments generates a disproportionate share of output and employment, while the majority of units operate at low productivity and limited scale. This distribution is consistent with findings on resource misallocation and size-dependent productivity differentials that constrain aggregate manufacturing performance (Hsieh and Klenow 2009). Overall, the results points, to incremental structural change rather than a fundamental transformation. The declining share of micro establishments and the expanding role of larger units indicate gradual consolidation and productivity-oriented scaling. However, the continued dominance of small establishments suggests that fragmentation remains deeply embedded in the industrial structure.

The distribution of manufacturing characteristics by capital size class (Table 3) highlights the concentration of production and employment within capital-intensive establishments, alongside the continued numerical dominance of low-capital units. Units with capital investment of up to ₹25 lakh account for nearly two-thirds of factories in both periods, though their share declines from 66.2% to 62.4%. Despite their predominance, their contribution to output and employment remains modest and declines further over time. The output share falls from 13.5% to 12.5%, while the employment share declines from 29.0% to 25.6%. The lower-middle capital category (₹25–₹500 lakh) shows relative stability in its share of factories but records declining contributions to output and employment. The modest rise in the share of establishments in the ₹500–₹1,000 lakh category is similarly accompanied by declining output and employment shares, reinforcing the notion of uneven scaling and constraints on upward mobility across capital thresholds.

Table 3: Key Characteristics by Size of Capital

Capital Range (₹ Lakh)	Factories in Operation (%)		Output (%)		Total Persons Engaged (%)	
	2017–18	2023–24	2017–18	2023–24	2017–18	2023–24
Up to 25	66.17	62.36	13.5	12.52	29.01	25.56
25–500	18.03	17.16	8.16	6.23	11.95	9.66
500–1,000	4.47	5.36	4.85	3.95	6.57	5.97
1,000 and above	11.33	15.11	73.5	77.3	52.48	58.8

Source: Computed from Annual Survey of Industries 2017–18, 2023–24.

By contrast, establishments with capital investment of ₹1,000 lakh and above exhibit marked expansion across all indicators. Their share of factories rises from 11.3% to 15.1%, while the output share increases from 73.5% to 77.3% and the employment share from 52.5% to 58.8%. The strengthening employment contribution further suggests that labour absorption is increasingly mediated through organised, capital-rich enterprises rather than dispersed low-capital units. Taken together, the evidence points to deepening capital concentration and incremental structural consolidation. This configuration aligns with broader findings on resource misallocation, where the persistence of numerous low-productivity units coexists with the growing dominance of large capital firms.

The distribution of manufacturing characteristics by net value added (NVA) class (Table 4) between 2017–18 and 2023–24 reveals increasing concentration of production and employment in higher value-generating segments, alongside a contraction in the relative importance of low-value units. This pattern points to incremental upgrading in the value structure of manufacturing, consistent with theoretical and empirical work emphasising the role of productivity differentials in shaping structural transformation (McMillan and Rodrik 2011; Syverson 2011).

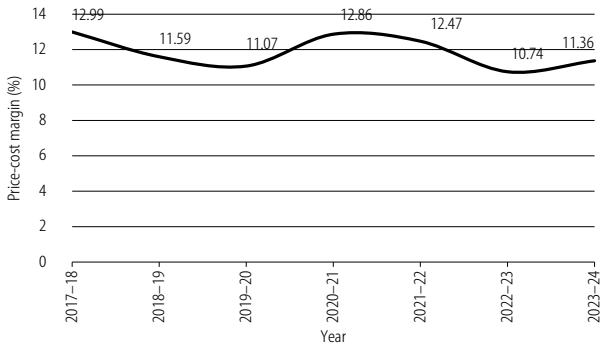
Table 4: Key Characteristics by Net Value Added

NVA Range (₹ Lakh)	Factories in Operation (%)		Output (%)		Total Persons Engaged (%)	
	2017–18	2023–24	2017–18	2023–24	2017–18	2023–24
Up to 2.5	14.55	10.69	5.33	4.08	5.1	3.95
2.5–5	2.26	1.51	0.03	0.01	0.18	0.09
5–10	5	3.49	0.09	0.06	0.5	0.25
10–20	8.93	6.16	0.31	0.14	1.28	0.63
20–50	18.38	15.59	1.36	0.79	4.94	2.79
50–100	13.45	13.49	2.31	1.49	5.34	3.74
100–200	10.7	12.49	3.62	2.81	6.41	5.08
200–500	10.99	13.63	7.38	5.85	11.28	9.7
500–1,000	5.66	7.57	7.13	6.11	10.12	9.53
1,000–5,000	7.07	10.41	19.6	18.75	25.19	25.42
5,000 and above	3.03	4.98	52.85	59.9	29.65	38.81

Source: Computed from Annual Survey of Industries 2017–18, 2023–24.

Establishments in the lowest NVA categories account for a declining share of factories over time. Units generating value added of up to ₹2.5 lakh fall from 14.6% to 10.7% of factories, and similar reductions are observed across the ₹2.5–₹50 lakh bands. Their contributions to output and employment are already marginal and will contract further by 2023–24. For instance, the ₹20–₹50 lakh category records declining shares in both output and employment despite retaining a sizeable presence in terms of factory counts. The contraction of these segments suggests a gradual reallocation of activity towards higher value tiers. Middle NVA segments display mixed dynamics. While the ₹50–₹200 lakh categories show relative stability or modest expansion in their share of factories, their

Figure 1: Price-cost Margins across All industries, 2017–18 to 2023–24



Source: Computed from Annual Survey of Industries.

contributions to output and employment either stagnate or decline slightly. In contrast, the ₹200–₹1,000 lakh range registers expansion across all indicators, signalling the strengthening presence of moderately productive establishments. These segments account for rising shares of factories while maintaining significant contributions to employment and output, indicating the importance of mid-value firms in bridging the productivity spectrum. Such firms often represent transitional nodes in industrial upgrading processes, combining scale expansion with incremental technological adoption (Page and Söderbom 2015).

The most pronounced shifts occur in the highest NVA classes. Establishments generating ₹1,000 lakh and above show a clear expansion in their share of factories while continuing to dominate output and employment. The topmost category (₹5,000 lakh and above) increases its share of factories and accounts for nearly three-fifths of output by 2023–24, along with a sharply rising share of employment. This concentration points to the deepening of value generation within a relatively small segment of highly productive firms, reflecting cumulative advantages associated with technology, capital intensity, and market integration.

Despite these shifts, the distribution retains a marked asymmetry. A minority of high-value establishments generates the bulk of output and employment, while a large number of firms continue to operate at low levels of value creation. The declining weight of low-value establishments and the strengthening dominance of the highest value classes indicate movement towards enhanced value generation and industrial capability. However, the persistence of wide dispersion across value bands underscores the layered nature of structural transformation, where processes of upgrading coexist with entrenched heterogeneity.

Implications

An important implication of a skewed industrial structure is the persistence of higher price-cost margins, indicating the presence of greater monopoly power (Suresh Babu 2018). This is examined at both the aggregate and sectoral levels. Price-cost margins are computed as the difference between output and the sum of total emoluments and the value of inputs, expressed as a percentage of output.

The trajectory of price-cost margins in total manufacturing industries between 2017–18 and 2023–24 (Figure 1) suggests moderate cyclical variation around a relatively stable long-term band. Margins fluctuate within a narrow range, indicating that the balance between output realisation and input costs has remained broadly resilient despite changing macroeconomic and sectoral conditions.

A decline is observed between 2017–18 and 2019–20, with margins falling to about 11.1%. The contraction suggests cost pressures or weakening output price realisation relative to inputs, highlighting the sensitivity of industrial margins to macroeconomic shocks and demand deceleration. The partial recovery in 2020–21, when margins rebound above 12.8%, points to temporary adjustment dynamics—possibly reflecting input cost compression or restructuring during a period of disruption—before easing again in subsequent years. The most recent period shows renewed volatility, with margins declining to around 10.7% in 2022–23 before recovering modestly to 11.4% in 2023–24. This movement suggests ongoing cost–price adjustments rather than a sustained improvement in industrial efficiency. Importantly, margin behaviour appears to be driven more by cyclical and price-related factors than by fundamental technological shifts. From a structural perspective, this pattern reinforces the view that productivity upgrading and cost competitiveness remain uneven.

The distribution of median price-cost margins across industries reveals significant heterogeneity in value realisation and cost structures within the production system. The overall

Table 5: Median Price-cost Margins

Industry	(%)
10 Food products	6.29
11 Beverages	18.17
12 Tobacco products	32.10
13 textiles	9.91
14 Wearing apparel	10.50
15 Leather and related products	9.01
16 Wood and products of wood and cork	10.79
17 Paper and paper products	11.73
18 Printing and reproduction of recorded media	16.79
19 Coke and refined petroleum products	8.73
20 Chemicals and chemical products	15.84
21 Pharmaceuticals, medicinal chemical and botanical products	25.37
22 Rubber and plastics products	13.08
23 Other non-metallic mineral products	19.02
24 Basic metals	10.04
25 Fabricated metal products, except machinery	11.85
26 Computer, electronic and optical products	10.87
27 Electrical equipment	11.40
28 Machinery and equipment (not elsewhere classified)	14.96
29 Motor vehicles, trailers and semi-trailers	11.76
30 Other transport equipment	14.21
31 Furniture	9.76
32 Other manufacturing	6.73
33 Repair and installation of equipment	14.72
38 Waste collection, treatment and disposal	8.23
58 Publishing activities	21.86
Others	18.68
Total manufacturing	12.45

Source: Computed from Annual Survey of Industries.

median margin of 12.45% masks sharp variation across resource-based activities, regulated sectors, and manufacturing segments characterised by differing technological intensities and market structures. Within manufacturing, margins vary along the lines of product differentiation, regulatory protection, and technological capability. Low-to-mid range margins in food products (6.29%), textiles (9.91%), apparel (10.50%), and leather (9.01%) point to competitive market structures and thin mark-ups typical of labour-intensive industries operating under cost pressures and global competition. Intermediate manufacturing segments—including fabricated metals, electrical equipment, and transport equipment—cluster near the aggregate average, suggesting moderate value addition under integrated supply-chain conditions. Similarly, sectors such as petroleum refining (8.73%) and basic metals (10.04%) reflect margin compression associated with input price sensitivity and capital intensity.

Higher margins appear concentrated in industries characterised by product specialisation, intellectual property intensity, or regulatory insulation. Tobacco products (32.10%), pharmaceuticals (25.37%), and publishing activities (21.86%) display relatively strong mark-ups, likely reflecting brand power, patent regimes, or restricted market entry. Beverages (18.17%), chemicals (15.84%), and non-metallic mineral products (19.02%) also show elevated margins consistent with differentiated output and scale economies. Printing and recorded media (16.79%) and machinery-related activities further underscore the role of niche production capabilities in sustaining margins above the system-wide median. Taken together, these patterns suggest that price-cost margins are shaped less by sectoral classification alone than by underlying structural attributes. Labour-intensive and price-competitive industries exhibit compressed margins despite their employment significance, while knowledge-intensive or regulated sectors capture relatively higher shares of value.

Conclusions

The combined examination of industrial size distribution, sectoral growth, and price-cost margins suggests a pattern of manufacturing transformation marked by concentration, selective diversification, and persistent heterogeneity rather than uniform upgrading. The evidence indicates that structural change is unfolding through the uneven reallocation of capital and value towards larger establishments, while a broad base of smaller units continues to shape employment outcomes. Size-based distributions show that establishments with modest capital and low NVA remain numerically dominant and continue to absorb a substantial share of labour, yet their contribution to output remains limited. At the same time, establishments with higher capital and higher NVA have expanded their shares of output and employment, signalling consolidation and scaling within the industrial structure. This coexistence of a modernising upper tier alongside a large lower-productivity segment reflects the incomplete nature of structural transformation, where inter-firm reallocation remains gradual and segmented.

Sectoral growth patterns reinforce this interpretation. Expansion has been concentrated in capital-intensive industries, many of which benefit from stronger investment flows. Traditional labour-intensive sectors, while remaining important for employment, have exhibited more moderate growth trajectories. Diversification therefore appears to be driven less by broad-based upgrading than by selective sectoral deepening. Variation in output–input margins provides further insight into patterns of value capture across sectors. Labour-intensive and fragmented industries display compressed margins, reflecting competitive pressures and weaker market power, whereas technologically sophisticated or regulated sectors exhibit substantially higher margins and greater surplus appropriation. These differences mirror the concentration patterns observed across capital and NVA classes, suggesting that structural position, technological capability, and scale jointly shape profitability outcomes. Taken together, the findings point to industrial restructuring along interconnected dimensions: consolidation towards larger producers, selective sectoral expansion led by capital-intensive activities, and an uneven distribution of value capture across industries. From a policy perspective, the central challenge lies not only in sustaining growth and diversification but also in strengthening linkages across firms and sectors.

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Unorganised Manufacturing Enterprises in India

Significance, Heterogeneity, Performance, and Constraints

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The characteristics and performance of the unorganised manufacturing enterprises in India are examined using nationally representative unit-level data for 2010–11, 2015–16, and 2023–24. The constraints that these enterprises face and the implications for their performance are also examined. Falling demand stands out as the most severe constraint, followed by finance-related constraints, while labour, power, and raw material challenges are less prominent overall. Therefore, policy design must recognise the heterogeneity within the sector and the varied constraints faced by different groups of entrepreneurs.

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The informal sector plays an indispensable role in sustaining livelihoods and economic activity in developing countries. It contributes close to one-third of the gross domestic product (GDP) and accounts for nearly 70% of total employment, though estimates vary across countries. Among non-agricultural workers globally, between 50% and 90% are engaged in informal sector activities (Gutiérrez Romero 2021). India is no exception. The informal sector continues to form a large part of the economy, accounting for most employment and a substantial share of national income. Recent estimates indicate that over 90% of employment in India remains informal, and that the sector contributes more than half of total gross value added (GVA) (Raveendran and Vanek 2020).

A striking feature of the Indian economy is the persistence of informality over time. Despite sustained periods of rapid growth, the share of the informal sector has remained largely unchanged over the past two decades (Kesar 2023). Equally notable is the continued dominance of microenterprises in the non-agricultural informal sector. Their stable and overwhelming presence points to limited upward mobility and weak structural transformation. This pattern has contributed to a dual structure, with many small informal firms coexisting alongside a relatively small number of modern firms in formal manufacturing and services, a feature long observed in development economics (Lewis 1954).

While there is a large existing scholarship on the formal (organised) manufacturing sector, relatively little is known about the informal (unorganised) manufacturing sector, especially in the 2010s and 2020s (Basole and Narayan 2020; Goldar 2023).[1] In this paper, we examine the characteristics and performance of informal manufacturing enterprises in India using nationally representative unit-level data for 2010–11, 2015–16, and 2023–24. We also examine the constraints that these enterprises face and the implications for their performance. In contrast to earlier research on the informal sector in India, which focuses on the conditions of informal workers, our paper focuses on informal enterprises, paying particular attention to the observed heterogeneity in the informal manufacturing sector. This paper therefore shifts the focus to a production lens, examining patterns and correlates of informal enterprise performance and growth.

Against this backdrop, the main objective of the study is to identify the key factors that restrict the growth and sustainability of informal enterprises. More specifically, the study aimed to (i) examine the size and composition of informal enterprises across selected firm and owner attributes, (ii) analyse

performance trends and patterns, (iii) identify the major constraints faced by informal firms and assess how these vary by firm characteristics, and (iv) probe the relationship between reported constraints and indicators of firm performance.

Data, Variables and Methods

Data: The study relies on enterprise-level data from the Government of India's National Sample Survey Office (NSSO) surveys of unincorporated non-agricultural enterprises. We focus on three survey rounds: 2010–11, 2015–16, and 2023–24 (Table 1).[2] For the analysis involving constraints, we replace the 2023–24 round with the 2022–23 round to maintain consistency in the type of constraints analysed.[3] According to the NSSO, unincorporated enterprises are those not registered under the Companies Act of 1956 or 2013 and are therefore not treated as corporate entities (NSSO 2025). The surveys cover manufacturing enterprises outside the purview of the Factories Act as well as enterprises engaged in trade and other services. A small subset of firms with partial registration under provisions such as Section 85 of the Factories Act or state-level Shops and Establishments Acts is also included but these firms fall outside both corporate- and factory-registered categories. The dataset therefore represents unorganised or informal enterprises and contains no coverage of the formal sector.[4]

Table 1: Number of Manufacturing Establishments Surveyed in Each Round

Round	Year	Number of Establishments
67	2011–12	99,282
73	2015–16	82,754
ASUSE (III)	2023–24	1,27,369
Total		3,09,405

Source: NSSO surveys.

The NSSO surveys are nationally representative and cover all states and union territories. The sampling design is multistage and stratified. Rural areas are stratified by districts and urban areas are grouped by population size. Census villages in rural areas and urban frame survey blocks in urban areas serve as first-stage units from which enterprises are drawn as final-stage units.

The surveys collect information on enterprise characteristics, ownership, employment, inputs, output, registration status and perceived constraints to operation. This information allows us to examine enterprise characteristics and constraints across firm types, locations and owner attributes over time within the informal sector.

Variables: The key variables used in the study include the number of enterprises, employment, GVA, wages and gross fixed assets. Employment is measured as the total number of persons engaged in production activity, which includes production workers, employees and owners. Nominal GVA is converted to real terms using the wholesale price index (WPI) for manufactured products at the two-digit industry level, with 2011–12 as the base year. Wages include payments to both formal and informal hired workers as well as employer contributions for formal workers. Real wages are obtained by deflating nominal wages using the consumer price index (CPI) for industrial workers at 2011–12 prices. Gross fixed assets include land, buildings, plant and machinery, transport equipment, tools and other fixed assets, and are converted to real values using the WPI for machinery and machine tools.

We examine changes over time in the composition of the informal sector across a set of firm attributes. Enterprises are classified by type, ownership, broad sector of activity and location. By enterprise type, we distinguish between own-account units that rely exclusively on family labour and hired worker enterprises. Ownership is classified into proprietary, partnership and other forms. By broad sector of activity, enterprises are grouped into manufacturing, trade and services.[5] Location is captured along two dimensions: rural–urban classification and whether the enterprise operates from within the household or outside it. Enterprises operating outside the household are further classified into those with fixed premises and permanent structures, those with fixed premises but temporary or no structures, and street vendors.

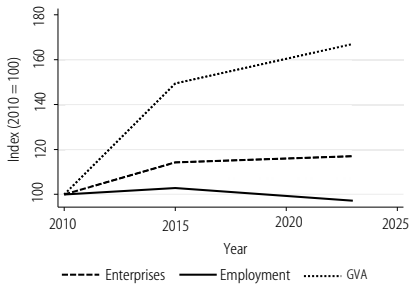
In addition to firm attributes, we analyse changes in composition by owner characteristics, namely gender, social group and education level. Gender refers to the sex of the enterprise owner, and enterprises are categorised as male-owned or female-owned.[6] Social group follows the standard NSSO classification into Scheduled Tribes (ST), Scheduled Castes (SC), Other Backward Classes (OBC), and general caste. Information on the education level of the owner is available only for the recent survey round (2023–24). Where available, education is grouped into six categories: not literate, below primary, primary, secondary, higher secondary, and graduate and above.

Firm performance is examined using labour productivity, wages per hired worker and the capital–labour ratio. Labour productivity is defined as the ratio of real GVA to the number of workers. Wages per worker are computed as total wages divided by the number of hired workers. The capital–labour ratio is measured as real fixed assets per worker.

A key objective of the study is to examine the constraints faced by informal enterprises, how these constraints vary across firm and owner attributes and their association with firm performance. Firms were asked to identify the most severe and second-most severe problems faced during the preceding 365 days from a pre-specified list of constraints. The analysis focuses on constraints reported as the most severe. These include power outages, shortage of raw materials, falling demand, credit constraints, non-recovery of financial dues, non-availability of skilled labour and other operational issues such as labour disputes. For analytical clarity, credit constraints and non-recovery of financial dues are combined into a single category termed finance-related constraints, while non-availability of skilled labour and labour disputes are grouped as labour-related constraints. Overall, six constraint categories are constructed: power outages, shortage of raw materials, falling demand, finance-related constraints, labour-related constraints and others.

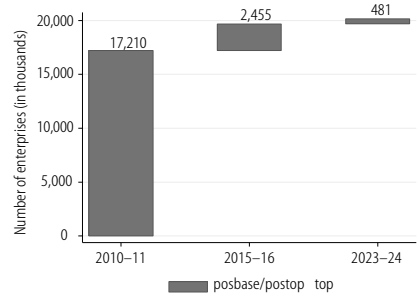
Methods: In addition to analysing the size, composition and performance of the informal sector using descriptive tables and figures, we employ a multivariate regression analysis to

Figure 1: Growth Trends of Enterprises, Employment and GVA



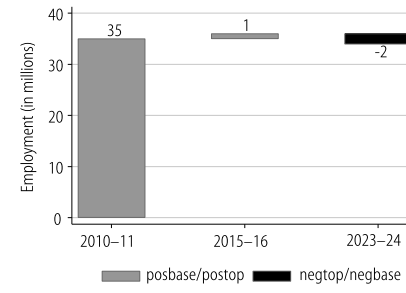
Source: Authors' estimates.

Figure 2: Changes in Number of Enterprises



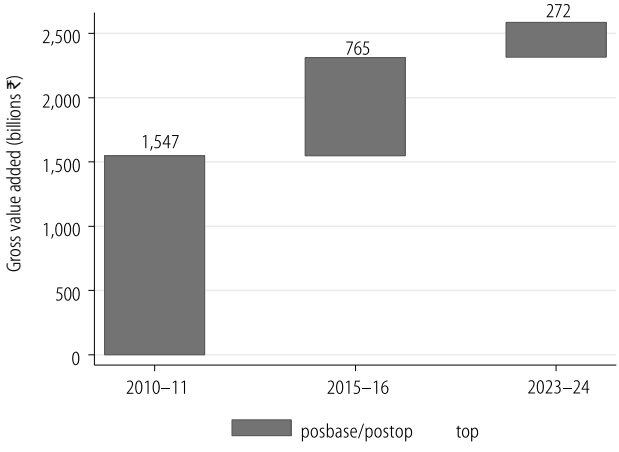
Source: Authors' estimates.

Figure 3: Changes in Employment Numbers



Source: Authors' estimates.

Figure 4: Changes in Gross Value Added



Source: Authors' estimates.

Table 2: Size and Trends of Enterprises, Employment and Gross Value Added

Variable	2010–11	2015–16	2023–24
Number of enterprises (thousands)	17,210	19,665	20,146
Employment (millions)	35	36	34
Gross value added (₹ billion)	1,547	2,312	2,584

Source: Authors' estimates.

identify correlates of firm performance. We estimate the following baseline specification:

$$Y_{it} = \beta_o + \sum_{k>1}\beta_k FIRM_{it} + \sum_{l>1}\mu_l OWNER_{it} + \sum_{p>1}\varphi_p CONSTRAINT_{it} + \gamma_j + \delta_s + \theta_t + \epsilon_{it} \quad \ldots(1)$$

where i denotes enterprises and t denotes survey rounds. The dependent variable Y_{it} denotes firm performance. We estimate three separate specifications corresponding to labour productivity, wages per worker and the capital–labour ratio.

$FIRM_{it}$ is a vector of variables capturing firm attributes and firm capabilities. Firm attributes include enterprise type, ownership, and location (rural versus urban and within household versus outside household operation). Firm capabilities are proxied by indicators for whether the enterprise maintained accounts registered under any act or authority and adopted digital technologies. Digitalisation is measured using binary indicators for computer and internet use.

$OWNER_{it}$ captures owner characteristics and includes gender and social group of the enterprise owner.

$CONSTRAINT_{it}$ is a vector of binary indicators representing the most severe operation problem reported by the enterprise. These include power outages, shortage of raw materials, falling demand, finance-related constraints, labour-related constraints and other operational issues.

The terms γ_j, δ_s and θ_t denote industry, state and year fixed effects, respectively. ϵ_{it} is the error term.

Results

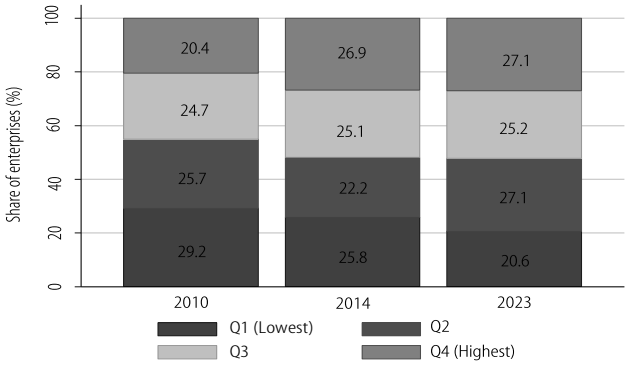
We organise the results into five subsections. In the first part of the analysis, we examine changes in the size and growth of the informal sector over time. We analyse shifts in the composition of the sector using selected firm attributes in the second part. The third part looks at trends in firm performance based on three measures. In the fourth part, we discuss the constraints reported by firms and how these have evolved over time. We then examine the association between reported constraints, firm and owner attributes, and firm performance to locate the main correlates of performance in the last part of the analysis.

Size of the sector: We begin by examining changes in the size of the informal manufacturing sector from 2010–11 to 2023–24 using three indicators: number of enterprises, employment, and GVA. These are summarised in Table 2 and presented in Figures 1 to 4.

Over the study period, the number of enterprises increased steadily from 17.21 million in 2010–11 to 19.67 million in 2015–16 and further to 20.15 million in 2023–24 (Table 2). This represents an overall increase of about 17%. A large share of this expansion occurred in the first sub-period. Nearly 85% of the total increase took place between 2010–11 and 2015–16 (Figure 2).

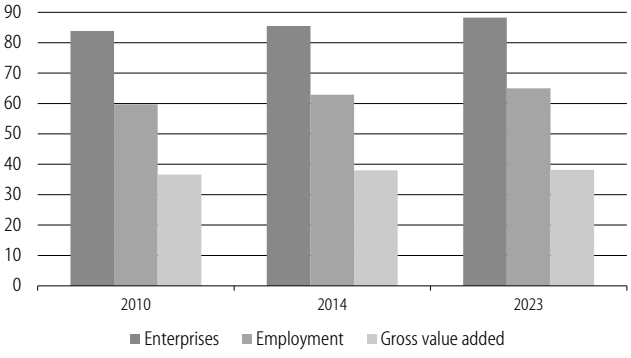
Employment trends, however, did not mirror the expansion in enterprise numbers. Employment increased marginally from 35 million in 2010–11 to 36 million in 2015–16 and then declined to 34 million by 2023–24. Overall, employment in the sector fell by about 3% during the study period, leading to a net loss of around one million workers (Figure 3). The first sub-period witnessed a modest increase in employment, but this trend reversed after 2015–16, during which the sector registered a contraction in employment despite a continued increase in the number of enterprises. Changes in employment were thus weak compared to those in

Figure 5: Distribution of Enterprises across GVA Quartiles



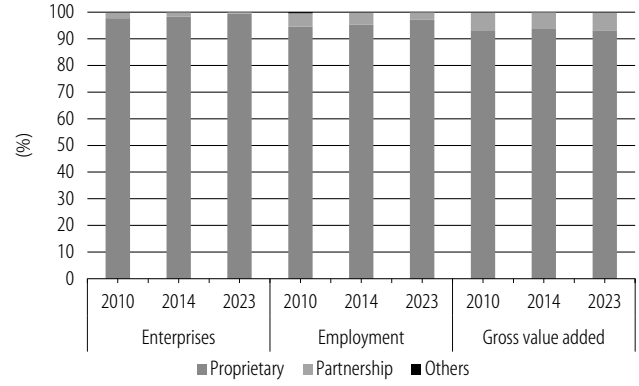
Quartile cut-offs are fixed using pooled all-India data for 2010, 2015, and 2023.
Source: Authors' estimates.

Figure 6: Share of Own-account Enterprises in Informal Sector



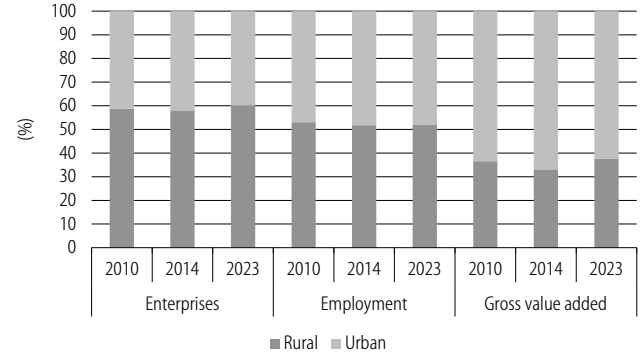
Source: Authors' estimates.

Figure 7: Ownership-wise Contribution in the Informal Manufacturing Sector



Source: Authors' estimates.

Figure 8: Rural–Urban Divide in the Informal Manufacturing Sector



Source: Authors' estimates.

enterprise numbers. This indicates a decline in average employment per enterprise.

The GVA increased substantially over the study period, from ₹1,547 billion in 2010–11 to ₹2,584 billion in 2023–24. This corresponds to an overall increase of about 67% (Table 2). However, the pace of GVA growth varied considerably between the two sub-periods. The bulk of the increase occurred between 2010–11 and 2015–16. During this period, GVA rose by nearly 50%. Growth decelerated between 2015–16 and 2023–24, and GVA increased by only about 12%.

The deceleration in value added is also evident from the distribution of enterprises across GVA quartiles (Figure 5). Between 2010–11 and 2015–16, there was a clear shift towards higher GVA enterprises. The share of firms in the bottom two quartiles (Q1 and Q2) declined from 55% to 48%, while the share in the top two quartiles (Q3 and Q4) increased from 45% to 52%. This pattern suggests a broad-based movement towards higher value added during this phase. However, between 2015–16 and 2023–24, shifts in quartile distribution were relatively limited. The distribution remained largely stable, with only marginal increases in the upper half. This points to a slowdown in upward movement across the GVA distribution in recent years.

