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INDUSTRIAL GROWTH IN PAKISTAN: REVISITING THE ROLE OF TECHNOLOGY, HUMAN CAPITAL, AND POLICY INCENTIVES

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Abstract
Following a period of intense inflationary pressure, Pakistan's industrial sector has entered a phase of stabilization, with headline growth reaching 4.77% in FY 2025. However, this recovery is marked by structural heterogeneity, where high-performing sub-sectors like wearing apparel (7.6% growth) contrast sharply with contracting segments like mining (-3.4%) and sugar (-7.1%). While the adoption of Industry 4.0 technologies such as Big Data and Smart Factories offers a pathway to increased efficiency, its implementation remains uneven and often leads to skill-biased labor displacement. Long-term growth is further constrained by a critical human capital deficit, evidenced by a Human Capital Index of 0.41 and a record-low education expenditure of 0.8% of GDP. This study argues that sustainable industrial expansion requires resolving the energy circular debt crisis, harmonizing Special Economic Zone (SEZ) policies, and diversifying exports beyond the traditional "textile trap"

INTRODUCTION

The industrial development of Pakistan in the mid-2020s represents a critical juncture in the nation's economic history, characterized by a transition from reactive stabilization to a structured, albeit challenged, pursuit of sustainable growth (Ullah, 2025). The fiscal years 2024 and 2025 have emerged as a period of profound macroeconomic recalibration, where the cooling of historic inflationary pressures has provided a tenuous window for industrial revival (Pakistan Economic Survey, 2025). Central to this narrative is the interplay between the manufacturing sector's resilience, the adoption of Industry 4.0 technologies, the quality of the nation's human capital, and the efficacy of policy incentives designed to integrate Pakistan into the global value chain (Bhardwaj, 2025; Twum, 2025; World Bank, 2023).

While the headline industrial growth of 4.77 percent in FY 2025 suggests a rebound from previous contractions, a deeper analysis reveals significant structural heterogeneity across sub-sectors, ranging from the burgeoning apparel industry to the persistently struggling mining and sugar segments (Makati, 2025). This report offers an exhaustive investigation into the mechanisms driving and inhibiting industrial expansion, articulating the relevance of technological disparities, the productivity-wage gap, and the overarching energy crisis on the nation's competitive posture (Ahmed, 2025).

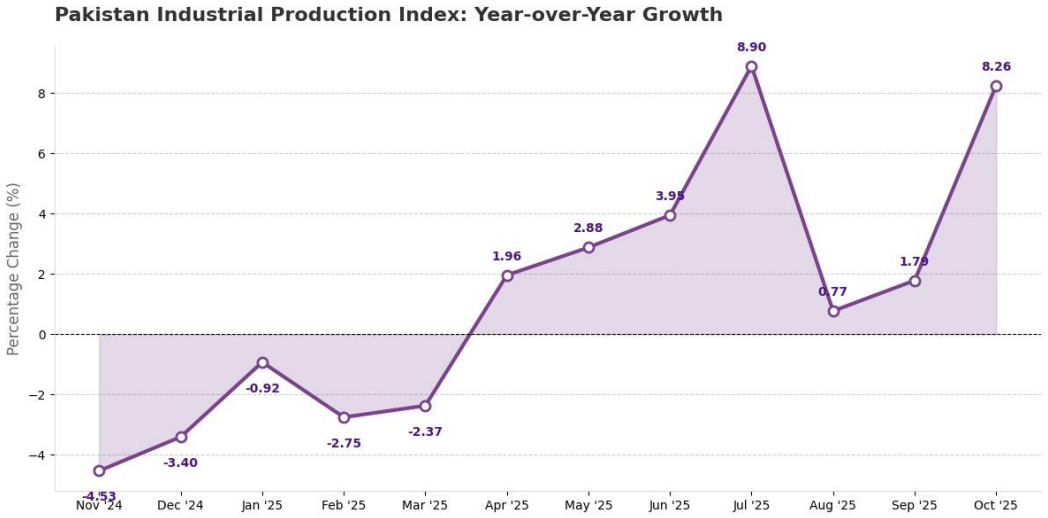


Figure 1 Pakistan Industrial production index Nov 2024- Oct 2025

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2. Macroeconomic Stabilization as a Prerequisite for Industrial Growth

