BAR Brazilian Administration Review

ANPAD

Research Article

Regulation of Artificial Intelligence: Between the Switch and Innovation — Is Brazil Prepared?

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How to cite: Serra, F. A. R., Scafuto, I. C., & Serra Vieira, P. (2025). Regulation of Artificial Intelligence: Between the switch and innovation — Is Brazil prepared?. *BAR-Brazilian Administration Review, 22*(4), e250015.

DOI: https://doi.org/10.1590/1807-7692bar2025250015

Keywords:
artificial intelligence; regulation; innovation; technology policy

JEL Code:
O38, L51, K20

ABSTRACT

Objective: to examine whether Brazil's proposed AI regulation promotes innovation and competitiveness in comparison with global regulatory models. **Methods:** qualitative, exploratory study using comparative document analysis of AI regulations in eight jurisdictions (USA, EU, UK, China, Brazil, India, Mexico, and Chile). The analysis applies Lessig's regulatory vectors — law, architecture, market, and norms — alongside institutional theory. **Results:** findings show that regulatory effectiveness depends on institutional capacity, implementation mechanisms, and policy alignment. **Conclusions:** adaptive and sectoral models (e.g., UK, USA, Chile) better support innovation than prescriptive or fragmented frameworks. Brazil's EU-inspired Bill 2338/2023 faces enforcement gaps, legislative overlaps, and uneven sandbox deployment, raising barriers for startups. Brazil's attempt to replicate EU rules without corresponding capacity may hinder AI development. A hybrid, phased strategy combining legal convergence with institutional adaptation could enhance innovation and regulatory credibility in emerging markets.

Received:
January 21, 2025.
This paper was with the authors for three revisions.

Accepted:
September 24, 2025.

Publication date:
November 07, 2025.

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Funding:
The authors the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil). Process number: 302352/2022-8

Conflict of Interests:
The authors stated that there was no conflict of interest.

Editors-in-Chief:
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Reviewers:
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One anonymous reviewer.

Peer Review Report:
The Peer Review Report is available at this external URL.

Editorial assistants:
Eduarda Anastacio and Simone Rafael (ANPAD, Maringá, Brazil).

Data Availability: Serra, Fernando (2025), "Regulation of artificial intelligence: between the switch and innovation — is brazil prepared?" Mendeley Data, V1, doi: http://doi.org/10.17632/65rr7t6z4d.1
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> The notion of a kill switch goes back to what we talked about before, that there's a single model we can regulate. Now, what if the model actually uses, say, 10, 20, 200 different kinds of nodes in a network? Where do you put the kill switch? ... A system like this, an AGI, that is basically a network of different kinds of models, will be even more distributed.
>
> Nicklas Lundblad (Google DeepMind)

INTRODUCTION

Artificial intelligence (AI) holds transformative potential in sectors such as healthcare, education, finance, and public administration. This potential has triggered a global race to define regulatory frameworks that balance innovation with societal control. Jurisdictions differ in how they govern AI, shaping diverse environments for technological development and investment (Butcher & Beridze, 2019; Sigfrids et al., 2022; Middleton et al., 2022). While some favor flexibility and experimentation, others emphasize legal certainty and oversight. These differences affect both domestic innovation and global competitiveness.

Regulatory models vary widely. The United States promotes a sectoral, market-driven approach that favors innovation and voluntary compliance (Cardozo, 2023; Hutson, 2023). The European Union, by contrast, adopts a risk-based model with binding obligations and strong rights protections (Djeffal et al., 2022; Leitão & Belchior, 2022). China emphasizes centralized planning aligned with state priorities, while the United Kingdom supports principle-based guidelines and regulatory sandboxes (Radu, 2021). These models reflect distinct political economies and institutional capacities.

Brazil's regulatory trajectory, built on the Brazilian Artificial Intelligence Strategy (EBIA) and Bill 2338 of 2023, seeks alignment with international standards, particularly the European model. Yet domestic constraints, including limited infrastructure, weak enforcement, budget restrictions, and fragmented coordination, threaten the model's viability (Belli et al., 2023; Cavalcante, 2023; Llamas Covarrubias et al., 2022; Rolim et al., 2024). Such constraints raise questions about adopting comprehensive frameworks developed for structurally different settings.