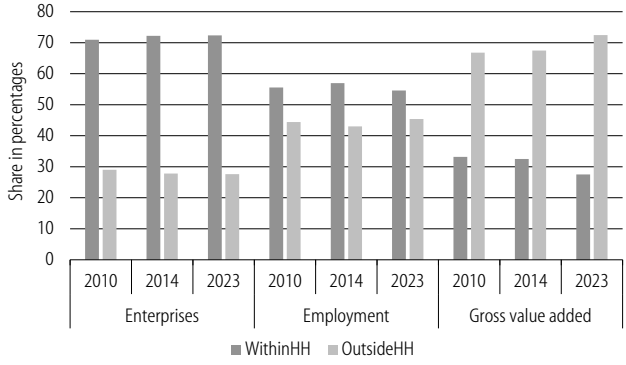
Overall, these trends suggest that the expansion of the informal sector over the past decade has been primarily driven by an increase in the number of enterprises. Employment, however, has failed to keep pace. Although aggregate GVA has continued to rise, its growth has decelerated. This pattern points to the growing presence of enterprises that generate limited employment and the slowdown in value added, despite expansion in the number of enterprises in the sector.

Composition of the sector: The composition of the informal sector remained largely stable over the study period, although discernible shifts were observed across firm characteristics, owner attributes and regions. Own-account enterprises and proprietary firms continued to dominate informal manufacturing in terms of the number of enterprises and employment (Figures 6 and 7). By the end of the study period, own-account enterprises accounted for 88% of all firms and about two-thirds of total employment. However, they contributed less than 40% of GVA. This gap highlights the limited value added generated by own-account enterprises despite their numerical dominance.

A similar pattern is evident when the sector is examined by ownership type. Proprietary enterprises constituted nearly the entire set of firms throughout the period. By 2023, they represented over 99% of enterprises, more than 97% of employment and over 93% of aggregate value added. Partnership enterprises, on the other hand, represented a small and steadily declining proportion of firms, employment, and GVA.

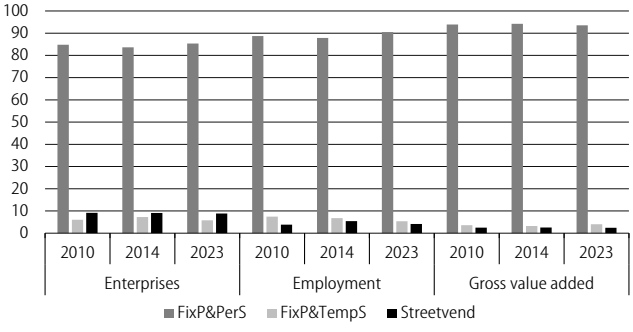
Rural enterprises accounted for the majority of firms. Their share stayed in the range of 58% to 60% throughout the study period (Figure 8). Urban enterprises, however, generated a

Figure 9: Where Firms Operate—Enterprises, Employment and GVA by Location



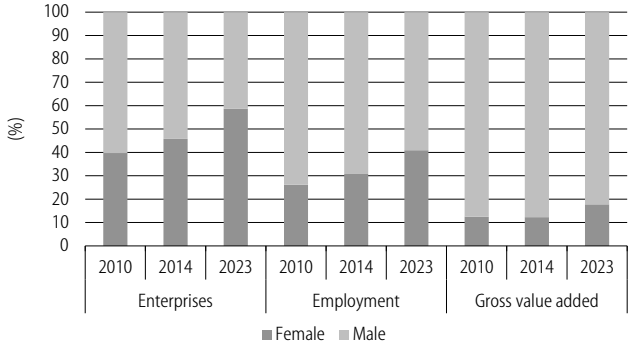
Source: Authors' estimates.

Figure 10: Where Firms Operate Outside the Household—Enterprises, Employment and GVA by Location



Fixed premises with temporary structure include fixed premises with no structure. Street vendors include mobile markets.
Source: Authors' estimates.

Figure 11: Gender Divide in Proprietary Firms

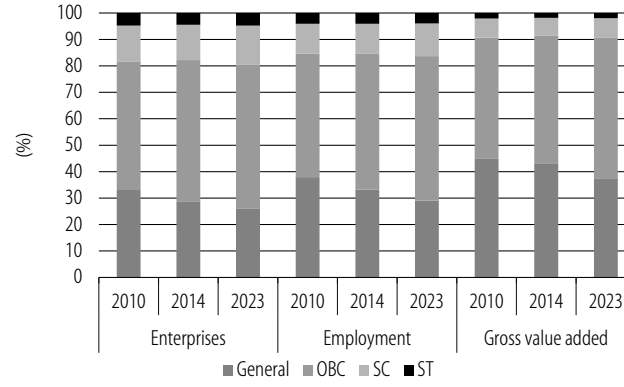


Source: Authors' estimates.

disproportionately large share of value added and a substantial share of employment. Although they represented only around two-fifths of enterprises, urban firms contributed nearly two-thirds of total GVA and had a stronger economic contribution than rural enterprises.

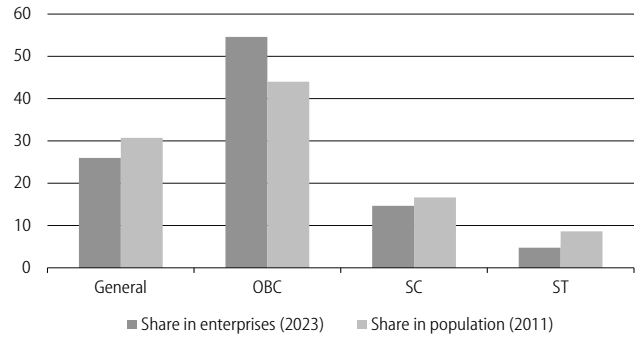
Changes in where and how firms operate are also important. Although most informal manufacturing enterprises continued to operate within households, firms located outside the household contributed a much larger share of employment and an even greater share of value added (Figure 9). By 2023, outside-household enterprises, which comprised less than 30% of all firms, generated over 70% of total GVA.

Figure 12: Ownership by Caste



Source: Authors' estimates.

Figure 13: Caste Ownership versus Caste Composition in Population



Source: Authors' estimates.

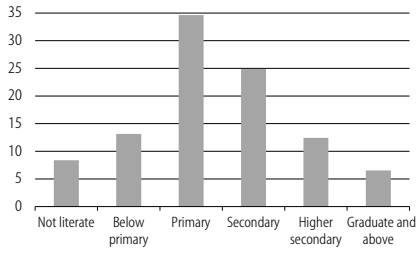
Among the outside-household enterprises, establishments with fixed premises and permanent structures sustained their role as major contributors to employment and value added (Figure 10). Street vendors, although still representing a small share of employment and GVA, expanded gradually over time, showing a gradual diversification in modes of operation.

Owner characteristics also show significant changes. Female ownership increased steadily over the period, albeit from a relatively low base. Gains were, however, more pronounced in the number of enterprises than in employment or value added (Figure 11). By 2023, women-owned enterprises accounted for nearly 59% of all firms, while their shares in employment and GVA remained considerably lower at 41% and 18%, respectively. This pattern demonstrates the continued concentration of women entrepreneurs in activities with low employment generation and lower value addition.

Caste composition also changed over time. Ownership among OBCs increased sharply and, as of 2023, they accounted for more than half of enterprises, employment and GVA. In contrast, the share of enterprises owned by the general category declined across all three indicators, whereas the shares of SCs and STs increased only marginally (Figure 12). Relative to population shares, OBCs appear over-represented in enterprise ownership, whereas STs remain underrepresented (Figure 13).

Most firm owners had low levels of formal education. Nearly three-fifths reported primary or secondary schooling and more than four-fifths had education at the secondary level or

Figure 14: Firm Distribution by Education Level of the Owner

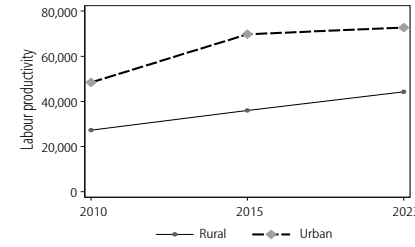


Source: Authors' estimates.

Figure 15: Trends in Productivity

Excludes outside values.
Source: Authors' estimates.

Figure 16: Average Productivity Trends by Rural–Urban Location



Source: Authors' estimates.

below (Figure 14). Only a small minority (about 7%) was educated at the graduate level or higher. This educational profile highlights the prevalence of enterprises operated by owners with limited formal human capital.

At the state level, the spatial distribution of the informal sector showed considerable persistence. Leading and lagging states in terms of enterprises, employment and GVA were largely unchanged between 2010 and 2023, indicating limited churning in regional composition. The share of top states declined marginally in enterprises and employment, whereas value added continued to be strongly concentrated. By the end of the period, six states, namely Gujarat, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal, and Andhra Pradesh, together accounted for nearly 80% of total GVA, highlighting the persistent regional concentration of economic activity in the sector (Table 3).

Overall, these patterns suggest that the informal manufacturing sector is dominated by own-account, proprietary and rural enterprises, whereas value generation is increasingly concentrated among outside-household and urban firms. The period also saw a rise in women and OBC entrepreneurs alongside persistent regional concentration in value added. Against this backdrop, the next section examines whether these compositional shifts are associated with differences in productivity, wages and capital intensity.

Performance Trends

This section examines the trends in firm performance across three indicators: labour productivity, wages per hired worker and the capital–labour ratio. We begin with labour productivity, followed by wages and capital intensity.

Labour productivity increased over the study period, though the pace of growth varied between subperiods (Figure 15). Average labour productivity increased sharply between 2010 and 2015 and continued to increase thereafter, albeit more gradually. In absolute terms, mean labour productivity grew from about 36,000 in 2010 to 50,000 in 2015 and to nearly 56,000 by 2023. Distributional evidence supports this pattern: the box plot of log labour productivity shows a clear upward shift in both the median and the interquartile range. Gains were the largest in the early years, suggesting that widespread productivity improvements weakened after 2015.

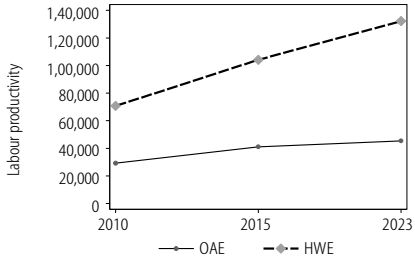
A persistent rural–urban divide is also evident (Figure 16). Urban enterprises consistently outperformed their rural counterparts, with productivity about 1.6 times higher by 2023. Although the productivity of rural enterprises increased after 2015, the gap remained substantial. Differences by enterprise type are even more pronounced (Figure 17, p 59). Hired-worker establishments consistently recorded higher productivity than own-account enterprises. As of 2023, productivity was nearly three times that of own-account enterprises. Productivity increased for both groups, but the pace of improvement slowed sharply for own-account enterprises, thereby widening the gap further. Differences by ownership status also widened over time (Figure 18, p 59). Partnership firms, which were

Table 3: State-wise Contribution in Number of Enterprises

State	Enterprises			Employment			Gross Value Added		
	2010	2015	2023	2010	2015	2023	2010	2015	2023
J&K + Ladakh	1.30	1.19	1.22	0.97	0.94	1.00	1.25	1.13	0.82
Himachal Pradesh	0.53	0.48	0.70	0.44	0.39	0.56	0.50	0.43	0.53
Punjab	2.25	1.95	2.38	2.22	1.91	2.50	2.83	2.68	3.62
Chandigarh	0.03	0.03	0.03	0.02	0.06	0.03	0.04	0.13	0.03
Uttarakhand	0.57	0.37	0.50	0.50	0.35	0.50	0.57	0.47	0.63
Haryana	1.10d	0.93	1.38	1.34	1.16	1.90	2.20	1.87	3.28
Delhi	1.19	0.92	0.89	2.14	1.97	2.04	4.51	4.82	3.86
Rajasthan	3.65	3.82	4.77	3.50	3.72	4.90	4.46	4.57	6.04
UP	13.60	11.24	11.79	14.98	13.07	12.46	9.79	9.96	9.84
Bihar	2.60	3.91	5.30	2.15	3.38	4.09	1.98	3.43	3.58
Sikkim	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01
Arunachal Pradesh	0.01	0.00	0.06	0.01	0.01	0.04	0.04	0.01	0.04
Nagaland	0.04	0.08	0.06	0.03	0.08	0.05	0.03	0.09	0.06
Manipur	0.24	0.33	0.38	0.17	0.25	0.27	0.12	0.20	0.23
Mizoram	0.02	0.04	0.00	0.02	0.03	0.00	0.03	0.05	0.01
Tripura	0.41	0.25	0.12	0.32	0.21	0.11	0.31	0.19	0.12
Meghalaya	0.11	0.08	0.12	0.11	0.08	0.11	0.11	0.09	0.09
Assam	1.27	1.03	0.97	1.21	1.07	0.87	1.42	1.17	0.96
WB	16.06	21.25	16.02	14.35	19.31	13.81	8.95	10.33	8.13
Jharkhand	1.95	2.51	2.39	1.73	2.09	2.16	1.02	1.14	1.81
Odisha	3.57	2.47	4.00	3.63	2.35	3.91	1.78	1.17	1.90
Chhattisgarh	0.96	0.99	1.23	1.01	1.17	1.23	0.73	0.79	0.88
MP	5.14	4.24	5.60	4.40	4.03	4.88	2.44	2.60	2.80
Gujarat	8.23	6.31	7.21	9.22	7.34	8.93	12.03	13.32	11.37
Daman + D&N Haveli	0.02	0.03	0.05	0.02	0.04	0.07	0.04	0.05	0.10
Maharashtra	8.05	6.32	7.72	9.23	6.92	8.68	13.12	10.13	10.51
AP + Telangana	9.41	11.01	9.53	8.90	9.55	7.97	7.75	7.02	7.95
Karnataka	5.00	6.35	5.85	4.33	6.04	5.23	4.86	7.18	5.35
Goa	0.05	0.06	0.04	0.05	0.08	0.06	0.23	0.18	0.13
Lakshadweep	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
Kerala	2.92	2.78	2.69	2.80	2.81	3.21	4.16	3.81	5.32
TN	9.60	8.87	6.91	10.07	9.44	8.28	12.53	10.81	9.82
Puducherry	0.09	0.12	0.07	0.10	0.13	0.09	0.11	0.17	0.13
A&N Islands	0.02	0.01	0.01	0.02	0.02	0.02	0.04	0.03	0.02

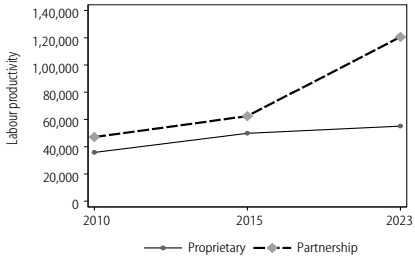
Source: Authors' estimates.

Figure 17: Trends in Average Productivity by Enterprise Type



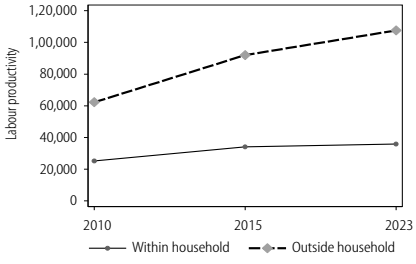
Source: Authors' estimates.

Figure 18: Trends in Average Productivity by Ownership



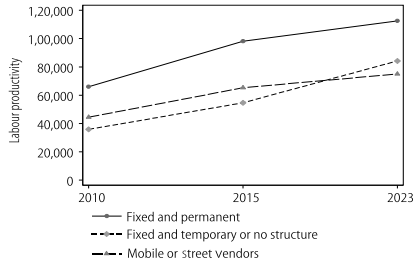
Source: Authors' estimates.

Figure 19: Average Productivity Trends by Location



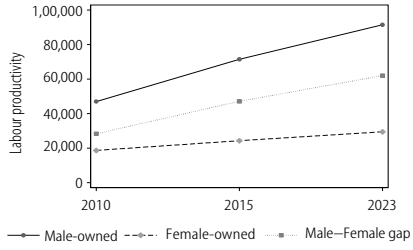
Source: Authors' estimates.

Figure 20: Average Productivity Trends by Location Outside the Household



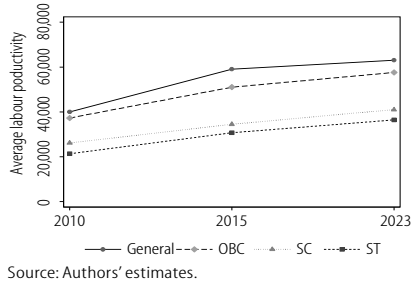
Source: Authors' estimates.

Figure 21: Average Productivity by Gender of the Owner



Source: Authors' estimates.

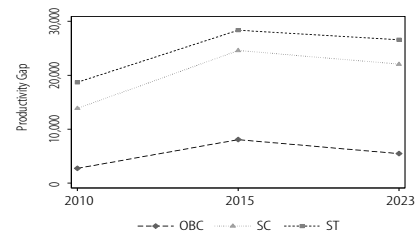
Figure 22a: Average Productivity by Caste of the Owner



Source: Authors' estimates.

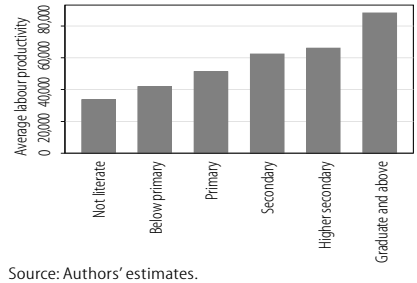
Figure 22b: Gap in Average Productivity by Caste of the Owner

(Gap = Absolute Productivity Difference from General Caste)



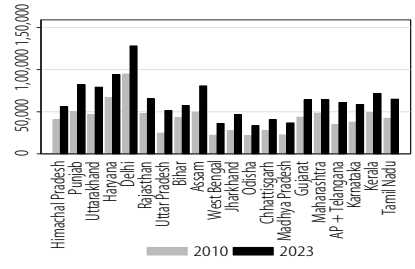
Source: Authors' estimates.

Figure 23: Average Productivity by Level of Education of the Firm Owner



Source: Authors' estimates.

Figure 24: Trends in Average Productivity across Indian States



Source: Authors' estimates.

already more productive than proprietary firms in 2010, registered strong productivity gains after 2015. Proprietary enterprises saw only marginal increases, thereby resulting in a larger gap between the two.

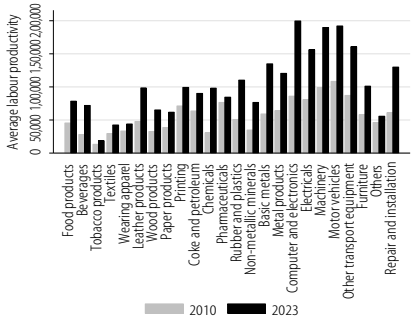
The location of operation also matters for productivity (Figure 19). Firms operating outside the household were substantially more productive than household-based enterprises. Household-based firms registered modest gains between 2010 and 2015, but their performance plateaued thereafter. In contrast, outside-household enterprises recorded sharp increases, further widening the gap. Productivity in outside-household enterprises was roughly three times that of household-based firms. Among outside-household enterprises, those with fixed premises and permanent structures maintained a clear productivity advantage throughout (Figure 20). Firms with fixed premises but temporary or no structures as well as street vendors also registered consistent gains. For street vendors, however, the pace of increase somewhat decelerated after 2015.

Productivity disparities are also evident across owner characteristics. Male-owned firms were considerably more productive than female-owned firms. The absolute gap increased over time despite gains for both groups (Figure 21). Across social groups, general category firms recorded the highest productivity, followed by OBC-run firms, which narrowed the gap marginally (Figure 22a). SC- and ST-owned enterprises lagged behind, with disparities widening sharply by 2015 and remaining substantial thereafter (Figure 22b).

Evidence supports the education-productivity nexus as productivity levels rise with education (Figure 23). Firms owned by less educated entrepreneurs recorded relatively low productivity, whereas those with education beyond secondary level achieved substantially higher levels. Owners with graduate education recorded productivity about 2.6 times higher than that of non-literate owners, thereby highlighting the strong link between education and firm performance.

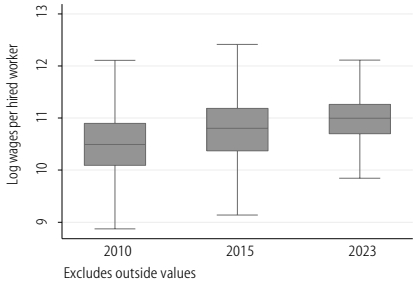
Regional and inter-industry disparities also persisted. Although all states experienced productivity growth between 2010 and 2023, relative rankings were largely unchanged. Delhi, Haryana, and Punjab remained among the most productive, while Odisha, Madhya Pradesh, and West Bengal were at the lower end (Figure 24). Substantial gaps were also evident across industries. In 2023, technology- and capital-intensive industries, such as computer and electronics, machinery and motor vehicles, recorded productivity levels way above those

Figure 25: Trends in Average Productivity across Industries



Source: Authors' estimates.

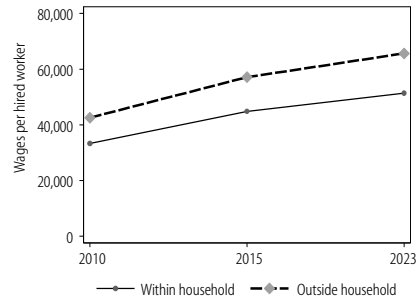
Figure 26: Trends in Average Wages per Worker



Source: Authors' estimates.

Figure 27: Trends in Wages per Worker by Location

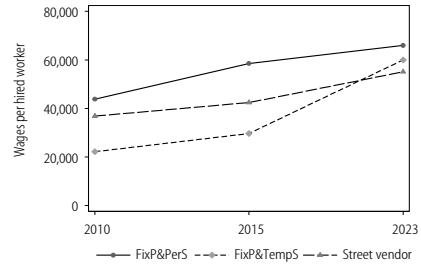
(₹)



Source: Authors' estimates.

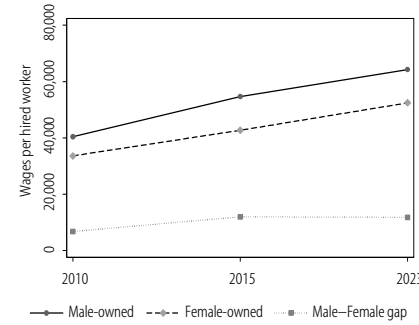
Figure 28: Trends in Wages per Worker by Location

(₹ thousand)



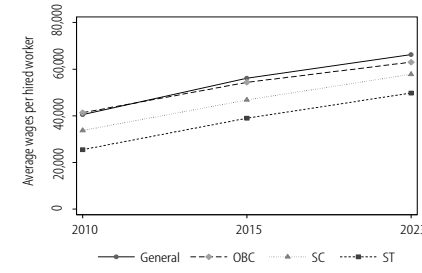
Source: Authors' estimates.

Figure 29: Trends in Wages per Worker by Gender



Source: Authors' estimates.

Figure 30: Trends in Wages per Worker by Social Group



Source: Authors' estimates.

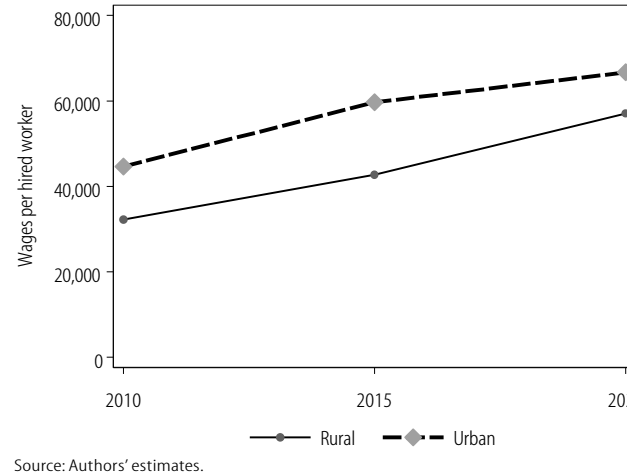
of traditional and labour-intensive sectors such as tobacco products, textiles and wearing apparel, which remained the least productive (Figure 25).

Wages per hired worker registered a steady increase during 2010–23 (Figure 26), though growth slowed after 2015. Overall wages increased by about 58% during the study period. The upward shift in the wage distribution, evident from the box plot of log wages per hired worker, indicates gains for both lower and higher paid workers.

Location-based differences were pronounced. Firms operating outside household premises consistently paid higher wages and the gap widened over time (Figure 27). Among outside-household locations, firms with fixed premises and permanent structures offered the highest wages throughout. Firms with fixed premises but temporary structures recorded strong gains, more than doubling their wages between 2015 and 2023 and substantially narrowing the gap with permanent structures by 2023 (Figure 28). Street vendors also experienced sizeable wage gains, though these were more modest in comparison and they continued to lag behind firms operating from permanent structures.

Gender and caste patterns show persistent earning differentials. Male-owned firms paid higher wages than female-owned firms throughout the period (Figure 29). The gender wage gap widened between 2010 and 2015 and narrowed marginally thereafter. Wages increased across all caste groups, though their relative positions changed over time (Figure 30). In 2010, OBC-run firms paid marginally higher wages than general category firms, but this pattern reversed by 2015. SC- and ST-run firms remained at the lower end of wage distribution.

Figure 31: Trends in Wages per Worker by Rural–Urban Location



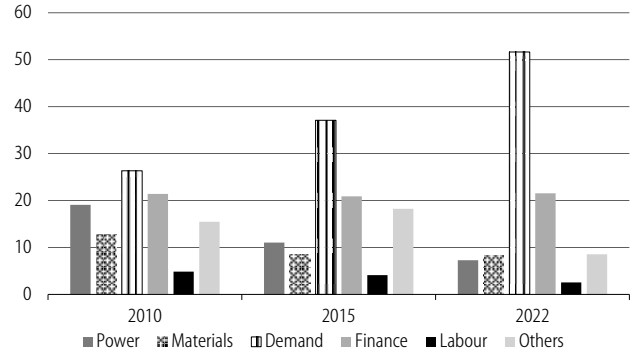
Source: Authors' estimates.

Finally, workers in urban firms earned a clear wage premium relative to their rural counterparts throughout the period (Figure 31). Although rural wages increased steadily and the urban–rural gap narrowed between 2015 and 2023, a substantial wage differential persisted in 2023.

Capital intensity, measured as the ratio of gross fixed assets to the number of workers, remained roughly stable between 2010 and 2015, but rose sharply by 2023 (Appendix Figure A1, p 64). The upward shift in the distribution of log capital intensity suggests that this increase was broad-based across enterprises.

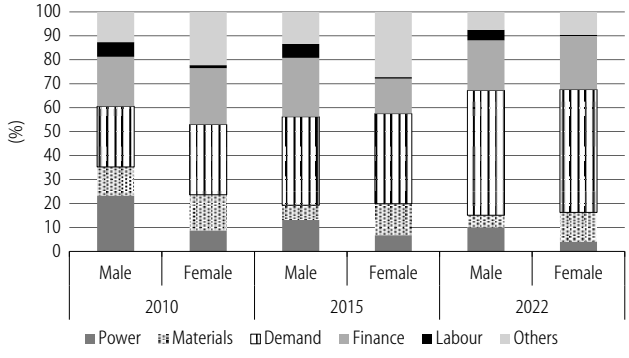
Firms operating outside the household invested substantially more in capital than those within (Appendix Figure A2, p 64). Among outside locations, firms with fixed premises and permanent structures strengthened their capital base the fastest,

Figure 32: Mapping Hurdles—Firm Classification by Constraints



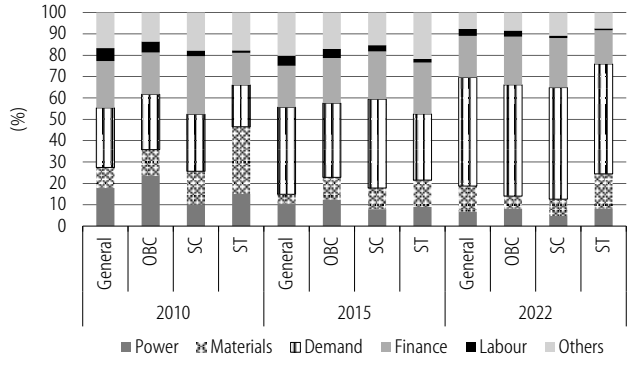
Source: Authors' estimates.

Figure 33: Share of Firms Reporting Constraints by Gender Over Time



Source: Authors' estimates.

Figure 34: Share of Firms Reporting Constraints by Social Group, 2010–22



Source: Authors' estimates.

while firms with temporary structures, which started far below permanent structures in 2010, more than doubled their investment between 2015 and 2023, thereby narrowing the gap. Street vendors also exhibited strong growth, nearly quadrupling their capital base from 2010, though they continued to lag behind firms in permanent structures (Appendix Figure A3, p 64).

Male-owned firms consistently reported higher capital intensity than female-owned firms, though both increased over time (Appendix Figure A4, p 64). The gender investment gap, which narrowed slightly between 2010 and 2015, widened sharply by 2023 as male-owned firms expanded their capital more rapidly. Capital intensity also varied across caste groups (Appendix Figure A5, p 64). General category-owned firms maintained the highest capital intensity throughout, followed by OBC-run firms. SC- and ST-run firms remained at the lower end, although ST-run firms narrowed the gap with SC-run firms. All groups saw their largest gains in the second sub-period, suggesting that the increase in capital investment was widespread across firms.

Urban firms maintained higher capital intensity than rural firms (Appendix Figure A6, p 64). The gap narrowed slightly between 2010 and 2015 as capital intensity among urban firms stagnated. Thereafter, the gap widened sharply as urban firms recorded much higher capital intensity by 2023.

Across all three indicators, labour productivity, wages per worker and capital intensity, clear and persistent patterns emerge. Firms operating outside the household, those with permanent structures, urban firms, and enterprises run by men or socially advantaged groups consistently report higher levels. While most categories have seen improvements over time, relative gaps persisted and in some cases widened. On the whole, the evidence points to persistent structural divides in firm performance that cut across productivity, earnings and investment.

Constraints to firm operations: We now turn to the challenges firms face and how these constraints vary across firm attributes. This helps identify which types of firms encounter the greatest difficulties.

Falling demand remains the most severe constraint faced by informal manufacturing firms. Its incidence increased sharply from 26.3% in 2010 to 37% in 2015 and further to 51.7% in 2022 (Figure 32). In contrast, supply-side constraints have weakened over time. The share of firms reporting power outages declined steadily from 19.1% in 2010 to 7.3% in 2022, whereas raw material shortages fell from 12.9% to about 8.4% over the same period.

