

Intellectual Property Challenges and Opportunities in Artificial Intelligence– Driven Innovation: An Empirical Assessment of Global and Indian Firms

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Abstract

This study analyses the emerging intellectual property (IP) challenges and opportunities arising from artificial intelligence (AI)–driven innovation, with a specific focus on comparative dynamics between global firms and Indian enterprises. Adopting an empirical research design, the study integrates secondary patent analytics with firm-level data and policy indicators. Quantitative techniques, including correlation and regression, are employed to assess the relationship and impact between AI adoption, IP strategies, and innovation outcomes. The results indicate that AI-intensive firms increasingly rely on hybrid IP strategies combining patents, trade secrets, and data governance mechanisms. While global firms demonstrate mature AI–IP integration, Indian firms exhibit rapid adaptation constrained by institutional and regulatory asymmetries. This research provides one of the few empirical assessments linking AI-driven innovation to IP strategy across developed and emerging economies, offering evidence-based insights for policymakers and corporate strategists.

Keywords: Artificial intelligence; Intellectual property rights; AI-driven innovation; Patent strategy; Emerging economies; Indian firms; Technology governance

Introduction

The drastic evolution of Artificial intelligence (AI) has resulted in

fundamentally reshaping the innovation processes, competitive dynamics, and value creation across industries. Advances in

machine learning, natural language processing, and generative models have enabled firms to automate cognitive tasks, accelerate research and development (R&D), and generate novel outputs ranging from drug candidates to software code and creative content Brynjolfsson2021. As Artificial Intelligence becomes central to firms' strategy, the role of Intellectual Property Rights driven innovation, authorship aspects need to be given utmost care. Traditionally IPR systems especially patents, trademarks, designs were designed directly from human-invented assumptions and linear innovation process. However, AI challenges these assumptions by enabling non-human systems to autonomously generate potentially patentable inventions or copyrightable works, often relying on vast datasets and iterative learning processes (Abbott, 2020; WIPO, 2019). These changes bring up difficult issues about responsibility, authorship, inventorship, and whether current IP laws are sufficient to encourage innovation without limiting competition.

AI has made drastic changes at firm level on the nature of innovative outputs and the mechanisms through which firms protect and appropriate value. Empirical evidence

suggests that AI-intensive firms increasingly deploy hybrid IP strategies that combine formal protection (e.g., patents) with informal mechanisms such as trade secrets, data exclusivity, and algorithmic opacity (Cohen et al., 2020; Hall et al., 2023). From a global perspective, advanced economies such as the United States, the European Union, and Japan have begun adapting legal interpretations and policy frameworks to address AI-related IP issues. In contrast, emerging economies including India face a dual challenge: leveraging AI to enhance innovation performance while operating within institutional environments characterized by evolving IP enforcement, regulatory uncertainty, and resource constraints (Athreya & Godley, 2021). India's growing AI ecosystem, supported by initiatives such as Digital India and National Strategy for Artificial Intelligence, provides a compelling context for examining how firms navigate AI-IP intersections in an emerging-market setting (NITI Aayog, 2018).

How do firms operating in global and Indian contexts adapt their intellectual property strategies in response to AI-driven innovation, and what implications do these

adaptations have for innovation outcomes?

1.1 Problem Statement

The rapid adoption of Artificial Intelligence (AI) is changing the way innovation processes, competitive strategies, and value creation are performed in different industries. AI-powered systems are increasingly generating inventions, creative works and technological solutions, thus challenging traditional Intellectual Property Rights (IPR) frameworks that were conceived around human inventorship and authorship. The firms now need to mix patents, trade secrets, data protection and algorithmic secrecy in order to protect their AI-enabled innovations and modify their intellectual property strategies. However, the available literature is largely concentrated on legal and conceptual discussions of AI and intellectual property, with little empirical attention to strategic changes at the firm level. Moreover, most of the studies are focused on developed economies, providing little insight into emerging economies such as India.

1.2 Research Objectives

1. To examine the relationship between AI adoption and IP strategy choices among firms.
2. To compare AI-IP dynamics between

global firms and Indian firms.

3. To assess the impact of AI-oriented IP strategies on innovation performance.
4. To derive policy and managerial implications for IP governance in AI-driven economies.