The industrial sector does not operate in a vacuum; its performance is inextricably linked to the broader macroeconomic environment (Intizar, 2025). In FY 2025, Pakistan achieved what many international observers termed a notable macroeconomic success among emerging markets (Finance Division, 2025). The cornerstone of this stabilization was the dramatic decline in inflation, which fell from a high of 17.3 percent in April 2024 to a six-decade low of 0.3 percent by April 2025 (GOP, 2025). This disinflationary trend was not an accidental occurrence but the result of a deliberate and tight monetary policy stance combined with exchange rate stability that anchored inflationary expectations (State Bank of Pakistan, 2025).

For industrial firms, this shift was transformative (Zafar, 2025). The high-interest-rate environment of previous years had stifled private investment and increased the cost of working capital (Gardezi, 2025). As inflation reached single digits, the State Bank of Pakistan (SBP) initiated a cumulative reduction of the policy rate by 1,100 basis points between June 2024 and June 2025 (Nisar, 2025). This easing of financial conditions served to revive business sentiment and encourage a gradual recovery in economic activity, particularly in the Large-Scale Manufacturing (LSM) sector toward the end of the fiscal year (Government of Pakistan, 2025).

Table 1: Key Macroeconomic Indicators and Industrial Context (FY 2024–2025)

Economic Indicator	FY 2024 Value	FY 2025 Value	Implications for Industry
Real GDP Growth	2.6%	2.68% – 3.0%	Moderate recovery in demand.
CPI Inflation (April YoY)	17.3%	0.3%	Reduced input cost volatility.
Policy Rate (End of FY)	High	Reduced by 1,100 bps	Lowered cost of borrowing.

Current Account	$1.3B Deficit	$1.9B Surplus	Improved import capacity.
National Savings (% of GDP)	12.6%	14.1%	Higher domestic investment potential.
Investment-to-GDP Ratio	13.1%	13.8%	Marginal uptick in capital formation.

Sources: (Government of Pakistan, 2025; Pakistan Economic Survey, 2025)

The transition from a current account deficit to a notable surplus of $1.9 billion during July–April FY 2025 further fortified the industrial sector's foundation (Government of Pakistan, 2025). This surplus, driven by record growth in workers' remittances ($31.2 billion) and steady technology exports, allowed the State Bank of Pakistan (SBP) to rebuild foreign exchange reserves to approximately $11.50 billion by May 2025 (Pakistan Economic Survey, 2025; SBP, 2025). For manufacturers, the availability of foreign currency is vital for the procurement of raw materials and advanced machinery (Nisar, 2025).

Furthermore, the stabilization of the Pak Rupee (PKR) against the US Dollar since January 2024 has reduced the "exchange rate risk" that previously deterred foreign direct investment (FDI) in capital-intensive industrial projects (U.S. Department of State, 2025).

3. Sectoral Analysis: Trends in Large-Scale Manufacturing and Mining

Despite the favorable macroeconomic tailwinds, the recovery within the industrial sector has been uneven (Ullah, 2025). The Large-Scale Manufacturing (LSM) sector exhibited a mixed trend during FY 2025.

While the sector as a whole witnessed a growth of 4.77 percent, the LSM sub-index recorded a contraction of 1.47 percent during the July–March period (Pakistan Economic Survey, 2025).

This divergence highlights a significant performance gap between small-scale manufacturing and large industrial units (PBS, 2025). A closer examination reveals that 12 industrial groups recorded positive growth, while 10 continued to face headwinds (Makati, 2025). The wearing apparel sector was the standout performer, sustaining a growth momentum of 7.6 percent (Government of Pakistan, 2025).