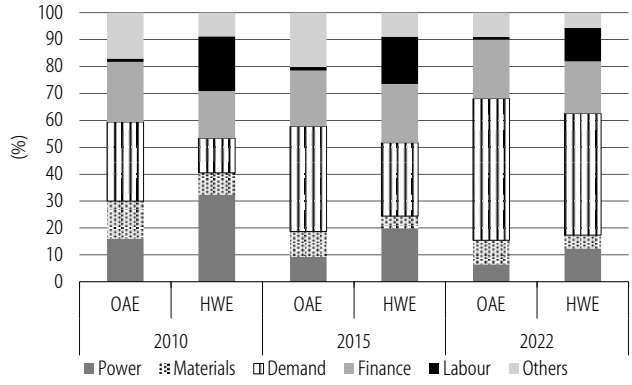
Finance-related constraints remained persistent, affecting about one-fifth of firms in all three years, with little change over time. Labour-related constraints were consistently reported by a small share of firms and declined gradually from 4.9% in 2010 to 2.6% in 2022. Other constraints, which increased between 2010 and 2015, declined sharply by 2022.

Constraints also vary by gender and caste. Female-owned firms are consistently more likely to report raw material shortages. On the other hand, power outages and labour-related constraints are markedly less prevalent among them (Figure 33). Finance-related constraints do not exhibit a uniform gender pattern over time and, by 2022, are at least as binding for female-owned firms as for male-owned firms. Falling demand affects both male- and female-owned firms almost equally and has emerged as the dominant constraint for both groups.

Across caste groups, falling demand is widely reported and shows only marginal variation across social groups (Figure 34). By the end of the period, finance-related constraints are more evident among OBC- and SC-run firms compared to others, while ST-run firms stand out primarily in terms of raw material shortages and elevated power-related constraints. Overall, these patterns highlight persistent heterogeneity in the nature of constraints faced by firms across social groups.

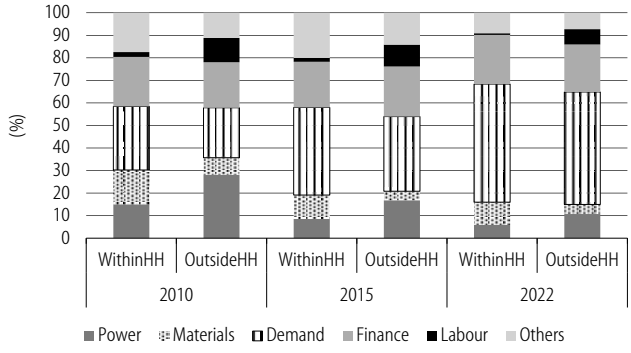
Enterprise type also matters for the nature of constraints faced. Own account enterprises identify falling demand and

Figure 35: Year-wise Share of Firms Reporting Constraints by Enterprise Type



Source: Authors' estimates.

Figure 36: Share of Firms Reporting Constraints by Location Over Time



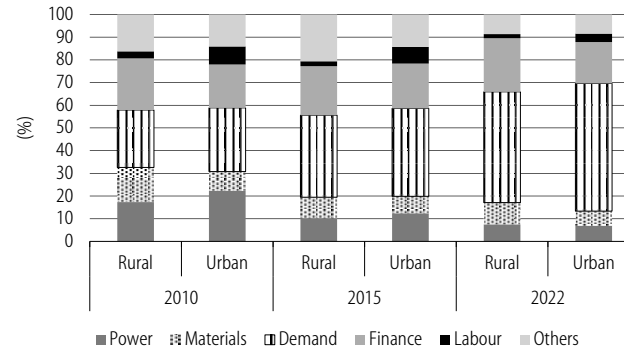
Source: Authors' estimates.

finance as their most pressing challenges (Figure 35). Firms with hired workers encounter similar constraints, but additionally report labour-related constraints and power outages far more frequently. Location-based differences endorse these patterns (Figure 36). Falling demand is the most severe constraint for both household-based and outside-household firms, and its salience has increased for both over time. Finance-related constraints remain important for both categories, with little change in their overall incidence. Raw material shortages are more common among household enterprises, whereas labour-related constraints and power shortages are more pronounced among firms operating outside the home. Power outages have declined steadily for both groups over the period.

Finally, constraints also differ by rural–urban location (Figure 37). Falling demand is the most binding constraint for both rural and urban firms, though it is more severe in urban areas, where over half of firms reported it as a major obstacle in 2022, compared to about 49% in rural areas. Power shortages and raw material constraints have declined sharply in both locations and now affect a relatively small share of firms. Finance-related constraints remain important in both rural and urban areas but are more binding for rural firms. Labour-related constraints are reported more frequently by urban firms, although their overall incidence remains low.

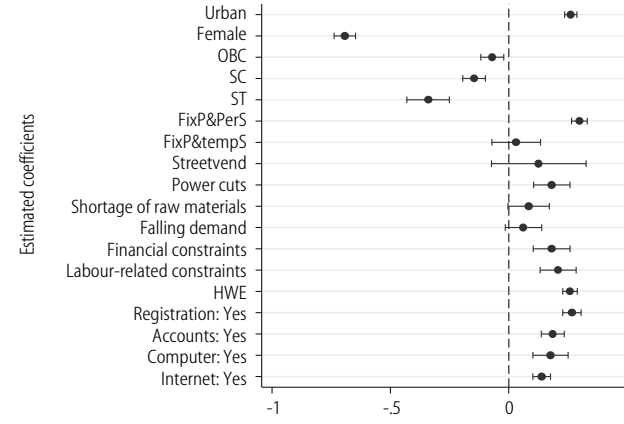
Across firm attributes, falling demand clearly emerges as the key constraint, and its importance has risen steadily over time. Finance-related constraints also remain significant,

Figure 37: Year-wise Share of Firms Reporting Constraints in Rural and Urban Areas



Source: Authors' estimates.

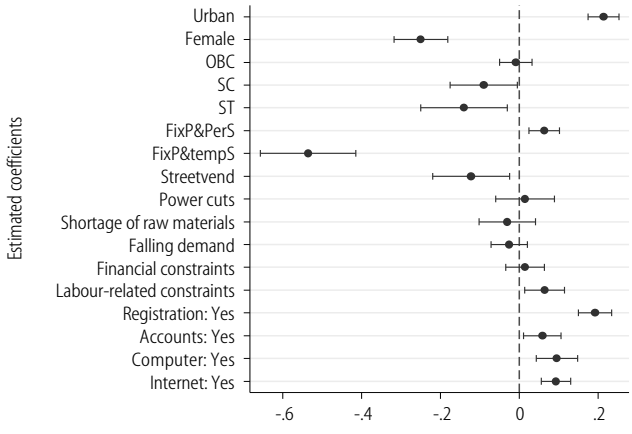
Figure 38: Correlates of Labour Productivity, 2010–22



State, year and industry effects are included.
Source: Authors' construction based on NSSO data.

though their severity varies across firm attributes and shows hardly any change in overall incidence during the study period. In contrast, power outages and raw material shortages have diminished in importance and now affect only a small share of firms, although power outages remain salient for ST-run firms and raw material shortages for household-based enterprises. Labour-related obstacles are limited overall and are concentrated largely among establishments with hired workers. Overall, firms with attributes linked to weaker performance also tend to report a higher incidence of binding constraints.

Figure 39: Correlates of Wages per Hired Worker, 2010–22



State, year and industry effects are included.
Source: Authors' construction based on NSSO data.

Correlates of Firm Performance

We analyse how firm attributes and reported constraints relate to firm performance, measured using labour productivity, wages per worker and capital intensity. Equation (1), described in the methods section, is estimated separately for each outcome. The results are presented using coefficient plots. Figure 38 corresponds to labour productivity, Figure 39 to wages per worker and Appendix Figure A7 (p 64) to capital intensity. All specifications include state, industry and year fixed effects.

The regression results show several consistent patterns across the three performance indicators. Strong ownership-based differences persist. Female-owned firms and those run by SC and ST entrepreneurs report lower performance across all measures. These gaps likely point to persistent structural disadvantages associated with gender and caste.

Firm attributes related to scale, location and capabilities are strongly associated with performance. Urban firms, enterprises operating from fixed premises with permanent structures and registered enterprises display higher productivity, wages and capital intensity. Maintaining formal accounts and adopting digital technologies such as computers and internet access are positively associated with performance, especially labour productivity and wages. Enterprises employing hired workers outperform own-account enterprises in terms of productivity, thereby highlighting the role of scale in influencing outcomes.

The associations between reported constraints and firm performance vary across indicators. Power outages, financial constraints and labour-related constraints show positive associations with labour productivity and capital intensity. Falling demand, although widely reported as a binding constraint, is only weakly associated with these outcomes. These patterns do not suggest that constraints improve performance. Instead, they point to differences in exposure: larger, more capital-intensive or more market-oriented firms are more likely to encounter and report such obstacles as these challenges become relevant only at a certain scale of operation. On the other hand, reported constraints show a limited or weak association with wages per worker. Labour-related constraints are the only category that remains positively and significantly related to wages.

Overall, the findings indicate that firm performance is closely linked to ownership, location, scale of operation, and digital and financial capabilities. At the same time, the positive relationship between several reported constraints and performance measures suggests selective exposure, whereby better-performing firms are more likely to encounter and report operational challenges. The consistent patterns across productivity, wages and capital intensity highlight how these factors collectively determine firm performance.

Conclusions

This paper shifts the focus from a labour lens to a production lens to understand the growth and performance of the informal manufacturing sector along with the constraints influencing firm outcomes. The evidence shows that the expansion of the sector has occurred mainly through an increase in the number of enterprises rather than through employment growth or capital accumulation. This pattern points to the persistent dominance of own-account and household-based firms. Gradual shifts toward urban locations, outside-household operations and greater participation by women and socially disadvantaged groups are visible. However, these changes have not yet translated into meaningful improvements in firm performance.

At the same time, firm outcomes are highly unequal and vary markedly across firm attributes. Enterprises operating at a larger scale, located outside the household and possessing strong financial and digital capabilities consistently perform better. They report higher levels of productivity, wages and capital intensity. In contrast, firms operating from households or operating at very small scales continue to lag behind. These patterns suggest that informality is not a uniform condition but instead represents a range of operating environments with very different growth possibilities.

Reported constraints by firms further support this picture. Falling demand has emerged as the most widespread challenge, indicating limited market opportunities for informal sector entrepreneurs. Finance-related constraints also persist across firm attributes. On the other hand, traditionally binding supply-side constraints, such as power outages and raw material shortages, have weakened overall and are now concentrated in selected segments. The evidence also shows that larger, more capital-intensive and more market-oriented firms are more likely to encounter and report these challenges, which explains the observed positive association between reported constraints and firm performance.

Overall, the findings suggest that improving performance in the informal manufacturing sector requires more than addressing isolated bottlenecks. The main challenge is to help firms move beyond survival-oriented production towards more stable and market-oriented operations. Policies that strengthen demand, ease financial constraints and help improve capabilities are therefore crucial. At the same time, the strong heterogeneity within the sector means that one-size-fits-all interventions are unlikely to work and calls for differentiated policy responses based on firm size, location, nature of operation and the constraints firms face.

NOTES

1 Exceptions are NCEUS (2007) and Raj and Sen (2016).

2 The NSSO has conducted annual surveys on unincorporated non-agricultural enterprises since 2021–22 under the ASUSE, marking a departure from the earlier practice of quinquennial rounds. This study uses data from the quinquennial surveys of 2010–11 and 2015–16 and from the annual survey of 2023–24. The broad concepts, coverage and sampling framework remain broadly comparable across the two survey designs.

3 In the survey round 2023–24, some constraints included in earlier surveys were dropped and new ones were introduced. For example, shrinkage or fall of demand, which was covered up to the 2022–23 round, is omitted in 2023–24. At the same time, new constraints such as a lack of connectivity to the market and a lack of technological upgradation were added.

4 A small number of surveyed enterprises report employment exceeding 20 workers, which is above the conventional size threshold for informal enterprises. It is unclear whether these enterprises operate illegally in the informal sector, expanded after initially being informal, or represent data entry errors. These enterprises are retained in the analysis. However, excluding them does not materially alter the results.

5 Electricity sector is excluded due to its negligible presence in the sample of firms surveyed.

6 Transgender-owned firms constituted a very small number of firms and were therefore omitted from the sample.

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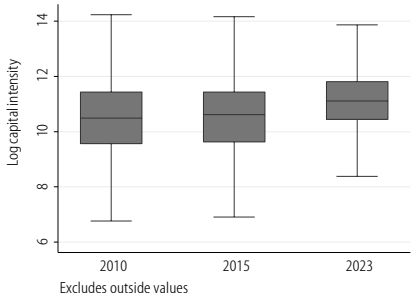
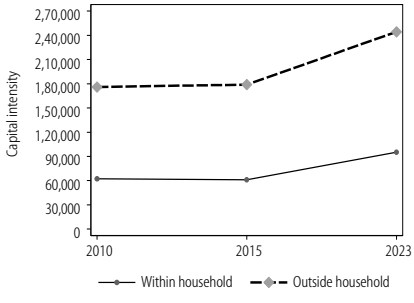
Appendix

Figure A1: Trends in Capital Intensity



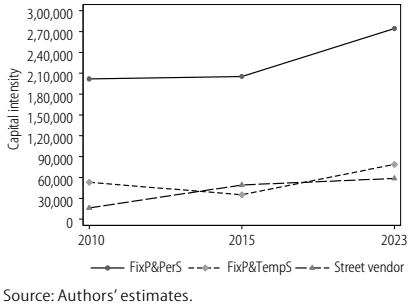
Source: Authors' estimates.

Figure A2: Trends in Capital Intensity by Location (₹)



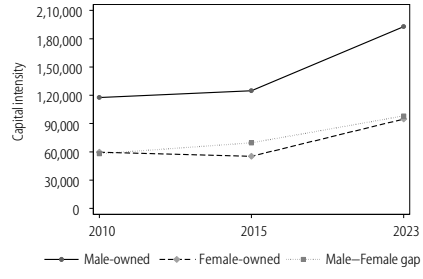
Source: Authors' estimates.

Figure A3: Trends in Capital Intensity by Location (₹ thousand)



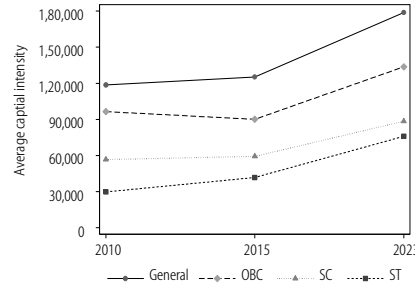
Source: Authors' estimates.

Figure A4: Trends in Capital Intensity by Gender (₹ thousand)



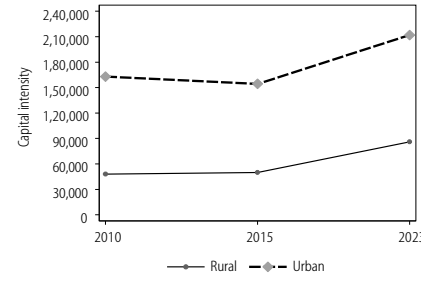
Source: Authors' estimates.

Figure A5: Trends in Capital Intensity by Social Group (₹ thousand)



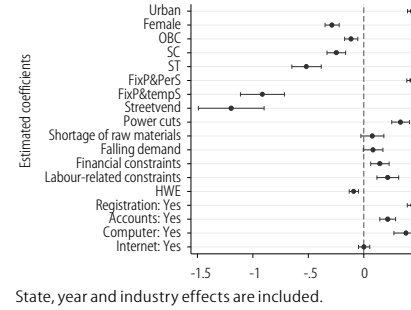
Source: Authors' estimates.

Figure A6: Trends in Capital Intensity by Rural–Urban Location (₹ thousand)



Source: Authors' estimates.

Figure A7: Correlates of Capital Intensity, 2010–22



State, year and industry effects are included.
Source: Authors' construction based on NSSO data.

Formal Credit and Persistent Constraints

Revisiting Access to Finance among Indian Enterprises

MOHD SHADAB DANISH, N R BHANUMURTHY

Access to finance remains a central concern in developing economies, such as India, where resource gaps constrain economic activity. Using World Bank Enterprise Surveys (2014, 2022), this paper examines institutional credit access among Indian small and medium enterprises. Generalised estimating equations logit estimates show no significant improvement over time; firms in 2022 were about 12 percentage points less likely to access credit than in 2014. Female-managed firms, exporters, and SMEs exhibit higher access, while micro-firms remain excluded. Women-led firms report borrowing costs as a key constraint. The findings highlight a dual challenge: expanding credit access and reducing transaction and compliance burdens.

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Access to finance constitutes a critical prerequisite for economic expansion, as it enables the growth of productive activities across sectors. In economies seeking to scale up manufacturing, services, and innovation, access to formal finance tends to be relatively easier for larger firms. However, a substantial body of literature indicates that small and medium enterprises (SMEs) face significant constraints in accessing external finance (Bhavani and Bhanumurthy 2014). Such credit limitations hinder their ability to modernise production processes, improve operations, and upgrade delivery systems—factors that are essential for survival in an increasingly competitive environment (Ayyagari et al 2008; Manova 2013). Improving access to finance remains a key policy objective in developing economies, particularly in India, where agency problems, information asymmetries, and inadequate collateral continue to constrain credit access (Kaur et al 2021).

This paper focuses on Indian SMEs, which constitute nearly 90% of the industrial base, contribute about 45% of manufacturing output, and account for around 40% of exports (Baker et al 2020). To enhance financial access for SMEs, the government has introduced several initiatives. Programmes such as the Pradhan Mantri Mudra Yojana (PMMY) and credit guarantee schemes have expanded credit outreach, with PMMY disbursing over ₹18.39 lakh crore to nearly 35 crore borrowers since 2015 (Gupta 2022). In parallel, efforts to strengthen financial infrastructure—particularly through digitalisation and the JAM (Jan Dhan Bank, Aadhaar, and Mobile number) trinity—have been instrumental in reducing leakage and promoting access to formal finance (Gupta and Singh 2025). Despite these initiatives, significant challenges persist in SME financing. Regional and sectoral disparities in credit allocation (Arora and Anand 2021), the rising burden of non-performing assets (Bhat et al 2024; Sardana et al 2024), and weaknesses in credit appraisal processes (Thampy 2010) point to continuing institutional and informational frictions.

Bose (2013) observes that nearly 87% of enterprises rely on self-finance or remain outside the formal credit system, with unorganised firms depending heavily on personal savings and informal networks. Bhavani and Bhanumurthy (2012), assessing financial access through the share of investment not financed by formal institutions, find that a substantial portion of business investment—particularly in the unorganised sector—continue to rely on informal sources, indicating persistent financial exclusion. In contrast, organised micro, small, and medium enterprises (MSMEs) are better positioned to benefit from institutional

mechanisms, such as the Credit Guarantee Trust Fund and specialised loan products offered by banks (Bose 2013).

A substantial body of literature examines access to finance for SMEs and its determinants (Baker et al 2020; Sushmitha and Jayabal 2025). However, relatively few studies address gender beyond ownership patterns (Chaudhuri et al 2020; Dutta and Mallick 2023). Women in top-management positions may face distinct constraints, yet evidence for India remains limited. This study examines the role of female top managers in shaping access to formal finance. The motivation stems from evidence that women manage 31%–38% of formal SMEs in emerging economies (Ahmad et al 2015) and that women-led firms often experience slower growth due to systemic biases (Bardasi et al 2011). Using the World Bank Enterprise Survey (WBES) data, only 8.7% of firms report having a female top manager.

Women entrepreneurs have historically faced significant constraints in accessing finance, owing to the systemic biases, reliance on collateral-based lending, and heightened risk aversion within the banking sector (Bardasi et al 2011; Ghosh 2023; Chhetri et al 2025). In addition, variation in credit allocation across sectors and regions further exacerbates these challenges (Arora and Anand 2021). The rise in non-performing assets in the banking system has also contributed to tightening credit conditions, particularly for smaller and more vulnerable borrowers (Bhat et al 2024).

Modigliani and Miller (1958) demonstrated that firms' access to finance varies with the business cycle conditions as well as firm-specific characteristics such as size, age, and sector. Extending this framework, Ayyagari et al (2008) document the nature of credit constraints faced by Indian SMEs, highlighting the roles of information asymmetry, high collateral requirements, and weak institutional frameworks. Smaller firms are particularly affected, facing greater financial frictions and limited access to external finance. Agency problems further constrain credit access. In the presence of asymmetric information, lenders tend to charge risk premia (Stiglitz and Weiss 1981). Empirical analysis of these dynamics requires robust firm-level panel data; reliance on disparate data sources may yield inconsistent estimates (Bhavani and Bhanumurthy 2012). Building on two rounds of the WBES (2014–22), this paper extends earlier cross-sectional analyses of Indian SMEs (Rakshit and Bardhan 2024; Shekar 2025; Biswas 2025) by adopting a longitudinal approach. It examines the impact of evolving credit policies on access to finance for women-owned firms using a gender-time difference-in-differences framework. The analysis is guided by a conceptual framework in which financial access is mediated through three channels: (i) credit demand preparedness, (ii) lender screening based on signals of firm capability, and (iii) structural operating conditions that shape perceived borrower risk. By integrating gender dynamics, temporal policy changes, and firm-level characteristics, the study provides a comprehensive account of the determinants of credit access among Indian SMEs.

The empirical analysis employs a population-averaged generalised estimating equations (GEE) framework, complemented by marginal effects estimation, to examine three dimensions of access to finance. First, the study analyses over time the likelihood of obtaining a formal loan or line of credit. Second, it investigates how firm characteristics shape the role of women in top management in securing credit, thereby capturing the influence of gender in leadership on financial access. The analysis controls for firm size, export orientation, digitalisation, and product innovation. Third, it examines firms' perceived credit constraints using a multinomial logit model to distinguish between cost-related barriers, procedural complexities, discouraged borrowing, and the absence of demand. While existing studies have largely focused on female ownership and access to finance (Chaudhuri et al 2018; Dutta and Mallick 2023), the role of women in managerial leadership remains underexplored. This study seeks to address this gap.

Literature Review and Hypothesis

The relationship between finance and corporate performance has received considerable attention in both advanced and emerging economies. Myers and Majluf (1984) argue that access to external finance is critical for firms to overcome internal resource constraints, particularly in the presence of imperfect capital markets. Empirical evidence suggests that small firms face greater financial pressures due to their relatively young age and limited scale, often relying on internal funds, whereas larger and more established firms are better able to access credit through stronger banking relationships, collateral, and formal financial records (Beck et al 2008). Recent evidence indicates that technology-driven monetary interventions may disproportionately benefit larger SMEs, potentially crowding out microenterprises (Lin et al 2023). Ayyagari et al (2015) further find that size and intrinsic characteristics are key determinants of early stage growth, while institutional factors play a comparatively limited role.

The institutional environment plays a critical mediating role in credit allocation (Su et al 2015). Evidence from China suggests that credit flows are shaped by the institutional environment, with local governments often exerting greater influence in securing bank credit relative to higher-level authorities (Su et al 2015). Banks, as the primary providers of credit to SMEs, face significant information asymmetries, leading to adverse selection (Stiglitz and Weiss 1981) and moral hazard, particularly when small firms cannot be closely monitored (Lean and Tucker 2001). High screening costs—often disproportionate to loan size—further constrain lending, contributing to credit rationing and limited availability of external finance (Bester and Hellwig 1989). Increased competition in the banking sector may also weaken relationship lending, reducing banks' ability to build close ties with small firms and exacerbating problems of adverse selection and moral hazard (Binks et al 1990).

Small firms often face difficulties in conveying the quality and viability of their investment projects to banks, reflecting a principal–agent problem that constrains lending decisions. While firm owners typically possess strong knowledge of their products, they often lack financial management capabilities, making it difficult to present credible financial information (Lean and Tucker 2001). This results in information asymmetry,

widely recognised as a key barrier to credit access (Langa and Govender 2019). Banks tend to rely on past performance as an indicator of future returns, which places younger firms with limited track records at a disadvantage (Watson 1986). Addressing this gap requires greater communication and cooperation between financial institutions and firms to improve the flow and credibility of information.

Beyond information asymmetry, Binks and Ennew (1996) highlight the heterogeneity of small firms, which complicates risk assessment for lenders. Smaller enterprises often have less experienced management and are more prone to operational volatility compared to larger firms. They are also financially vulnerable due to limited internal resources and reduced ability to attract investors. Rajamani et al (2022) propose a causal framework for MSME financial constraints, emphasising the roles of firm characteristics, sources of finance, and the stage of the firm's life cycle (Thampy 2010; Bhavani and Bhanumurthy 2014; Beck et al 2008, 2011; Manova 2013). Bhavani and Bhanumurthy (2014) further find that firm-specific attributes play a decisive role in determining both the likelihood of accessing formal credit and the adequacy of such credit for productive investment.

Banks employ a range of lending techniques, including relationship-based lending, collateral requirements, and the assessment of firms' financial statements (Beck et al 2008). While the literature has extensively examined the roles of firm size, age, export orientation, innovation and collateral in shaping access to finance, these factors often operate through identity and leadership characteristics. Recent evidence suggests that the attributes of top managers influence firms' financial behaviour as well as lenders' perceptions (Muravyev et al 2009). In this context, female leadership is an important, yet underexplored, determinant of access to finance, reflecting differences in information signals, risk preferences, institutional constraints, and social norms affecting women entrepreneurs.

Galli et al (2020), using cross-country SME data, find that female-led firms are less likely to apply for loans; however, conditional on applying, they do not face greater discrimination from lenders. This bias appears more pronounced during expansionary phases of the business cycle. Hewa-Wellalage et al (2022), analysing 8,921 firms during the COVID-19 period, report that female entrepreneurs are up to 2 percentage points more likely to access debt financing than their male counterparts, attributing this to lenders' preference for conservative borrowers. Both studies suggest that gendered patterns in credit access vary over the business cycle, underscoring the importance of longitudinal data. In the Indian context, Chaudhuri et al (2020) find that firms with higher female ownership are more likely to face difficulties in accessing bank finance, even after controlling for firm characteristics.

The study extends the existing literature by moving beyond static descriptions towards a dynamic and heterogeneity-sensitive analysis of credit access in India. It examines the temporal evolution of loan availability (H1), the persistence or reduction of gender disparities in the post-reform period (H2), and the role of firm size, export orientation, and capability indicators in shaping bankability (H3 and H4). By distinguishing between loan application behaviour and borrowing outcomes, the study further analyses the participation margin of credit markets (H5). Finally, the analysis of reported constraints highlights a "dual reality" of borrowing, wherein access to finance may be relatively easier, but is accompanied by high transaction costs and procedural burdens (H6). Overall, the framework provides a contemporaneous perspective on credit access in India, with particular attention to women-led and small enterprises situated at the margins of formal finance.

Data and Variable Description

This study draws on data from the WBES to analyse access to lines of credit and their determinants, using a stratified random sample of formal, non-agricultural private enterprises in India. The WBES employs standardised survey instruments to benchmark national business environments and firm performance across countries. Two survey rounds—2014 (covering 9,281 establishments surveyed between June 2013 and December 2014) and 2022—are utilised to obtain a representative sample of firms ranging from small to large across manufacturing, retail and wholesale trade, transport, and construction. The unit of analysis is the individual establishment, each maintaining distinct financial records and obligations. The 2022 round includes both new entrants and a panel of firms surveyed in 2014, thereby enabling a longitudinal assessment of access to finance over time. The analysis is restricted to firms that are present in both the 2014 and 2022 survey rounds, thereby enabling a consistent longitudinal comparison of changes in credit access within the same establishments over time. Firms appearing only in either 2014 or 2022 are excluded from the estimations. This panel construction allows the study to focus on temporal dynamics while accounting for time-invariant firm heterogeneity, thereby strengthening the causal interpretation of observed changes in financing outcomes. Table 1 and Table 2 (p 68) present the summary statistics and variable definitions, respectively.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std Dev	Min	Max
Loanacc_ clean	7,970	.216	.412	0	1
Credit barrier	5,893	3.074	1.286	1	4
Year	8,132	2018	4	2014	2022
Fem mgr	8,132	.086	.281	0	1
Size cat	8,132	2.506	.824	1	4
Exporter	8,132	.146	.353	0	1
ln emp	8,105	3.897	1.285	.693	9.21
k16 clean	7,812	.087	.282	0	1
k21 clean	8,026	.752	.432	0	1
c22 clean	8,132	.616	.486	0	1
b8	8,057	1.589	.492	1	2
h1 clean	8,125	.255	.436	0	1
c6	8,129	1.557	.497	1	2
j6a	7,998	1.869	.337	1	2
b2a	8,132	97.379	14.102	0	100
b2b	8,123	.553	5.778	0	100
b2c	8,125	.093	2.048	0	78
b2d	8,126	1.889	12.322	0	100

Source: Authors' estimation using World Bank Enterprise Surveys, India (2014 and 2022).

Table 2: Description of Key Variables

Variable	Label/Definition	Type/Coding
Loan_access/Line of Credit or k8	Firm has a bank loan or line of credit	Dummy: 1 = Yes, 0 = No
Credit_barrier or k17	Main reason for not applying for new/loans or new lines of credit	Cost, application complexity, discouraged, and no demand
Year	Survey year indicator	Dummy: 1 = 2022, 0 = 2014
Fem_mgr or b7a	Top manager is female	Dummy: 1 = Female, 0 = Male
Size_cat or a6b	Firm size category based on employment	Categorical: 1 = Micro, 2 = Small, 3 = Medium, 4 = Large
Exporter	Firm exports directly or indirectly	Dummy: 1 = Yes, 0 = No
Employment	Natural log of the number of permanent full-time employees	Continuous
k16	Firm applied for a loan or line of credit in the previous fiscal year	Dummy: 1 = Yes, 0 = No
k21	Financial statements audited by an external auditor	Dummy: 1 = Yes, 0 = No
c22	Firm has its own website	Dummy: 1 = Yes, 0 = No
b8	Firm holds an internationally recognised quality certification (for example, ISO)	Dummy (recoded): 1 = Yes, 0 = No
h1	Firm introduced a new product or service in the previous three years	Dummy: 1 = Yes, 0 = No
c6	Establishment experienced power outages during the last fiscal year	Dummy: 1 = Yes, 0 = No
j6a	Establishment secured or attempted to secure a government contract in the last 12 months	Dummy: 1 = Yes, 0 = No
b2a	Percentage of ownership by private domestic individuals/companies	Continuous: 0–100 (%)
b2b	Percentage of ownership by private foreign individuals/companies	Continuous: 0–100 (%)
b2c	Percentage of ownership by government/state	Continuous: 0–100 (%)
b2d	Percentage of ownership by other entities	Continuous: 0–100 (%)

All variables are drawn from the World Bank Enterprise Surveys for India (2014 and 2022).