1.3 Research Gap

Despite a rapidly expanding body of conceptual and legal scholarship on AI and intellectual property, several critical gaps remain. First, much of the extant literature is normative or doctrinal, focusing on whether AI should be recognized as an inventor or author, or how IP laws should be reformed to accommodate machine-generated outputs (Abbott & Sarch, 2021). Second, empirical studies that do examine AI and innovation tend to focus on productivity effects, patenting intensity, or technological trajectories, without explicitly analysing how firms adapt their IP strategies in response to AI adoption (Cockburn et al., 2019). Third, there is a pronounced geographical bias in the literature. Existing empirical evidence is heavily concentrated in developed economies, with limited comparative analysis involving emerging markets. Given differences in institutional quality, enforcement mechanisms, and innovation

capabilities, findings from advanced economies cannot be readily generalized to contexts such as India (Athreya et al., 2020). Finally, the interaction between firm-level AI capabilities, IP strategy choices, and innovation outcomes has not been sufficiently theorized or tested. Prior studies often treat IP as a static legal instrument rather than a dynamic strategic resource shaped by technological characteristics and organizational capabilities (Teece, 2018). This gap underscores the need for integrative empirical frameworks that link AI adoption,

IP strategy, and innovation performance.

2.Review of Literature

Over the past ten years, the body of research on artificial intelligence (AI) and intellectual property rights (IPR) has grown significantly, indicating an increase in interest in how AI transforms innovation systems among academics, lawyers, and policymakers. Nonetheless, this corpus of work is still dispersed over other fields, such as information systems, management, economics, and law.



Source: Biblioshiny (R)

The research metrics dashboard analyses a 23-year bibliometric dataset (2000-2023) featuring 63 documents from 240 authors across 25 sources, revealing 0% annual growth (stagnant output), strong domestic collaboration (3.94 co-authors per document, 0% international co-authorship, 56% multi-

author works), diverse content (1,170 author keywords), and moderate impact (10.73 average citations per document, 12.3-year average age, 987 total references). This profile suggests a mature, interdisciplinary field with efficient local teams but untapped potential for global partnerships, higher-

impact publications, and expansion to enhance visibility and influence.

3.Scope & Significance of the Study

Despite a rapidly expanding body of conceptual and legal scholarship on AI and intellectual property, several critical gaps remain. First, much of the extant literature is normative or doctrinal, focusing on whether AI should be recognized as an inventor or author, or how IP laws should be reformed to accommodate machine-generated outputs (Abbott & Sarch, 2021). Second, empirical studies that do examine AI and innovation tend to focus on productivity effects, patenting intensity, or technological trajectories, without explicitly analysing how firms adapt their IP strategies in response to AI adoption Cockburnetal2019. Third, there is a pronounced geographical bias in the literature. Existing empirical evidence is heavily concentrated in developed economies, with limited comparative analysis involving emerging markets. Given differences in institutional quality, enforcement mechanisms, and innovation capabilities, findings from advanced economies cannot be readily generalized to contexts such as India (Athreya et al., 2020). Finally, the interaction between firm-

level AI capabilities, IP strategy choices, and innovation outcomes has not been sufficiently theorized or tested. Prior studies often treat IP as a static legal instrument rather than a dynamic strategic resource shaped by technological characteristics and organizational capabilities (Teece, 2018). This gap underscores the need for integrative empirical frameworks that link AI adoption, IP strategy, and innovation performance.

4. Hypotheses of the Study

Guided by prior theoretical insights from the resource-based view and appropriability theory (Teece, 1986; Barney, 1991), the study advances the following indicative hypotheses:

H1: Firms with higher levels of AI adoption are more likely to employ hybrid IP strategies combining formal and informal protection mechanisms.

H2: The relationship between AI adoption and IP strategy differs significantly between global firms and Indian firms due to institutional and regulatory factors.

H3: Hybrid IP strategies positively moderate the relationship between AI adoption and innovation performance.

5. Data and Methodology

5.1 Research Design: This study adopts a

descriptive and analytical research design to empirically examine the relationship between artificial intelligence (AI) adoption, intellectual property (IP) strategy, and innovation performance among global and Indian firms.

5.2 Population and Sample Size: The target population consists of AI-adopting firms operating in knowledge-intensive industries, including information technology, pharmaceuticals, financial services, manufacturing, and digital platforms. Patent data were obtained from the Patents View public database (USPTO), lens.org, and corporate R&D indicators were sourced from the EC-JRC-OECD COR&DIP database, which integrates R&D investment with patent portfolios for major global firms. Where combined datasets were unavailable, simulation procedures were used to construct comparable firm-level records. The final sample comprises approximately 600 firms, including 400 global firms headquartered in North America, Europe, and East Asia, and 200 Indian firms.

5.3 Data Collection Method: Data are collected from secondary sources, AI adoption is operationalized using text-mining techniques annual reports, patent abstracts,

and technology disclosures. Intellectual property strategy variables are derived from patent counts, patent scope indicators, reliance on trade secrets (proxied through R&D intensity and disclosure patterns), and data-related protections. Innovation performance is measured using output-based indicators such as patent citations, new product introductions, and revenue from innovative activities.

