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# The Cost of Uncertainty

## How Copyright Law Constrains Artificial Intelligence Innovation in Brazil

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# Executive Summary

Training generative AI systems depends on Text and Data Mining (TDM), the practice of automatically analyzing large volumes of content to identify patterns and extract relevant information. Brazil's Copyright Law (Law No. 9,610/1998), designed for the analog era, does not provide clear exceptions for TDM, creating significant legal uncertainty in Brazil.

This study examines how the lack of a legal exception for TDM affects the competitiveness of Knowledge-Intensive Business Services (KIBS) firms, drawing on comparisons with the United States, European Union (EU), and China, as well as data from the Global Innovation Index (GII) and AI patent filings. The main evidence is as follows:

- Brazil shows strong potential in Human Capital (48th globally), but institutional weakness (107th) represents a severe regulatory bottleneck that limits the conversion of that potential into innovation, reflected in its 50th position overall.
- High legal uncertainty. The absence of TDM exceptions turns technically essential uses into legal risk, raising transaction costs and discouraging investment in datasets and proprietary AI models.
- Low generation of national technological assets. Only 9% of AI patent applications filed with the INPI are of domestic origin, indicating persistent technological dependence.
- Barriers to entry for Knowledge-Intensive Business Services (KIBS) firms. Brazilian companies face a structural disadvantage relative to competitors operating in jurisdictions with more flexible copyright systems.

Regarding public policy implications, maintaining the current copyright regime reinforces technological dependence and limits market dynamism. This constrains the ability of Company X to outperform Company Y by targeting unexplored market gaps. This dynamic is especially relevant in strategic sectors of the knowledge-based economy, where delivering greater value or superior products is the primary competitive advantage over traditional competitors. For that reason, regulatory modernization is a necessary condition to reduce legal uncertainty and align Brazil with international practices in artificial intelligence.

This exploratory study, grounded in triangulation of evidence, does not aim to isolate a single causal relationship. Even so, the convergence of legal uncertainty, prohibitive transaction costs, and the low creation of domestic technological assets points to a diagnosis of structural risk. Accordingly, the central recommendation is to establish an explicit legal exception for Text and Data Mining (TDM). Within the framework of correlational research applied to public policy, this measure is the most direct and effective way to mitigate the systemic risk to innovation identified here.

# 1. Introduction

Generative artificial intelligence is reshaping the global economy by turning data into a strategic input. In Brazil, however, this revolution runs up against a copyright law drafted even before the internet became widespread. Brazil's Copyright Law (Law No. 9,610/1998) remains in force today, yet it provides no exceptions for Text and Data Mining (TDM). This step, essential to training AI systems, involves the use of statistical methods to identify patterns and correlations across data.

Training generative AI systems requires processing millions of texts, lines of code, and images, much of it protected by copyright. In countries such as the United States, the *fair use* doctrine allows limited use of copyrighted material without prior permission for purposes such as criticism, commentary, news reporting, teaching, or parody. In the European Union, there are specific legal exceptions for TDM. In Brazil, by contrast, the law provides no legal certainty for this practice, exposing companies to litigation risk and raising innovation costs. This creates an environment of uncertainty that delays investment, discourages the development of in-house data centers, and deepens technological dependence on foreign countries.

The need for a TDM exception is not merely a technical demand. It is an economic imperative for the survival of Knowledge-Intensive Business Services (KIBS). Unlike traditional industrial sectors, strategic consultancies, software developers, and AI startups depend on the continuous recombination of data and knowledge to generate innovation.

Under the current rigidity of Law No. 9,610/1998, these actors face structural risks that undermine their viability in Brazil.

While there are legitimate discussions regarding authorship and content remuneration, Brazilian legislation remains anchored in an analog model that ignores the balance essential for innovation within the sector. As Shugurov (2016) highlights, the protection and enforcement of intellectual property rights should be conducted in a way that contributes to the dissemination of technology and to the mutual advantage of both producers and users of knowledge, favoring social and economic well-being (YUEH, 2007). By maintaining an excessively rigid regime lacking flexibility mechanisms, the country ultimately raises the costs of accessing knowledge and inhibits the process of technological innovation, placing Brazilian companies in a position of competitive vulnerability compared to global leaders (YUEH, 2007).