Although AI regulation literature has grown, it still focuses on developed countries. Little attention is paid to how regulatory diffusion affects emerging economies with limited state capacity and fragmented innovation ecosystems (Almeida, 2022; Mendes et al., 2024; Smuha, 2021; Souza & Roveroni, 2023). In these contexts, policy transfer often overlooks enforcement asymmetries and the unequal distribution of compliance burdens, leaving gaps in understanding how credible and feasible governance can be built.

This study draws on institutional economics to analyze how transaction costs, regulatory complexity, and enforcement structures influence innovation (Cardozo, 2023). Neo-institutional theory further explains Brazil's emulation of European models as legitimacy-seeking behavior driven by mimetic isomorphism (Cavalcante, 2023; Santos & Santos, 2024). Together, these frameworks guide the research question: How do Brazil's institutional conditions affect the feasibility of European-style AI regulation, and what adaptations could better support its innovation ecosystem?

To answer this, the study compares AI regulatory architectures in eight jurisdictions using Lessig's framework of law, architecture, market, and norms, along with the Regulatory Impact Assessment. The analysis identifies structural misalignments that hinder Brazil's effectiveness and proposes alternatives suited to its institutional realities.

LITERATURE REVIEW

Fundamentals of AI regulation

AI presents regulatory challenges that differ substantially from previous technologies due to its opacity, autonomy, and social impact (Corrêa et al., 2023; Llamas Covarrubias et al., 2022; Smuha, 2021). These characteristics create tensions between innovation and rights protection, transparency and intellectual property, and global integration and national sovereignty (Aguiar, 2024; Almeida, 2022; Madhavan et al., 2020). This study adopts an institutional lens to examine how regulatory capacity and structural conditions shape AI governance in emerging economies such as Brazil (Cavalcante, 2023; Santos & Santos, 2024).

The analytical framework follows Lessig's model of regulatory modalities: law, architecture, market, and social norms. Recent research has adapted this framework to understand AI governance (Judge et al., 2024; Viljanen & Parviainen, 2022). This study compares how these four vectors are configured in eight jurisdictions, and how different combinations influence innovation and foundational model development (Alves, 2024; Souza & Roveroni, 2023). The analysis also considers the global diffusion of regulatory models, particularly the 'Brussels Effect,' and the institutional limitations of adopting advanced frameworks in less prepared national contexts (Bradford, 2020; Cardozo, 2023; Mendes et al., 2024).

AI raises distinct governance challenges. Unlike traditional technologies, AI systems often function as opaque 'black boxes' that hinder explainability and accountability, especially in high-stakes areas such as healthcare,

finance, and public services (Corrêa et al., 2023; Llamas Covarrubias et al., 2022; Smuha, 2021). In contexts with limited regulatory capacity, such as Brazil, these issues are magnified (Cardozo, 2023). Deep learning models may yield accurate outcomes without interpretable reasoning, increasing risks when oversight institutions are weak.

A second tension arises from AI's dependence on large volumes of personal data. Strict data protection rules can slow innovation, whereas weak enforcement may result in fundamental rights violations (Santos & Santos, 2024; Souza & Roveroni, 2023). The Brazilian General Data Protection Law illustrates this trade-off and reveals institutional enforcement fragilities (Cavalcante, 2023).

The transnational deployment of AI systems complicates regulatory alignment. Models trained in one jurisdiction are often deployed in others, raising complex questions about accountability and legal interoperability (Almeida, 2022; Madhavan et al., 2020). These challenges intensify for emerging economies with limited influence in global standard-setting.

Risks of algorithmic bias and discrimination also demand attention. AI systems trained on biased data may reinforce structural inequalities, such as lower accuracy in facial recognition for women and racial minorities (Ntoutsi et al., 2020). Addressing these risks requires technical expertise and governance capacity often lacking in regulatory bodies.

Excessive regulatory rigidity may inadvertently constrain innovation. Overly demanding regulations can discourage investment and advantage global firms, making it harder for local startups to compete (Santos & Santos, 2024; Souza & Roveroni, 2023).

Institutional perspectives on regulation

AI regulation depends not only on legal architecture but also on the broader institutional environment where rules are enforced. Countries differ in legal cultures, administrative traditions, political institutions, and technological infrastructures, which explains why similar regulatory designs produce divergent outcomes. This is especially important for countries like Brazil that seek to adopt comprehensive models developed in more robust institutional environments (Cavalcante, 2023; Santos & Santos, 2024).