This growth was partially fueled by regional geopolitical shifts; political unrest in Bangladesh between late 2024 and early 2025 led to the redirection of global export orders to Pakistani producers (Bhardwaj, 2025; Textile Today, 2025). Conversely, sectors like mining and quarrying contracted by 3.4%, indicating that structural bottlenecks such as elevated energy costs and outdated technology still hinder the broader industrial base (Aurangzeb, 2025; Sattar, 2024).

Table 2: Growth Performance of Key Industrial Segments (July–March FY 2025)

Industrial Sub-Sector	Growth Rate (%)	Primary Contributing Factors
Wearing Apparel	7.6%	Global order diversion; export-oriented demand.
Textiles (Overall)	2.2%	Reversal from -8.8% contraction in FY24.
Cotton Yarn	8.4%	Increased spinning capacity utilization.
Terry Towels & Bathrobes	4.0%	Steady demand from US and EU markets.
Automobiles	(Positive Trend)	Easing of import curbs and lower interest rates.
Food Group	-0.5%	Contraction in sugar and confectionery.
Sugar Industry	-7.1%	High input costs; FED impact.
Mining & Quarrying	-3.4%	Fragmentation in provincial-federal policy.

Sources: (Government of Pakistan, 2025; Pakistan Economic Survey, 2025)

The textile sector's recovery is significant given its 60 percent share in total exports (Naveed, 2024; PIDE, 2024; Hayat, 2025). The sector grew by 2.2 percent, a stark improvement from the 8.8 percent contraction observed in the same period of the previous year (Government of Pakistan, 2025; Finance Division,

2025; Ministry of Commerce, 2024; VIS Credit Rating, 2025). However, this growth remains concentrated in low-value-added products (Ishrat Husain, 2023; Ahmad, 2025; Ihsan, 2024; Irshad, 2025).

Conversely, the mining sector contracted by 3.4 percent (Government of Pakistan, 2025; State Bank of Pakistan, 2025; Dawn Research, 2025; ProPakistani, 2025), plagued by institutional incoherence and a fragmented licensing regime (Government of Pakistan, 2025; Makati, 2025; Gardezi, 2025; USGS, 2025).

4. Technological Transformation and the Industry 4.0 Paradigm

In the global industrial landscape, Industry 4.0 has redefined competitiveness (Ali & Xie, 2025; Deloitte, 2026). For Pakistan, the role of technology is central to industrial growth (Shahzad et al., 2024; Alkhodair & Alkhudhayr, 2025). Research indicates that the adoption of Industry 4.0 factors including Big Data analytics and Cyber-Physical Systems (CPS) has a significant positive impact on organizational performance (Sajjad et al., 2024; Uzair Khan et al., 2023; Mahmood et al., 2025; Serbinenko & Ludviga, 2025).

In the textile and logistics industries, technology has been identified as a key driver for resolving inefficiencies (Bhardwaj et al., 2025; Uraan Framework, 2024; Tao & Chao, 2024). For instance, Big Data implementation allows firms to optimize supply chains, while Smart Factories enhance production efficiency by minimizing downtime (Bhardwaj et al., 2025; Sajjad et al., 2024; Lalic et al., 2024; Rana & Jani, 2023).

However, technological preparedness remains uneven (Mahmood et al., 2025). In the aerospace sector, the vast majority of firms invest less than 5 percent of their annual revenue into these technologies (Sajjad, 2024; NASTP, 2025; Friday Times Economics, 2024). This investment gap exists despite the establishment of the National Aerospace Science & Technology Park, which aims to bridge the R&D divide (Zardari & PAF, 2025).

Table 3: Core Technologies of Industry 4.0 and their Impact in Pakistan

Technology Pillar	Adoption Status in Pakistan	Impact on Performance
Big Data Analytics	Emerging in Large Firms	Significant positive relationship.
Internet of Things (IoT)	Limited to Specialized Units	Improves real-time monitoring and logistics.
Smart Factory	Pilot phases in Textiles	Highest impact on production efficiency.
Cloud Computing	Growing in Retail/Service	Solves unorganized system challenges.
Robotics	Low Adoption (High Cost)	Primarily in high-end export units.