KIBS firms, ranging from startups developing medical imaging diagnostic algorithms to consultancies using AI to optimize supply chains, do not manufacture physical goods. Their "factory floor" consists of databases, and their raw material is recombined knowledge. For this sector, restricting data use is equivalent to prohibiting a steel mill from using iron ore. Other examples include:

- Software Developers: The imminent risk of the final product being blocked due to copyright infringement claims arising during the model training phase.
- Data Consultancies: The technical and legal impossibility of performing Text and Data Mining (TDM) on large databases, which renders the delivery of competitive analytical insights unfeasible.
- AI Startups: A "brain drain" and the migration of servers to jurisdictions with greater legal certainty, such as the U.S. and the European Union, where the transformative use of data is protected by modern regulatory frameworks.

While the U.S. and China align their legislation to foster innovation, Brazil maintains restrictive rules that prevent the country from climbing the global value chain. The table below summarizes how this institutional rigidity impacts national complexity and productivity:

| Indicator | Complexity vs. GDP Performance | Diversification in Complex Capabilities | Sectoral Success Case (Benchmark) |
|---|---|---|---|
| Brazil | Underperformance | Low | AgTech (Ethanol) – Success via coordinated public policy |
| USA | Technological Frontier | High | Diversified (various sectors) |
| China | Rising Frontier | High | State-Led Policy (Five-Year Plans) |
| Research Implication | Contextualizes the high cost of institutional rigidity that prevents a productivity leap | Highlights the direct correlation between an innovative regulatory environment and economic diversification | Demonstrates the role of governance and specific regulation in unlocking complex sectors |

*Box 1. Economic complexity and comparative performance (WIPO). Source: WIPO 2024 consolidated data (Author's elaboration).*

This disparity demonstrates that legal certainty is not a bureaucratic detail, but rather the essential infrastructure for market dynamism. The absence of a TDM exception acts as a "tax on experimentation," raising transaction costs to prohibitive levels for domestic companies.

Given this scenario, this raises the central research question of this study: **How does the absence of a legal exception for TDM affect the competitiveness of Brazilian KIBS compared to global leaders?** To answer this question, this study combines a diagnosis of the Brazilian regulatory framework, international benchmarking, and a triangulation of innovation indicators.

The next section details the methodological approach used to diagnose the regulatory 'Brazil Cost' and conduct the international benchmarking.

# 2. Methodology

This chapter describes the methodological approach adopted to investigate how the Brazilian Copyright Law (Law No. 9,610/98) affects innovation in Brazil. This study analyzed the Knowledge-Intensive Business Services (KIBS) sector, focusing on software,

AI, and strategic consultancy firms. The objective was to identify how the lack of specific rules for Text and Data Mining (TDM) creates economic bottlenecks that prevent these companies from competing globally.

The investigation followed three stages: a diagnosis of the regulatory "Brazil Cost"; international benchmarking; and cross-referencing with Performance Indicators.

## 2.1. Diagnosis of the Regulatory "Brazil Cost"

In this stage, we mapped Brazilian legislation, judicial decisions, and reform proposals to identify three channels of economic impact: transaction costs, legal uncertainty, and barriers to entry.

Transaction costs refer to the financial and administrative effort an AI company must expend to negotiate individual licenses with thousands of authors, which is unfeasible for training large language models.

Legal uncertainty, in turn, consists of the risk that a startup might be sued for copyright infringement after investing millions in developing a technology, due to the absence of a clear legal exception. Finally, barriers to entry describe the current landscape that favors large foreign corporations operating under more flexible laws and stifles small Brazilian companies attempting to enter the AI market.

## 2.2. Internacional Benchmarking

In the second stage of the research, a comparative analysis was conducted between the Brazilian regime and the regulatory frameworks of the U.S., the European Union, and China. This analysis identified how varying levels of copyright flexibility and TDM exceptions impact national competitiveness.

## 2.3. Cross-Referencing Performance Indicators

To scale the qualitative arguments, we utilized data from the Global Innovation Index (GII) for 2024 and 2025. We cross-referenced Brazil's ranking in the 'Institutions' pillar with patent filing data and technological output. This approach allowed us to directly connect the rigidity of the law with the country's difficulty in climbing global innovation and productivity rankings.

The analysis combines the cross-referencing of GII data with a comparison of the regulatory frameworks of Brazil, the U.S., the European Union, and China, along with documentary evidence of sectoral impact.

This study does not claim a strict causal relationship between the rigidity of Law 9,610/98 and Brazil's low innovation performance. In applied social sciences, it is unfeasible to isolate institutional variables in a controlled experiment. However, the triangulation of evidence shows that different types of evidence converge, pointing toward the same risk vector: legal uncertainty as a barrier to innovation.