According to institutional economics, institutions comprise both formal rules and informal norms governing behavior (North, 1991). Effective regulation requires legislation, administrative enforcement, interagency coordination, and technical expertise. In Brazil, institutions such as the National Data Protection Authority (*Autoridade Nacional de Proteção de Dados* [ANPD]) face structural limitations including constrained autonomy, low funding, and limited technical staff (Cardozo, 2023; Mendes et al., 2024). These gaps create high transaction costs and undermine regulatory efficacy regardless of legal design.

Sociological neo-institutionalism shows how countries adopt foreign models through isomorphic pressures. According to DiMaggio and Powell (2000), this occurs through coercion, emulation, or normative diffusion. Brazil's alignment with the EU's AI Act exemplifies mimetic isomorphism — seeking legitimacy by reproducing external models (Cavalcante, 2023; Santos & Santos, 2024). Such symbolic adoption may result in what Meyer and Rowan (1977) term organizational decoupling: formal rules poorly enforced in practice.

Other emerging economies have taken more cautious approaches. India emphasizes sector-specific guidance and regulatory pilots, allowing institutional evolution. Mexico focuses on institutional development before binding legislation. Chile implements regulatory sandboxes and cross-sector collaboration to adapt principles locally. These examples suggest that institutional development must precede regulatory ambition.

In Brazil, fragmentation across federal entities, low interagency coordination, and resource scarcity hinder effective implementation. Technical and organizational infrastructure cannot be imported with legal frameworks. Informal norms, bureaucratic routines, and enforcement practices also shape regulatory outcomes.

International regulatory dynamics add complexity. The 'Brussels Effect' describes how EU standards influence global rules through market incentives rather than formal agreements (Bradford, 2020). While alignment with European norms grants symbolic legitimacy, it may impose disproportionate costs on local firms and limit domestic innovation. In Brazil, such alignment could reinforce technological dependency and hinder the emergence of a local AI ecosystem (Souza & Roveroni, 2023).

These institutional perspectives converge on one insight: legal transplants are insufficient without local adaptation. Phased implementation, regulatory experimentation, and institutional strengthening are essential. Brazil's challenges extend beyond ANPD capacity to include low regulatory awareness, uneven compliance burdens, and policies favoring international firms over domestic startups.

A hybrid governance model combining principles-based guidance, regulatory sandboxes, and flexible enforcement may offer a more effective path forward. Regulatory ambition must align with institutional reality. For Brazil and similar countries, this alignment is foundational for building credible, functional, and inclusive AI governance.

Lessig's regulatory model and its application to artificial intelligence

To understand AI governance, it is necessary to look beyond formal laws and consider how behavior is shaped by infrastructure, market incentives, and social expectations. Lessig's (1999) framework outlines four regulatory modalities — law, architecture, market, and social norms — which interact to shape outcomes. This approach is particularly useful for analyzing AI, as it highlights the gap between formal legal convergence and practical implementation (Judge et al., 2024; Viljanen & Parviainen, 2022).

Different countries prioritize these vectors according to institutional capacity and policy preferences. The United States emphasizes market dynamics and industry self-regulation. The European Union prioritizes legal safeguards and rights-based mandates. China integrates centralized legal control with aligned technical and market systems. The United Kingdom favors adaptive, principles-based regulation with experimentation.

Brazil represents a hybrid configuration. Although its legal instruments reflect the European model, its enforcement capacity and supporting infrastructures remain limited (Cardozo, 2023; Cavalcante, 2023; Santos & Santos, 2024). This misalignment results in symbolic adoption without effective implementation.

Lessig's framework reveals structural gaps in regulatory transfers. Successful governance requires legal enforcement, infrastructure development, and social legitimacy. These dynamics are summarized in Table 1, comparing five jurisdictions across Lessig's four regulatory vectors.

Table 1. Global comparison of AI regulatory approaches using Lessig's four modalities.

Country/Region	Law	Architecture	Market	Social norms
United States	Sectoral laws and case-by-case enforcement	Industry-led design standards and voluntary frameworks	Strong market incentives driving innovation with minimal constraints	Innovation-oriented with emphasis on competitive advantage
European Union	Comprehensive risk-based framework (AI Act) with detailed requirements	Mandated technical safeguards (explainability, human oversight)	Market shaped by compliance requirements and certification	Strong rights-protection norms and ethical considerations
China	Centralized regulatory authority with direct state intervention	Technical design aligned with political priorities and surveillance capabilities	State-guided market development in strategic sectors	Collective-oriented norms emphasizing national priorities
United Kingdom	Principles-based, sectoral approach with regulatory flexibility	Experimentation through sandboxes and tailored technical guidance	Balance between innovation incentives and risk management	Pragmatic approach balancing rights and innovation
Brazil	Emergent framework inspired by EU model but with implementation gaps	Limited architectural governance and underdeveloped technical standards	Constrained by limited investment and dependence on foreign technology	Evolving norms with active civil society and judicial influence

Note. Developed by the authors.