Sources: (Bhardwaj et al., 2025; Sajjad et al., 2024)

5. The Automation-Employment Dialectic and Skill-Biased Change

The integration of advanced technology often leads to labor displacement (Razzaq, 2025; World Economic Forum, 2025; Deming et al., 2026). Research suggests that technological innovation in the manufacturing sector has a "skill-biased" effect, where the benefits are disproportionately skewed toward high-skilled workers (Intizar et al., 2025; Malik, 2025; Pi & Zhang, 2026; Ul-Haq et al., 2021).

In the textile sector, the introduction of automated cutting machines (CAD/CAM) has begun to replace traditional roles (Asian Productivity Organization, 2025; Technavio, 2026; Lalic et al., 2025; AIUB Research, 2025). While ICT improvements are dominant factors in sector growth, they have been "substantially unfavorable" to overall employment levels due to the adverse impacts of automation (Intizar et al., 2025; Journal of Asian Development Studies, 2025; ILO, 2025; Kettaf et al., 2025).

6. Human Capital Development: A Structural Constraint on Productivity

The most profound challenge to long-term growth is the state of human capital (Haque, 2024; Zahid,

2025; Naz et al., 2025). The Human Capital Index (HCI) for Pakistan is currently 0.41, meaning a child born today will be only 41 percent as productive as she would be with adequate investments in health and education (World Bank, 2023; UNICEF, 2025; UNDP, 2024).

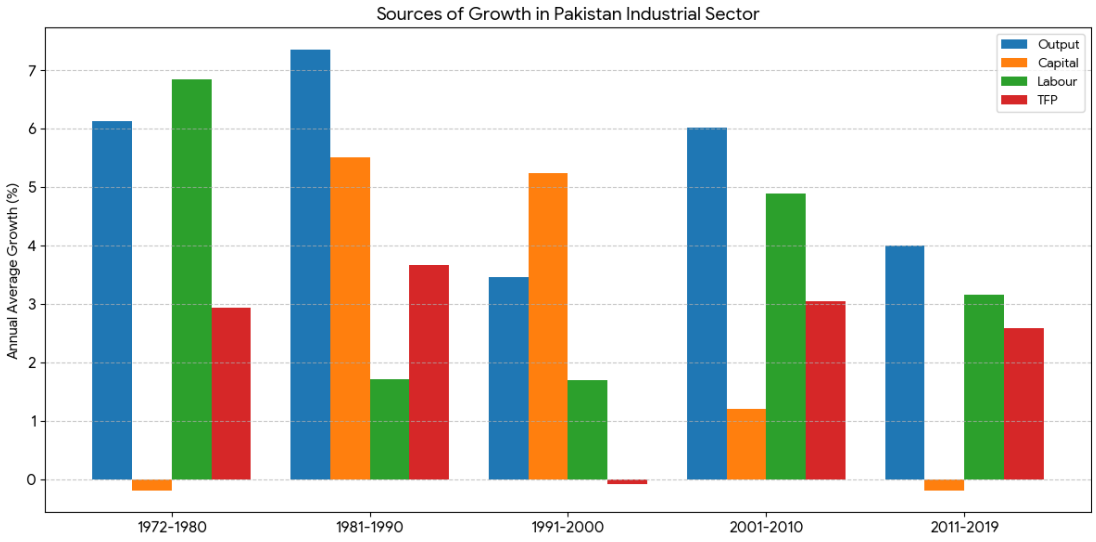


Figure 2: The Nexus Between Investment Levels (% of GDP) and Total Factor Productivity (TFP) Growth

This trails noticeably behind the South Asian average of 0.48 (World Bank, 2023; Finance Division, 2025; ADB, 2024). Compounding this issue is a record-low education expenditure of approximately 0.8 percent of GDP, which limits the fiscal space for essential teacher development and vocational training (UNICEF Pakistan, 2025; Pakistan Economic Survey, 2025). Consequently, "learning poverty" remains a critical bottleneck, with 75 percent of children unable to read a basic text by age 10, effectively ceiling the country's industrial value-addition potential (World Bank Learning Poverty Brief, 2025; Fasih & Baron, 2025).