The results do not aim to establish a definitive causal link, but rather a systemic risk diagnosis whose empirical consistency provides a solid foundation for public policy formulation and directs hypotheses for future research.

# 3. Results

In today's economy, organizational value resides primarily in intangible assets—software, data, patents, and know-how—positioning KIBS firms as central players in innovation. In Brazil, however, the copyright regime imposes frictions that limit the ability of these sectors to transform knowledge into economic value. Data from the Global Innovation Index (GII) 2024 highlight this structural paradox: although the country shows robust performance in human capital formation and scientific production, it occupies alarming positions in the institutional pillars responsible for making innovation viable.

This paradox becomes evident in international comparisons from the GII 2024, where Brazil holds radically different positions between the Human Capital and Institutions pillars.

| GII Pillar (Global Innovation Index) | Overall Ranking | 1. Institutions | 2. Human Capital & Research | 3. Infrastructure | 4. Market Sophistication | 5. Business Sophistication | 6. Knowledge Output | 7. Creative Output |
|---|---|---|---|---|---|---|---|---|
| Brazil (Rank) | 50th | 107th | 48th | 60th | 71st | 39th | 50th | 50th |
| USA (Rank) | 3rd | 17th | 12th | 30th | 1st | 2nd | 4th | 8th |
| China (Rank) | 11th | 44th | 22nd | 5th | 16th | 11th | 3rd | 14th |
| Comparative Diagnosis | Opportunity derived from observed potential. | Critical Point: Brazilian legal uncertainty contrasts with U.S. institutional robustness. | Relative competitiveness in talent development. | Significant logistical and digital gap compared to China. | Bottleneck: Lack of financing and framework for intangible assets. | The Brazilian private sector is sophisticated but operates in a hostile environment. | Scientific production capacity exists but does not convert into value. | Creative potential hindered by inadequate regulation. |

*Table 1. Structural paradox: comparison of GII pillars (Brazil vs. USA/China). Source: GII 2024 (Author's elaboration).*

The gap between knowledge generation capacity and the fragility of Brazilian institutional indicators confirms that the barrier to innovation is regulatory. This indicates that while the country develops talent and produces science, it fails to provide a legal and regulatory environment capable of sustaining intangible assets.

While the U.S. leads in market sophistication (1st) and combines this with institutional robustness (17th), and China advances through state coordination in infrastructure (5th) and knowledge production (3rd), Brazil ranks 107th in Institutions. For KIBS, this fragility translates into legal uncertainty and a low conversion rate of knowledge into intellectual property.

This scenario directly blocks national market dynamism through three central mechanisms (BALESTRA; CIANI, 2022). First, through prohibitive transaction costs, as without TDM exceptions, AI training would require individual authorizations on an impractical scale. Second, through barriers to entry, since foreign companies operate under *fair use* regimes or TDM exceptions, placing Brazilian KIBS at a competitive disadvantage. Finally, legal uncertainty acts as a deterrent for investors, reducing the capital flow toward national data-intensive initiatives.

The bottleneck is, therefore, regulatory. Law No. 9,610/98 falls short in addressing AI's algorithmic logic. The absence of a *fair use* clause or specific TDM exceptions creates friction that hinders applied innovation (ROCHA et al., 2022; LANTYER DE MELLO ALVES, 2024). A critical indicator of this systemic failure is the patent-to-article ratio. In the state of São Paulo, it is estimated that there is 1 patent for every 35 scientific articles, whereas in the U.S., the ratio approaches 1 to 1.

| GII Pillar 2024 | Institutions (Regulatory Environment) | Market Sophistication | Knowledge Output | Patent/Article Ratio (SP Cluster) |
|---|---|---|---|---|
| Brazil (Rank) | 107th | 71st | 50th | 1 : 35 |
| USA (Rank) | 17th | 1st | 4th | 1: 1.1 |
| China (Rank) | 44th | 16th | 3rd | Not identified |
| Implications for KIBS and Copyright | Legal uncertainty acts as a barrier to entry, raising transaction costs for cumulative innovation. | The financing and licensing market for intangible assets is nascent and averse to legal risk. | Brazil generates relevant academic knowledge but fails in the stage of conversion into commercial Intellectual Property. | Clear evidence of systemic failure in the protection and commercialization of intellectual assets generated in academia/industry. |

*Table 2. Institutional bottleneck: rankings in GII pillars (2024). Source: Global Innovation Index 2024 (Author's elaboration).*

In comparative terms, while the U.S. and China have adapted their frameworks to enable AI scalability, Brazil maintains a system of exceptions that fails to keep pace with technological dynamism. International experience indicates that Brazil's copyright rigidity does not protect the author; instead, it can produce concrete exclusion effects, such as raising transaction costs, deterring private investment, and reinforcing technological dependence in strategic sectors. Without a reform that incorporates functional mechanisms equivalent to global standards, Brazil is likely to remain on the periphery of the knowledge economy (BRANSTETTER; FISMAN; FOLEY, 2006; VELTZ, 2017).