Brazil's AI regulatory trajectory in comparative perspective

Brazil's approach to AI regulation is part of a broader effort to modernize digital governance. The General Data Protection Law (LGPD), modeled after the European GDPR, laid the foundation for Bill 2338 of 2023, which introduces a risk-based classification system, oversight structures, and transparency requirements (Cardozo, 2023; Cavalcante, 2023).

Although the bill reflects European legal design, its application in Brazil raises significant concerns. Regulatory impact assessments have identified potential compliance burdens for domestic firms, including obligations for human oversight, detailed documentation, and technical safeguards (Mendes et al., 2024; Santos & Santos, 2024). Such requirements can act as entry barriers, particularly in consolidating innovation ecosystems.

These difficulties are compounded by institutional limitations. Brazil's data protection authority, the ANPD, operates with significantly fewer resources than its European counterparts, limiting enforcement and advisory capacity (Souza & Roveroni, 2023). Regulatory coordination across agencies is weak, and judicial intervention often substitutes for proactive regulation (Cavalcante, 2023).

From an institutional economics perspective, these deficiencies increase transaction costs and reduce legal predictability. This disconnect raises the risk of symbolic regulation without operational impact, a pattern observed when legal transplants lack institutional adaptation (Santos & Santos, 2024).

Brazil's approach contrasts with that of other emerging economies adopting more adaptive regulatory strategies. While Bill 2338 seeks alignment with the European Union's model, its applicability in contexts with limited institutional capacity is contested (Cardozo, 2023; Cavalcante, 2023).

India's National Strategy for AI favors sector-specific experimentation and gradual implementation, enabling regulatory maturity to evolve alongside innovation (NITI Aayog, 2018; Souza & Roveroni, 2023). Mexico

focuses on institutional capacity-building and digital inclusion before enacting AI-specific legislation (Santos & Santos, 2024). Chile integrates UNESCO's ethical guidelines and employs regulatory sandboxes for real-world testing (Mendes et al., 2024).

These cases suggest that institutional development should precede legal emulation. From the lens of sociological institutionalism, Brazil's adoption of European-style regulation may reflect mimetic isomorphism, driven more by the search for legitimacy than by practical enforcement (DiMaggio & Powell, 2000; Meyer & Rowan, 1977). Legal convergence alone is insufficient without robust enforcement agencies, technical infrastructure, and interagency coordination (Cavalcante, 2023).

METHOD

Research strategy and theoretical framework

This study adopts a qualitative and comparative approach to examine how eight countries regulate artificial intelligence, with a focus on Brazil. It investigates how Brazil's institutional and infrastructure conditions affect the implementation of AI regulation inspired by the European model. The study also asks what adjustments could better align regulation with Brazil's innovation environment. It compares different combinations of regulatory tools across countries and identifies barriers that may limit Brazil's ability to adopt similar approaches.

Our analytical lens integrates four complementary theoretical perspectives. Lessig's regulatory modalities provide a systematic framework for comparing how legal rules, technical constraints, economic incentives, and social expectations interact in each jurisdiction. Institutional theory — drawing on transaction cost economics and neo-institutional sociology's insights into isomorphism and legitimacy — helps explain why similar legal structures yield different implementation outcomes. Economic regulation theory focuses on market barriers, information asymmetries, and compliance costs, illuminating the incentives and constraints faced by firms and regulators. Finally, Regulatory Impact Assessment methodology offers a structured approach to evaluating Brazil's Bill 2338/2023 in terms of costs and benefits for diverse stakeholders.

Case selection and comparative logic

We selected eight jurisdictions: the European Union, United States, United Kingdom, China, Brazil, India, Chile, and Mexico. The selection followed a purposive sampling strategy to include both major AI regulators and emerging economies with contexts similar to Brazil. This set combines global models, such as the EU's risk-based framework, the US market-driven approach, and the UK's use of regulatory sandboxes, with more gradual and capacity-focused strategies in India and Mexico, and experimental models in Chile. Brazil is the central case, showing how an emerging economy seeks to apply European-style regulation under institutional constraints. Together, these cases help identify patterns in the use of legal rules, technical infrastructure, market incentives, and social norms, offering both ideal models and practical lessons for AI governance in Brazil. Details on case selection, criteria, and source classification are provided in Supplementary Material A.