Table 3 reports the variance inflation factors (VIFs), which indicate the absence of problematic multicollinearity, thereby supporting the reliability of the estimated coefficients.

Methodology

The study employs descriptive statistics and multivariate techniques to examine access to finance among Indian SME over 2014–22. A population-averaged GEE specification is used to identify the determinants of loan provision and to trace their evolution over time, while the third model evaluates the perceived financial constraints, incorporating firm-level characteristics and the gender of firm leadership as covariates. The results indicate discernible differences in access patterns between female- and male-led firms.

Determinants of loan access: Logistic regression models are employed to estimate the probability of access to institutional credit, with the dependent variable taking the value one if the firm has an active loan, overdraft, or line of credit (loanacc_clean). The baseline specification includes a time indicator for 2022 (with 2014 as the reference category), along with firm-level characteristics, such as size category, export orientation, gender of the top manager, and the logarithm of permanent employment. Measures of basic financial inclusion—namely the presence of a checking or savings account and the use of personal loans to finance business operations—are also incorporated, alongside indicators of the institutional environment, proxied by firms' perceptions of access to finance and tax rates as constraints on business activity.

Table 3: Variance Inflation Factors for Explanatory Variables

	VIF	1/VIF
Credit barrier	1.121	.892
Year	1.642	.609
Female _Manager	1.031	.97
2.size cat	3.057	.327
3.size cat	3.147	.318
4.size cat	2.125	.471
Exporter	1.106	.904
k21	1.159	.863
c22	1.281	.781
b8	1.309	.764
h1	1.343	.744
c6	1.394	.717
j6a	1.045	.957
b2a	1.236	.809
b2b	1.186	.843
b2c	1.036	.965
Mean VIF	1.514	.

All VIF values are well below the conventional threshold of 10 (mean VIF = 1.51).

$$P(LoanAcess_i=1)=Logit^{-1}\ (\alpha+\beta_1 Year_i+\beta_2 FirmCharecteristics_i + FinancialInclusion_i+\beta_3 FinancialInclusion_i +\beta_4\ InstitutionalEnvironment_i+\varepsilon_i \quad \ldots (1)$$

A population-averaged GEE logit specification is employed, given the availability of only two survey waves (rounds). When panel effects, especially those of the gender of the top manager, are time-varying (essentially time-varying), the GEE will retain such variables and take advantage of cross-sectional variation. In contrast, a conditional fixed-effects logit would remove such time-invariant factors, and only firms that have changes in the access to loans within the firm, thus reducing the effective sample and invalidating the primary research question.

The GEE estimators exploit the full panel by retaining firms both with and without within firm variation in the outcome variable, while explicitly accounting for serial correlation at the firm level. Given the two-period panel structure, an exchangeable correlation structure is adopted, along with a binomial family and logit link function. This specification is well-suited to short panels with limited time periods. The primary outcome of interest is access to finance, measured as the probability of a firm having a formal loan or line of credit.

Credit barriers as a dual reality under borrowing: While firms may succeed in obtaining formal credit, they can continue to face substantial constraints during the borrowing process. Access to credit does not eliminate the burdens associated with high collateral requirements, compliance costs, complex documentation, or stringent risk-screening procedures. These constraints may persist even after firms have entered the credit market (Myers and Majluf 1984; Boumlik et al 2025). This points to a "dual reality" of credit access, wherein borrowing firms are not necessarily free from financial stress; rather, they may report a higher incidence of cost-related and procedural constraints relative to firms that do not seek external finance, often due to limited demand for credit.

The dependent variable is specified within a multinomial logit framework, capturing the principal credit constraint reported by firms—namely high cost, procedural complexity, discouragement, or absence of demand (reference category). The key explanatory variable is access to credit, proxied by observed borrowing status. Control variables include firm size, export orientation, gender of the top manager, scale of employment, survey year, and indicators of financial inclusion. The model tests the hypothesis that firms with access to credit exhibit a higher likelihood of reporting cost-related or procedural barriers relative to "no demand," thereby examining the coexistence of formal market participation and transaction costs.

Robustness check: To address potential sources of modelling bias, a comprehensive sensitivity analysis is undertaken using alternative estimators of loan access. In addition to the baseline population-averaged GEE logit specification, the analysis employs an independent-correlation GEE, a conditional fixed-effects logit, and a fixed-effects linear probability model with firm-level clustered standard errors. This multi-model approach facilitates an assessment of the robustness of the estimated coefficients across specifications that differ in their treatment of unobserved heterogeneity, correlation structures, and sources of variation. The consistency of results across these frameworks strengthens the credibility of the core findings and supports the validity of the baseline GEE results.

Table 4: Population-averaged GEE Logit Estimates

Loan Access	M1 Baseline	M2 + Finance Links	M3 + Innovation and Cert	M4 + Asset+ Outages	M5 Full Controls
2022	-1.244***	-1.165***	-1.101***	-1.014***	0.995***
	(0.0631)	(0.0681)	(0.0757)	(0.0792)	-(0.0824)
Female manager	0.0928	0.109	0.0857	0.0785	0.159
	(0.117)	(0.126)	(0.128)	(0.128)	(0.132)
2022 # female manager	1.291***	1.248***	1.292***	1.335***	1.154***
	(0.177)	(0.192)	(0.193)	(0.194)	(0.202)
Small	0.347**	0.336**	0.357**	0.351**	0.307**
	(0.136)	(0.142)	(0.143)	(0.143)	(0.148)
Medium	0.508**	0.500**	0.525**	0.508**	0.466**
	(0.206)	(0.217)	(0.218)	(0.219)	(0.227)
Large	0.308	0.361	0.379	0.351	0.291
	(0.288)	(0.306)	(0.307)	(0.308)	(0.319)
Exporter	0.807***	0.724***	0.737***	0.748***	0.695***
	(0.0754)	(0.0824)	(0.0834)	(0.0835)	(0.0864)
Employment	0.0130	-0.0415	-0.0401	-0.0372	-0.00533
	(0.0610)	(0.0654)	(0.0659)	(0.0660)	(0.0684)
Applied for loan/LOC (=1)		1.480***	1.472***	1.449***	1.470***
		(0.0904)	(0.0907)	(0.0909)	(0.0933)
External audit of financial statements (=1)		1.272***	1.295***	1.266***	1.108***
		(0.0993)	(0.101)	(0.101)	(0.103)
Has own website (=1)		-0.192***	-0.201***	-0.207***	-0.175**
		(0.0702)	(0.0732)	(0.0735)	(0.0760)
Does the establishment have an internationally recognised quality certification?			0.0573	0.0511	0.106
			(0.0703)	(0.0703)	(0.0728)
Introduced new product/service (=1)			0.160**	0.144**	0.140*
			(0.0723)	(0.0726)	(0.0749)
Over the last FY, did this establishment experience power outages?				-0.248***	-0.263***
				(0.0663)	(0.0690)
Government contract secured (or attempted) in the last 12 months?					-1.260***
					(0.0779)
% owned by other					0.00509*
					(0.00262)
% owned by government/state					0.00739
					(0.0140)
% owned by private foreign individuals, companies or organisations					0.000662
					(0.00495)
Constant	-1.395***	-2.301***	-2.510***	-2.132***	0.118
	(0.156)	(0.184)	(0.239)	(0.259)	(0.301)
Observations	7,944	7,645	7,586	7,584	7,500

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Result

Table 4 presents the population-averaged GEE logit estimates of firms' access to institutional credit over 2014–22. Across all specifications, the coefficient on the year indicator is consistently negative and statistically significant, indicating that the probability of firms obtaining bank finance in 2022 is significantly lower relative to 2014. This pattern lends support to Hypothesis 1, suggesting a tightening of credit conditions over time, despite ongoing policy interventions. These findings are consistent with Gosh (2022), who documents rising financial stress in India notwithstanding the expansion of digital financial structure and the JAM trinity.

The effect of female top management, while generally positive, is not uniformly estimated across specifications. Controlling for firm characteristics, there is no evidence of a systematic gender gap in access to credit in 2014. However, the interaction between the 2022 time indicator and female management is consistently positive and statistically significant across models. Despite an overall decline in loan availability, firms led by women exhibit a relative improvement in access compared to those led by men. This suggests a narrowing—and in some specifications, a reversal—of the gender gap in credit access between 2014 and 2022, indicating that changes in the credit environment have become comparatively more favourable to women-led enterprises.

SMEs continue to exhibit a higher likelihood of accessing credit relative to micro firms. Across all specifications, exporting firms are significantly more likely to obtain formal credit, a pattern that may be attributed to greater formalisation, more predictable revenue streams, and more effective lender screening. Indicators such as active loan applications and independently audited financial statements further mitigate information asymmetries and enhance firm credibility, thereby improving approval probabilities. Interestingly, the presence of a firm website is associated with a lower likelihood of obtaining credit. This may reflect the composition of

Table 5: Average Marginal Effects from GEE Logit Model (Outcome = Loan_Access)

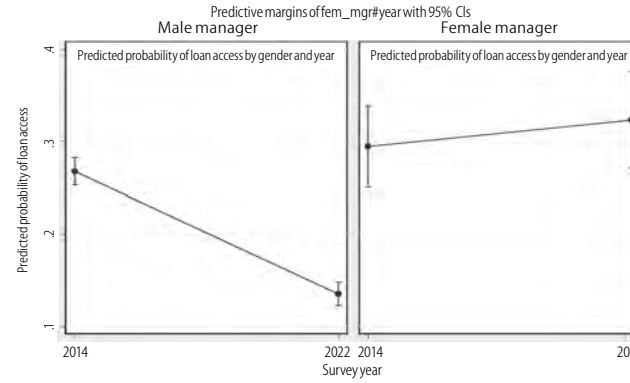
Year of survey=2022	-0.118***
	(0.0107)
Female manager	0.101***
	(0.0177)
Small	0.0386**
	(0.0172)
Medium	0.0608**
	(0.0282)
Large	0.0365
	(0.0401)
Exporter	0.0944***
	(0.0116)
Employment	-0.000724
	(0.00929)
Applied for loan/LOC (=1)	0.200***
	(0.0119)
External audit of financial statements (=1)	0.150***
	(0.0139)
Has own website (=1)	-0.0237**
	(0.0103)
Does the establishment have an internationally recognised quality certification?	0.0143
	(0.00989)
Introduced new product/service (=1)	0.0189*
	(0.0102)
Over the last FY, did this establishment experience power outages?	-0.0357***
	(0.00935)
Government contract secured (or attempted) in the last 12 months?	-0.171***
	(0.00987)
% owned by other	0.000692*
	(0.000356)
% owned by government/state	0.00100
	(0.00191)
% owned by private foreign individuals, companies or organisations	0.0000898
	(0.000672)
Observations	7,500

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

such firms, with a greater concentration in technology- or service-oriented sectors where tangible collateral is limited, thereby constraining lending despite greater digital presence.

Despite India's relatively low expenditure on research and development (R&D) (less than 1% of GDP), the results indicate that firms engaging in product or process innovation are more likely to obtain bank finance. Even in uncertain environments, lenders appear to interpret innovation as a signal of future growth potential. Given that a large share of Indian SMEs primarily serve domestic markets, the absence of formal international quality certification does not emerge as a significant constraint on access to credit outcomes. Infrastructure conditions also play an important role in shaping credit outcomes. Using the incidence of power outages over the preceding three years as a proxy for infrastructure reliability, the findings suggest that firms experiencing electricity disruptions are less likely to secure loans, consistent with the view that operational volatility heightens perceived lending risk. In contrast, firms with government contracts appear to face more limited access to credit, possibly due to procedural delays, payout uncertainty, and the compliance burdens associated with public procurement. The average marginal effects reported in Table 5 yield intuitive probability-based interpretations consistent

Figure 1: Predicted Probabilities of Loan Access by Gender and Year



with the logit estimates. Firms are estimated to have approximately 12 percentage points lower access to formal credit in 2022 relative to 2014. Women-led enterprises exhibit, on average, a nearly 10 percentage point higher probability of accessing credit. SMEs outperform micro firms, while export orientation increases the likelihood of obtaining loans by about 9 percentage points. With respect to demand-side factors and compliance, firms that actively apply for credit and maintain externally audited accounts are approximately 20% and 15% more likely, respectively, to secure loans. In contrast, the incidence of power outages and participation in government procurement are associated with significantly lower access to credit, underscoring the role of operational instability and institutional frictions in constraining borrowing.

Figure 1 presents the predictive margins plot, which visualises the regression estimates in terms of predicted probabilities. It traces the evolution of loan access by the gender of firm management over the study period. In 2014, firms led by men and women exhibited comparable probabilities of obtaining formal credit. By 2022, however, access to credit declines for male-managed firms, while it improves for those led by women. This divergence reflects the positive interaction effect identified in the GEE estimates. It suggests that tightening credit conditions have had a more adverse impact on male-led firms, whereas women-led enterprises appear to have been relatively more resilient over time.

Credit Barriers

Table 6 (p 71) presents firms' perceptions of credit constraints, categorised into four groups: cost, application complexity, discouraged, and no demand. The pattern shows that in 2022, businesses reported fewer cost or discouragement barriers and more application complexity complaints. This pattern suggests

Table 6: Multinomial Logit Estimates of Credit Barriers

Variables	Baseline MNL	Borrower-Conditioned MNL	Baseline MNL	Borrower-Conditioned MNL	Baseline MNL	Borrower-Conditioned MNL
	Cost		Application Complexity		Discouraged	
Year of survey=2022	-0.460***	-0.317***	0.166	0.229**	-1.500***	-1.398***
	(0.0794)	(0.0819)	(0.109)	(0.112)	(0.240)	(0.243)
Female manager	-0.0890	-0.144	0.342	0.293	-0.633	-0.665
	(0.163)	(0.167)	(0.231)	(0.235)	(0.525)	(0.526)
2022 # female manager	1.072***	1.063***	0.490	0.497	1.118	1.107
	(0.242)	(0.247)	(0.312)	(0.317)	(0.906)	(0.907)
Exporter	-0.0304	-0.144	-0.587***	-0.641***	-0.139	-0.202
	(0.101)	(0.104)	(0.165)	(0.167)	(0.326)	(0.328)
Employment	0.0460	0.0460	0.0323	0.0362	-0.0247	-0.0236
	(0.0283)	(0.0288)	(0.0372)	(0.0374)	(0.0813)	(0.0816)
External audit of financial statements (=1)	0.593***	0.485***	0.114	0.0831	-0.576***	-0.677***
	(0.0828)	(0.0842)	(0.0973)	(0.0986)	(0.196)	(0.200)
Has own website (=1)	0.183**	0.230***	0.105	0.133	-0.373*	-0.354*
	(0.0763)	(0.0776)	(0.0977)	(0.0983)	(0.213)	(0.215)
Introduced new product/service (=1)	0.178**	0.164*	0.00978	0.0201	0.288	0.257
	(0.0861)	(0.0878)	(0.129)	(0.130)	(0.211)	(0.212)
Does the establishment have an internationally recognised quality certification?	0.0800	0.0603	0.143	0.146	0.0282	0.0293
	(0.0767)	(0.0779)	(0.103)	(0.104)	(0.222)	(0.224)
Applied for loan/line of credit (=1)		0.954***		0.411***		0.792***
		(0.0864)		(0.133)		(0.224)
Constant	-1.712***	-1.850***	-2.333***	-2.437***	-2.196***	-2.310***
	(0.210)	(0.214)	(.277)	(.280)	(0.565)	(0.570)
Observations	5773	5735	5773	5735	5773	5735

Standard errors in parentheses, levels of significance are denoted by a star * p < 0.10, ** p < 0.05, *** p < 0.01.

a shift in the nature of constraints, with procedural and compliance-related hurdles becoming more prominent, even as fewer firms appear to be deterred by high costs or discouraged from seeking credit.

In general, the presence of female top management does not exert a statistically significant independent effect on the likelihood of reporting credit constraint. However, the interaction between female management and the 2022 survey year is positive and significant for cost-related barriers. This indicates that women-led firms are more likely than their male-led counterparts to report the cost of borrowing as a constraint in the later period. This finding is consistent with the notion of a "dual reality" of credit access: even where women-led enterprises are able to secure loans, they appear to face relatively higher cost burdens and associated financial frictions.

Exporting firms, owing to their greater degree of formal integration and lower screening frictions, are likely to report discouragement-related barriers. Firms with independent audited financial statements are more likely to report cost-related barriers, but are less prone to discouragement. This suggests that deeper engagement with formal financial systems reduces the likelihood of exclusion, while simultaneously exposing firms to pricing and compliance-related costs. Similarly, the process of business websites and engagement in product innovation are associated with a higher incidence of reported cost barriers. This pattern indicates that more visible and growth-oriented firms are more likely to actively seek external finance, but encounter cost pressures rather than withdrawing from the credit market.

The borrower-conditioned estimates indicate that access to credit is positively associated with the likelihood of reporting all three categories of constraints or barriers. Firms that participate in credit markets are more likely to identify cost-related, procedural, and discouragement barriers relative to firms with no demand for external finance. This finding reinforces the central interpretation that credit barriers do not go away when businesses enter the loan market; instead, they are transformed from barriers to access into ongoing compliance and transaction-related burdens.

Sensitivity Analysis

Table 7 (p 72) compares the baseline GEE estimates with alternative modelling strategies, including an independent-correlation GEE specification, a conditional fixed-effects logit, and a fixed-effects linear probability model. The principal results remain intact in all the models. In particular, the overall decline in access to credit between 2014 and 2022, as well as the relative improvement in access to credit for women-led firms, observed in each model, indicates the robustness of the baseline findings. Although time-invariant regressors are omitted in the fixed-effects logit model, and coefficient magnitudes vary—as expected—across non-linear and linear estimators, the direction and statistical significance of the central relationships remain unchanged. This consistency of results suggests that the main conclusions are not dependent on any single estimator or correlation assumption but reflect robust underlying patterns in the data.

Conclusions

This paper examines the evolution of access to finance among Indian firms between 2014 and 2022 using data from the WBES. It employs descriptive statistics, population-averaged GEE logistic models, average marginal effects, and multinomial regressions on credit constraints to analyse the pattern of institutional finance among Indian SMEs, with particular attention to heterogeneity across firms, especially women-led enterprises.

Three principal findings emerge from the analysis. First, even after controlling for firm characteristics and financial linkages, firms in 2022 were estimated to be approximately 12 percentage points less likely to possess a loan or line of credit than in 2014, indicating a broad-based tightening of credit conditions. Second, firm heterogeneity plays a significant role: women-led firms are found to be relatively more successful in

Table 7: Sensitivity Analysis—Robustness of Loan Access Results

Variables	GEE Logit (Exchangeable)	GEE Logit (Independent)	Fixed-effects Logit	FE Linear Probability Model
Year of survey=2022	-0.995***	-0.991***	-1.323***	-0.116***
	(0.0824)	(0.0838)	(0.152)	(0.0133)
Female manager	0.159	0.157	0.296	0.0519
	(0.132)	(0.132)	(0.323)	(0.0320)
Year of survey=2022 # female manager	1.154***	1.152***	1.458***	0.133**
	(0.202)	(0.202)	(0.403)	(0.0518)
Small	0.307**	0.312**		
	(0.148)	(0.148)		
Medium	0.466**	0.478**		
	(0.227)	(0.227)		
Large	0.291	0.306		
	(0.319)	(0.319)		
Exporter	0.695***	0.692***	1.141***	0.119***
	(0.0864)	(0.0862)	(0.222)	(0.0225)
Employment	-0.00533	-0.00860	0.0977	0.0279**
	(0.0684)	(0.0684)	(0.118)	(0.0109)
Applied for loan/line of credit (=1)	1.470***	1.482***	1.876***	0.256***
	(0.0933)	(0.0934)	(0.232)	(0.0237)
External audit of financial statements (=1)	1.108***	1.092***	1.531***	0.126***
	(0.103)	(0.103)	(0.176)	(0.0147)
Has own website (=1)	-0.175**	-0.186**	0.225	0.00464
	(0.0760)	(0.0760)	(0.165)	(0.0148)
Does the establishment have an internationally recognised quality certification?	0.106	0.101	0.352**	0.0287*
	(0.0728)	(0.0728)	(0.170)	(0.0152)
Introduced new product/service (=1)	0.140*	0.140*	0.361**	0.0466***
	(0.0749)	(0.0752)	(0.168)	(0.0168)
Over the last FY, did this establishment experience power outages?	-0.263***	-0.262***	-0.0436	-0.0450***
	(0.0690)	(0.0691)	(0.152)	(0.0149)
Government contract secured (or attempted) in the last 12 months?	-1.260***	-1.265***	-1.477***	-0.225***
	(0.0779)	(0.0780)	(0.174)	(0.0218)
% owned by other	0.00509*	0.00477*	0.0113**	0.00141***
	(0.00262)	(0.00265)	(0.00560)	(0.000428)
% owned by government/state	0.00739	0.00981	-0.0635*	-0.00480
	(0.0140)	(0.0139)	(0.0334)	(0.00464)
% owned by private foreign individuals, companies or organisations	0.000662	0.000773	-0.00984	-0.000490
	(0.00495)	(0.00494)	(0.01000)	(0.00130)
Constant	0.118	0.153		0.453***
	(0.301)	(0.301)		(0.0709)
Observations	7,500	7,500	2,308	7,500

Standard errors in parentheses, levels of significance are denoted by a star * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

accessing finance. In the context of overall tightening, these firms exhibit a comparative advantage, suggesting a narrowing—and in some cases reversal—of gender disparities in credit access. Third, the analysis points to a "dual" nature of financial constraints. On the one hand, there are issues in access to finance by SMEs in the country, and on the other, those who do access funds report different types of barriers in access to finance. Thus, the policies need to be streamlined to tackle this problem of duality. This can be accomplished by having a single-window clearance, reducing the burden of collateral for SMEs, providing incentives for focusing on innovation, and reducing overall application or procedural barriers.

Future research may extend the present analysis by utilising more granular, scheme-specific and gender-disaggregated data to assess the effectiveness of targeted policy interventions in improving access to finance for women-led firms. Policy initiatives such as the production linked incentive (PLI) scheme provide opportunities for quasi-experimental analysis to evaluate their impact on firms' credit access, investment behaviour, and growth outcomes. Such approaches would enable a shift beyond aggregate measures of financial inclusion towards identifying the specific policy instruments that are most effective in easing credit constraints for different segments of SMEs.

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India's Industrial Archipelago

Uneven Manufacturing Growth in a Services-led Economy

MEENAKSHI SHEKHAR, TWINCLE HALDER

India's economic structure reflects a persistent paradox: 46% of the workforce remains engaged in agriculture, which contributes about 9% to gross value added, while services account for around 55% of output, with less than 30% of the workforce. This asymmetry points to deeper structural imbalances in the process of transformation. The pattern is further marked by significant interstate variation, where some states have experienced relatively stronger industrial growth supported by policy interventions, while others exhibit tendencies of premature deindustrialisation. From the development of planned industrial estates in Uttarakhand to the persistence of a services-led structure in the north-eastern states, India's structural transformation has diverged from conventional trajectories. This pattern underscores the centrality of policy in shaping sectoral outcomes, rather than geography alone.

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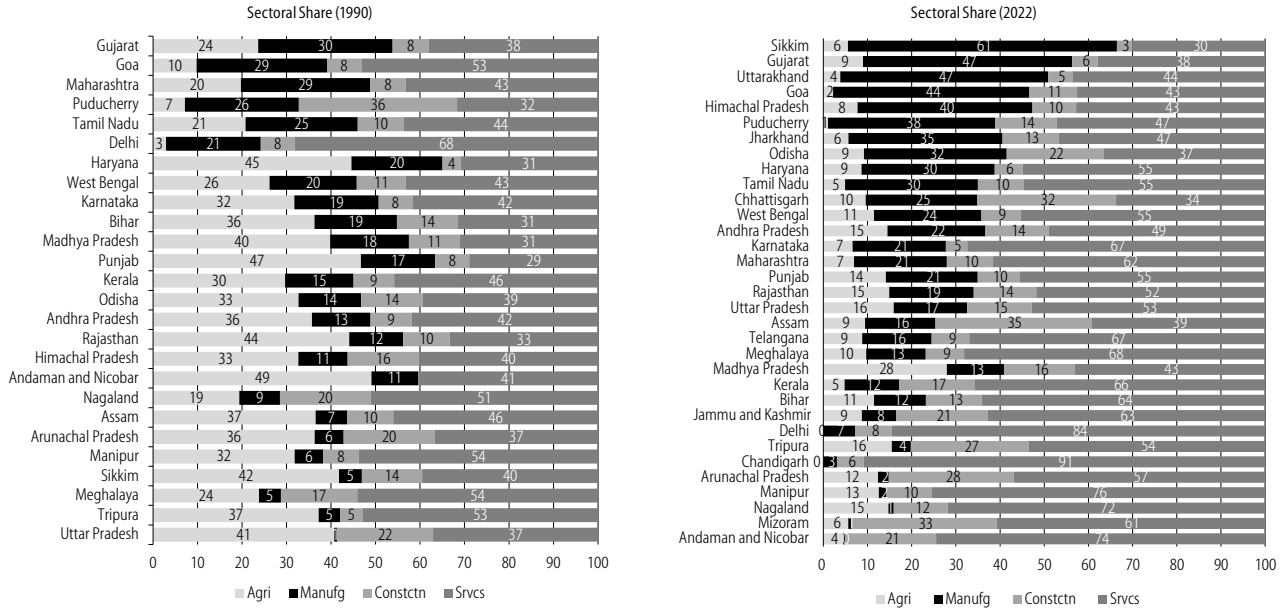
Between 1990 and 2025, India emerged as one of the fastest-growing major economies in the world. However, this growth story is marked by a structural paradox. Conventional development theory posits a transition from agriculture to manufacturing and subsequently to services. In contrast, India's experience reflects a relatively direct shift towards a services-led economy, with manufacturing playing a more limited intermediary role. Services account for over 55% of gross domestic product (GDP) but employ less than 30% of the workforce, while nearly 46% of workers remain engaged in agriculture, which contributes only 9% of output. Manufacturing, often considered the principal conduit for labour absorption and productivity growth, has remained broadly stagnant at around 21% of GDP over the past three decades. At the same time, significant interstate variation in sectoral transformations suggests divergent developmental trajectories that depart from standard theoretical expectations. These patterns call for a re-examination of the processes underlying structural change in the Indian economy.

Figure 1 (p 75) highlights three salient patterns. First, the relative importance of agriculture has declined across states; even traditionally agrarian states such as Bihar, Uttar Pradesh, and Assam now derive less than one-fifth of their gross state domestic product (GSDP) from this sector, indicating a broad-based shift away from agriculture. Second, the spatial distribution of manufacturing has become increasingly uneven. While it remains concentrated in states such as Gujarat, Maharashtra, and Tamil Nadu, newer centres have emerged in states like Sikkim, Uttarakhand, Himachal Pradesh (HP), and Odisha, where the share of industry in output often crosses 40%–50%. Third, services have come to dominate not only in metropolitan regions, such as Delhi and the southern states, but also across much of the north-eastern region, resulting in service-led economies in areas with limited industrial development.

The Uttarakhand Miracle: When Planning Beats Markets

The experience of Uttarakhand and HP presents a useful comparison between two hill states operating under similar incentive structures, yet exhibiting divergent outcomes. In the case of Uttarakhand, a more proactive and state-led development strategy appears to have played a significant role. Despite being a relatively new state with a large population and a narrower fiscal base, it invested in the development of integrated industrial estates with supporting infrastructure, including

Figure 1: Sectoral Composition of Gross State Domestic Product across States, 1990–2022



Arranged in descending order of manufacturing share: agriculture declines across all states; industry is concentrated in the western region and in emerging hill and mineral-based hubs; and services dominate the southern states, Delhi, and the north-eastern region.
Source: Ministry of Statistics and Programme Implementation.

roads, power supply, water, drainage, sewage systems, logistics hubs, and even residential townships. This approach marked a departure from reliance on market-driven industrial location decisions and private land acquisition. Given its fiscal constraints, such an interventionist strategy entailed considerable risk, but it appears to have contributed to a more rapid expansion of industrial activity.

The outcomes were significant. Within just three years, Uttarakhand developed over 8,000 acres of fully serviced industrial land from scratch. Between 2000 and 2011, the state recorded a higher average annual rate of 11.05% as compared to HP's 6.91%. Over the subsequent two decades, manufacturing output in Uttarakhand expanded 9.5 times, while HP's grew only 4.6 times. By 2010, Uttarakhand's per capita income had caught up with and surpassed that of HP, rising from just 64% of HP in 2000 to 102% within a decade. The expansion of the industrial workforce was further associated with a considerable increase in the state's own revenues over time. Uttarakhand's industrial employment expanded 12-fold by 2019, vastly outpacing HP's 5.6-fold increase. The state's own tax revenue increased 18-fold over a 22-year period. What began as a risky, infrastructure-first vision evolved into one of India's most striking state-level industrial turnarounds—demonstrating that strategic public investment, when executed effectively, can outperform a hands-off, market-led approach.

The comparison suggests that similar incentive structures can yield divergent outcomes depending on the role of state intervention. The experience of Uttarakhand indicates that, in contexts characterised by coordination failures and investment uncertainty, sustained public investment in integrated industrial infrastructure may be more effective than a predominantly market-led approach in promoting industrial development.

High Services, Thin Industrialisation, North East and Delhi Story

If the experience of Uttarakhand raises questions about the relative roles of markets and state intervention, the trajectory of north-eastern states presents a different analytical puzzle, namely the implications of a services-led transition in the absence of a significant manufacturing base. States such as Nagaland, Meghalaya, and Mizoram have recorded persistently high service sector shares above 60% of their state GDP for decades, among the highest in India. However, unlike advanced economies such as Singapore or Luxembourg where the expansion of services following industrialisation, these states appear to have experienced a relatively direct shift towards services. A more pronounced version of this pattern is observed in Delhi, where the share of services in output has risen sharply since the early 1990s as the services share rose from 68% in the early 1990s to an astonishing 85%–89% by 2023. No other major economy in the world has experienced such a pronounced shift towards services at India's level of per capita income. Delhi essentially skipped the entire industrial phase of development, moving directly from being a modest administrative centre to a services superpower.