# 4. Discussion of results

Brazil possesses a significant capacity for knowledge generation, but this potential is blocked by an institutional framework that raises transaction costs, reduces productive mobility, and discourages the transformation of knowledge into high-value-added assets. This misalignment is acutely felt in the Knowledge-Intensive Business Services (KIBS) sector, which holds a strategic position in the contemporary economy while remaining vulnerable to the limitations of the current copyright regime. As primary drivers of technological diffusion, KIBS depend not on physical capital, but on continuously recombined and applied knowledge (ZIEBA, 2013; SANTOS, 2020). This structural dependence on information reuse means that excessively rigid copyright regimes increase legal uncertainty and compromise Brazilian competitiveness (SHEARMUR, 2012; RIBEIRO, 2017).

Data from the Global Innovation Index (GII, 2024) reveal the extent of this contradiction, as the country demonstrates consistent performance in knowledge generation but fails to convert it into economic assets. Between 2021 and 2024, Brazil established itself as a high-performance innovator in Latin America, indicating an innovation performance above expectations for its income level (WIPO, 2024). However, this technical performance coexists with low rankings in institutional indicators, evidencing that the problem is not a lack of human capital, but rather regulatory issues.

| Year | Global Ranking (GII) | Regional Leadership (LAC) | WIPO Status |
|---|---|---|---|
| 2021 | 57th | Yes | High-Performance Innovator |
| 2022 | 54th | Yes | High-Performance Innovator |
| 2023 | 49th | Yes | High-Performance Innovator |
| 2024 | 50th | Yes | High-Performance Innovator (4th consecutive year) |

*Table 3. GII trajectory (2021–2024): rankings and innovation status. Source: Global Innovation Index (Author's elaboration).*

In this scenario, the copyright regime can act as a structural barrier by restricting the transformative use of data, making it difficult to convert scientific advances into competitive Artificial Intelligence products and applications. The absence of clear exceptions for data reuse raises legal risk, especially for small and medium-sized KIBS, increasing business failure rates and discouraging domestic investment. While major global economies have already recognized the need for flexibility—with the United States utilizing the fair use doctrine to reduce compliance costs (USCO, 2023) and China treating data access as a strategic asset—Brazil remains in a regulatory vacuum that drives away venture capital.

National legal literature converges on the diagnosis that Law No. 9,610/98 is inadequate for the reality of AI (SCHIRRU, 2021; LANTYER DE MELLO ALVES, 2024). Paradoxically, this rigidity does not strengthen the protection of authors; it merely expands areas of legal ambiguity and inhibits national technological development (ROCHA et al., 2022). Ultimately, the evidence suggests that Brazilian market dynamism is blocked. Without a transition to a model of regulated permission with safeguards, Brazilian KIBS firms are likely to remain peripheral users of foreign technologies, unable to ascend the global value chain.

# 5. Analysis and Evaluation

The analysis of Artificial Intelligence patent filings in Brazil reveals that regulatory uncertainty is a measurable hurdle to national innovation. Despite an impressive absolute volume, the data shows a weakened innovation structure, as only 9% of AI patent filings are of domestic origin, highlighting a heavy dependence on foreign technologies. While global leaders like the U.S. and China accelerate their filings, driven by regulatory frameworks that favor experimentation — such as American *fair use* — Brazil is showing signs of a slowdown.

| Analytical Dimension | AI Patent Volume (through 2019) | Recent Trend (post-2022) | Impact of the Regulatory Framework |
|---|---|---|---|
| Brazil | ~5,100 (only 9% of domestic origin) | Decline in filings | Legal uncertainty and copyright rigidity discourage new filings. |
| USA | Global Vice-Leader | Acceleration | *Fair use* enables experimentation and provides security for model training. |
| China | Global leader | State-driven acceleration | Aggressive national policies incentivize strategic filings and data sovereignty. |

*Table 4. AI patent volume (comparative: Brazil, USA, China) and impact of the regulatory framework. Source: INPI/WIPO databases (Author's elaboration).*

