



# ARTIFICIAL INTELLIGENCE, STRUCTURAL CHANGE, AND EMPLOYMENT TRANSITIONS: THE ROLE OF INNOVATION SPILLOVERS IN SECTORAL DYNAMICS

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**Abstract:** This study explores how Artificial Intelligence (AI) has transformed and impacted productivity, innovation diffusions, and labour markets in a diverse set of economic sectors with a specific focus on India. The adoption of AI is reinforcing the structural economic change through its advancement of efficiency and stimulating innovation in the manufacturing, financial, healthcare, agricultural, and governmental spheres. It has been shown empirically that AI will lead to productivity improvements of up to 15 to 40 per cent in labour-intensive industries, significant operational cost savings, and accelerate the product development cycle via increased research efficacy and increased patenting, among other attributes. AI spread reshapes the job structure, replacing daily activities but amplifying the need to hire cognitive and digital skills, and thereby generating heterogeneous labour-market responses including not only job creation by fields of knowledge-intensive services but also an augmented threat of automation of low-skill workforce. The fast pace of AI adoption in India, which is boosted by national programs and industry-specific developments, like precision agriculture and fintech development, can be characterized by significant economic returns. However, the problem persists in the form of the lack of digital infrastructure, unequal distribution of technologies,

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and skills gaps, which are bound to increase the sizes of regional and socioeconomic inequalities. This study points to the dual nature of AI as a driver of productivity and innovation, and it is also an indication of how the technology can contribute to the growth of emerging economies in a sustainable and inclusive way.

**Keywords:** Artificial intelligence, Innovation spillover, Economic transformation, Labour

**JEL Classification:** O14, O33, O31, J23

## INTRODUCTION

Artificial Intelligence (AI) has been rapidly developed as a game-changing general-purpose technology (GPT) which is fundamentally changing the production model, the organisational structure, and the allocation of labour in all economies of the world (Kaaria, 2024; Martens & Tolan, 2018; Yahaya et al., 2023). The diffusion of AI, including predictive analytics and machine learning, autonomous decision systems, etc., has been more and more evident as a core productivity growth and innovation acceleration force, as well as structural economy transformation (Damioli et al., 2021; X. Gao, 2023; Trammell, 2025). With businesses integrating AI-driven applications into the production, services, agriculture, and citizen governance, there is an increased efficiency in the production, reduced error margins, and data-based optimisation tends to be made in production (Filippucci et al., 2024; Rane et al., 2024). The technological changes have triggered the measurable productivity changes in sectors especially when digital capital replaces repetitive activities, or supplements skilled labour (Bulut & Keleş, 2024; Labhard & Lehtimäki, 2022).

AI does not only improve productivity, but it also acts as an impetus to innovation (BONDAROUK & 'AN, 2022; Olutimehin et al., 2024). Enabling fast experimental testing, achieving better knowledge combinatory, and data-based research, AI significantly increases the innovation boundary of companies and industries (Brock & Wangenheim, 2019). Industries embracing AI are likely to experience the launch of new products, a faster rate of development, and the emergence of completely new ways of doing business (Enholm et al., 2022; Mikalef & Gupta, 2021). These dynamics of innovation monopolise the growth opportunities even as they mount the level of competition, particularly in the economies with heterogeneous adoption of technologies (Kostić, 2018).

Artificial intelligence is disruptive and is spreading throughout labour markets with much cause of concern over job replacement/displacement, polarisation of wages and skill mismatches (Georgieva, 2024b; Krstic, 2024; Mäkelä, 2025). The up-to-date empirical evidence suggests that AI will dislodge routine and manual activities and increase the need of non-routine cognitive, analytical and digital skills (Georgieva, 2024a; Goller et al., 2025). Therefore, adjustments in the labour market are heterogeneous in the sector; this depends on the degree of technological preparedness, the current structure of the workforce in the economy, and the degree of labour and capital substitution elasticity (Ernst et al., 2019; Petit et al., 2023). Even though overall employment implications are still case-specific, AI in most settings has demonstrated an augmentation and not complete displacement pattern of the labour force, a trend that is particularly high in service intensive economies (Gmyrek et al., 2023; Wang & Lu, 2025).