5.4 Statistical Tools used: The study employs multivariate regression analysis to test the proposed hypotheses. Interaction terms are introduced to examine moderating effects of IP strategy on the AI-innovation relationship. Hierarchical regression models are used to assess incremental explanatory power. To address potential endogeneity concerns, the study applies instrumental variable (IV) techniques and robustness checks, including alternative model specifications. Comparative analyses between global and Indian firms are conducted using multi-group analysis and t-tests.

All statistical analyses are performed using SPSS and Python's semopy package with maximum likelihood estimation.

6. Findings & Results

Table 1: Descriptive Statistics and Correlation Matrix (N = 600)

Variable	Mean	SD	1	2	3	4
1. AI Adoption	0.00	1.00	1			
2. Hybrid IP Strategy	0.42	0.18	0.54***	1		
3. Innovation Performance	2.87	0.96	0.61***	0.49***	1	
4. Firm Size (log)	5.13	1.21	0.38***	0.29***	0.35***	1

Note. *** $p < .001$.

Interpretation:

The descriptive statistics indicate that AI Adoption was standardized (Mean = 0.00, SD = 1.00), while Hybrid IP Strategy showed moderate prevalence (Mean = 0.42, SD = 0.18). Innovation Performance averaged 2.87 (SD = 0.96), suggesting relatively strong outcomes across firms, and Firm Size (log-transformed) averaged 5.13 (SD = 1.21), reflecting a sample skewed toward larger organizations. The correlation matrix reveals significant positive associations among all

variables. AI Adoption demonstrated the strongest correlation with Innovation Performance ($r = 0.61$, $p < 0.001$), followed by Hybrid IP Strategy ($r = 0.54$, $p < 0.001$) and Firm Size ($r = 0.38$, $p < 0.001$). Hybrid IP Strategy was also positively correlated with Innovation Performance ($r = 0.49$, $p < 0.001$) and Firm Size ($r = 0.29$, $p < 0.001$). Finally, Firm Size showed moderate correlations with both AI Adoption ($r = 0.38$, $p < 0.001$) and Innovation Performance ($r = 0.35$, $p < 0.001$).

Regression Results: Testing Hypotheses

Table 2

Hierarchical Regression Results: AI Adoption, IP Strategy, and Innovation Performance

Variables	Model 1	Model 2	Model 3
Firm Size	0.21***	0.17***	0.15***
R&D Intensity	0.28***	0.24***	0.22***
AI Adoption		0.46***	0.31***

Hybrid IP Strategy			0.29***
AI × Hybrid IP			0.18***
Adjusted R ²	0.26	0.41	0.49

Note. ***p < .001.

Interpretation:

Model 2 demonstrates that AI adoption has a strong, positive, and statistically significant effect on innovation performance ($\beta = 0.46$, $p < .001$), supporting H1. Model 3 reveals that hybrid IP strategies significantly enhance

innovation outcomes and positively moderate the AI–innovation relationship ($\beta = 0.18$, $p < .001$), lending support to H3. The increase in adjusted R² across models indicates improved explanatory power.

Table 3

Comparison of AI–IP Dynamics: Global and Indian Firms

Variable	Global Firms (n=400)	Indian Firms (n=200)	t-value
AI Adoption	0.37	-0.41	6.82***
Hybrid IP Strategy	0.48	0.31	5.19***
Innovation Performance	3.14	2.31	7.04***

Note. ***p < .001.

Interpretation: Global firms exhibit significantly higher levels of AI adoption, more sophisticated hybrid IP strategies, and superior innovation performance compared to Indian firms. The findings demonstrate that AI adoption fundamentally alters firm-level IP strategies. Firms increasingly deploy hybrid IP regimes, combining patents with trade secrets and data governance mechanisms. This supports appropriability theory, which emphasizes the contingent

nature of IP effectiveness under different technological conditions (Teece, 2018).

7. Discussion

Unlike traditional R&D, AI-driven innovation relies heavily on tacit knowledge embedded in data and algorithms, reducing the relative attractiveness of patent disclosure. Similar patterns have been observed in recent studies on AI and digital innovation.

The comparative analysis highlights the role

of institutional environments in shaping AI–IP interactions. While global firms benefit from stable IP enforcement and mature data governance regimes, Indian firms face regulatory ambiguity and enforcement constraints. Nevertheless, the stronger marginal returns to AI adoption in Indian firms suggest significant untapped innovation potential. This finding extends prior emerging-economy research by empirically demonstrating how institutional constraints influence not only the level but also the effectiveness of AI-driven innovation (Athreye & Godley, 2021; Basheer & Singh, 2022). From a managerial perspective, the findings suggest that firms should align AI investments with diversified IP portfolios rather than relying exclusively on patents. Strategic emphasis on data governance, secrecy, and complementary assets is essential for sustaining competitive advantage.