The predominance of services in north-eastern states can be attributed partly to geographical constraints, such as difficult terrain and limited connectivity, which raise the costs of large-scale industrial activity. At the same time, policy factors have also shaped this trajectory. Public expenditure, particularly in administration, defence, education, and health, has played a significant role in driving service-sector expansion. Consequently, activities such as trade, transport, hospitality, real estate, and government services constitute a large share of economic output in these states. However, this pattern is accompanied by employment challenges. Despite the high

contribution of services to output, the capacity to generate adequate and productive employment remains limited. A substantial portion of service sector growth is concentrated in relatively low-productivity activities and government employment, which may not be sufficient to absorb the expanding workforce at higher wage levels. This has resulted in a structural configuration characterised by relatively higher service sector output alongside persistent underemployment.

This experience of the north-eastern states points to the limitations of a services-led growth trajectory in the absence of a robust manufacturing base. While the expansion of services can contribute to output growth, it may not generate sufficient employment to absorb labour transitioning out of agriculture. As a result, the process of structural transformation remains incomplete, with limited improvements in broad-based employment and living standards.

The Mineral States' Divergence: Why Odisha Surged While Jharkhand Stagnated

Odisha and Jharkhand, both mineral-rich states carved out of the same industrial belt, possess abundant reserves of coal, iron ore, bauxite, and other strategic minerals. Each inherited a legacy of heavy industry from the pre-liberalisation period. Yet, their developmental trajectories over the past two decades have diverged markedly.

Odisha has, over time, transformed itself into a major industrial hub. Its Industrial Policy Resolution of 2015, building on earlier policy frameworks initiated in 2007, streamlined regulatory procedures, extended capital subsidies and goods and services tax-linked incentives, and institutionalised single-window clearance mechanisms. The state also undertook systematic upgradation of its mineral resource base through expanded exploration, identification of new auctionable blocks, and facilitation of investment by large steel, aluminium, and cement producers. By 2023, Odisha had emerged as India's largest steel-producing state and a leading player in aluminium and metal processing. The share of industry in the states' GDP rose significantly, crossing 40%, with manufacturing accounting for a substantial proportion (shares sometimes exceeding 40%–60%). The state also recorded the highest number of mineral block auctions in the country and ensured the relatively timely operationalisation of mines. The development of downstream metal processing parks attracted major firms, while tourism began to evolve as a complementary sector to the industrial base.

Jharkhand, despite possessing comparable—if not greater—mineral endowments, has not undergone a similar structural transformation. The state accounts for over 40% of India's total mineral output, with extensive coal reserves, yet continues to exhibit high levels of poverty, relatively low literacy, and underdeveloped social infrastructure. Although successive industrial policies were introduced in 2016, 2021, and 2022, their impact has been constrained by infrastructural bottlenecks, power shortages, delays in approvals, and limited investor outreach. The iron industry of Jharkhand employs approximately 1,00,000 people, which supplies domestic steel mills and exports to China, Japan, Europe, and Southeast Asia. However, this resource base has not translated into a broad-based industrial expansion. Jharkhand thus exemplifies the paradox of resource abundance coexisting with persistent developmental deficits.

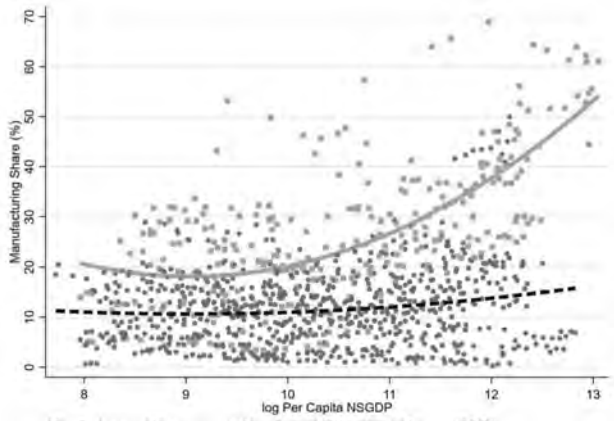
What explains this divergence? Odisha invested significantly in governance capacity, policy continuity, and infrastructure. It established institutional mechanisms, maintained relative stability in political commitment across electoral cycles, and actively facilitated private investment. Jharkhand, by contrast, was marked by political instability and weaker administrative capacity, limiting its ability to translate mineral wealth into diversified manufacturing value chains. The comparison between Odisha and Jharkhand suggests that natural resource endowments alone do not ensure successful industrial transformation. Rather, state capacity—the ability to design, implement, and sustain effective industrial policies—emerges as a more critical determinant than factor endowments.

Sikkim and Assam: The Unexpected Industrial Tigers

Perhaps the most striking transformations occurred in states that few analysts had anticipated would emerge as industrial centres. Sikkim and Assam defied expectations, transitioning from industrial laggards to above-average performers.

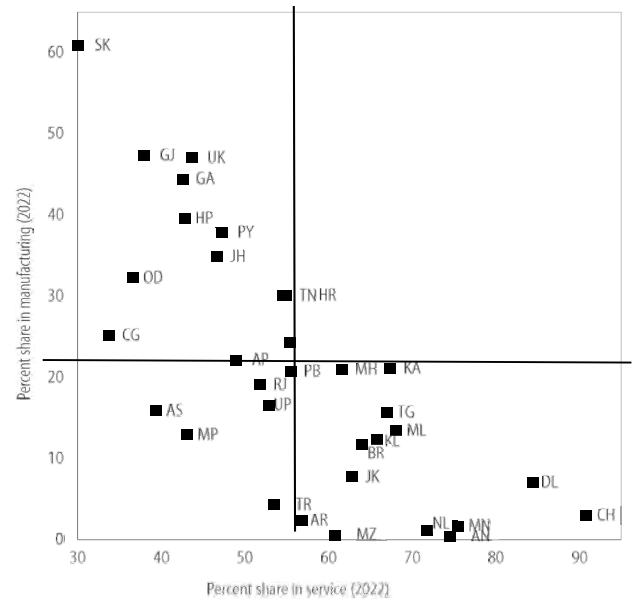
Sikkim's industrial expansion gathered momentum following its inclusion in the North East Industrial and Investment Promotion Policy in April 2007. The policy framework provided a range of fiscal incentives, including 100% excise duty exemption, a 10-year income tax holiday, a 30% capital investment subsidy, a 3% interest subsidy on working capital, freight subsidies, and full insurance premium reimbursement. Pharmaceutical firms such as Sun Pharmaceutical Industries,

Figure 2: Manufacturing Intensity and Income Growth



States that attained a manufacturing share exceeding 30% at some stage of their development trajectory ("manufacturing-dominant" states) (light grey) exhibit a steeper rise in per capita income, whereas "manufacturing-weak" states (grey) follow a comparatively flatter trajectory, indicating a positive association between manufacturing intensity and income growth.
Source: MOSPI.

Figure 3: State-wise Sectoral Shares in 2022 Highlighting Pronounced Divergence across India



Sikkim, Uttarakhand, and Himachal Pradesh exhibit relatively high manufacturing intensity, whereas Delhi, Chandigarh, and most north-eastern states are predominantly services-oriented with limited industrial presence. The dotted horizontal and vertical lines represent the national average shares of manufacturing and services, respectively.
Source: MoSPI.

Cipla, and Unichem Laboratories established manufacturing facilities in the state in response to these incentives. By 2023, the share of manufacturing in Sikkim's GSDP had exceeded 40%–60%, an unusually high proportion for a small landlocked state. The growth of the pharmaceutical industry was driven not only by fiscal incentives but also by relatively lower production costs, limited government interference, the availability of a skilled workforce, and an enabling business environment. In parallel, Sikkim became India's first 100% organic state, creating additional opportunities in food processing and organic exports.

Assam's turnaround is equally remarkable. For decades, the state remained below the national average in terms of industrial share. It has, however, moved above the average in recent years, reflecting sustained policy interventions and an improved business environment. The Assam Industrial Policy 2023 sets out ambitious targets, including attracting ₹10,000 crore in new investment by 2028, while supporting large projects, such as the Numaligarh refinery expansion and the Assam gas cracker initiative. The development of sectoral clusters—for bamboo, tea processing, food products, petrochemicals, and semiconductors—has further strengthened the state's manufacturing base. Assam's transition from an industrial laggard to an above-average performer constitutes a notable instance of regional convergence in India.

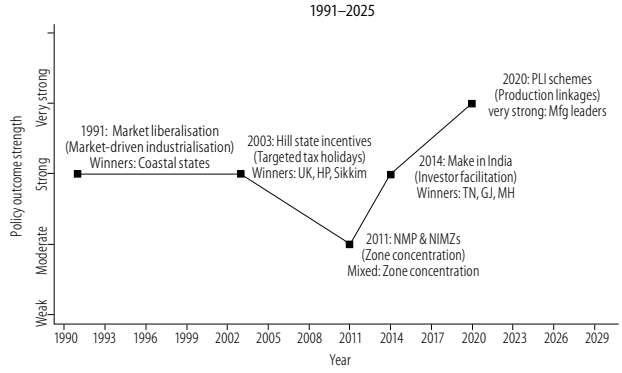
These developments suggest that small- and medium-sized states can outperform expectations when policy incentives are coherently aligned, stability is maintained, and strategic emphasis is placed on sectors in which they possess a comparative advantage.

The Missing Middle: India's Employment Crisis

The most disquieting aspect of India's structural transformation lies in its implications for employment. The economy exhibits a "missing middle": a disproportionately large workforce remains in low-productivity agriculture, a relatively small share is absorbed in medium-productivity manufacturing, and a narrow segment is engaged in high-productivity services. Equally concerning is the persistence of high unemployment among the educated. The Periodic Labour Force Survey (PLFS) 2022–23 reports unemployment rates of 13.4% among graduates and 12.1% among postgraduates, as against around 2% for those with secondary education. While services-led growth has contributed to output expansion, it has not translated into broad-based employment generation.

Manufacturing remains the critical bridge between low-skilled agriculture and high-skilled services. As indicated in Figure 2, states that industrialised more rapidly—crossing the 30% manufacturing threshold—exhibit a steeply rising income trajectory, whereas services-led economies tend to stagnate. This divergence becomes more pronounced at higher income levels, underscoring the centrality of manufacturing for both convergence and sustained prosperity. Manufacturing is uniquely positioned to absorb semi-skilled labour, generate backward linkages with agriculture, and anchor regionally dispersed development. Despite this, employment growth in manufacturing has remained modest. Between 2014 and 2024, the number of workers in the sector increased from about 10 million to 15 million—an addition of only 5 million jobs over a decade in which roughly 120 million individuals entered the workforce. Much of this expansion has been concentrated in labour-intensive industries such as textiles and apparel, food processing, electronics, chemicals, automobiles, and auto components. This pattern points to an early manifestation of premature deindustrialisation: the services sector is expanding rapidly in the absence of a robust manufacturing base. Unlike classical deindustrialisation—where high-income economies transition from manufacturing to services after

Figure 4: India's Industrial Policy Timeline over the Past Four Decades



Industrial policy outcomes are classified on the basis of measurable indicators, including output growth, employment generation, export performance, ease of doing business, and infrastructure development. The classification draws on evidence from official industrial reports, Periodic Labour Force Survey (PLFS) data, World Bank and UNIDO competitiveness rankings, and assessments by the Ministry of Commerce and Industry for the respective periods.

Source: RBI *Handbook of Statistics on Indian States*; author analysis of state-level outcomes.

achieving industrial maturity—India is witnessing a decline in manufacturing's share in GDP before it has emerged as a significant source of employment.

Empirical evidence indicates that convergence across Indian states is observable primarily in the manufacturing sector. States with initial lower manufacturing bases have, over time, recorded relatively higher growth rates, enabling a degree of catch-up. In contrast, both agriculture and services exhibit persistent divergence, with initially better-performing states continuing to pull ahead. This suggests that manufacturing provides the most viable pathway for reducing regional inequalities; however, it remains insufficiently developed at the national level.

The Convergence–Divergence Paradox

State-level evidence from India points to a significant paradox in the process of economic transformation: states following distinct structural trajectories exhibit markedly different convergence dynamics. States with a stronger manufacturing base tend to experience faster and more balanced growth, as manufacturing absorbs relatively less skilled labour, strengthens inter-sectoral linkages, and generates productivity gains through processes of industrial clustering.

The scatter plot in Figure 3 (p 73) illustrates the uneven pattern of industrial transformation across Indian states. On the vertical axis, states such as Sikkim (SK), Uttarakhand (UK), Gujarat (GJ), and HP stand out for their relatively high manufacturing shares—often exceeding 40%–60% of state GDP—and tend to exhibit stronger overall GDP growth performance. In contrast, Delhi (DL), Chandigarh (CH), and several north-eastern states, including Nagaland (NL), Mizoram (MZ), and Manipur (MN), are clustered in the lower-right quadrant, characterised by service-sector shares exceeding 70%–90%. Such service-led structures are typically spatially concentrated in urban centres, contributing to widening regional disparities. Most large states lie between these extremes, revealing a pronounced divergence. While some have achieved a more balanced distribution between manufacturing and services, others—notably Delhi and parts of the North East—have effectively bypassed industrialisation and evolved into services-first economies. This divergence helps explain interstate differences in employment generation: states with a stronger manufacturing base tend to create more broad-based employment, whereas services-dominated economies often exhibit persistent joblessness and underutilised labour. The gains from such a growth pattern accrue disproportionately to educated segments in urban centres, with limited spillovers to rural and less developed regions. The uneven trajectory of structural transformation across states and over time underscores the need for state-specific industrial and labour policies aimed at achieving more inclusive growth.

Policy Lessons: What Works and What Does Not

Five decades of state-level industrial policy experimentation (Figure 4) offer important insights into the determination of successful structural transformation within India's federal framework.

First, coordinated public intervention assumes greater significance than market-led processes in contexts characterised by severe coordination failures. The experience of Uttarakhand, in comparison with the relatively modest performance of HP, suggests that sustained public investment in integrated industrial ecosystems—encompassing infrastructure, logistics, power, water, and residential facilities—can yield outcomes superior to those arising from a reliance on private land markets for industrial development.

Second, policy continuity appears to be more consequential than policy generosity. States that have maintained relatively stable industrial policy frameworks across electoral cycles—such as Gujarat (Industrial Policy 2015), Tamil Nadu (successive policies since 1992), Maharashtra (policy continuity since the 1960s), and Odisha (frameworks in place since 2007)—have tended to outperform those characterised by frequent policy reversals. In contrast, repeated shifts in West Bengal's industrial policy regime, including the withdrawal of incentives in 2025, have been associated with a reported exit of around 6,600 firms during 2011–25.

Third, state capacity appears to be more decisive than natural resource endowments. Odisha has been able to translate its mineral wealth into industrial development through sustained public investment and institutional effectiveness, whereas Jharkhand, despite possessing a large resource base, has achieved comparatively weaker outcomes due to limited administrative and implementation capacity. Natural resources, while important, are not sufficient; the ability of the state to design and execute policy is critical.

Fourth, targeted policy incentives can help offset inherent geographical disadvantages. The 2003 Concessional Industrial Package and subsequent schemes facilitated industrial expansion in hill states despite challenging terrain. States such as Sikkim, HP, and Uttarakhand leveraged tax concessions and subsidies to attract industries, including pharmaceuticals, food processing, and other manufacturing activities, notwithstanding high transportation costs.

Fifth, manufacturing remains the only sector that exhibits evidence of convergence across states. Empirical studies consistently show that manufacturing-led development enables relatively poorer states to catch up, whereas services-led growth tends to concentrate gains in already-advanced regions. From the perspective of reducing regional inequality, the expansion of manufacturing assumes particular importance.

Looking Forward: The Road to 2047

As India aspires to become a $5 trillion economy and beyond, the experience of structural transformation over the past three decades offers both cautionary signals and policy opportunities. The principal concern is that services-led growth, in the absence of a strong manufacturing base, generates structural imbalances—resulting in output expansion without commensurate employment creation. This is reflected in rising unemployment among the educated, alongside limited pathways into productive work for the less skilled. At the same time, there is scope to extend lessons from successful state-level transformations to the national level. These include prioritising infrastructure development, strengthening governance capacity, ensuring policy continuity, and deploying targeted incentives. Industrial policy needs to be conceived as a stable, long-term framework rather than a contingent political instrument, with changes introduced only in response to substantive shifts in strategic priorities. Strengthening centre–state coordination in investment, logistics, and skill development remains critical, in line with the principles of cooperative federalism. Infrastructure—particularly reliable power, multimodal logistics networks, and digitised land markets—continues to be foundational. Greater emphasis is also required on labour-intensive sectors such as textiles, food processing, and electronics assembly. A key priority is the rebalancing of growth towards eastern and central India. Resource-rich but lagging states, including Jharkhand, Bihar, and Chhattisgarh, require sustained and credible industrial policy interventions that move beyond declaratory intent. The experience of states such as Uttarakhand underscores the importance of long-term commitments to infrastructure, administrative capacity and ecosystem development in enabling durable industrial transformation.

In Conclusion: Factories, Not Just Offices

India's structural transformation since 1990 reflects considerable heterogeneity across states. While some states have developed strong manufacturing bases, others have effectively leapfrogged to services, and a few have managed to combine both trajectories. A significant number, however, remain dependent on agriculture. This variation underscores the critical role of policy choices in shaping development outcomes. The resulting pattern resembles an "archipelago," with pockets of manufacturing excellence dispersed within a broader landscape dominated by services. While this configuration captures important achievements, it also points to an incomplete transformation. Such fragmented development is inherently unsustainable, as it leaves a large share of the population excluded from productive opportunities. The central challenge for the coming decades lies in expanding the footprint of manufacturing and integrating these dispersed centres into a more cohesive economic landscape, wherein the gains from growth are more widely shared across regions and social groups.

The experience of the north-eastern states' services-led trajectory, Bihar's persistent underdevelopment, and Jharkhand's unrealised potential all point to a common conclusion: the expansion of manufacturing is indispensable. While the continued growth of services is both inevitable and desirable, it cannot substitute for a dynamic manufacturing sector capable of absorbing labour transitioning out of agriculture and anchoring regionally dispersed development. In the absence of such a base, economic growth is likely to remain characterised by limited employment generation, widening inequalities, and structural imbalances. The states that have performed relatively well over the past three decades have, to varying degrees, recognised this imperative. The prospects for the coming decades will depend on whether other states internalise and act upon these lessons in a timely manner.

[The statistics are compiled from multiple sources, including the RBI *Handbook of Statistics on Indian States*, the Economic Census, Annual Survey of Industries (ASI), the Periodic Labour Force Survey (PLFS) conducted by the Ministry of Statistics and Programme Implementation (MoSPI), and various Parliamentary (Sansad) reports.]

Identification of Star Firms and Decoding Investment in Intangibles

Evidence from the Indian Manufacturing Industry

JITAMITRA BEHERA, RUCHI SHARMA

The star firms phenomenon, focusing on the changing structure of investment dynamism in Indian manufacturing industries, is explored. Analysing firm-level information from the Centre for Monitoring Indian Economy Prowess database for 2000 to 2023, this study investigates the emergence of star (superstar) firms and presents a comparative analysis highlighting intangible expenditure and intangible assets. We find that star firms are intangible-intensive relative to non-star peers and such investment in intangibles increases the likelihood of transforming a firm into a star. So, a regulatory framework is suggested that encourages investment in intangibles to leverage scale advantage and enhance performance.

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The global economy has witnessed a new market phenomenon where a small subset of firms stands out as benchmark performers in their respective industries and sectors. Researchers regard those firms as "superstar firms.[1]" For instance, the worldwide known superstar firms, such as Google, Apple, Microsoft, Facebook, Amazon and Tesla, have distinguished themselves with extraordinary performance in their respective industries and economy (Manyika et al 2018; Dorn 2021). Studying the industries in the United States (US), Autor et al (2020) attribute the growth of these firms to the use of automation and digital capital that generates unparalleled scale advantage. Exploring a step ahead, Ayyagari et al (2024) link the prevalence of such star firms[2] with rising intangible capital in the same US economy and suggest that the competitive advantages of intangible inputs enhance a firm's performance. But analysing European firms, Capello et al (2025) highlight the adverse impact of intangible investment on profit share in the initial year of investment. The authors argue that the increase in intangible investments leads to a decrease in the remuneration of the capital due to the fixed and bulky nature of outlay. These two contrasting arguments generate contextual ambiguity and pose an open question about the gestation period, scale, and nature of intangible investments that enhance firm performance and further transform an ordinary firm into a star performer. Addressing this question would bring a new insight for both corporate decision-makers and policymakers in formulating strategies to foster firm growth and competitiveness, respectively.

Furthermore, the discussion about superstar firms revolves around developed economies such as the United Kingdom (UK), the US, and a few European countries (Autor et al 2020; Ayyagari et al 2024; Manyika et al 2018; Abraham and Bormans 2020). The research in the context of emerging countries has been ignored although the prevalence of similar kinds of star and superstar firms has been observed in different industries. For example, in the post-liberalisation phase, India experiences the growth of a few big companies like Sun Pharma Laboratories, Hindustan Unilever, Tata Steel, and Jindal Steel and Power in the manufacturing sectors, which emerges with outstanding growth performance (Menon 2019; Sen et al 2021). Such businesses occupy a dominant share of industrial revenue in their respective industries, like superstar firms in developed countries. Acharya (2023) also highlights the influential

role of such big businesses in India that obtain greater profit margin relative to other companies in the industries. Babu (2023) highlights that such firms (megacorps) behave like a strategic agent possessing larger assets and credit connections and gain a greater profitability. Together, these findings suggest that the large firms in India also play a pivotal role in obtaining scale advantages and industrial distributions.

Particularly, exclusive investigation about the dynamics of big companies through the lens of the star firms' phenomenon is important and timely for an economy like India to address industrial structure and performance. Because the economy encounters the coexistence of a larger population of small and medium enterprises (SMEs) and informal entities, with the prevalence of a few mega-corps (Basant and Mishra 2019; Babu 2023). Additionally, as the industrial structure is considerably different in terms of characteristics of factor markets and regulatory environments relative to developed economy, the phenomenon of a star firm possibly appears differently. For instance, in the developed economies, the emergence of superstar firms leads to market concentrations and an anti-competitive scenario creating entry barriers for small competitors (Autor et al 2017; De Loecker et al 2020). But in the developing countries like South Korea, the study on Hyundai Motor and Samsung Electronics shows a positive spillover and value chain linkages with small firms (Pyo and Lee 2018). Additionally, Ciani et al (2020) posit that large firms in developing economies substantially contribute to economic growth and encourage the progress of small firms as well. The authors also suggest the need for more large firms in emerging economies to strengthen the economic development. So, understanding the investment strategies of such star performers is essential to explain how investment behaviour and firms' performance interact to shape the evolution of the corporate landscape and economic growth.

In view of these research gaps, this study attempts to initiate a systematic identification of both superstar and star firms in the Indian manufacturing industries. In the second part, this research examines the investment in intangibles, highlighting the extent of differences between star firms and non-star firms. To conduct the empirical investigation, this study collects the firm-level data from the Centre for Monitoring Indian Economy (CMIE) Prowess database for 2000 to 2023. The study employs the Fligner-Policello test to understand the difference in the level of investment, while estimates panel logistic regression using generalised estimating equation (GEE) to investigate the incidence of star firms subject to intangible investment. Our results show that star firms are a handful in every industry (around 2% to 4%) while superstars are less than that. But the comparative analysis shows that the star firms spend substantially higher amounts in research and development (R&D), advertisement, marketing, and technological expenditure relative to its non-star peers. The regression analysis uncovers the role of different intangible investments as key differentiators between star and non-star.

Our findings contribute to the current literature in the following ways. First, the systematic documentation of star firms at the industry level provides a novel insight into the industrial structure of a developing economy like India. Second, the comparison between star and non-star firms, highlighting investment behaviours, illustrates industrial variation, which offers policy implications for designing industrialisation strategy. Finally, the study provides a research base for further investigation in the domain.

Against this backdrop, this study is organised in the following ways. It first discusses the comprehensive literature review in three subsections incorporating theoretical and empirical underpinnings and then three elucidates methodology, including the identification strategy, empirical strategy as well as details about data and other variables. Later, it highlights the empirical results and then delivers a comprehensive discussion and policy implications. Finally, it provides concluding remarks with limitations and future research directions.

Literature Review

Superstar firms' phenomenon: The general essence of the superstar phenomenon is associated with a structure where a small subset of individuals or entities captures a larger share of revenue relative to its industrial peers. Although this is not a new observation, the discussion has recently emerged in the field of industrial organisation which was initiated in the arena of sports. Rosen (1981) talks about the extraordinary remuneration of a few superstar players in sports who earn a massive amount of income. Autor et al (2020) connect such a phenomenon with manufacturing and service sectors, referring to superstar firms in the case of the US economy. The authors highlight that the sales concentration of top 20 firms (regarded as superstar firms) rises over time with high productivity and greater profitability, with a simultaneous decline of the labour share.

Further, Rostami et al (2023) discovered Chinese superstar firms that also capture larger export share relative to other peers in the industries. Tambe et al (2020), focusing on the top 10 percentile firms in terms of market capitalisation and turnover, observe larger investment of digital capital by the superstar firms. Looking at the resource endowment structure, Ayyagari et al (2024) regard the top 10 percentile firms in terms of return on invested capital (ROIC) as star firms and link larger concentration of intangible capital with the rise of star firms in the US.

Behera and Sharma (2024) distinguish superstar firms as technologically advanced and efficient units, unlike mere large ones in terms of market share. These firms are not merely large but also unparalleled in terms of performance and influence. De Loecker et al (2022) comprehensively elaborate on the scenario of the US and the UK economy. The authors underscore the changing patterns of business dynamism with rising market concentration, increasing productivity and wage dispersion, and augmenting markup growth as the major indications of the prevalence of the superstar firms.

Earlier studies in the Indian context have shown an increase in industrial concentration along with the concentration of social, economic, and organisational resources (Siddharthan and Pandit 1998; Athreye and Kapur 2006). It has been recently noted that the manufacturing sector in India is also characterised

by the prevalence of a large number of micro-units with a small number of macro units, highlighting the market concentration and unequal share of revenue (Mishra et al 2011; Ray 2019; Ghosh and Gupta 2025). Additionally, the manufacturing sector shows an upward growth trend, with an increasing share of large-scale units and a declining share of small ones. As reported by Ray (2019), the lion's share of large units outpaces the share of both medium- and small-scale units, which denote the unequal growth of businesses. Further, the authors also postulate that a productivity dispersion across Indian companies within industries indicates heterogeneity among firms.

Role of Intangible Investment

The investment in intangibles, such as R&D, advertising, branding, and technical know-how expenditure, has been a crucial driver of scale and margin. Empirical research by Griliches (1998) demonstrates that such intangible expenditure enhances firm performance and increases value-creating scale and scope. Similarly, Brynjolfsson et al (2021) identify digital capital (intangible capital), such as software, information technology (IT) systems, and data as an underlying force of productivity growth. Such intangible investment enables innovation activities and generates competitive advantage, resulting in higher output against small marginal inputs. Interestingly, intangible investment is fixed with negligible marginal cost, producing high marginal profits for the intangible intensive production.

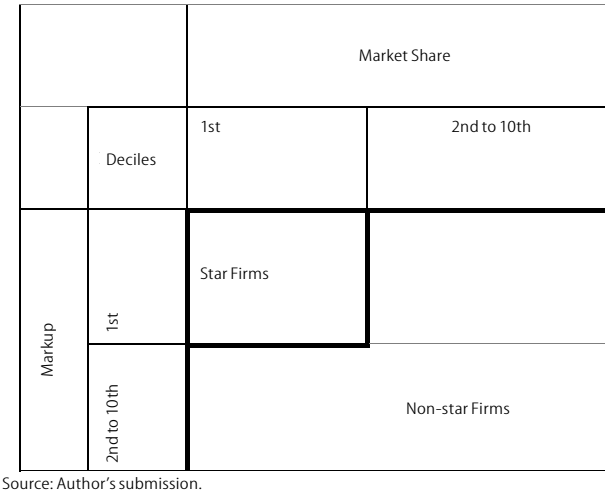
The fixed nature of expenditure on intangibles increases the overall cost of the firm in the short run, which adversely affects the profit margin (Capello et al 2025). Additionally, the huge amount of one-time investment is also a concern for small-scale businesses causing mostly big and established businesses to make such investments. This results in a disproportionate margin and a huge profitability gap between invested and non-invested firms (Bajgar et al 2025; Haskel and Westlake 2017). Therefore, Ayyagari et al (2024) explain that the star firms employ more intangible capital relative to their competitors to obtain a competitive advantage. But the question on the other way around remains unclear. Particularly, an empirical investigation specifying different types of intangibles, their scale and nature that turn an ordinary firm into a star or superstar firm is still in the grey area of research. Addressing such a gap is essential to uncover the importance of intangible investments in shaping industrial structure.

Methodology

Identifying strategy: Most approaches that define and determine superstar firms focus on single indicators, such as market share, markups, market capitalisation, or productivity (Tambe et al 2020; Rostami et al 2023) that are individually incapable of representing the multidimensional aspect of star firms. For instance, a firm may be highly productive relative to its peers but may capture less market share in the industry, as Mishra et al (2011) has shown an ambiguous relationship between market share (which expresses the market concentration) and markup (which denotes the market power) in the case of Indian industries. So, a single variable-based criterion is not appropriate for the identification of star firms. Therefore, our study partially follows the identification strategy provided by Cheng et al (2024) to include the suggested variables, that is, profit margin and the size of the firms. Unlike Cheng et al (2024), who chose a particular threshold of profit margin, we identify firms based on the top deciles with respect to two dimensions (profit margin and size of the firms). This approach ensures that industry-wise variations are not ignored. Thus, our approach includes the firms in an industry that are not merely large in terms of market share but are also profitable with a higher profit margin and enjoy market power. Here, we identify not only the large firms but also the productive and efficient firms. Where the market share indicates the market power of the firms and the profit margin specifies the competitive advantages over inputs and signifies the competence of the firms (Mishra and Rao 2014; De Ridder et al 2022).