## **AI IN INDIA AND STRUCTURAL TRANSFORMATION**

India is a good example of studying these forces, as a developing digital economy with a big, easily mobilizable population, significant heterogeneity of the sector and bold national AI strategies (Chahal et al., 2021; Vipra, 2025). The AI has been prompted by government programmes like AI for All, Digital India, and the National Program on Artificial Intelligence to ensure that AI penetration in the healthcare sector, farming, fintech sector, manufacturing, and delivery of social services occur (AAYOG, 2018; Rodriguez, 2025). Some research also reveals that AI-enabled automation has resulted in better manufacturing quality control, credit-risk modelling within the fintech sector, greater yield forecasting within the agricultural sector, and more efficient administration (Aderibigbe et al., 2023; Comunale & Manera, 2024; Furthermore et al., 2023; J. Gao & Wang, n.d.).

India has to confront structural constraints, such as the low level of digital infrastructure in rural markets, low level of R&D effort, lack of skills, and unequal dissemination of technology across micro, small and medium enterprise markets (Pande et al., n.d.; Pandey et al., 2024). Those limitations create different productivity paths in states and sectors that may increase inequality unless they are mitigated by means of co-ordinated actions by the policy makers. Furthermore, India has a demographic structure and a growing

digital workforce that can enjoy significant gains of AI-oriented change, as long as it focuses on complementary investments in skills advancement, innovation system, and institutional preparedness (Dwivedi et al., 2021; Kumar, 2025; Version, 2021).

It is in this context that the current study looks at the adoption of AI as a general-purpose technology and the cross-sectoral implications of AI on productivity growth, innovation dynamics and labour market adjustments in India (Jadhav & Banubakode, 2024; Kathuria et al., 2020; Version, 2021). Through the synthesis of the international evidence and country-specific expertise, the analysis provides an overall empirical and theoretical framework of how AI can assist in creating sustainable, inclusive, and growth based on innovation in its developing economies.

## **AI ADOPTION, ECONOMIC PERFORMANCE AND LABOUR MARKET IMPLICATION**

Artificial intelligence adoption has also been identified to have a high correlation with productivity increment (Shchepkina et al., 2024). According to the empirical studies, there are notable improvements in efficiency in the data-intensive and capital-intensive industries. As an example, (Joshi, 2020; Shchepkina et al., 2024) studies claimed that organizations that used AI-based decision-support systems scaled their decisions by a fifth and their managers by a quarter. The effect of AI innovation is usually measured by the number of patents, the level of research and development in productivity, and new product development (Septiandri et al., 2024). AI has demonstrated that it is a significant discovery-automation driver, in particular in the pharmaceutical and materials-science fields (Sampene & Nyirenda, 2024; Toner-rodgers, 2024).

The scholarly discourse about the future of work is still controversial. Whereas some researchers highlight the robotization of jobs as complementary due to its productivity benefits, others warn about the possibility of job replacement. The International Monetary Fund (IMF, 2023) estimates that around 40 per cent of the world labour force is in a position to be replaced by the automation phenomenon, and, in its turn, the International Labour Organization (ILO, 2022) forecasts that new spheres of activity facilitated by the use of this technology will partially replace such displacement. Experiential studies dedicated to India highlight how AI can make the administration more

efficient (Chopra & Sharma, 2020), make manufacturing and agriculture more productive (C et al., 2023), and create new jobs in the sphere of IT-based services (NASSCOM, 2022). However, the lack of skilled workers and long-standing digital inequalities remain a major setback.