Document selection and sources

We conducted a structured document analysis using a multi-criteria protocol to ensure both comprehensive coverage and analytical focus. Six inclusion and exclusion criteria were applied, including institutional relevance, public availability, publication period between 2018 and 2025, specific focus on AI governance, diversity of sources, and balance across jurisdictions. Retrieval followed five stages: initial identification, manual reference review, source validation, database search, and final assessment across the eight selected countries. The process included grey literature and expert reports when official records were limited. All steps were documented to support transparency and replicability. Full definitions of the criteria, detailed procedures, the coding protocol, MAXQDA reliability checks, jurisdictional coverage, and the complete list of 52 documents analyzed are presented in Supplementary Material A, including Table SP1.

Analytical framework

Our analysis follows a three-stage process based on established document analysis methods and guided by the theoretical frameworks described earlier. First, we conduct an initial review to map document characteristics and key themes. Second, we perform a detailed reading to identify both explicit content and underlying assumptions. Third, we apply systematic coding and cross-country comparison using MAXQDA. This approach moves from description to interpretation, showing how legal rules, technical design, market incentives, and social norms interact across different contexts. Full details of the coding process, procedures, and validation steps are available in Supplementary Material A.

FINDINGS

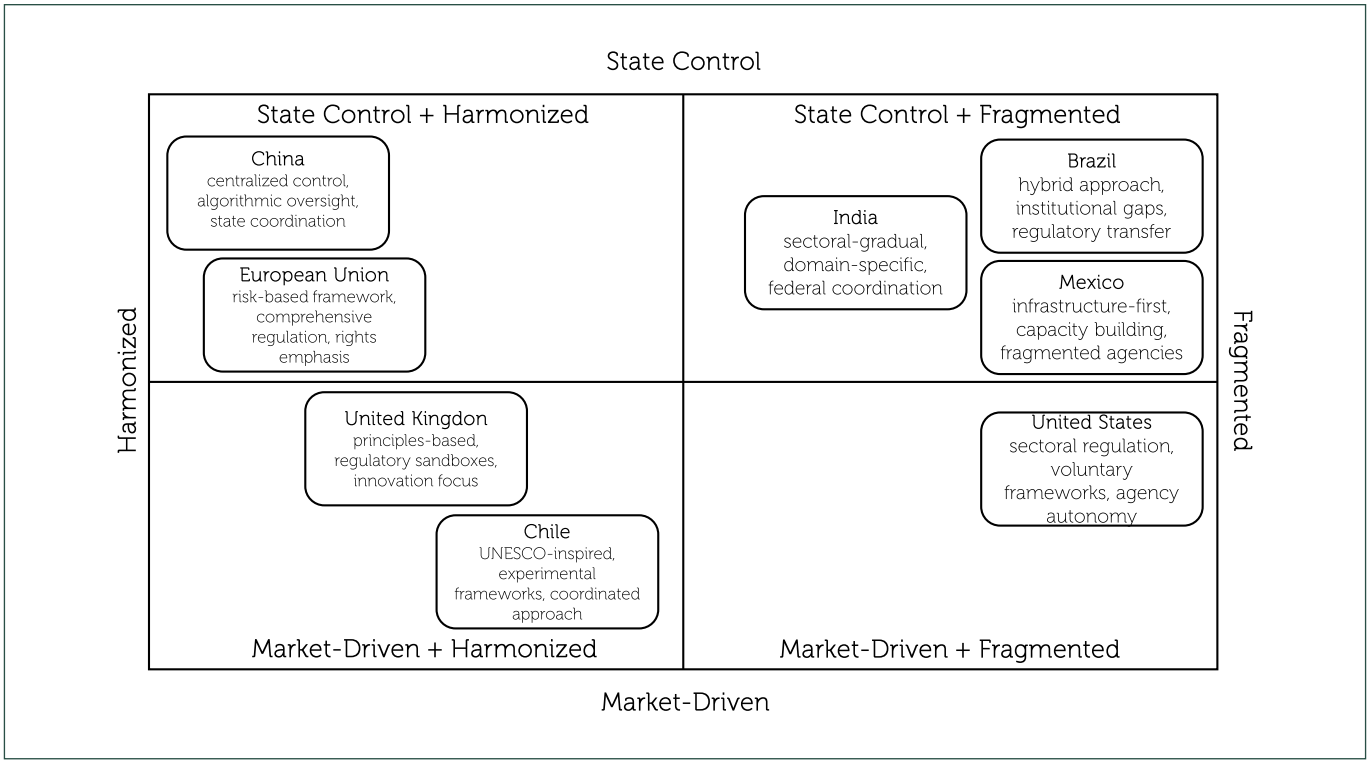
Overview of regulatory archetypes

AI regulation differs across countries due to legal traditions, institutional capacity, and policy goals. Using Lessig's four vectors — law, architecture, market, and

social norms — we identify regulatory models across eight jurisdictions.

The U.S. promotes flexible, market-led governance with limited coordination. The EU follows a risk-based model with strict rules, which may burden smaller firms. The UK emphasizes principles and uses sandboxes to support innovation. China centralizes control, aligning legal and technical systems with political goals.

Brazil replicates European legal design but faces weak enforcement, limited infrastructure, and fragmented governance. India adopts gradual, sector-specific regulation. Mexico focuses on capacity building before formal laws. Chile combines ethical guidelines with experimental tools. These cases show that legal convergence does not guarantee effective implementation. For Brazil and similar countries, success depends on aligning regulation with institutional capacity.



Source: Developed by the authors.

Figure 1. AI regulation archetypes: 2x2 matrix.

Figure 1 maps eight jurisdictions along two dimensions: the vertical axis captures state control versus market-driven approaches, while the horizontal axis reflects regulatory harmonization versus fragmentation. The U.S. sits at the market-driven and fragmented end, reflecting decentralized oversight and sectoral governance, aligned with codes like market-led governance.