Table 4: Human Capital and Labor Productivity Metrics

Metric	Pakistan Value	Regional Peer Avg	Industrial Implication
Human Capital Index (HCI)	0.41	0.48 – 0.56	Lower future workforce potential.
Labor Productivity Growth	1.0%	Higher in VN/BD	Erosion of export competitiveness.
Female LFPR	22.2%	~30% - 50%	Underutilization of 50% of talent.
Informal Employment	88.0%	Varied	Low capacity for firm-level R&D.

Sources: (World Bank, 2023)

The relationship between education levels and growth is critical (Rehman et al., 2025; Fasih & Baron, 2025; Naz et al., 2025). Advanced education and gross fixed capital formation (GFCF) are significant drivers of long-run economic development (Kausar et al., 2024; Ullah et al., 2025; Zahid, 2025), whereas illiteracy has a direct adverse impact on real GDP (Kausar et al., 2024; Batul et al., 2024; Scribd Economics, 2025).

Despite this, government spending on education remains below the South Asian average, further hindering the ability of the labor force to acquire

needed technical skills (World Bank, 2023; DAWN Research, 2025; Save the Children, 2025). In the first three quarters of FY25, cumulative education spending plummeted to just 0.8 percent of GDP, a staggering decline that leaves Pakistan lagging behind every regional peer except Afghanistan (Pakistan Economic Survey, 2025; ReliefWeb, 2025; Ministry of Finance, 2025).

7. Policy Incentives: The Efficacy of Special Economic Zones (SEZs)

Pakistan has increasingly relied on Special Economic Zones (SEZs) to attract FDI and stimulate growth (KJPPM, 2025; Board of Investment, 2025; NIPA, 2025). Under the CPEC framework, priority SEZs have been established to act as catalysts for structural change (Paradigm Shift, 2024; Akram et al., 2025; ResearchGate, 2025; CPEC Authority, 2024). These zones, such as Rashakai and Dhabeji, are designed to transition the economy toward export-led industrialization by offering fiscal incentives and streamlined customs procedures (Khurshid & Rashid, 2025; Margalla Papers, 2025).

However, many zones are plagued by infrastructure deficiencies and institutional fragmentation (Bukhari et al., 2025; Paradigm Shift, 2024; Samad, 2025; Hashmi et al., 2025). Challenges such as unreliable power supply, inconsistent policy frameworks across federal and provincial levels, and administrative bottlenecks continue to undermine investor confidence (Hafeez et al., 2024; Zafar, 2025; Akhtar et al., 2025).

Table 5: Key Barriers to SEZ Success in Pakistan

Success Factor	Pakistani Status	Recommendation for Improvement
Regulatory Framework	Exists (SEZ Act 2012)	Harmonize provincial/federal rules.
One-Stop Shop Services	Often Missing	Establish Special Delivery Units (SDUs).
Infrastructure (Utilities)	Inadequate	Shift to private-sector-led development.
Stakeholder Feedback	Limited Consultation	Formalize public-private dialogue.
Linkage with Global Value Chains	Weak	Target sector-specific FDI promotion.

Sources: (Bukhari et al., 2025; Paradigm Shift, 2024)

8. The Strategic Trade Policy Framework (STPF) 2020-2025

The STPF 2020-2025 aims to transition the economy toward export-led growth by diversifying beyond traditional sectors like textiles (Ministry of Commerce, 2025). It emphasizes geographical diversification, including the "Look Africa Policy" and improved access to Central Asian markets (Ministry of Commerce, 2025).

Table 6: STPF 2020-2025: Strategic Pillars and Challenges

Strategic Pillar	Objective	Status/Challenge
Tariff Rationalization	Reduce manufacturing costs.	Ongoing; anomalies persist.
Export Diversification	Move beyond textiles.	Textiles still 60% of exports.
Market Access	FTAs/PTAs with new regions.	Implementation is fragmented.
Institutional Strengthening	Coherence between departments.	Policy inconsistency remains high.
Digital Transformation	Promote e-commerce/IT exports.	ICT exports are a bright spot ($1.9B).