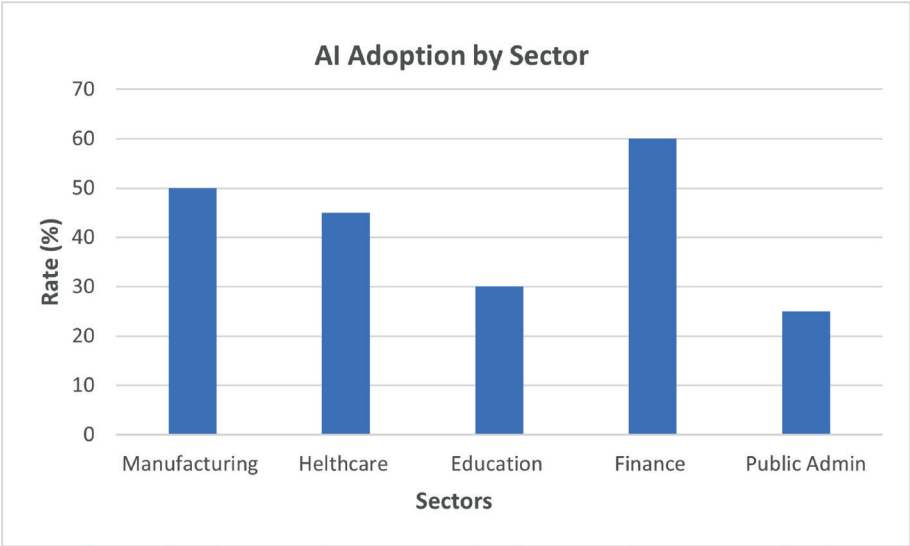


**Figure 1: AI Adoption by Sector**

*Source:* Author’s interpretation based on IMF, NASSCOM and NITI Aayog Reports.

## OBJECTIVE

1. To assess global sectoral trends in AI adoption.
2. To quantify AI’s impact on productivity and innovation across industries.
3. To analyse implications for labour markets and future of work.
4. To examine India-specific AI adoption patterns and sectoral outcomes.

## METHODOLOGY

The current article is based on the synthesis of secondary quantitative data that resorts to a collection of macro-level global reports and sectoral (or industry) reports (PwC, McKinsey, IMF, WEF) and then on the analysis of India-specific policy and industry reports (NASSCOM, ICRIER, NITI Aayog, IBEF, Reuters, Government of India) and concludes with a literature review on artificial intelligence, productivity, and employment.

The inclusion criteria include (i) the publication dates since 2017 of policy and industry sources, (ii) the availability of clear quantitative estimates on the effects of AI on the GDP, productivity, or employment, and (iii) changes relevant to India or other developing economies. Methodologically, the strategy is a kind of systematic narrative synthesis, enhanced with the help of comparative tabular maps and cross-referencing of quantitative scales. In the case of the Indian setting, specific care is taken in terms of estimates of the contribution of AI to GDP, the size and growth pattern of AI in the market, total factor productivity impacts, as well as labour-market reimbursement.

## RESULT AND DISCUSSION

### **Objective: To assess global sectoral trends in AI adoption**

The use of AI is transforming the productivity of sectors across the globe, and the growth has been particularly significant in the manufacturing, finance, healthcare, agriculture, and the public sectors. AI-enabled robotics, digital twins and predictive maintenance in manufacturing save up to 30.50% of downtime, automation enhances the accuracy of production 15.20% and decreases defects by 18% executing capital productivity and quality management (McKinsey Global, 2023). In the retail and financial sector, AI minimizes the loan default risk (reduces it by 8-12%) and improves fraud detection accuracy (over 95%) and personalized recommendations systems increase revenues (10-15% per customer), which suggests overall efficiency in risk management, as well as better revenues per customer (McKinsey Global, 2023).

The healthcare industry is also becoming a significant beneficiary with diagnostic imaging models achieving approximately 92.95% accuracy and artificial intelligence software being used to reduce drug discovery cycles by up to 50 accelerating the innovation process and possibly reducing ultimate R&D expenditures (Region et al., 2022). In agriculture, AI-based precision agriculture can boost yields up to 10.20% and cut water consumption by 40%, and also achieve both productivity and resource-saving effects at the same time which is extremely important in climate-limiting economies (FAO, 2023). The applications in the public sector, such as AI-based welfare services and smart city analytics, minimize leakage by a range of 20-35% as well as alleviate congestion by approximately 8-15% which is indicative of improvements in targeting, urban efficiency and fiscal efficacy (UNDP, 2025). In this scenario, South

Korea, Japan, and Germany are all found to be in the list of countries in the world to be up to date in terms of adoption of AI with the pace of high digital infrastructure, extensive manufacturing foundation, and proactive industrial and innovation policy, which promote implementation of AI solutions in large scale.