The EU and China both fall within the state-controlled and harmonized quadrant. China represents the extreme in centralized, state-directed control, while the EU combines coordination and rights-based oversight without ideological constraints. The UK and Chile occupy the harmonized and market-aligned space. The UK balances flexibility and legal principles, whereas Chile emphasizes structured experimentation through coordinated governance.

Brazil, India, and Mexico are positioned within the fragmented and state-oriented quadrant. Brazil shows regulatory ambition but suffers from institutional fragmentation. India applies purposeful fragmentation to build capacity gradually, while Mexico prioritizes institutional readiness over formal regulation. These differences suggest that fragmentation in emerging economies stems from diverse institutional trajectories.

This mapping underscores that effective AI governance depends on both regulatory coherence and institutional capability. Although the framework captures a current snapshot, positions may shift as countries adapt to policy feedback, technological disruption, or political realignment. Emerging economies could migrate across quadrants as governance capacity evolves.

The matrix is therefore an analytical lens rather than a predictive model. It facilitates comparison across regulatory strategies and informs policy adaptation. The next sections explore each archetype in detail, culminating in a focused assessment of Brazil's Bill 2338/2023 using regulatory impact assessment.

Sectoral flexibility in the United States

As shown in Figure 1, the U.S. follows a sectoral and flexible regulatory model within a market-driven and fragmented context. Its system is decentralized, shaped by strong private-sector influence, limited federal oversight, and sector-specific rules. Market dynamics and social norms play a greater role than formal legal or technical controls, as outlined in Lessig's framework.

Legal vector

U.S. regulation of AI is characterized by fragmentation. Rather than a national AI law, governance emerges through a mosaic of federal guidelines, state legislation, and agency-specific initiatives. This fragmented legal structure surfaced in our coding with the dominant themes of 'regulatory asymmetry' and 'market-led governance.'

The Algorithmic Accountability Act (AAA), introduced in 2022, represents a rare federal initiative targeting transparency in automated decision-making. The bill defines such systems as: "any system, software, or process … that uses computation, the result of which serves as a basis for a decision or judgment" (Algorithmic Accountability Act, 2023).

However, the AAA applies only to 'covered entities' exceeding certain revenue and data-processing thresholds, "raising concerns that small and medium-sized enterprises (SMEs) may not be subject to these requirements" (Algorithmic Accountability Act, 2023).

This selective application reinforces legal asymmetry — regulation targets large platforms while exempting most local firms, minimizing compliance burdens but introducing uneven oversight.