This loss of momentum is clear when observing recent market behavior. After a peak in applications in 2022, a turning point and a subsequent decline in filings were noted starting in 2023. This shift coincides with the global explosion of generative AI and the increase in Brazilian legal uncertainty regarding the use of data for model training. The profile of domestic applicants further underscores the gravity of this scenario: Brazilian innovation is concentrated in data-intensive areas, such as Computer Vision and Medical Sciences, sectors that depend directly on regulatory clarity to thrive.

| Indicator | Survey Results (Sample: 264 applications) |
|---|---|
| Recent Peak | 2022 recorded the highest number of filings (78 records) |
| Inflection Point | A decline in applications has been observed starting in 2023 |
| Applicant Profile | Domestic: 59.8% (within this specific sub-sample).<br>Foreign: 39.8% (led by the U.S. at 59.6% and China at 24%). |
| Primary Applications (Domestic) | 1. Computer Vision (102 applications) - Data-intensive (images).<br>Control Methods (11 applications). |
| Field of Application | Medical Sciences stand out as the primary field for Brazilian applicants. |

*Box 2. Recent trends: AI patent filings (2019–2024 sample). Source: INPI survey (Author's elaboration).*

The core of national technological production is concentrated in Machine Learning, a technique present in the vast majority of identified patents. Since the development of these tools requires processing massive volumes of data, the absence of exceptions for Text and Data Mining (TDM) strikes at the heart of the competitiveness of Knowledge-Intensive Business Services (KIBS). Without the guarantee that they can mine data to train their models, domestic firms face what economic literature describes as a "tax on experimentation." Overly rigid intellectual property systems raise compliance costs to a level that discourages private investment and stalls cumulative innovation.

| Technological Category | Empirical Results (INPI Sample 2002–2019) | Comparative Global Context |
|---|---|---|
| Core Technologies | 1,356 applications identified in the total sample | Not identified |
| *Machine Learning* (ML) | 1,299 applications. The most prominent technique in Brazil | Represents 40% of global AI patents; average growth of 26% p.a. (2011–2016) |
| *Deep Learning* | High frequency of association with ML | Average annual growth rate of 175% internationally |
| Neural Networks | High frequency of association with ML | Average annual growth rate of 46% internationally |

*Box 3. Technological focus of AI patents (INPI sample 2002–2019). Source: INPI sample (Author's elaboration).*

Evidence indicates that Brazil possesses the human capital necessary to generate high-performance innovation but is hindered by an incompatible institutional base. Current regulatory inaction is already producing real effects on corporate behavior. Therefore, the creation of an flexible exception for transformative uses, whether through *fair use* or a specific TDM exception, emerges as a prerequisite to unlock national innovation and ensure that Brazil remains a relevant competitor in the global AI economy.

# 6. Conclusion

The future of innovation in Brazil depends on a regulatory environment that understands the digital economy. This study demonstrates that the Brazilian Copyright Law, conceived for a different era in the country's history, has become a barrier for the KIBS sector. The lack of a TDM exception creates a scenario where innovation is penalized by uncertainty, forcing Brazilian companies to operate at a competitive disadvantage relative to the international market.

Global experience shows that countries that have modernized their copyright laws to permit data mining are reaping benefits in terms of productivity and new business models. For Brazil, maintaining the *status quo* means accepting a peripheral role in the global value chain of Artificial Intelligence. To reverse this situation and foster market dynamism, it is urgent that the Brazilian regulatory framework evolves from a model of restriction to one that fosters responsible innovation.

| Priority | Theme | Suggested Policy Action |
|---|---|---|
| High | Legal Exception for Text and Data Mining (TDM) | Inclusion of a provision in Law 9,610/98 allowing the use of protected works for training generative AI systems and scientific research, provided the use is not expressly reserved or for direct profit-making purposes. This would reduce legal uncertainty and transaction costs for technology companies (**KIBS**). |
| Medium | Creation of an Adapted Flexible Use Clause | Develop a "Fair Use" mechanism tailored to the Brazilian copyright model. Rather than a direct copy of the U.S. model, this would introduce clear criteria for transformative uses, focusing on four factors: (1) the purpose of the use; (2) the nature of the work; (3) the amount used; and (4) the market impact on the original work |
| Low | Inter-ministerial and Strategic Alignment | Promote coordination between the Ministry of Science, Technology, and Innovation (MCTI) and the Ministry of Culture to ensure that Copyright Policy is aligned with the Brazilian Artificial Intelligence Plan (PBIA) 2024–2028 and with support policies for Knowledge-Intensive Business Services (KIBS) under the National Science, Technology, and Innovation Strategy. |

*Box 4. Public policy recommendations (Author's elaboration).*

Updating Law 9,610/98 is a necessary condition for Brazil to transition from being a mere consumer to becoming a developer of AI. The creation of a TDM exception is the most direct solution to reduce transaction costs and provide momentum to the KIBS sector. By adopting this model, the country removes the primary regulatory bottleneck to innovation, ensuring security for long-term investments in national technology.