Table 1: AI Adoption Across Sectors (Globally)

| Manufacturing                                                                                                                                                                                   | Finance/Retail                                                                                           | Healthcare                                                   | Agriculture                                                                               | Public Sector                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| AI driven robotics, digital twins, and predictive maintenance reduce downtime by 30 to 50 %.<br>AI automation increases production accuracy by 15 to 20% and reduces defects by 18% on average. | 1. AI reduces loan default risk by 8 to 12 %.<br>2. Fraud detection accuracy exceeds 95% with ML models. | AI diagnostic models achieve 92 to 95% accuracy in imaging . | AI based precision agriculture increase yields by 10 to 20% and reduces water use by 40%. | AI enabled welfare system reduce leakage by 20 to 35%.<br><br>Smart city analytics reduce congestion by 8 to 15%. |
| Countries with highest adoption<br>South Korea<br>Japan<br>Germany                                                                                                                              | Personalised recommendation system boost revenues by 10 to 15%.                                          | AI reduces drug discovery cycles by up to 50%.               |                                                                                           |                                                                                                                   |

Source: Author’s analysis based on McKinsey, FAO, UNDP and WHO Reports

**Objective 2 : To analyse implications for labour markets and future of work**

Companies that aggressively embrace AI technologies record multiples of revenue growth of 1.7 in conjunction with labour productivity growth of 20-40%, which have shown high efficiency gains and increased outputs per employee (OECD Digital, 2022). The productivity of labour within the manufacturing industry varies amongst 15-25%. The logistics industry and the BFSI industry record 10 to 15 % and 8 to 12 % growth respectively. Since AI-driven enhancements move production boundaries of companies, they enhance the underlying production functions, so the output increases account 8 to 14 % of aggregate output (OECD Digital, 2022). On the innovation side, AI saves on research and development (R&D) by 15 to 22 % decreasing the innovation process and enhancing cost-effectiveness in product development (Cockburn, 2018).

**Objective 3: To quantify AI’s impact on productivity and innovation across industries**

Companies that incorporate AI show higher gains in patenting by 18 to 30 %, which means that they have a stronger innovations ecosystem. Moreover, AI startups also received investments amounting to USD 196 billion globally in 2023, which also supports the idea that AI-based entrepreneurship is highly funded (Teare, 2025). All in all, the use of AI is accompanied by high productivity concentration on cost-saving, improved operational efficiency, and accelerated innovation, strengthening competition and developmental opportunities of firms in the AI-intensive business community. The measurements indicate that AI has driven an optimistic economic change, which is in agreement with the rest of the literature that shows how AI can increase the performance of firms and increase innovation scale due to the use of AI.

**Table 2: Quantitative Productivity Impact and Innovation**

| <i>Firm-Level Productivity</i>                                                                       | <i>Cost Reduction</i>                                                                | <i>Production Frontier Shift</i>                                             |
|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| AI intensive firm show 1.7 multiplier higher revenue growth and 20 to 40% labour productivity gains. | Manufacturing<br>15 to 25%                                                           | AI upgrades a firms production function. AI rises 8 to 14% of production.    |
|                                                                                                      | Logistic<br>10 to 15%.                                                               |                                                                              |
|                                                                                                      | BFSI<br>8 to 12%.                                                                    |                                                                              |
| <i>AI and Innovation</i>                                                                             |                                                                                      |                                                                              |
| <b>R&amp;D Efficiency</b><br>AI reduced R&D costs by 15 to 22% .                                     | Patent Output<br>AI integrate firm experience 18 to 30% increases in patent filings. | Start-up Ecosystem<br>AI startups received USD 196 billion globally in 2023. |

Source: Author’s compilation based on OECD and Crunchbase Reports

**Objective 4: To examine India-specific AI adoption patterns and sectoral outcomes**

Table 3 demonstrates the fast expanding rate and industry specific effects of artificial intelligence (AI) in the Indian economy. It is estimated that the AI market will grow by about USD 7.8 billion in the year 2024 and this figure is estimated to grow significantly to about USD 30 billion by 2026 (Jyoti et al., 2024). The contribution of AI to the gross domestic product (GDP) of India is estimated to 450 to 500 US dollars by 2025 which is a massive transformation of the Indian economy as a result of the application of digital. Productivity in

manufacturing is improved by 15.20 % in areas like automotive and electronics and predictive maintenance (CII, 2025), which has yielded cost reductions by 23 % per year.