Sources: (Ministry of Commerce, 2025)

9. The Energy Crisis and Industrial Competitiveness

Energy availability and cost remain major sources of industrial distress (Shafiq, 2020; Rasool, 2025; PIDE, 2025). Despite an expanded generation capacity of over 45,000 MW (Ministry of Power Division, 2025; NEPRA, 2025), the sector is burdened by "circular debt," which reached Rs 1.6 trillion by FY 2025 (ICMA Pakistan, 2025; Afia Malik, 2024; Masroor & Ullah, 2023; NSPP, 2025). The high cost of industrial electricity makes it difficult for local manufacturers to compete with regional rivals like Vietnam and Bangladesh (ICMA Pakistan, 2025; FPCCI, 2026; Business Recorder, 2025).

Table 7: Industrial Electricity Tariffs: Regional Comparison

Country	Industrial Tariff (cents/kWh)	Competitive Impact
Pakistan	12.9	Renders exports uncompetitive.
Regional Benchmark	~9.0	Allows for sustainable export growth.
Pakistan (Pro-Relief)	9.0	Projected rate if cross-subsidies were removed.

Sources: (ICMA Pakistan, 2025; Pakistan Economic Survey, 2025)

10. Comparative Analysis: Pakistan vs. Regional Competitors

Pakistan's industrial performance has been described as "stagnant" compared to the "multi-fold increases" seen in neighboring countries (Ishrat Husain, 2023; Shahzad, 2025; SDPI, 2025; M. Aurangzeb, 2025). While Pakistan's real GDP growth recorded a modest 2.68 percent in FY2025 (Finance Division, 2025), peer economies like India and Bangladesh have maintained significantly higher per capita income growth trajectories (World Bank, 2025; Ammar H. Khan, 2025). While Pakistan's Revealed Comparative Advantage (RCA) in textiles is increasing (Ishrat Husain, 2023; World Bank, 2023; K. Shahzad, 2025; ResearchGate, 2025), neighbors like Vietnam and Bangladesh are successfully diversifying (Ishrat Husain, 2023; World Bank, 2023; Fahmida Khatun, 2025; JECD, 2025; LCCI, 2025).

Table 8: Comparative Textile Industry Dynamics

Feature	Pakistan	Bangladesh	Vietnam	India
Key Advantage	Raw cotton; low-cost yarn.	Low labor cost; RMG scale.	Trade agreements (CPTPP).	Diverse product base; R&D.
Tech Status	"Less mechanized"	Improving (CAD/CAM)	High Investment/Tech	Technical Textiles focus
RCA Index	Increasing (Reliance)	Declining (Diversifying)	Declining (Diversifying)	Declining (Diversifying)

Sources: (Ishrat Husain, 2023; World Bank, 2023)

11. Fiscal Policy and Tax Incentives for Industrialization

The 2024-2025 budget introduced several relief and regulatory measures to protect domestic industry and promote export-led growth (FBR, 2025; PwC Pakistan, 2025; Ministry of Finance, 2024). These included exemptions from customs duties on machinery for solar panel manufacturing and tariff rationalization for raw materials (Ministry of Commerce, 2025; Crowe Pakistan, 2024; Customs Act Highlights, 2025). Protectionist measures like regulatory duties on iron and steel items were also implemented to encourage import substitution (Government of Pakistan, 2025; Pakistan Economic Survey, 2025; SDPI, 2026).

12. Theoretical Framework: Total Factor Productivity and Long-Term Growth

To articulate the causal relationships between variables, we can use a basic production function where output (Y) is determined by Capital (K), Labor (L), and Total Factor Productivity (A):

Output (Y) = Total Factor Productivity (A) * Capital (K) ^ alpha * Labor (L) ^ (1 - alpha)

In Pakistan, the long-term trend in investment (K) has been downward, and the labor input (L) lacks the human capital quality necessary for high-value production (Beyer, 2025; World Bank, 2023). Total Factor Productivity (A), capturing technology and innovation, remains stagnant (Kausar et al., 2024).