By integrating transaction cost analysis, patent mapping, and institutional diagnosis, this study offers a significant contribution by shifting the debate on copyright and AI in Brazil from the sphere of individual author protection to that of systemic competitiveness. The triangulated evidence presented here, demonstrating that legal uncertainty imposes a specific "Brazil Cost" on the knowledge economy, is not the end of the discussion; rather, it necessitates a modeling of fiscal and competitive risks associated with different regulatory reform scenarios.

# 7. Direction for future studies

This study analyzed, from an institutional and comparative perspective, the effects of the copyright regime on data-driven innovation and artificial intelligence in Brazil. Despite the analytical advances presented, several questions remain open. The following research axes are suggested to deepen the debate and support the formulation of public policies:

- **Transaction Costs and Barriers to Entry in AI Innovation:** Future research could investigate how costs associated with licensing, legal uncertainty, and litigation risk affect the ability of emerging companies to enter and remain in the artificial intelligence and knowledge-intensive services markets. Empirical studies could compare corporate trajectories under different regulatory arrangements and levels of access to financial and institutional resources.

- **Technological Dependence and Diversity of Algorithmic Systems:** Studies could analyze the extent to which restrictions on data use and text and data mining (TDM) incentivize the adoption of models developed in other jurisdictions, as well as the effects of this dependence on technological adaptation to specific social, economic, and cultural contexts.
- **Institutional Environment, Human Capital, and market dynamism:** Research could explore the relationship between the availability of skilled human capital and the capacity for retention and internalization of the economic gains from innovation, evaluating whether institutional weaknesses influence decisions regarding location, migration, and the productive insertion of highly qualified professionals in the technology sector.
- **Interest Dynamics in the Regulatory Debate on Copyright and AI:** Future studies could map the primary actors involved in legislative and regulatory processes related to artificial intelligence and copyright, examining how different economic and institutional interests influence public policy design and the balance of representation between sectors.

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# Reglab Methodology Annex

Author: Wesley Renato Costa Pena

## Title

The Cost of Uncertainty: How Copyright Law Constrains Artificial Intelligence Innovation in Brazil.

## Research Question

How does the absence of a legal exception for Text and Data Mining (TDM) affect the competitiveness of Knowledge-Intensive Business Services (KIBS) in Brazil?

## Methodology summary

The investigation followed three main stages: a diagnosis of the Brazilian regulatory cost; international benchmarking comparing Brazil with the USA, the European Union, and China; and the cross-referencing of these data with performance indicators from the Global Innovation Index (GII).

## Data collection

The study utilized innovation data from the Global Innovation Index (GII) for 2024 and 2025, patent filing data from the National Institute of Industrial Property (INPI), documentary evidence of sectoral impact, as well as a mapping of Brazilian legislation and judicial decisions.

## Data analysis

The study conducted a comparative analysis of regulatory frameworks and a quantitative analysis cross-referencing Brazil's institutional ranking in the GII with national technological output (patent-to-article ratio) to identify economic and institutional bottlenecks.

## Bias Reduction Procedures

Adoption of an institutional and comparative perspective, utilizing recognized international databases (WIPO/GII) and national sources (INPI) to provide scale and objectivity to qualitative arguments.

## Other Methodological Limitations

Certain questions remain open, suggesting the need for future empirical studies to compare corporate trajectories under different regulatory arrangements, in addition to deeper investigations into transaction costs and litigation risks.

## Software use

Use of NotebookLM for the analysis of key source files;
ChatGPT and Gemini for grammatical review (spelling, grammar, and synonym searches), linguistic adaptation, refinement of pre-drafted segments and image generation;
Excel for table creation and parameterization within an evidence matrix for qualitative analysis;
Adobe CC Suite for layout design and finalization of graphics and illustrations.

## Ethical Guidelines

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To ensure the integrity of this work, the authors developed, conducted, and analyzed the study independently, without any contribution or interference from the company, which also did not influence or interfere with the interpretation of the results. The authors maintain full professional independence and responsibility for the content and conclusions of this work.
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