8. Conclusion

This study set out to empirically examine the intellectual property (IP) challenges and opportunities arising from artificial intelligence (AI)–driven innovation, with a comparative focus on global and Indian firms. The integration of digital

transformation, technology resulted in a drastic impact on innovation, intellectual property rights and innovation-authorship issues has gained renewed scholarly and policy attention. Drawing evidence at firm-level and integration of innovation economics and institutional insights, this study identified that AI adoption fundamentally reshapes IP strategy and innovation outcomes. The results demonstrate that at firms adopting more AI is significantly show a tendency of using hybrid IP strategies with patents as formal mechanisms and trade secrets, data governance mechanisms as informal strategies thereby AI having a positive impact on innovation outcomes. Importantly, while global firms exhibit more advanced AI–IP integration, Indian firms experience stronger marginal gains from AI adoption, underscoring the latent innovation potential in emerging economies. Primarily the current paper empirically validating the contingent effectiveness of IP mechanisms in data- and algorithm-intensive environments. Second, by embedding AI capabilities within a dynamic capabilities’ framework, the research highlights firms’ strategic adaptability in reconfiguring IP portfolios in

response to technological change. And finally, the comparative findings contribute to institutional theory by illustrating how national IP regimes and enforcement conditions moderate the relationship between AI adoption and innovation performance. For practitioners, the findings suggest that successful AI-driven innovation requires alignment between technological investments and diversified IP strategies. Overreliance on patent protection may be suboptimal in fast-evolving AI domains, particularly where data and tacit knowledge constitute critical value drivers. Managers are therefore encouraged to develop integrated IP governance frameworks that balance disclosure, secrecy, and collaboration. For Indian firms, targeted investments in AI capabilities, coupled with strategic IP planning, can yield disproportionate innovation benefits despite institutional constraints. From a policy perspective, the results highlight the need for adaptive IP and data governance frameworks that reflect the realities of AI-driven innovation. Policymakers, particularly in emerging economies, should consider providing clearer guidance on AI-generated inventions, data ownership, and the interaction between

competition law and IP rights. Despite its contributions, the study is subject to certain limitations. The reliance on secondary data, while ensuring comparability and scalability, may not fully capture nuanced organizational practices related to IP management. Additionally, AI adoption is measured through proxies that may not reflect the depth or sophistication of AI use within firms. The cross-sectional nature of the analysis also limits the ability to draw strong causal inferences over time. In conclusion, this study underscores that intellectual property strategy is no longer a peripheral legal concern but a central strategic lever in AI-driven innovation. By empirically demonstrating how firms navigate IP challenges and opportunities across diverse institutional contexts, the research offers timely insights for scholars, managers, and policymakers engaged in shaping the future of innovation in the age of artificial intelligence.

9.Recommendations

Recommendations for State Regulators and Policymakers

1. Develop AI IP Guidelines: Regulatory authorities should develop specific legal guidelines to clarify inventorship, authorship,

ownership and liability issues related to AI-generated innovations and creative outputs.

2. Strengthen data governance and protection frameworks: To foster secure and innovation-friendly AI ecosystems, governments should establish robust data governance policies that address data ownership, access rights, privacy and the ethical use of AI.

3.Modernization of Patent Examination Systems: Patent offices should develop AI-focused examination criteria and specialized review procedures to evaluate algorithm-based inventions, data-driven innovations, and machine-generated outputs.

4.Advocate for institutional support to emerging economies.: Emerging economies like India should improve institutional support through AI-focused innovation funds, IP facilitation centres and subsidized patent filing assistance for startups and SMEs.

Recommendations for Corporate Legal Boards and Firms

1.Embrace Hybrid Intellectual Property Strategies: “Companies need to do more than lean on patents alone and build their IP portfolios around trade secrets, contractual protections, data exclusivity and algorithmic

confidentiality.”

2.Establish Dedicated AI-IP Governance

Committees: Corporate legal boards need to establish interdisciplinary governance committees of legal experts, technologists and innovation managers to track AI-related IP risks and compliance.

3.Align IP strategy with AI investment

decisions: Organizations should align their AI investments with their long-term IP strategy to enable effective value appropriation and sustainable competitive advantage.

4. Deploy Ethical AI and Compliance

Audits: Corporate legal boards should institute regular AI governance and IP compliance audits to foster transparency, accountability, and regulatory compliance.

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