Indian banks have on record reduced fraud incidents by 22 % according to the banking, financial services and insurance sector (BFSI) in addition to an increase in 12 percent accurate credit agreements which are an indication of improved financial stability and risk avoidance (RBI, 2025). AI tools in healthcare increase the accuracy of detecting diseases to 90 -94 % and the use of telemedicine increased by 45 % during the aftermath of the pandemic. In agriculture, specifically in Punjab, Haryana, and Maharashtra, the yield has grown by 8-15 % due to precision farming with the help of AI (Perappadan, 2023). Individualizing retail and e-commerce through AI increase conversion rates by 12-18 in percentage, thus increasing revenue in sectors. Some of the employment impacts such as a high risk of automation of about 9% of India workforce are mostly in low waged regular jobs (IAMAI, 2024). On the other hand, IT and professional services sectors will create 1.5 to 2 million AI-related jobs in the next decade (by 2030) (NASSCOM, 2022). Without effective upskilling policies, wage disparity can become even more pronounced, and hence the importance of inclusive labour-market policies that should be based on AI adoption. On the whole, AI is a significant driving force behind the productivity of industries, innovativeness and economic development in India as well as challenges in employment and equity that require a concerted policy action.

Table 3: Sector wise AI impacts in India

| AI market overview of India                                                           |                                   |                                            | Sectoral Breakdowns                                                                                                               |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |
|---------------------------------------------------------------------------------------|-----------------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Market Size USD 7.8 Bn in 2024.                                                       | Expected reach USD 30 Bn by 2026. | Contribution to GDP USD 450-500 Bn by 2021 | Manufacturing Increase productivity by 15 to 20% in automotive and electronic. Predictive maintenance saves USD 2 to 3% annually. | BFSI Indian Bank 22% reduction in fraud. 12% increase in credit accuracy. | Healthcare AI diagnostic tools improve detection accuracy to 90 to 94%. Telemedicine adoption increased by 45% post pandemic. | Agriculture Precision agriculture increases yields by 8 to 15%, especially in Punjab, Haryana, and Maharashtra. | Retail and E-commerce AI powered personalization increases conversion rates by 12 to 18%. |
| Employment implication for India                                                      |                                   |                                            |                                                                                                                                   |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |
| 9% of India's workforce exposed to high automation risk.                              |                                   |                                            |                                                                                                                                   |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |
| Low skilled routine workers most vulnerable.                                          |                                   |                                            |                                                                                                                                   |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |
| IT and professional services gain approximately 1.5 to 2 million new AI jobs by 2030. |                                   |                                            |                                                                                                                                   |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |
| Wage inequality likely to widen without a skill strategy.                             |                                   |                                            |                                                                                                                                   |                                                                           |                                                                                                                               |                                                                                                                 |                                                                                           |

Source: Author's analysis based on NASSCOM, CII, IAMAI and NITI Aayog Reports

## CONCLUSION

The use of Artificial Intelligence (AI) is a radical force that supports meaningful productivity increase, drives the innovation process, and catalyses the development of an economy on the world and national scale in India. In all industries, such as manufacturing, finance, healthcare, agriculture, and government services, AI makes operations more efficient, more accurate, and utilizes resources in the most efficient way possible. The Indian market is experiencing rapid AI adoption, accompanied by a significant increase in the market share and significant profits in the major industries. The evaluation of companies at the firm-level demonstrates that AI integration can bring about increased growth of revenues, labour productivity, and establishment of a dynamic ecosystem of innovation, which is enabled through affordable research and development, and augmented patent activity.

However, even though the AI creates new job opportunities, particularly in the information technology and professional services, it also creates the risk of automation which disproportionately impacts the low-skilled employees, thus, potentially leading to an increase in wage inequality. This contradiction highlights the importance of positive policy measures and specific skills-training programs to ensure the optimal utilization of inclusive benefits.

## RECOMMENDATION

The focus on investing in digital infrastructure and AI capacity-building is a strategic necessity, especially in the areas where the adoption levels are not optimal. It is believed that such investments would result in productivity improvement and unleash the power of innovation. Intensive upskilling and reskilling efforts will equip the labour force with AI-based changes in labour market, which will reduce the vulnerability of employees undertaking routine or low-skill labour processes. One must facilitate the creation of AI innovation ecosystems through the public-privatization partnerships, which ensures the help of start-ups and research and development as well as guarantees the safety of ethical considerations and sustainable implementation. It is advised to use AI to enhance the efficiency and service delivery of the public sector with strict supervision of social effects to achieve fair distribution of benefits.

In the Indian situation, AI adoption plans need to be regionalized, such as precision agriculture in Punjab and Haryana States, and faster automation

of AI in finance and health industries to enhance economic sustainability in the post-pandemic period. The dual economic and social benefits of AI require a holistic approach to increase its benefit and avoid concomitants at the same time. This kind of paradigm places AI as the driver of both sustainable and inclusive growth at a globalized level as well as in such developing economies as India.

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