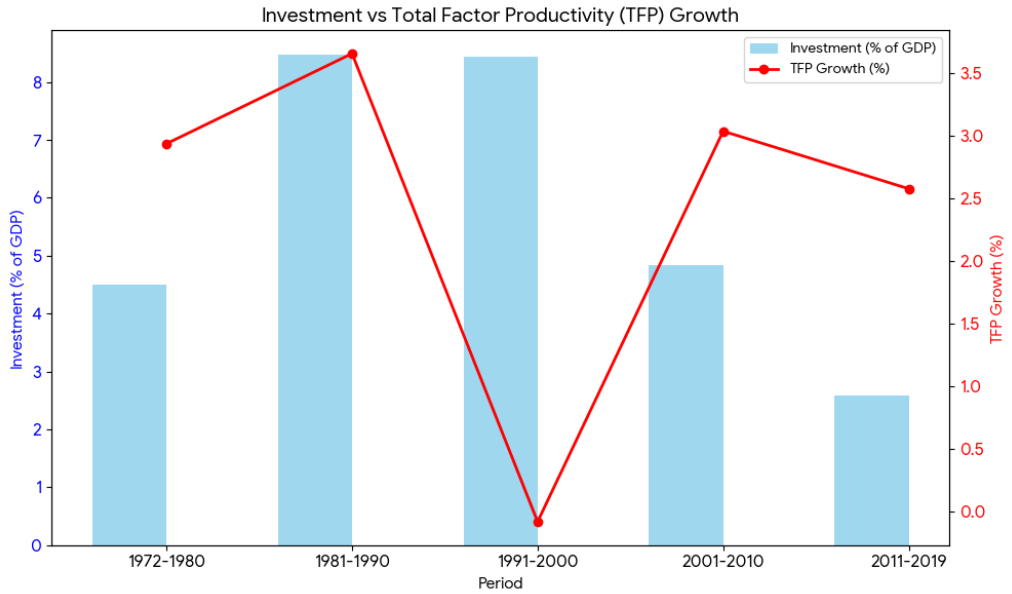


Figure 1: Decadal Breakdown of Industrial Output Growth by Input Factor (1972–2019)

13. Theoretical Implications of Industry 4.0 Adoption

The adoption of Industry 4.0 technologies can be viewed as an attempt to shift the "efficiency frontier" of the production function. For a firm in the textile sector, the introduction of IoT and Big Data analytics reduces the marginal cost of production (MC) by optimizing input use:

Marginal Cost (MC) = Change in Cost / Change in Output

Empirical results suggest that production services have a high degree of sensitivity (beta-value = 0.751) to technological upgrades (Bhardwaj et al., 2025).

14. Synthesis and Future Strategic Outlook

The analysis paints a picture of a nation at a crossroads (CBER-IBA, 2025; Uraan Framework, 2025; UNDP, 2025). Macroeconomic stabilization in 2025 has created space for recovery, but sustainability depends on fundamental structural shifts (IMF, 2025; World Bank PDU, 2025; M. Aurangzeb, 2025).

- **Technology:** Industry 4.0 is a practical necessity for meeting international standards (Sajjad et al., 2024; Uzair Khan et al., 2025; Textile 4.0 Assessment, 2025).

- **Human Capital:** The HCI of 0.41 is the most significant threat to growth (World Bank, 2023; UNICEF Pakistan, 2025; Save the Children, 2025). Without a national emergency in education, the next generation will be 60 percent less productive than their potential (World Bank, 2023; NEPDF, 2024).
- **Energy and Reform:** Sustainability depends on "unbundling" the power sector and addressing the circular debt crisis (ICMA Pakistan, 2025; NEPRA, 2025; Afia Malik, 2024).
- **Product Diversification:** Breaking the "specialization trap" of textiles is critical for reducing vulnerability to external shocks (Ishrat Husain, 2023; Ministry of Commerce, 2025; PBC, 2024; 13th Five Year Plan, 2024).

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