Figure 1 shows the steps undertaken to identify star firms. First, we segregate the firms based on the market share and consider the top decile firms at the industry level. Similarly, the markup is also taken into consideration and classified into deciles. Then, we find out the intersection of top decile firms based on two indicators and regard those firms as star firms.

Figure 1: Identifying Methods



Source: Author's submission.

Further, we identify the superstar firms incorporating time factors and follow the definitions of Ayyagari et al (2018) and Cheng et al (2024). Ayyagari et al (2018) distinguish superstar firms that are continuously in the star position for at least five years, whereas Cheng et al (2024) restrict it to a mere three years. In this study, we identify superstar firms in both ways following the criteria of Ayyagari et al (2018) and Cheng et al (2024) separately. But due to the discontinuation and absence of superstar firms' information across industry as well as in different years, we confine the intangible investment behaviour analysis to mere star firms, which inclusively encompasses superstar firms.

Analysis strategy: Intangibles are significant drivers of the firm's performance as elaborated in the literature review. To analyse such investment, we categorise the intangibles into

two broad categories (expenditure and assets) based on Wyatt and Abernethy (2003) and the World Intellectual Property Organization (WIPO 2024). It is expected that the present R&D, marketing, and advertising spending (expenditure category) result in patenting, goodwill, and brand reputations (asset category) in the future (Heiens et al 2008; Intara and Suwansin 2024). Further, we make a comparative analysis of the distributions of the variables of interest, depicting the industrial variation, estimating the average mean and standard deviation. We validate the differences by conducting the Fligner-Policello test, which helps to evaluate the statistical dominance of star firms over non-star firms (Fligner and Policello 1981). Then, to understand the industrial variation, we use a non-parametric Kruskal-Wallis test to check the differences in the distribution among the groups (Ostertagova et al 2014).

Further, to understand the relationship between the prevalence of star firms and investment on intangibles, we estimate a panel logistic regression model (Cameron 2007; Jemović and Marinković 2021). The dependent variable is 1 when the individual firm is a star, otherwise 0. The independent variables are R&D, advertising, marketing, and technological expenditures, which help to increase the markup and revenue of the firms (Athreye and Kapur 2006; Ayyagari et al 2024). As the expenditure variables are correlated, we constructed an intangible expenditure index (IEI) using the principal component analysis (PCA) from all four intangible expenditure variables, such as R&D, advertisement, marketing, and technological expenditure. We control variables, namely size set-up, age, industrial concentration (Herfindahl-Hirschman Index, abbreviated as HHI) and number of competitors, which also influence the firm's performance (Rhoades 1995; Atheye and Kapur 2006). Our estimated regression equations:

$$\text{Star Status}_{i,t} = \alpha + \beta 1\ \text{Intangible Assets}_{i,t-1} + \gamma_i \text{Controls}_{i,t} + T_t + \varepsilon_{i,t} \quad \ldots (1)$$

$$\text{Star Status}_{i,t} = \alpha + \beta_1\ \text{Intangible Expenditure Index}_{i,t-1} + \gamma_i\ \text{Controls}_{i,t} + T_t + \varepsilon_{i,t} \quad \ldots (2)$$

Here *i* represents the individual firm and *t* represents the year. We choose a panel logistic regression model, that is, panel GEE with robust standard errors, clustering on firms, which addresses the lack of independence among the residuals for specific firms over the years (Cameron 2007). The estimations are also robust to correlation misspecification, ensuring better generalisation.

Data, Variables and Indicators

We use the CMIE Prowess IQ which is one of the largest and most widely used data sources for firm-level studies in India. For ease of analysis and representative study, we categorise the firms into industries at three-digit National Industrial Classification (NIC) 2008 and include only eight different industries covering high-tech to low-tech firms from 2000 to 2023. As our objective is to identify star performers in the industries over time, we select the industries considering the availability of substantial observations for comprehensive investigation. The following industries are included: the manufacture of drug formulations and vaccines; automobile parts and accessories; fertilisers; other chemical products; plastics products; textiles, food products, and iron and steel. In the end, we are left with only 5,877 individual firms for 24 years. The data having negative values for the key variables studied are dropped. The variables and indicators are detailed in Table 1 and the descriptive statistics are presented in the appendix (Tables A I and A II, p 89).

Table 1: Variables and Indicators

	Variables	Definitions	Source
1	Market share	Market share is the ratio of a firm's sales to the aggregate sales of the industry in a fiscal year $MS_{it} = \frac{Sales_{it}}{\sum_{i=1,t=1}^{m,T} Sales_{it}}$	Own calculation
2	Markup	Markup is the profitability over turnover $Markup_{it} = \frac{Sales_{it} - (RW_{it} + PF_{it} + WS_{it} + AD_{it})}{Sales_{it}}$	Own calculation
3	Intangible assets	Intangible assets of the firms in a fiscal year	CMIE Prowess
4	R&D expenditure	R&D expenditure in a fiscal year.	CMIE Prowess
5	Advertisement expenditure	Advertising expenditure in a fiscal year	CMIE Prowess
6	Marketing expenditure	Marketing expenditure in a fiscal year	CMIE Prowess
7	Technological expenditure	Technological expenditure in a fiscal year	CMIE Prowess
8	Age	Difference between the present year and the year of incorporation	Own calculation
9	Market concentration (HHI)	Sum of square of the market share of firms in a particular industry	Own calculation
10	Size setup	Ratio of industry sales to median net fixed assets	Own calculation
11	Number of competitors	Number of firms in the industry	Own calculation

The value of sales and assets is deflated by industry-specific wholesale price index deflators, while wage and salaries values are deflated using the consumer price index of industrial workers as a deflator. Remaining variables are deflated by the WPI deflators values of the overall manufacturing industry.

Empirical Findings

Identification of star firms: We ascertain star firms following the procedure mentioned earlier and report the number of star firms in the eight industries in Table 2. We find the lowest number of star firms in the food industry (2.58%) while the highest number share of star firms is in the textiles industry.

In Figure 2, we depict the star firms in eight different industries that have been in a star position for at least a year. For instance, Tata Consumer Products and Parle Biscuits in the food product industry; Jindal Poly Films in textiles; Nagarjuna

Table 2: Star and Non-star Firms in Different Industries

NIC Code	Industry	Star Firms' Observations	Total Observations	Percent	Number of Star	Total Number Firms	Percent
107	Food products	59	8,947	0.65	16	618	2.58
131	Textiles	119	12,919	0.92	37	930	3.97
201	Fertilisers	60	8,318	0.72	21	633	3.31
202	Other chemical products	114	8,732	1.30	25	662	3.77
210	Drug formulations and vaccines	162	10,597	1.52	33	807	4.08
222	Plastics products	135	9,139	1.47	22	698	3.15
241	Iron and steel	150	12,620	1.18	44	956	4.6
281	Automobile	121	7,252	1.66	19	573	3.31

Sources: Authors' compilation.

Figure 2: Star Firms in Different Industries

The reported firms have been in a star position for at least one year.
Sources: Authors' depiction.

Fertilisers and Chemicals and Gujarat Alkalies and Chemicals in fertilisers; Colgate-Palmolive (India) in chemical products are the well-known star firms. Similarly, Cipla, Pfizer and Serum Institute of India in drug formulations and vaccines industries; 3M India and Nilkamal in plastics products; and Jindal Steel and Power in the iron and steel industries are star firms that are renowned for extensive product variety and strong brand recognition.

Identification of Superstar Firms

We identify the superstar firms which have been in star positions for at least three years (Cheng et al 2024) and five years (Aayagari et al 2018). We find very few numbers of superstar firms in different industries as presented in Table 3 (p 84).[3] The results show that 102 and 55 firms out of a total of 217 star firms are consistently in a star position for at least three and five years, respectively, which are referred to as the superstar firms.

Intangible Investment Behaviour of Star Firms

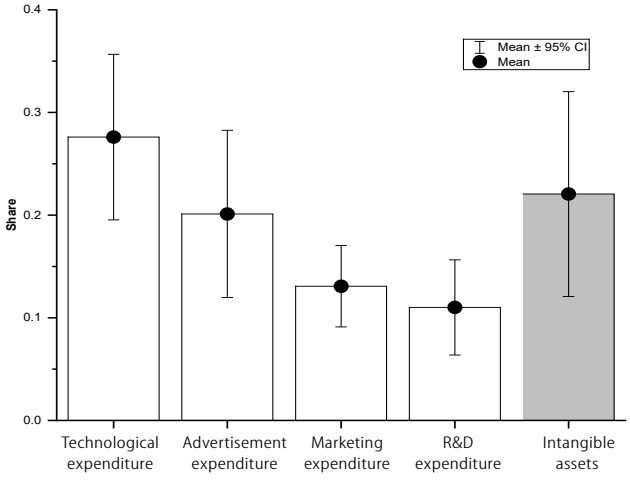
We now investigate the investment characteristics through the lens of investment in intangibles (both the expenditure and asset categories) to uncover the strategy that supports and sustains the firm's extraordinary performance. We illustrate the aggregate difference of investment share of star firms against non-star firms in terms of R&D, advertisement and marketing and technological expenditure in Figure 2. The results show

Table 3: Superstar and Star Firms in Different Industries

NIC Code Industry	Superstar Firms' Observations (at least for three years)	Superstar Firms' Observations (at least for five years)	Star Firms' Observations	Number of Superstar Firms (at least for three years) of Star	Number of Superstar Firms (at least for five Years) of Star	Number of Star Firms
107 Food products	21	6	59	8	2	16
131 Textiles	48	21	119	15	7	37
201 Fertilisers	25	9	60	10	3	21
202 Other chemical products	52	32	114	11	8	25
210 Drug formulations and vaccines	86	57	162	16	11	33
222 Plastic products	88	68	135	13	7	22
241 Iron and steel	55	30	150	15	7	44
281 Automobile	74	46	121	14	10	19

Sources: Authors' compilation.

Figure 3: Investment Share



Shares represent the proportion of intangible investment and assets captured by all-star firms of the full sample, where the total share equals 1.
Sources: Authors' depiction.

that on average, star firms capture around 27% share of total technological expenditure and about 20% of advertising expenditure in the sample. Similarly, the same star firms cover approximately 11% and 13% of total industrial R&D and marketing expenditure, respectively. Correspondingly, star firms occupy nearly 22% of the total industrial intangible assets share.

We conduct a detailed examination about the expenditure share of star and non-star firms to gain insights into industrial variation. An in-depth analysis of firms' investment in eight different industries is separately depicted in Figure 4 illustrating the comparison between star firms and non-star firms across the different expenditure categories. As presented in the figure, in food industries, star firms capture around 16% of both marketing and technological expenditure out of the total industrial spending in each category. Similarly, in chemical product industries, star firms cover nearly 33% and 28% of technological and advertising expenditure, respectively. This highlights the greater focus of the star firms in chemical industries on process innovation. Besides, in the iron and steel industries, star firms show lion's share of technological expenditure, capturing around 56% of the industrial share. This highlights the greater intangible investment concentration in the industries. Similarly, we find that the star firms in plastics product industries cover greater amounts of R&D expenditure, while in the automobile industry such firms invest a larger amount of advertisement expenditure. Overall, the results denote that the star firms spend relatively a greater amount of intangible expenditure within the industries.

We present the asset category of intangibles in Figure 5. The star firms in drugs formulation and vaccine industries occupy around 29% of intangible assets such as goodwill, patent and trademark, etc, while similar firms in iron and steel have approximately 20% of such assets. The star firms in the textile industry have the lowest share of intangible assets among other industries. On average, this analysis indicates unequal asset distribution where star firms occupy a major share in most of the industries.

We apply the Fligner-Policello test industry-wise (shown in Table 4) to confirm the significant difference in investment and assets concentration between the two groups: star and non-star firms. A greater value denotes a larger difference between star and non-star firms, while a negative value signifies the difference between non-star firms and star firms. For instance, the median R&D expenditure of non-star firms is significantly lower than star firms in the food product industries. The results show that the overall investment in intangibles (both asset and expenditure difference) is significantly larger in high-tech industries (such as chemical products and drug formulations and vaccine industries) relative to low-tech industries such as food products and textile industries.

To test the group difference of different intangible investment by industries, we use the Kruskal-Wallis test (shown in Table 5). The results denote a significant difference among the different intangible indicators across the industries, which show the industrial variation in terms of intangible investment behaviour.

Table 4: Investment Difference between Star and Non-star Firms (Fligner-Policello Test)

Industry	U-Statistics				
	Intangible Assets	R&D Expenditure	Advertisement Expenditure	Marketing Expenditure	Technological Expenditure
Food products	–1.446	–3.075**	–9.578***	–13.075***	–9.6***
Textiles	–1.945**	–1.176	–6.594***	–23.592***	–5.27***
Fertilisers	–12.927***	–2.817***	–5.502***	–8.160***	–10.331***
Other chemical products	–8.597***	–18.802***	–33.699***	–27.374***	–20.555***
Drug formulations and vaccines	–18.563***	–14.73***	–28.960***	–42.846***	–14.573***
Plastics products	–4.2***	–13.691***	–17.284***	–26.126***	–11.748***
Iron and steel	–6.309***	–12.883***	–9.586***	–19.781***	–15.972***
Automobile	–8.545 ***	–11.598***	–37.259***	–22.857***	–20.16***

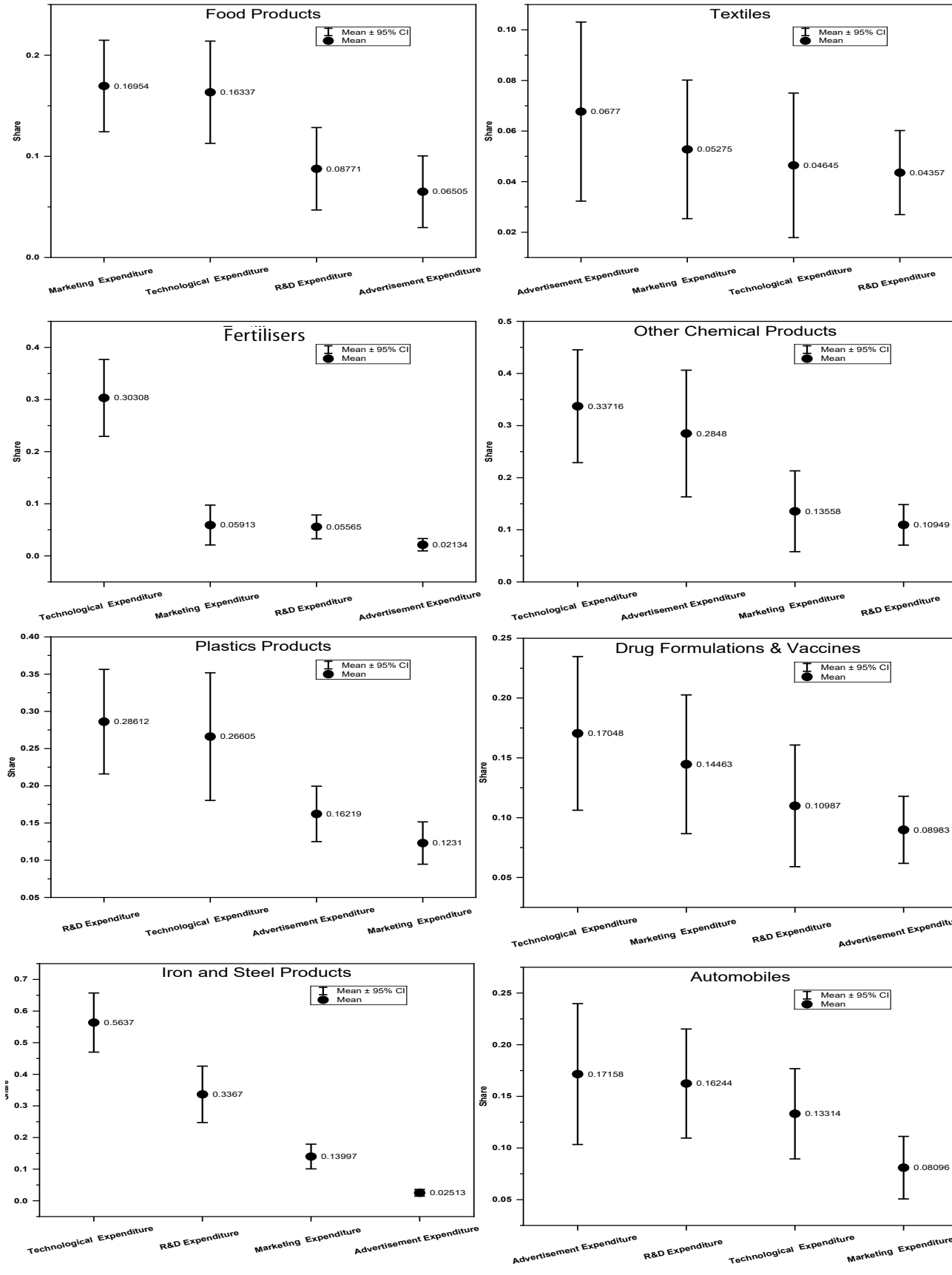
The test assumes the equality of the population medians between star and non-star firms for a particular indicator.
Sources: Authors' estimations.

Table 5: Expenditure-wise Difference between Star and Non-star Firms (Kruskal-Wallis Test)

Kruskal-Wallis Test	Intangible Assets	R&D Expenditure	Advertisement Expenditure	Marketing Expenditure	Technological Expenditure
chi2(7)	871.879	1755.532	1327.539	2496.152	1374.765
Prob	0.0001	0.0001	0.0001	0.0001	0.0001
chi2(7) with ties	873.333	1755.534	1327.564	2496.154	1374.772
Prob	0.0001	0.0001	0.0001	0.0001	0.0001

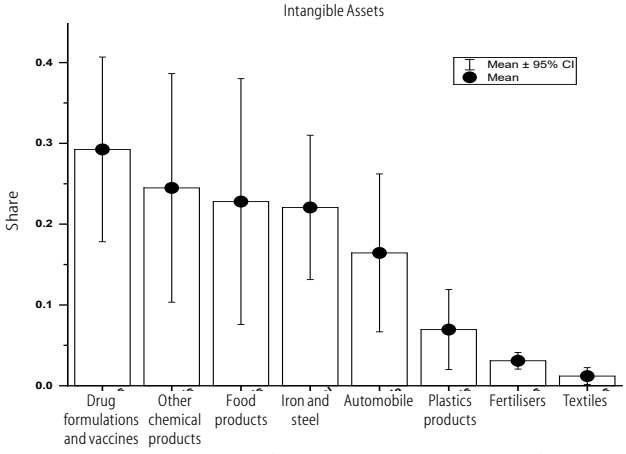
This test reveals the significant differences in different indicators across industries.
Sources: Authors' estimations.

Figure 4: Industry-wise Star Firms' Share in Different Categories of Expenditure



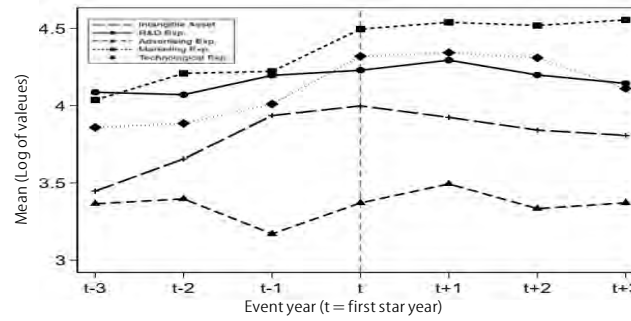
The shares represent the proportion of intangible assets occupied by all-star firms within each industry, where the sum of industrial share equals 1.
Sources: Authors' depiction.

Figure 5: Industry-wise Share of Intangible Assets



The shares represent the proportion of intangible assets occupied by all-star firms within each industry, where sum of industrial share equals 1.
Sources: Authors' depiction.

Figure 6: Investment Trends before and after Achieving Star Status



The figure plots the mean (log) values of different types of investments and assets over time, relative to the first star year ($t = 0$).
Sources: Authors' depiction.

Incidence of Star Firms

The gestation phase of capability accumulation from intangible expenditure and assets can be explained by Figure 6, which shows the pre-star and post-star period of firms' investment trends. The figure depicts the trends of firms' mean (log-transformed) investment values, which shows an upward movement in most of the investment activities leading up to $t = o$ when the firm becomes a star. This also denotes that firms intensify their intangible investments prior to becoming star performers, while investments peak around the star year or subsequent year, reflecting the most productive phase of growth efforts. In subsequent years, the trends stabilise, suggesting that once firms establish their market dominance, their investment continues but at a moderating rate. This pattern highlights the gestation period during which firms build strategic capabilities where pre-star investment behaviour shapes post-star performance and market leadership.

To comprehend the incidence of star firms, we employ a panel logistic regression model using GEE with robust standard errors. Our estimation in Table 6 shows the investment in different intangible expenditures associated with the incidence of star firms. As postulated in specification (1), a one unit increase in intangible assets leads to a 0.08 percentage point probability of transforming an ordinary firm into a star firm. This result aligns with the existing research, which suggests intangible assets like patents and trademarks create a brand value for the firms to enhance their economic value (Ayyagari et al 2024). Specification (3) shows that a one unit rise in lagged R&D expenditure tends to increase the likelihood of being a star firm by about 1.1 percentage point. We find a significant and positive association of R&D expenditure with the occurrence of a star firm, which aligns with the findings of Crouzet and Eberly (2018), where the authors mentioned that the R&D expenditure is positively associated with the rising performance of firms. The result also shows a one unit increase in advertising expenditure in the previous year, leading to the probability of transforming into a star firm by around 0.07 percentage points. We find a similar relation in the case of marketing expenditure, although existing studies demonstrate an increase in the firm's performance with larger advertising and marketing expenditure (Bhangu 2020). Specification (4) denotes significant results for technological expenditure, indicating technological advancement as an underlying force behind the attainment of star status. As the expenditure variables are highly correlated with each other (shown in Appendix Table A II), we constructed as IEI using PCA from all four intangible expenditure variables, such as the log of R&D expenditure, log of advertisement expenditure, log of marketing expenditure and log of technological expenditure. We find

Table 6: Panel Logistic Regression Results of Star Firms (Marginal Effect)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log of intangible assets	0.00869***					
	(0.00101)					
Intangible expenditure index		0.0158***				
		(0.00144)				
Log of R&D expenditure			0.0111***			
			(0.00156)			
Log of advertisement expenditure				0.00723***		
				(0.000837)		
Log of marketing expenditure					0.00794***	
					(0.000805)	
Log of technological expenditure						0.0170***
						(0.00246)
Size set-up	0.0200**	0.0116***	0.0259	0.00805	0.00854*	0.0127
	(0.00968)	(0.00452)	(0.0182)	(0.00606)	(0.00450)	(0.0168)
Log of age	0.0183***	0.00225	0.0242***	0.00238	0.000771	0.0109**
	(0.00474)	(0.00184)	(0.00836)	(0.00234)	(0.00198)	(0.00558)
HHI	-0.459*	-0.303***	-0.480	-0.234	-0.223**	-0.865**
	(0.272)	(0.109)	(0.333)	(0.143)	(0.105)	(0.386)
Competitors	-0.0178	-0.00176	-0.0139	-0.00367	0.00382	0.00387
	(0.0140)	(0.00696)	(0.0226)	(0.0107)	(0.00652)	(0.0224)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	25,238	63,705	14,983	33,688	58,536	11,221
Number of firms	2,721	5,347	1,527	3,583	5,084	1,660
Wald chi2	200.3***	614.6***	177.1***	369***	520.2***	240.4***

*, ** and *** symbolise significance at 10%, 5%, and 1% levels, respectively. Robust standard errors in parentheses.
Source: Authors' estimation.

a positive and significant relationship between IEI and the incidence of the star firm, which shows a one unit increase in IEI in the preceding year, leading to the probability of transforming into a star firm by nearly 0.01% point. We also estimate a linear probability model for a robustness check and find that the outcomes are largely consistent.

We have added controls for the age, size set-up and number of competitors. The age and size set-up have a significantly positive impact on the likelihood of being a star firm, denoting the star firms are incumbent and established firms. Market concentration (HHI) shows a negative relation, indicating firms in more competitive industries (low HHI) get greater opportunity for upward mobility and innovation (Porter and 1980).

Summary and Policy Implications

This study, for the first time, discusses star and superstar firms in the context of Indian manufacturing industries, where the average proportion of star firms has been identified as between 1% to 3% in the respective industries. The percentage of superstar firms is even lower. The empirical enquiry shows that star firms in Indian manufacturing sectors are larger in semi and low-tech industries (textiles and iron and steel product) unlike in developed countries where such firms are larger in high-tech industries (Autor et al 2017). But most of the star firms are shooting stars, which appear in top performers category for a short time rather than showing persistent performance. Superstar firms, which are more consistent in performance over the time, are greater in mid- and high-tech industries (drug formulations and vaccines and automobiles). One can claim that higher technology-based firms occupy continuous dominance over time.

Furthermore, the Indian manufacturing sector shows a unique scenario of market structure and the dynamics of competition where the number of firms (both star and non-star) is expanding unlike the shrinking in developed countries. This structure is likely to boost the economic growth by creating backward and forward linkages. Like, Pyo and Lee (2018) find about South Korea's big businesses (Hyundai Motor, Samsung Electronics) that significantly impact the growth rate of vendor SMEs. Similarly, the spillover effect and value chain linkages of large firms contribute to the growth of other firms (Ciani et al 2020). In addition, policy provision on entrepreneurship such as start-ups India, digital public infrastructure encourages the growth of start-ups while subsidies and tax incentives push the star firms. The institutional arrangements of rapid scaling provide substantial space for new businesses to expand and technological catch-up opens the door for new leaders.

The second part of our findings denotes that star firms (both in high- and low-tech sector) devote a larger percentage of their budget on intangible investment, which also is a driver of their star stature. Thus, intangible investment creates competitive advantage and superstar premium and accordingly, firms need to focus on such cost-effective investment. Corporate decision-makers need to enhance resource allocation towards intangibles by identifying their capabilities—such as R&D capacity, marketing strategy and technological advancement that are vital for enhancing long-standing success. Since star firms also exhibit industry-specific behaviour, corporates need to tailor their growth approaches accordingly. For instance, in technology-driven industries, emphasis on R&D is critical, whereas food product companies should focus on advertising and marketing, while drugs formulation companies need to prioritise R&D, patenting and brand-building.

The greater market power of a few may put the status quo under a monopoly where the small businesses may struggle for survival. In such a situation, a robust regulatory mechanism sustains competitiveness. Further, the rapid replacement of fixed and intangible investment in place of tangible investment will be a concern for the developing countries like India, which is abundant in unskilled labour, and the economy may encounter the scarcity of technological capital. So, policy measure should also emphasise on skilled upgradation and technological use.

In conclusion, the study specifies that the increasing specialisation of intangible investment acts as both the driving force and the driven outcome of the emergence of star firms. As the intangible investments like R&D and technological investment generate a positive spillover and externalities, future studies can explore the spillover effect of star and superstar firms. Lastly, the emergence of star firms has implications for innovation, competition, and employment, among others, that need to be investigated by future studies.

NOTES

1 Superstar firms are the highly productive firms, which have a larger market share and greater profit margin in the industries (Autor et al 2020; Behera and Sharma 2024).

2 Ayyagari et al (2018) define the star firms as the highly productive large firms in a particular year where superstar firms are consistent star performers for at least five years.

3 The number of stars and superstar is also calculated for each industry over time but not presented due to the paucity of space.

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Annexure

Table A I: Overall Descriptive Statistics

Variable	Observations	Mean	Std. dev.	Min	Max
Star firms	78,524	0.011716	0.107606	0	1
Superstar (three years)	78,524	0.005718	0.075401	0	1
Superstar (five years)	78,524	0.003426	0.05843	0	1
Markup	78,524	-3.33399	95.70233	-16720.4	1
Market share	78,524	0.002445	0.008253	9.30E-09	0.327292
Log of intangible assets	27,662	1.676905	1.893844	0	12.7223
Log of advertisement expenditure	35,877	1.308239	1.682154	0	10.40161
Log of marketing expenditure	62,303	2.132527	1.681314	0	10.41897
Log of R&D expenditure	15,828	2.326491	1.823268	0	9.785259
Log of technological expenditure	11,990	1.883403	1.880089	0.056944	11.33289
Size set-up	78,524	8.856541	0.727383	7.030274	10.52494
Log of age	78,490	3.09485	0.701381	0	5.081404
HHI	78,524	0.028001	0.018523	0.009256	0.132474
Number of competitors	78,524	6.06544	0.316629	4.787492	6.584791
Sales	78,524	3448.084	17562.42	0.070522	1031121
Salaries and wages	77,153	2415.387	42759.46	0	4559345
Power and fuels	74,952	183.6043	1267.175	0	81108.64
Raw materials	76,079	1748.011	7533.338	0	469412.9

Source: Authors' estimation.

Table A II: Correlation Matrix and Variance Inflation Factor

Variables	Correlation Coefficients					VIF	
	(1)	(2)	(3)	(4)	(5)	VIF	1/VIF
Log of advertisement expenditure (1)	1					2.17	0.4603
Log of marketing expenditure (2)	0.6139	1				1.43	0.6985
Log of R&D expenditure (3)	0.4431	0.386	1			1.54	0.648
Log of technological expenditure (4)	0.6015	0.4135	0.4465	1		1.73	0.5774
Log of intangible assets (5)	0.3672	0.3191	0.3591	0.2478	1	1.63	0.6133

Source: Authors' estimation.

Does Competition Spur Investment?
Evidence from India's Manufacturing Industries

HARENDRA KUMAR BEHERA, PAWAN GOPALAKRISHNAN, ABHINAV NARAYANAN

This paper examines whether greater market competition stimulates investment. Cross-country evidence suggests that higher levels of competition are associated with increased investment rates, particularly in emerging economies and in contexts characterised by low baseline investment. Industry-level evidence from India's manufacturing sector similarly indicates a positive association between competition and investment. Notably, the effects of competition appear to be concentrated in export-oriented and digitally intensive industries. From a policy perspective, these findings point to the need for an industrial strategy that integrates competition policy with targeted investment incentives to support sustained investment growth.

Over the past decade, India's manufacturing sector has experienced a notable deceleration in investment activity despite a relatively stable macroeconomic environment and sustained policy efforts to promote industrial growth. The share of manufacturing in gross domestic product (GDP) has remained largely stagnant, around 15%–17%, while gross fixed capital formation has weakened since the early 2010s. This slowdown has persisted notwithstanding major policy initiatives such as "Make in India" (2014), production-linked incentive (PLI) schemes, and an improvement in ease of doing business indicators. The subdued investment response raises important questions regarding the structural determinants of investment behaviour and the evolving nature of market competition within Indian industry.

A growing body of literature suggests that insufficient competition and rising market concentration may be contributing to the subdued investment climate. The increasing dominance of a few large firms in key industries—often part of diversified business groups—may have raised entry barriers, constrained market dynamism, and dampened investment incentives for smaller firms (Acharya 2023). Conversely, greater competition may stimulate investment by improving efficiency, encouraging innovation, and promoting capital deepening. However, empirical evidence on the relationship between competition and investment in the Indian context remains limited, particularly at the industry level. By documenting both the evolution of market structure and its relationship with investment, this paper contributes to the existing literature in three ways.

First, it examines the relationship between competitiveness and investment across advanced and emerging economies using longitudinal data for 1980–2024. The analysis seeks to assess whether higher competitiveness—measured using the Organisation for Economic Co-operation and Development's (OECD) relative price-based index—is associated with stronger investment activity, after controlling for foreign direct investment (FDI) inflows and country-specific heterogeneity.

Second, it provides updated evidence on the evolution of market competition in Indian manufacturing during 2012–22, a period marked by significant policy and structural changes. By constructing industry-level Herfindahl–Hirschman indices (HHIs) and combining them with investment data from the Annual Survey of Industries (ASI), the study directly links measures of competition to investment behaviour—an area that remains relatively underexplored in the Indian context.

Views expressed in this paper are of the authors and do not necessarily represent those of the Reserve Bank of India.

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The findings complement the broader discourse on India's investment slowdown, suggesting that while competitive intensity is an important determinant, a revival in investment is likely to depend on a combination of factors, including macroeconomic stability, demand recovery, access to finance, and institutional reforms. In this respect, the study extends the literature on industrial organisation and investment dynamics in emerging economies and offers policy-relevant insights for the design of competition and investment promotion frameworks in India. The remainder of the paper is organised as follows. It first reviews the literature on market competition and investment. It then presents cross-country evidence on the relationship between competitiveness and investment. Subsequently, it discusses the findings for Indian manufacturing. And finally, the paper concludes.

Literature Review

The relationship between market competition and investment has long occupied a central position in the literature on industrial organisation and corporate finance. Classical theories posit that greater competition enhances efficiency and induces firms to invest in innovation and productivity improvements (Schumpeter 1942; Arrow 1962). Competitive pressures can strengthen incentives for firms to expand capacity or upgrade technology in order to sustain profitability, thereby contributing to higher aggregate investment. At the same time, the Schumpeterian notion of "creative destruction" emphasises that competition facilitates the reallocation of resources towards more productive firms, reinforcing dynamic efficiency over the long run.

Models of imperfect competition emphasise that the impact of competition on investment is contingent on market conditions, financing constraints, and the irreversibility of capital (Aghion et al 2005; Vives 2008). On the one hand, greater competition can increase expected returns to efficiency-enhancing investment when entry threats are credible and access to finance is adequate. On the other hand, intensified competition may compress profit margins, reduce internal funds, and thereby dampen investment incentives, particularly in financially constrained environments. Bustamante and Donangelo (2017) highlight that competition generates offsetting "investment" and "operating leverage" effects, leading to ambiguous aggregate outcomes. Consequently, whether competition promotes or discourages investment remains an empirical question, contingent on the degree of market power, the level of financial development, and the broader policy environment. Empirical evidence from advanced economies presents a mixed picture. Gutiérrez and Philippon (2017) document that rising market concentration and declining competition in the United States have been associated with weak corporate investment despite high profitability, suggesting that excessive market power may discourage new capital formation. In contrast, cross-country studies indicate that, in well-functioning market environments, greater competition is often associated with higher productivity and investment (Nicoletti and Scarpetta 2005).

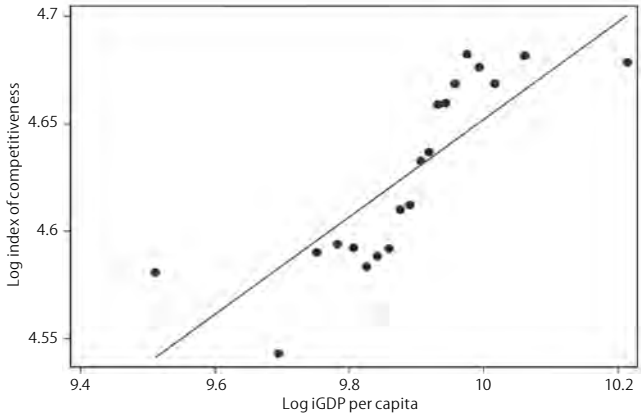
For emerging economies, the empirical evidence remains limited, though it is gradually expanding. Olalere and Mukuddem–Petersen (2023) find that product-market competition significantly influences corporate investment decisions in BRIC economies, although the relationship is moderated by economic policy uncertainty. Their results suggest that the impact of competition on investment is critically conditioned by institutional and financial factors. Frésard and Phillips (2024), further emphasise that firms' financing and investment decisions are shaped by the competitive environment, implying that credit market frictions can amplify the real effects of market structure.

In the Indian context, the question of whether weak competition has contributed to the investment slowdown has received renewed attention. Following the post-liberalisation reforms of the 1990s, India witnessed a gradual reduction in entry barriers and an expansion of private manufacturing capacity. However, since the early 2010s, gross fixed capital formation in manufacturing has decelerated, even as the policy environment has become more liberal. A number of studies point to the increasing dominance of large business groups and limited mobility among smaller firms as structural constraints on competition and investment (Pushpangadan and Shanta 2006; Saraswathy 2022). Mishra (2008) finds a positive association between market concentration and mark-ups in Indian manufacturing, suggesting the persistence of oligopolistic structures. More recent analyses highlight increasing consolidation within key industries through mergers, acquisitions, and group affiliations (Saraswathy 2022). Prabhakar et al (2025) similarly observe that the manufacturing sector continues to exhibit weak competitiveness despite policy efforts, with relatively high concentration in industries such as automobiles, steel, and cement. Galle (2020), using firm-level evidence, shows that financial constraints can attenuate the positive effects of competition on capital accumulation, underscoring that competition alone may be insufficient to stimulate investment in the presence of imperfect credit markets. Taken together, the evidence suggests that while competition may enhance efficiency and stimulate investment at the industry level, structural rigidities and the concentration of market power among large firms can create entry barriers that constrain investment by smaller firms. This pattern is consistent with India's broader macroeconomic experience of a declining investment rate despite improvements in competitiveness indicators in certain industries.

Cross-country Evidence

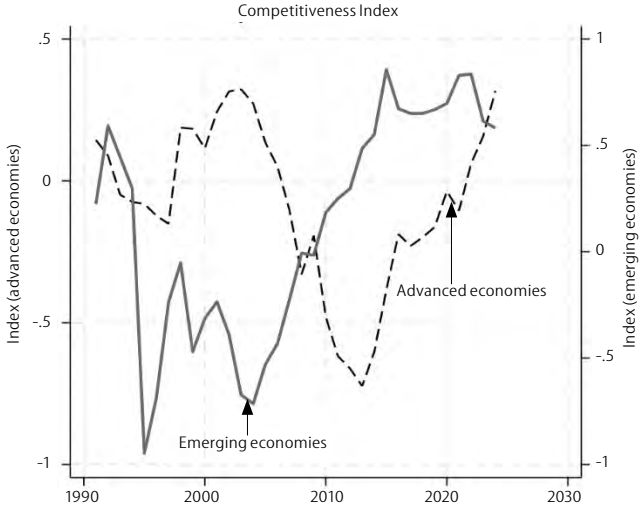
The relationship between competitiveness and economic development across countries is central to understanding long-run growth outcomes and structural differences between advanced economies and emerging market economies (EMEs). Figure 1 (p 92) presents a bin scatter plot of GDP per capita (sourced from the World Bank) and a competitiveness index derived from the OECD database for a panel of 46 countries over the period 1980–2024, comprising 32 advanced economies and 14 EMEs. The competitiveness index is constructed by the OECD on the basis of relative prices.[1] Each observation in the scatter plot represents the average competitiveness score within a given range ("bin") of GDP per capita values, which also serves

Figure 1: GDP Per Capita versus Competitiveness



Source: WDI, OECD; authors' calculations.[2]

Figure 2: Competitiveness—Advanced versus Emerging Economies



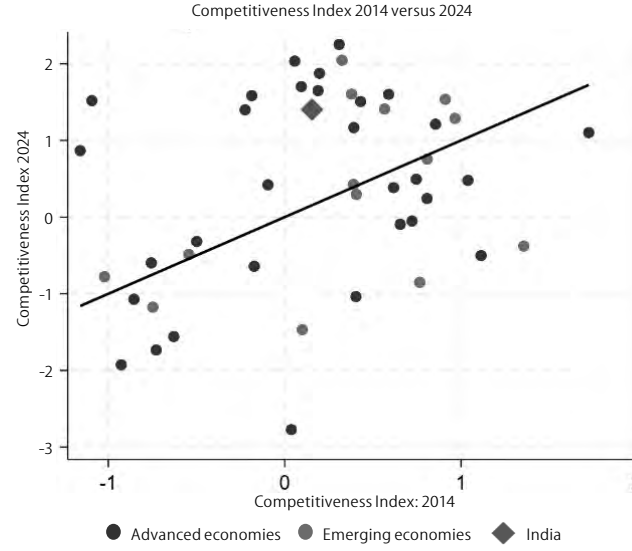
Source: WDI, OECD; authors' calculations.

as a proxy for labour productivity. As shown in Figure 1, there is a clear positive relationship: higher levels of GDP per capita are associated with greater competitiveness. This finding is consistent with the broader proposition that more advanced economies tend to exhibit more efficient markets, stronger institutions, better developed infrastructure, and higher levels of innovative capacity.

While a positive association between per capita GDP and competitiveness is evident, it is also pertinent to examine how the evolution of competitiveness in EMEs compares with advanced economies. Figure 2 presents a comparison of the time-series trends in the competitiveness index for advanced economies and EMEs.

It is observed that from the 1990s until the late 2000s, advanced economies exhibited higher levels of competitiveness than EMEs. However, following the global financial crisis (GFC), EMEs began to narrow this gap and eventually overtake advanced economies.[3] During the post-GFC period up around 2021, competitiveness in EMEs remained significantly higher than in advanced economies, reflecting improvements in institutional frameworks and deeper integration into global value chains. In the period following the COVID-19 pandemic—marked by heightened geopolitical tensions and repeated

Figure 3: Evolution of Competitiveness



Source: OECD and authors' calculations.

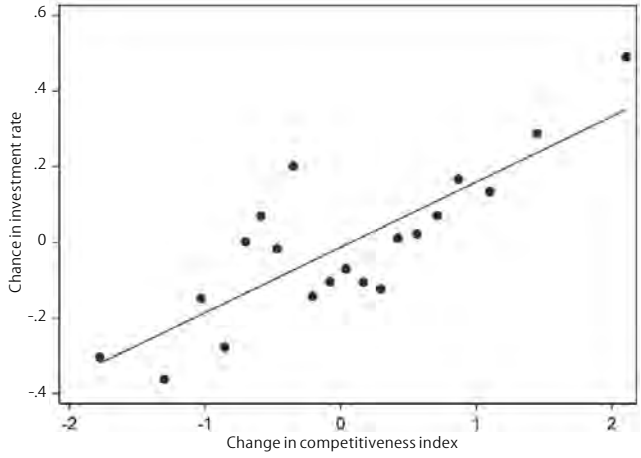
disruption to global supply chains—competitiveness in EMEs appears to have become more volatile and, in recent years, has fallen below that of advanced economies. This shift underscores the heightened vulnerability of emerging economies to global shocks and structural disruptions.

India's competitiveness has improved steadily over time, particularly over the past decade, reflecting progress in physical and digital infrastructure, fiscal consolidation, monetary policy reforms, and the anchoring of inflation expectations. Figure 3 presents a scatter plot comparing the evolution of competitiveness between advanced economies and EMEs during 2014–24.

As indicated in Figure 3, several advanced economies have recorded significant improvements over the past decade. In contrast, relatively fewer EMEs have experienced comparable gains. Among the EMEs that have improved, India stands out for its notable progress. However, the extent of India's improvement remains broadly comparable with that observed in several EMEs as well as in a subset of advanced economies.

The positive association between competitiveness and GDP per capita suggests that more competitive economies tend to be richer, more productive, and structurally more efficient. However, understanding how competitiveness translates into higher economic activity requires an examination of its direct impact on one of the core components of economic activity, that is, investments. Specifically, as improvements in competitiveness for aggregate demand, namely investment. Improvements in competitiveness—reflecting more efficient resource utilisation—can have favourable effects on economic activity, particularly through domestic investment and international trade. Higher competitiveness may stimulate domestic investment through several channels, including enhanced business confidence, productivity gains, and a more credible policy environment. Figure 4 (p 93) presents a bin scatter plot of changes in the country-level competitiveness index against the changes in the investment rate. The results indicate that, after controlling for FDI inflows as a share of GDP, as well as

Figure 4: Competitiveness versus Investment Rates



country and year fixed effects, an increase in competitiveness is associated with higher investment rates.

An important question is whether this relationship differs between advanced and emerging economies. To examine this, baseline panel regressions are estimated of the following form:

$$I_{i,t} = \alpha_i + \gamma_t + \beta_1 . Comp_{i,t} * D_i + \beta_2 . FDI_{i,t} + \epsilon_{i,t} \quad \ldots (1)$$

where $I_{i,t}$ is the standardised investment rate of country i, α_i is the country fixed effect, γ_t is the year fixed effects, $Comp_{i,t}$ is the standardised country-level competitiveness index of country i, D_i takes the value if country i is an EME. $FDI_{i,t}$ is the standardised FDI rate received by country i and is an additional control. Note that β_1 is the coefficient of interest. Finally, $\varepsilon_{i,t}$ is the residual.

The results, reported in Table 1, provide consistent evidence of a positive association between competitiveness and investment. The column labelled "all countries" corresponds to a panel regression estimated for all countries without categorising them into EMEs or non-EMEs, whereas the column "with EME dummy" includes a dummy variable that is interacted with competitiveness. It is found that when controlling for FDI inflows, a higher country-level competitiveness corresponds to higher investment rates. Specifically, a 1 standard deviation increase in competitiveness raises investment rates by 0.17 standard deviations. When including an interaction with an EME dummy, the effect rises to 0.252 for EMEs, compared to 0.144 for advanced economies. FDI inflows remain significant, with coefficients of around 0.10, indicating complementarity between competitiveness and external capital. Overall, the results suggest that the investment-enhancing effects of competitiveness are more pronounced in emerging economies than in advanced economies.

Table 1: The Impact of Competitiveness on the Investment Rates

	All Countries	With EME Dummy
Competition index	0.173***	0.144***
	(0.026)	(0.028)
EME # competition index		0.108*
		(0.065)
FDI (share of GDP)	0.101***	0.102***
	(0.025)	(0.025)
Constant	-0.014	-0.013
	(0.022)	(0.022)
Country FE	Yes	Yes
Year FE	Yes	Yes
N	1713	1713
R2	0.22	0.23

Robust standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

In a cross-country context, the relationship between competitiveness and investment is unlikely to be uniform across countries. Given the differences in structural characteristics and policy environments, the effect of competitiveness on investment may vary across the distribution of investment rates. Countries located at the lower end of the investment distribution—typically low-income or structurally constrained economies—may exhibit greater sensitivity to improvements in competitiveness, as reductions in input costs, enhanced market access, and improved profitability can more directly facilitate investment decisions. In contrast, countries with relatively high investment rates—often advanced economies or rapidly growing emerging economies—may experience smaller marginal effects, as many enabling conditions are already in place and investment decisions are increasingly driven by technological change rather than relative price competitiveness. To examine this potential non-linearity, a quantile regression framework is employed of the following form:

$$I_{i,t}(\tau|\alpha_i, \gamma_t) = \alpha_i + \gamma_t + \beta_1(\tau).X_{i,t} + \beta_2(\tau).FDI_{i,t} + \epsilon_{i,t}(\tau) \quad \ldots (2)$$

where $I_{i,t}(\tau|\alpha_i, \gamma_t)$ is the conditional τ^{th} quantile of the dependent variable, which is the standardised investment rate of country i; α_i is the country fixed effect; γ_t is the year fixed effects; $X_{i,t}$ is the standardised country-level competition index of country i; $FDI_{i,t}$ is the standardised FDI rate received by country i and is an additional control. Note that $\beta_1(\tau)$ and $\beta_2(\tau)$ are the quantile-specific slope coefficients that vary with τ. Finally, $\varepsilon_{i,t}(\tau)$ is the residual associated with the τ^{th} quantile.

The results indicate that improvements in competitiveness have a stronger effect on countries with lower levels of investment than on those with higher investment rates. In particular, at the lower quantiles of the investment distribution—corresponding to countries and periods characterised by weak investment—competitiveness exerts a larger positive impact. At higher quantiles, this effect diminishes, suggesting the presence of declining marginal returns. This pattern is consistent with the distinction between EMEs and advanced economies, as EMEs are more likely to be concentrated in lower investment regimes where gains in competitiveness yield proportionately larger benefits. These findings are in line with the results reported in

Figure 5: Impact of Competitiveness across Different Investment Regimes

Quantile regression estimates with 95% CI

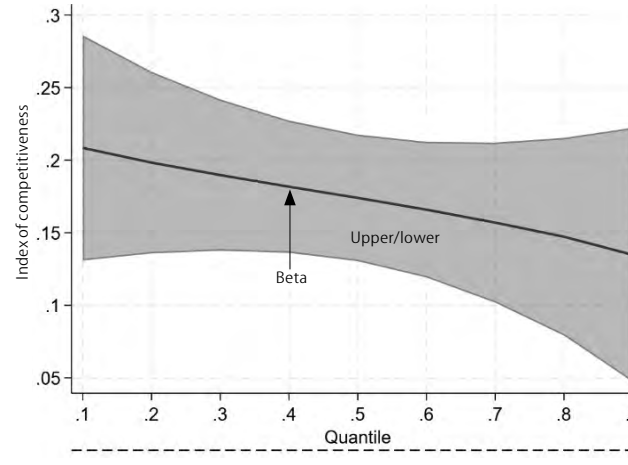


Table 1, which also indicate stronger investment responses to competitiveness in EMEs relative to advanced economies.

Evidence from Indian Manufacturing

While the cross-country analysis presented in the previous section provides broad empirical support for a positive association between competitiveness and investment, the magnitude and transmission channels of this relationship are likely to be context-specific. In the Indian case—characterised by a distinct macroeconomic environment, evolving competitiveness, and policy on promoting investment—it is important to assess whether these cross-country findings hold at the domestic level and to identify the underlying mechanisms. Accordingly, this section examines the relationship between market competition and investment activity in India's manufacturing sector using firm-level data from the ASI for 2012–22. Market concentration is measured using the HHI constructed at the three-digit industry level, while investment intensity is proxied by the ratio of gross capital formation to gross value added. The HHI is measured as follows:

$$\mathrm{HHI}_{j,t} = \sum_{i=1}^{N} (s_{i,j,t})^2 \quad \text{for } \forall\, j \in \text{(NIC 3 digit codes)}$$

where:

$s_{i,j,t}$ = market share of firm i in the industry j in year t

N = total number of firms in the industry j

$$s_{i,j,t} = \frac{weight_{i,j,t} \cdot GVA_{i,j,t}}{\sum_{i=1}^{N} (weight_{i,j,t} \cdot GVA_{i,j,t})}$$

A lower (higher) value of the HHI indicates a more (less) competitive market structure. Accordingly, the analysis employs a transformed measure, defined as *Competition = 1–HHI,* such that higher value corresponds to greater competition. The evolution of this measure across manufacturing industries over the period 2011–23 (Figure 6) indicates a gradual decline in market concentration and an increase in competitive intensity. This pattern appears to be broad-based, suggesting a general easing of entry barriers and greater exposure to competitive pressures across sectors.

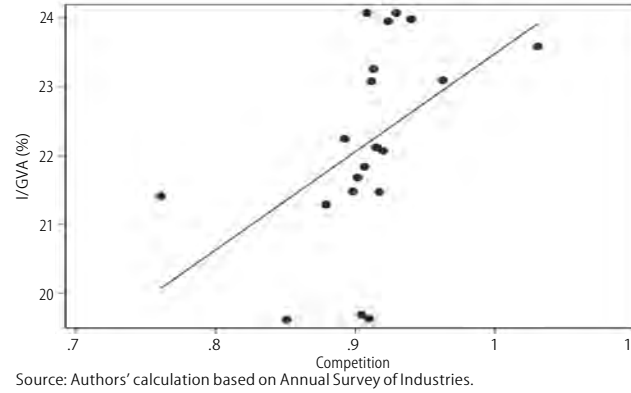
To examine the relationship between market competitiveness (measured as 1–HHI) and investment intensity across Indian manufacturing industries, a partial correlation is estimated after controlling for industry and year fixed effects. The resulting scatter plot, along with the fitted regression line, indicates a positive association: industries characterised by higher levels of competition tend to exhibit higher investment (Figure 7). At the same time, the dispersion of observations points to considerable heterogeneity across industries. The upward-sloping trend suggests that competitive pressures can, in general, stimulate capital formation, consistent with theoretical expectations that firms in more competitive environments must invest to maintain or expand market share. However, the aggregate decline in investment over 2012–22 indicates that rising competition has not translated into a broad-based investment revival. The relatively weak within-industry correlation suggests that micro-level incentives arising from competition may be offset by broader

Figure 6: Market Competition in India's Manufacturing Sector over Years

Source: Authors' calculation based on Annual Survey of Industries.

Figure 7: Relationship between Competitiveness and Investment Rates

(Controlling for industry and time fixed effects and other control variables)



Source: Authors' calculation based on Annual Survey of Industries.

macroeconomic and structural constraints, including subdued demand conditions, credit frictions, and policy uncertainty.

The analysis next explores the mechanisms underlying the relationship between competition and investment rates, with particular attention to whether this association is stronger for export-oriented and digitally intensive industries. Industries with a higher export orientation are typically better positioned to scale up production, enhance productivity through innovation, and adapt to more stringent quality standards compared to those primarily serving domestic markets. In such contexts, increased competitive pressure may induce firms to undertake higher investment in plant, machinery and product upgrading in order to remain competitive. To examine this hypothesis, the following empirical specification is estimated. In addition, the sample is partitioned into industries below and above the median export share, allowing for a comparison of the impact of competition across the two groups.

$$\mathrm{InvRate}_{i,t} = \beta_1.\mathrm{Comp}_{i,t} + \beta_2.\mathrm{ExportShare}_{i,t} + \beta_3.(\mathrm{Comp}*\mathrm{ExportShare})_{i,t} + \gamma.X_{i,t} + \mu_j + \lambda_t + \tau_k.t + \epsilon_{i,t} \quad \ldots (3)$$

where

$InvRate_{i,t}$: Investment rate of industry in year

$Comp_{i,t}$: Competition measure

$ExportShare_{i,t}$: Export share in total output

$X_{i,t}$: Vector of industry-level controls

μ_j : NIC-3 fixed effects

λ_τ : Year fixed effects

$\tau_k.t$: NIC-2-specific year trend

$\varepsilon_{i,t}$: Error term

A similar line of inquiry is pursued for digitally intensive industries. Such industries may be better positioned to scale up in response to increased competition, as competitive pressures can amplify the importance of intangible assets such as skills, technology, and organisational capabilities in producing higher-quality products. In this context, increased investment may facilitate the embedding of these intangibles into strategic and technological upgrading. To test this hypothesis, the following empirical specification is estimated.

$$\text{InvRate}_{i,t} = \beta_1.\text{Comp}_{i,t} + \beta_2.\text{DigShare}_{i,t} + \beta_3.(\text{Comp*DigShare})_{i,t} + \gamma.X_{i,t} + \mu_j + \lambda_t + \tau_k.t + \epsilon_{i,t} \quad \ldots (4)$$

where $DigShare_{i,t}$ denotes the digital intensity of a sector, measured as the share of investments in computers, software and hardware in total investments. The remaining variables retain the same interpretation as in equation (3). As in the previous specification, the analysis also examines whether the association between investment and competition is stronger for industries with above the median share of digital investment.

Table 2 presents the results from the estimation of specification (3). Column (1) indicates that, on average, competition is positively and statistically significantly associated with the investment rate, suggesting that industries facing greater competitive pressures are more likely to invest in productive capacity.

The interaction term between competition and export share is not statistically significant, suggesting that export intensity does not materially alter the baseline relationship between competition and investment. However, splitting the sample into industries below and above the median export share reveals notable heterogeneity. Among industries with below-median export orientation (column 2), the coefficient on competition remains positive but not statistically significant, indicating that industries with limited exposure to international markets respond less strongly to competitive pressures in their investment decisions. In contrast, the effect of competition is more pronounced among high-export industries (column 3), where the estimated coefficient is larger than in the full sample and remains statistically significant. This suggests that industries more integrated into global markets are better positioned to scale up investment in response to increased competition, possibly reflecting stronger productivity dynamics, greater market opportunities, and enhanced incentives for innovation.

The industry-level control variables generally exhibit weak or statistically insignificant effects on investment, with operating expenses showing a marginally positive association only in the full sample. Overall, the results suggest that competition functions as an effective catalyst for investment primarily in export-oriented industries.

Table 3 presents the results from the estimation of Specification (4). The coefficient on competition is positive and statistically significant at the 5% level. However, neither the digital intensity variable nor its interaction with competition is statistically significant, suggesting that digital intensity does not fundamentally alter the average relationship between competition and investment rates. However, splitting the sample into industries with below- and above-median digital investment shares reveals important heterogeneity. For industries with below-median digital investment shares (column 2), the association between competition and investment remains positive but is not statistically significant, suggesting that such industries may face capacity constraints or limited productivity spillovers that inhibit a strong investment response

Table 2: Does Competition Matter More for Export-intensive Industries?

	Exports Share	Below-median Exports	Above-median Exports
	(1)	(2)	(3)
Competition	12.392**	4.546	30.666**
	(6.018)	(9.909)	(12.473)
Exports share (%)	-0.171		
	(0.295)		
Competition # exports	0.032		
share (%)	(0.411)		
Employess (Ln)	-3.677	-4.734	2.157
	(2.626)	(4.445)	(2.522)
Loans (Ln)	-0.215	1.369	-1.506
	(0.954)	(1.118)	(1.622)
Op expenses (Ln)	2.194*	1.103	-0.161
	(1.305)	(1.831)	(1.391)
Constant	7.413	12.602	8.615
	(21.507)	(24.350)	(32.794)
NIC3 FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
NIC2*YearTrend	Yes	Yes	Yes
N	946.00	484.00	438.00
Clusters	73.00	54.00	51.00
R2	0.48	0.55	0.51

Standard errors are clustered at the NIC-3 level.
* p<0.10, ** p<0.05, *** p<0.01.

Table 3: Does Competition Matter More for Digital-intensive Industries?

Measure of Digitalisation: I(Computer Equipment including software)/Total I in period *t*

	Digital Share (I)	Below-median Digital I (Contemp)	Above-median Digital I (Contemp)
	(1)	(2)	(3)
Competition	13.623**	11.555	17.384**
	(6.634)	(9.471)	(7.587)
Digital share (% in I)	0.088		
	(0.235)		
Competition # digital	-0.077		
share (% in I)	(0.358)		
Employees (Ln)	-3.874	-4.534	-3.020
	(2.551)	(3.646)	(3.774)
Loans (Ln)	-0.116	-1.246	-0.476
	(0.900)	(1.224)	(1.351)
Op expenses (Ln)	2.115*	5.687***	1.451
	(1.236)	(2.106)	(1.521)
Constant	7.262	-33.635	13.697
	(21.376)	(34.866)	(24.191)
NIC3 FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
NIC2*YearTrend	Yes	Yes	Yes
N	946.00	467.00	459.00
Clusters	73.00	55.00	50.00
R2	0.48	0.54	0.45

Standard errors are clustered at the NIC-3 level.
* p<0.10, ** p<0.05, *** p<0.01.

to competitive pressures. In contrast, among industries with above-median digital investment shares (column 3), competition exerts a large and statistically significant effect on investment. This finding underscores the role of digital capabilities in amplifying investment responsiveness, consistent with the view that technologically advanced industries are better able to leverage competition as a catalyst for efficiency-enhancing expansion. As a robustness check, digital intensity is alternatively measured using the capital stock and lagged values of digital investment shares within a similar empirical framework. The results remain qualitatively unchanged. These estimates are reported in Appendix Table A1.

Conclusion and Policy Implications

The analysis indicates that, although competitive intensity has increased across India's manufacturing industries over the past decade, investment has not kept pace. While industries characterised by higher levels of competition tend, on average, to exhibit higher investment rates, increases in competitiveness within industries have not translated into a commensurate rise in investment. The positive effects of competition appear to be concentrated in export-oriented and technologically advanced industries. These findings suggest that promoting competition, in isolation, may be insufficient to revive private investment. Complementary reforms—such as improving access to finance, strengthening infrastructure, stimulating demand, and ensuring regulatory stability—are necessary to translate competitive pressure into sustained capital formation. From a policy perspective, this underscores the importance of a comprehensive industrial strategy that integrates competition policy with targeted investment incentives and support for innovation.

NOTES

1 The OECD measures international competitiveness primarily using two indicators—relative prices and relative labour costs. Adjusted for nominal exchange rates, these are equivalent to real effective exchange rates (REER). This index captures differences in general price levels across countries, thereby providing a measure of the relative costs of goods and services (https://www.oecd.org/en/data/indicators/price-level-indices.html).

2 The bin scatter plot is constructed from a panel regression of the logarithms of real GDP per capita on the logarithm of the competitiveness index, controlling for year and country fixed effects.

3 The competitiveness index for advanced economies and EMEs in Figure 2 is computed as a weighted average of the standardised competitiveness index for each group, with real GDP (at constant prices) used as weights.

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Appendix Table A1: Does Competition Matter More for Digital-intensive Industries?

Measure of Digitalisation: K (Computer equipment including software)/ Total K in period *t-1*

	Digital Share (K Lag)	Below Median Digital K (Lag)	Above Median Digital K (Lag)
	(1)	(2)	(3)
Competition	14.082**	8.081	18.719*
	(7.014)	(14.337)	(10.210)
Digital share (% in K–1)	0.694		
	(0.688)		
Competition # digital share (% in K–1)	-0.760		
	(0.854)		
Employess (Ln)	-2.901	-4.720	-0.806
	(2.801)	(3.801)	(5.356)
Loans (Ln)	-0.287	1.557	-0.482
	(0.949)	(1.430)	(1.157)
Op expenses (Ln)	1.529	5.102**	-0.104
	(1.244)	(2.010)	(1.658)
Constant	13.058	-84.861**	24.549
	(21.778)	(40.559)	(42.269)
NIC3 FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
NIC2*YearTrend	Yes	Yes	Yes
N	873.00	495.00	425.00
Clusters	73.00	52.00	45.00
R2	0.48	0.51	0.44

Standard errors are clustered at the NIC-3 level.
* p<0.10, ** p<0.05, *** p<0.01.

Industrial Growth and Environmental Degradation

Evidence from India's Core Industries

NIVAJ GOGOI, FARAH HUSSAIN

The primary objective of the study is to investigate the relationship between industrial growth and environmental degradation, with reference to the environmental Kuznets curve hypothesis, in the context of the Indian core industries. Both the traditional inverted U-shaped and the contemporary N-shaped industrial EKC have been empirically tested to understand the long-term environmental impact of the core industries' growth. The findings indicate that even though the core industries' growth is expected to help momentarily improve environmental quality for a duration, failing to emphasise the innovation of industrial products and processes can cause further ecological imbalance in the long run.

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Industrialisation has become a critical economic and environmental issue for the world in recent decades. Developing countries have been prioritising industrialisation to establish stronger economies, while causing severe damage to their environmental conditions. Industries around the world have become a major source of pollution that has started affecting the global environmental well-being, too. Higher carbon emissions, sea-level rise, acidification of the oceans, extreme weather conditions, etc, are a few of the burning ecological issues that demand serious attention from mankind. International organisations have also started spreading awareness on these critical issues, appealing to the countries to take necessary steps to minimise such devastating environmental effects as soon as possible. As per reports, an average of 1.1°C surge above the pre-industrial levels has been caused in the global temperature during 2011–20, primarily due to the greenhouse effect (World Meteorological Organization 2023). In the Paris Agreement 2015, the countries were asked to keep the temperature increase well below 1.5°C to ensure long-term global environmental health (IPCC 2019, 2021; United Nations 2015). Considering that, it is high time that countries adopt sustainable industrial practices for the safe survival of all living beings.

Industries are often considered major pollution sources that encourage high pollutant emissions. It has become an inevitable element for developing nations to foster economic growth, which poses a great threat to the countries' environmental conditions. Therefore, the assessment of these industries' ecological impact has become vital for the well-being of these nations. In this context, the environmental Kuznets curve (EKC) hypothesis has received significant attention from researchers (Grossman and Krueger 1995; Kuznets 1955). It indicates that economic growth leads to greater environmental degradation in the initial period of growth. When a certain level of growth is attained, sustainable economic growth reduces stress on the environment, portraying an inverted U-shaped curve between economic growth and environmental degradation. The contemporary literature also hints at an N-shaped EKC (2020), where it is argued that the nation once again tends to cause environmental destruction while it continues to achieve further economic growth. After a certain point, the existing technologies and energy structure start failing to accommodate the growing production levels of industries. Nevertheless, the EKC hypothesis can potentially be applied at the industrial level to identify how industrial

growth affects the level of environmental degradation in a particular country. However, very few have tested the industry-specific EKC (IEKC) hypothesis in the context of various industries. It leads to the formulation of the following research questions, which have been primarily addressed in the study:

RQ_1: Is there a significant relationship between industrial growth and environmental degradation in the core industries of India?

RQ_2: Is there a bidirectional causal relationship between industrial growth and environmental degradation in the core industries of India?

With reference to these research questions, there are certain research gaps in the existing literature that the study addresses. First, most studies that have explored the EKC hypothesis have been conducted in the context of developed countries. Developing countries play equally significant roles in building a sustainable global environment. In fact, these countries are burdened with fundamental setbacks that make investigating the EKC hypothesis more critical for them. In particular, India was declared the third-highest carbon-emitting country in 2021, which made the country a global focus point. However, the exploration of the EKC hypothesis remains inadequate for the Indian context in the prevailing literature. Second, the investigation of the EKC hypothesis at an industrial level is still minimal, as most have investigated the hypothesis at country levels. However, exploring the IEKC hypothesis is crucial for assessing the sustainable aspects of various industries as they are considered a major source of pollution across nations. In particular, studies failed to focus on the Indian core industries, which are valuable industries for the economy, but also a few of the globally recognised high-polluting industries. Therefore, monitoring their sustainable growth is also crucial for enabling sustainable economic growth in India. Third, limited studies have explored the contemporary N-shaped IEKC, which add long-term implications for industrial growth. It helps estimate the expected long-term environmental impacts resulting from industries' growth, which is critical to understand for sustainable economic progress.

The paper discusses the various issues using a very logical structure. It first discusses the relevant past literature and formulates the hypotheses for the study and then describes the empirical methodology and reports its results. A brief discussion on the empirical results is then presented before the study is finally concluded.

Review of Literature

In recent years, the relevance of the EKC hypothesis has grown, considering its simplified and meaningful application. However, only limited exploration has been conducted on the IEKC hypothesis. Initially, Simon Kuznets (1955) was the one to suggest an inverted U-shaped curve between economic growth and income inequality. This later became popular as the Kuznets curve among scholars. Later, Grossman and Krueger (1991, 1995) demonstrated that a similar inverted U-shaped relationship can be established between economic growth and environmental degradation, which later became popular as the EKC hypothesis. The hypothesis argues that when an economy prospers through its initial stages of growth, it is expected to worsen environmental health. Developing economies are weighed down with legacy issues like obsolete technologies, inefficient energy mix, low awareness, lack of financial and non-financial resources, etc, which constrain them from attaining sustainable industrialisation. However, once a certain level of growth is realised, the economy overcomes such issues, allowing it to take necessary steps for minimising the harmful ecological influences of industries and helps improve the environmental quality. Thus, an inverted U-shaped relationship occurs between economic growth and environmental degradation.

Regarding the validation of the EKC hypothesis, mixed findings can be found in the existing literature. Based on the growth stage that a country is in, the validity of the EKC may vary from nation to nation (Bader and Ganguli 2019). A brief discussion on the past studies on such findings is reported henceforth. Hua and Boateng (2015) explored the validity of the EKC hypothesis with a sample of 167 nations and confirmed the inverted U-shaped hypothesis. Considering countries with different income levels, Nasreen and Anwar (2015) showed that the existence of the EKC hypothesis is stronger in cases of high-income countries, while the hypothesis is not very prominent in middle- and low-income nations. In China, Pata and Caglar (2021) found evidence for the inverted U-shaped EKC, rejecting the traditional inverted U-shaped hypothesis. They demonstrated the need for human capital and renewable energy in their study. On the other hand, Akadırı et al (2021) confirmed the inverted U-shaped curve hypothesis in the BRICS (Brazil, Russia, India, China and South Africa) nations. They have underlined the harmful impact of fossil fuel sources (coal, crude oil and natural gas) on the environment. Adeel-Farooq et al (2021) provided evidence for the inverted U-shaped EKC hypothesis in the ASEAN countries. Similarly, Koshta et al (2021) proved the existence of the traditional EKC in the context of a few emerging nations, signifying the role of energy conservation policy in improving one's environmental health.

Similar studies have been conducted in the Indian context as well. Managi and Ranjan (2008) have demonstrated a valid EKC hypothesis in India. The study further highlights the degrading impacts of industrialisation, where the scale effect of production is dominant over the technical effect. Emphasising the need for a renewable energy structure, Kanjilal and Ghosh (2013) verified an inverted U-shaped EKC hypothesis in India. The study highlighted the need to constrain the environmental threats of fossil fuel energy sources to prevent emissions from rising. The significance of research and development activities in improving the country's ecological condition has also been highlighted in this study. In contrast, Villanthenkodath et al (2021) confirmed the U-shaped EKC in the Indian context, arguing that India must reduce *t* high reliance on fossil fuel to improve its environmental health. Similarly, Adamu et al (2019) and Gogoi and Hussain (2024) documented that the U-shaped EKC hypothesis is applicable in India.

In recent developments, the existence of an N-shaped EKC hypothesis has also been discovered by researchers. It adds

a third phase to the U-shaped EKC, where economic growth and environmental degradation share a positive relationship again. In other words, economic growth starts worsening the ecological conditions again. Studies could be found both supporting (Alshubiri and Elheddad 2020; Awan and Azam 2021; Bekun et al 2021) and rejecting (Gyamfi et al 2021; Numan et al 2022) the N-shaped EKC based on different geographical locations. Similarly, the exploration of the EKC hypothesis at the industrial level is also very limited in the prevailing literature. Most of these studies are focused on various industries from China such as that of Zhao et al (2019) on China's textile industry, Du et al (2020) on China's construction industry, Lv et al (2021) on China's manufacturing industry, Wu et al (2022) on China's tertiary sector, etc. In the Indian context, only two studies could be found in a similar context. Gogoi (2023) found that in the Indian agro-based industry, manure fertiliser application demonstrates an inverted U-shaped IECK and the synthetic fertilisers confirm a U-shaped IEKC. Likewise, Gogoi and Hussain (2024) reported that India's crude oil industry has validated the existence of the U-shaped IEKC, while the inverted U-shaped IEKC hypothesis is applicable for its electricity industry. Nevertheless, no other similar study could be found investigating the IEKC hypothesis, particularly for developing nations.

It is evident from this discussion that it is imperative that the exploration of the IEKC hypothesis needs further scrutiny in developing countries, especially in the Indian context, considering its economic and environmental significance on the global platform. Therefore, the following hypotheses have been formulated by the study in order to empirically test the IEKC hypothesis with regard to the core industries in India.

H1: There exists an inverted U-shaped relationship between industrial growth and environmental degradation.

H2: There exists an N-shaped relationship between industrial growth and environmental degradation.

Further, various studies have attempted to explore the causal relationship between economic growth and carbon emissions. Stamatiou and Dritsakis (2019) documented a strong unidirectional causal relationship between economic growth and carbon emissions in Italy. By considering the case of the BRICS nations, Zhang (2021) demonstrated a unidirectional causality between economic growth and carbon emission levels. Gyamerah and Gil-alana (2023) demonstrated that in western and central Africa, there is a unidirectional causality that flows from carbon emissions to economic growth. Zuhal and Göcen (2024) found a bidirectional causality between carbon emissions, renewable energy and economic growth in the context of the United States (US). The study highlights the role of renewable energy consumption in improving one's environmental conditions. However, the existing literature could not find any study that has explored a similar causal relationship at an industrial level between industrial growth and environmental degradation. Such studies are non-existent in the Indian context as well. Thereby, the following alternative hypothesis has been formulated by the study to be empirically tested in the context of the Indian core industries.

H3: There exists a bidirectional causality between industrial growth and environmental degradation.

Data and Methodology

Data: The study considers unbalanced panel data consisting of eight core industries. The eight core industries are coal, crude oil, natural gas, petroleum refinery products, fertilisers, steel, cement, and electricity. Among them, the natural gas and the fertiliser industries were added to the list of core industries in 2005. Therefore, the study period has been chosen from 2005 to 2023, based on the availability of data.

Variables: The levels of carbon dioxide (CO_2) emissions have been considered as the dependent variable of the study to measure environmental degradation. CO_2 is the most harmful among all the greenhouse gases, leaving a continual environmental impact for about 100 years after emission (IPCC 2014). The data on CO_2 emissions of the core industries are collected from FAOSTAT (for the fertilisers industry), CEEW (for steel and petroleum products industries) and Carbon Disclosure Project (for the rest of the industries). Next, the Index of Eight Core Industries (ICI) has been considered as the primary explanatory variable of the study in order to measure industrial growth. It is an index published by the Ministry of Commerce and Industry of the Government of India to indicate the growth and production levels, exclusively for the core industries of the country. The data is collected from the EPW Research Foundation database. Moreover, past studies have shown that economic growth (Nazir et al 2018; Usman et al 2019), energy consumption (Dietzenbacher and Mukhopadhyay 2007; Fujii and Managi 2016) and forestation (Driscoll et al 2024; Rajan et al 2020) may also have significant influences on industries' emission levels. Therefore, these variables have been considered as control variables for the study. Table 1 presents the details of all variables considered in the study.

Table 1: List of Variables

Variable	Indicator	Abbreviation	References
Dependent variable:			
Environmental degradation	Carbon emission measured by the natural log of industrial carbon dioxide emission levels, tonnes	$\ln CO_2$	(Fujii and Managi 2013; Htike et al 2022)
Explanatory variables:			
Industrial growth	Index of Eight Core Industries	ICI	-
Economic growth	Gross domestic product (GDP) per capita, annual percentage growth	GDP	(Erdogan et al 2020; Taşdemir 2022)
Energy consumption	Industry electricity energy consumption in gigawatt hour, annual percentage growth	EC	(Ahmad et al 2019; Asumadu-Sarkodie and Owusu 2017)
Forest area	Natural log of forest area, sq km	lnFOR	(Begum et al 2020; Kocoglu et al 2024)

Source: Authors' compilation.

Econometric methods: In order to answer the first research question (RQ_1), the study adopts a non-linear regression analysis. This analysis also sheds light on the applicability of the EKC hypothesis in Indian core industries. Further, the study employs a Granger causality analysis to address the second research question (RQ_2). The various econometric methods employed are systematically detailed below.

First, to investigate the inverted U-shaped IEKC hypothesis, the study formulates a quadratic equation model, as represented by Model (1).

$$\ln CO_2 = \alpha + \beta_1 ICI_{it} + \beta_2 ICI_{it}^2 + \beta_3 GDP_{it} + \beta_4 EC_{it} + \beta_5 \ln FOR_{it} + \varepsilon_{it} \quad \ldots (1)$$

Here, β_i's denotes the coefficients of the explanatory variables, which reflect the degree of the impact on the dependent variable. The inverted U-shaped IEKC will be validated if $\beta_1 > 0$ *and* $\beta_2 < 0$. If the coefficient values do not conform to this expectation, the inverted U-shaped IEKC hypothesis will be rejected. Lastly, α is the constant and ε_{it} is the error term of the regression equation.

Additionally, we test the N-shaped IEKC in the Indian core industries using Model (2). The cubic equation model will confirm the N-shaped relationship between industrial growth and environmental degradation only if $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 > 0$. Any deviation from the expected coefficient values will imply the non-existence of the N-shaped IEKC in the core industries.

$$\ln CO_2 = \alpha + \beta_1 ICI_{it} + \beta_2 ICI_{it}^2 + \beta_3 ICI_{it}^3 + \beta_4 GDP_{it} + \beta_5 EC_{it} + \beta_6 \ln FOR_{it} + \varepsilon_{it} \quad \ldots (2)$$

To explore the long-run relationship between industrial growth and environmental degradation in the Indian core industries, the fully modified ordinary least squares (FMOLS) regression approach has been applied in the study. This approach has various statistical advantages that help arrive at a robust outcome. First, FMOLS is statistically capable of handling statistical issues like serial correlation and endogeneity and provides robust long-term estimations (Chowdhury et al 2022; Farhani and Balsalobre-Lorente 2020; Zafar et al 2020). Second, the FMOLS approach is suitable even for small samples, presenting asymptotically unbiased, normally distributed coefficient estimates (Kao and Chiang 2001; Pedroni 2000; Ramirez 2007). Therefore, FMOLS is determined to be a suitable option for the empirical analyses in the present study. In order to perform FMOLS, the variables must be integrated at first difference, that is, I(1). In order to confirm the stationarity levels of the variables, the ADF-Fisher chi-square and PP-Fisher chi-square panel unit root tests are conducted (Guan et al 2023; Xu and Lin 2017). Using both the unit root tests will help confirm the consistency and reliability of the variables' stationarity.

Table 2: Descriptive Statistics

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
$\ln CO_2$	18.374	18.792	2.859	11.320	21.432
ICI	101.497	97.900	27.028	59.300	185.700
GDP	5.114	6.064	3.008	-6.690	8.791
ELEC	9.123	10.152	7.008	-4.513	29.239
lnFOR	13.467	13.467	0.020	13.438	13.500

Source: Authors' calculations.

Further, the study explores if there is any causal relationship between the Indian core industries' growth and emission levels by applying the Granger non-causality test, suggested by Dumitrescu and Hurlin (2012). The test is capable of applying individual Wald-statistics to assess the causal relationship across each cross-sectional unit in heterogeneous panel datasets. The mathematical expression of the Granger non-causality test is presented in Models (3) and (4). Here, K is the lag number and ϵit is the white-noise error term.

$$\ln CO_2 = \alpha_i + \sum_{k=1}^{k} \gamma_i^{(k)} \ln CO_{2\,it-k} + \sum_{k=1}^{k} \beta_i^{(k)} ICI_{it-k} + \epsilon it \quad \ldots (3)$$

$$ICI_{it} = \alpha_i + \sum_{k=1}^{k} \gamma_i^{(k)} ICI_{it-k} + \sum_{k=1}^{k} \beta_i^{(k)} \ln CO_{2\,it-k} + \epsilon it \quad \ldots (4)$$

For Model (3), the null hypothesis states that industrial growth (ICI) does not Granger-cause environmental degradation ($lnCO_2$) against the alternative hypothesis that it does for at least one cross-section. Similarly, the null hypothesis for Model (4) states that environmental degradation does not Granger-cause industrial growth against the alternative hypothesis that it does for at least one cross-section.

Empirical Results

The descriptive statistics for all variables have been presented in Table 2. The mean and median values of all variables are observed to be close to each other, depicting normality in the dataset to a considerable extent. Moreover, there is a satisfactory level of variation in the variables, making it suitable for applying regression analysis further.

Next, the correlation matrix in Table 3 confirms that all the pairwise correlation degrees among the variables are less than 0.80. It confirms that the dataset is free from the statistical issues of high multicollinearity and thus, suitable for further regression analysis (Gujarati and Porter 2004).

As stated before, all variables must be integrated at first difference, that is, I(1), in order to fulfil the applicability of the FMOLS. Table 4 presents the results of the ADF-Fisher chi-square and PP-Fisher chi-square panel unit root test, confirming that all variables considered in the study are integrated at I(1). Henceforth, the FMOLS approach is applied for the long-run estimations.

Table 3: Correlation Matrix

Variables	$\ln CO_2$	ICI	GDP	ELEC	lnFOR	$\ln CO_2$
$\ln CO_2$	1.000					
ICI	-0.172	1.000				
GDP	-0.217	0.113	1.000			
ELEC	0.561	-0.189	-0.112	1.000		
lnFOR	0.648	-0.333	-0.394	0.745	1.000	

Source: Authors' calculations.

Table 4: Unit Root Test Results

Variable	ADF-Fisher Chi-square		PP-Fisher Chi-square	
	First-differenced		First-differenced	
	Intercept	Intercept and Trend	Intercept	Intercept and Trend
$\ln CO_2$	45.973*	33.162*	86.926*	75.804*
ICI	42.554*	32.476*	69.260*	68.118*
GDP	78.006*	54.856*	295.689*	155.401*
EC	65.772*	44.682*	177.153*	171.540*
lnFOR	36.854*	25.012***	31.846**	42.203***

*, ** and *** represent significance levels at 1%, 5% and 10%, respectively.
Source: Authors' calculations.

The inverted U-shaped IEKC: The empirical results for the inverted U-shaped IEKC hypothesis are reported in Table 5. As per the table, the coefficient of *ICI* is found to be significantly positive, whereas the coefficient of ICI^2 is significant and negative. It means that the core industries' growth has initially caused higher emissions levels. However, in the long run, the growth of these industries is expected to reduce environmental degradation levels by limiting carbon emissions. Thus, the inverted U-shaped IEKC hypothesis is reported to be valid for the Indian core industries, confirming the *H1*.

The control variables in Table 5 have shown a few significant effects on the emission levels of the core industries. Here, GDP and EC have shown significantly positive coefficient values, indicating that economic growth and industrial energy consumption have led to higher carbon emission levels. In contrast, *lnFOR* has demonstrated a significantly negative coefficient value. It implies that India's deforestation policies have helped control emission levels from the core industries.

The results with regard to the testing of the N-shaped IEKC are reported in Table 6. Here, the coefficient value of *ICI* is observed to be significant and positive, the coefficient value of ICI^2 is significantly negative and lastly, the coefficient value of ICI^3 is found to be significant and positive again. The results show that the core industries' growth will cause higher carbon emissions at first. After achieving the threshold growth point, their industrial growth will assist in curbing the emission levels, validating the inverted U-shaped relationship. However, the testing of the N-shaped IEKC reveals that if the core industries continue to grow beyond this inverted U-shaped position, a second threshold point will be attained. After this point, the core industries' growth will start degrading the environmental quality again. It indicates that industrial growth may potentially hurt the environmental conditions with growing production levels. In short, the N-shaped IEKC hypothesis is found to be applicable in the context of the Indian core industries, which supports *H2*.

The control variables in Table 6 have shown similar results to those in Table 5, thus, confirming the robustness and consistency of the obtained results. Regarding the diagnostic tests for Model (1) and Model (2), the insignificant test-statistics of the White's heteroscedasticity test confirms that the empirical models do not suffer from the issues of heteroscedasticity. Next, the results of the test-statistics of the Pesaran CD cross-sectional test are found to be non-significant, implying that cross-sectional dependency does not appear in the models. Finally, the test-statistics for the Breusch–Godfrey LM test are found to be significant at 10% significance levels. It indicates that serial correlation exists in the modes. However, as stated earlier, the FMOLS approach can overcome the statistical issues of serial correlation and endogeneity to provide robust and consistent results (Chowdhury et al 2022; Farhani and Balsalobre-Lorente 2020; Zafar et al 2020).

Causality relationship: The Granger panel causality estimations are presented in Table 7. The results reveal that *ICI* Granger causes $lnCO_2$, while $lnCO_2$ does not Granger cause *ICI*. It implies that industrial growth of the core industries adds to carbon emission levels. Similarly, the results confirm that ICI^2 Granger causes $lnCO_2$ but not vice versa. The unidirectional causality from the squared term of industrial growth, ICI^2, to $lnCO_2$ supports the non-linear relationship between industrial growth and environmental degradation in the Indian core industries, in support of the EKC hypothesis. However, *H3* is rejected by the empirical results.

Table 5: FMOLS Results for the Inverted U-shaped IEKC Hypothesis

Variable	Coefficient	t-statistics	Standard Error
ICI	0.032*	0.003	9.729
ICI^2	-0.000*	0.000	-8.885
GDP	0.002***	0.001	1.748
EC	0.001**	0.000	2.030
lnFOR	-0.073*	0.010	7.521
Adjusted R^2		0.998	
White's heteroscedasticity test		1.31 (0.287)	
Breusch–Godfrey LM test		1.463 (0.074)	
Pesaran CD cross-sectional test		1.143 (0.191)	

*, ** and *** represent significance levels at 1%, 5% and 10%, respectively.
Source: Authors' calculations.

Table 6: FMOLS Results for the N-shaped IEKC

Variable	Coefficient	t-statistics	Standard Error
ICI	0.036*	0.011	3.210
ICI^2	-0.000**	0.000	-2.527
ICI^3	0.001**	0.000	2.301
GDP	0.002***	0.001	1.734
EC	0.003**	0.001	2.235
lnFOR	-0.058*	0.014	4.046
Adjusted R^2		0.897	
White's heteroscedasticity test		35.924 (0.373)	
Breusch–Godfrey LM test		1.514 (0.059)	
Pesaran CD cross-sectional test		0.544 (0.699)	

*, ** and *** represent significance levels at 1%, 5% and 10%, respectively.
Source: Authors' calculations.

Discussion

The inverted U-shaped IEKC: The empirical results of the study have confirmed the validity of the inverted U-shaped IEKC hypothesis in the Indian core industries. Initially, the growth of the core industries is expected to increase their carbon emission levels, causing environmental degradation. It is because as India's population continues to grow, demand for industrial goods will also rise. In other words, the industries' production levels will have to be expanded to fulfil the market demand. However, India experiences certain technological setbacks as a developing economy. Moreover, the polluting energy structure of the country mostly relies on fossil fuel energy sources (CERC 2023). However, the limited resources of the developing nations are mostly focused on achieving their economic growth, compromising the improvement of the economy's environmental factors. As a result, the growth of

Table 7: Panel Causality Test Results

Null Hypothesis	Z-bar	Z-bar tilde
$\Delta ICI \neq \Delta lnCO_2$	18.796*	5.598*
$\Delta lnCO_2 \neq \Delta ICI$	0.682	0.079
$\Delta ICI_2 \neq \Delta lnCO_2$	45.293*	14.431*
$\Delta lnCO_2 \neq \Delta ICI^2$	0.783	0.148

*, ** and *** represent significance levels at 1%, 5% and 10%, respectively.
Source: Authors' calculations.

the core industries is found to be worsening the environmental health of the country in the initial stages. However, the core industries start to contribute to environmental welfare after attaining a certain growth point. As the industries grow, they generate more revenues and funds, which enable the economy to offer opportunities for environmental improvements by allocating funds for research and development activities. Gradually, it leads to the accommodation of advanced technologies and energy structures that preserve the ecological balance. Stakeholders also become environmentally concerned, which pushes industries to undertake eco-friendly approaches. Hence, the core industries' growth is expected to help build a greener industrial setting in the long run.

The N-shaped IEKC: The applicability of the N-shaped IEKC hypothesis in the core industries is directed at the future threat of causing environmental degradation by the core industries' growth after the attainment of a second threshold point. The hypothesis argues that if the industries fail to provide continuous efforts for product and process innovation, they will lose their advantageous environmental status that was achieved with the inverted U-shaped IEKC. As the production levels of the industries increase, the technologies become obsolete as they start to fail in accommodating the growing production. Moreover, innovation in energy sources is to give equal significance as industries' energy consumption levels also increase with higher production levels. The validation of the N-shaped IEKC should be taken as a warning by industries and policymakers, signifying the importance of consistent research and development efforts for improving the nation's environmental health.

Concerning the control variables, economic growth has led to greater emission levels in the Indian core industries. India's economic growth and industrialisation depend on the core industries' progression to a great extent. In other words, greater economic growth invites higher industrial processing, leading to the chances of higher emissions. Second, industrial energy consumption is found to have an escalating impact on the core industries' carbon emissions. As discussed before, India still heavily relies on fossil fuel sources to accommodate the energy needs of the industries and households. Therefore, consumption of such environmentally harmful energy results in greater emission levels from the core industries. Third, the results have demonstrated that an increase in forest areas has helped India curb its industries' emission levels. As per the *World Bank Statistics*, India's forestation rate has been positively increasing in recent years, which explains its negative coefficient value. Trees are the cheapest and most effective way of storing and reducing carbon emissions. Therefore, industries leading to higher deforestation should always be prevented to the extent possible in order to promote environmental health.

Unidirectional causality: The results have confirmed a unidirectional causal relationship from the core industries' growth to their emission levels. Industrial growth increases the production levels, which rely upon conventional, harmful energy consumption and obsolete technologies, particularly in developing countries like India. Therefore, the industries' rising production activities become a direct factor contributing to emission escalation.

Conclusions

The study delves into an empirical exploration of the IEKC hypothesis in the context of the Indian core industries using data from 2005 to 2023. In addition to the traditional inverted U-shaped IEKC, the study also investigates the contemporary N-shaped IEKC. The results have shown that both the inverted U-shaped and the N-shaped IEKC hypotheses are valid in the core industries. Moreover, the study posits a unidirectional causal relationship from the core industries' growth to their emission levels. Thus, the study addresses both the research questions in the study. The results are crucial for policymakers and industrial managers to promote and maintain sustainable industrialisation in the country. The implications of this study are briefly discussed as follows:

Managerial implications: The confirmation of the N-shaped IEKC indicates the possible recurrence of environmental threats from the core industries' growth in the future. As and when industrial production increases, the technologies and resources will become obsolete, making them unable to cater to the environmental demands and expectations for a balanced harmony. Thus, industrial growth loses the advantageous ecological position attained in the second phase of the IEKC hypothesis. In order to prevent such situations, industries must focus more on the innovation of advanced technologies and eco-friendly energy sources that can help mitigate the carbon emission levels. Research and development are critical factors in paving the way for sustainable industrial and economic growth. So, continuous efforts are required to be channelled to the industries' product and process innovations. In addition to that, environment-preserving practices can benefit industries to create positive market influences that can add to their smooth survival. Therefore, a strategic shift towards sustainable practices can lead to a win-win situation, where both the environment and the industrialists can benefit.

Practical implications: The study has provided a novel contribution to the existing literature by focusing on the sustainable aspects of the core industries in India. Especially, the investigation of the N-shaped IEKC hypothesis and the causal relationship in these industries still remain a prominent research gap in the literature, which the study has attempted to fulfil. Nevertheless, future studies are required on similar lines in order to arrive at a more comprehensive approach for facilitating green industrialisation, particularly for the developing economies. Focusing on other industries can also be equally beneficial for policymakers and industrialists to build a healthier industrialised nation.

Social implications: The Indian stakeholders must become more aware and concerned regarding their ongoing ecological

conditions. Facilitating a greener industrialisation cannot be the sole responsibility of the industrialists. Stakeholders should also push the industries, especially the polluting ones, to spend more resources on environmental welfare so that a safe future can be preserved for future generations.

Policy implications: Based on the levels of pollution caused, the concerned authorities may have to introduce or reform the industrial regulations, emission norms, pollution control acts, etc, of the nation. Policies should be aimed at long-term economic planning where industrial growth can be achieved without degrading the nation's environmental quality. Protecting public health and promoting its welfare is required to preserve a healthy environment for future generations, considering the ongoing climate situations around the globe. Corporate accountability must be given more priority, especially for those who belong to highly polluting industries. Environmental transparency and responsibility of the corporate bodies are required to make significant movement towards green industrialisation. Policymakers should facilitate ample investments in research and innovation and technological advancements to retain the benefits of sustainable industrialisation. Moreover, if the financial sector of the country advances loans to industries for (i) greater research and development, (ii) adoption of greener technologies, and (iii) for renewable energy projects, with constant monitoring of the funds allocated to the industries, it would greatly aid the process of sustainable industrialisation.

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