Social norms vector

The AI Bill of Rights (AIBoR), issued by the White House in 2022, articulates five normative principles: safe and effective systems, algorithmic transparency, human alternatives, privacy, and non-discrimination. According to the document:

> "Systems should undergo pre-deployment testing, risk identification and mitigation, and ongoing monitoring that demonstrate they are safe and effective based on their intended use …" (The White House, Office of Science and Technology Policy, 2022, p. 4).

These principles remain non-binding, relying on reputational pressures and civil society advocacy rather than enforcement. They illustrate the prominence of social norms in shaping ethical expectations in the absence of mandatory standards.

Architectural vector

Federal guidance increasingly embeds technical constraints into AI system design. The *Blueprint for an AI Bill of Rights* and the *NIST AI Risk Management Framework* recommend safeguards such as pre-deployment testing, transparency, and fairness-by-design. These measures regulate behavior through architecture, but their voluntary nature results in uneven adoption and fragmented compliance across contexts.

Market vector

The dominant regulatory driver in the U.S. remains the market. As emphasized in the *NIST AI Risk Management Framework*, the national approach avoids a centralized legal structure, favoring sector-specific practices and voluntary adoption: "The Framework is intended to be voluntary, rights-preserving, non-sector-specific, and use-case agnostic, providing flexibility to organizations of all sizes and in all sectors" (NIST, 2023, p. 1). Industry narratives frequently promote 'market differentiation through ethics' and 'competitive advantage through responsible AI,' suggesting that reputational incentives often substitute for legal mandates. While this model lowers transaction costs and supports innovation, it also raises the risk of long-term coordination failures and systemic vulnerabilities — especially in the context of general-purpose AI.

Critical assessment

From an economic regulation theory perspective, this model minimizes upfront compliance burdens but fosters regulatory inconsistency and asymmetric obligations between firms. The absence of a central authority complicates governance of general-purpose AI systems that cut across sectors: "The sectoral approach creates regulatory gaps for foundation models that operate across traditional industry boundaries …" (NIST, 2023, p. 12).

In comparative terms, the U.S. model contrasts sharply with the EU's risk-based regulation, which imposes ex-ante obligations uniformly. While it shares the UK's emphasis on innovation, the U.S. lacks coordinated principles or centralized oversight. It also diverges fundamentally from China's centralized enforcement and ideological alignment.

For countries like Brazil, this model may appear attractive for its flexibility, but it assumes institutional maturity, legal stability, and market depth, conditions still under development in many emerging economies. Without these, the fragmented approach could exacerbate regulatory gaps, accountability deficits, and inequitable market dynamics.

These patterns are reflected in quantitative outcomes: the U.S. attracted $67.9 billion in AI investments in 2023, representing 76% of global funding, and fostered the creation of 4,633 AI startups between 2013 and 2022, including 524 new ventures in 2022 alone (AIPRM, 2024; CB Insights, 2025; Edge Delta, 2024).

Risk-based regulation in the European Union

As shown in Figure 1, the European Union follows a risk-based and harmonized regulatory model, marked by strong state control and legal coherence. Based on the 2024 AI Act, this approach reflects a commitment to protecting fundamental rights through centralized legal enforcement. It is the most structured framework among the eight jurisdictions examined.

Legal vector

The EU's legal infrastructure rests on a tiered classification of AI systems according to potential risk:

Unacceptable risk systems are banned outright, including public facial recognition and social scoring; high-risk systems (e.g., in health, education, public services) must comply with strict obligations such as conformity assessments and human oversight; limited-risk systems must meet transparency rules; minimal-risk systems face no regulatory burden.

The AI Act aims to harmonize internal governance and external influence, as noted:

> The purpose of this Regulation is to ... promote the uptake of human-centric and trustworthy artificial intelligence (AI) while ensuring a high level of protection of health, safety, fundamental rights ... (Regulation [EU] 2024/1689, 2024, p. 3).

The Act also bans practices deemed incompatible with EU values, such as untargeted scraping of facial data, which "... should be prohibited because that practice adds to the feeling of mass surveillance and can lead to gross violations of fundamental rights" (Regulation [EU] 2024/1689, 2024, p. 12).

Our document coding confirms the dominance of 'fundamental rights emphasis,' 'compliance burden,' and 'legal harmonization,' reflecting a top-down regulatory philosophy deeply rooted in legal formalism.

Architectural vector

The architectural dimension is tightly embedded in legal mandates. High-risk systems must include human oversight, maintain detailed technical documentation, and adopt risk management processes. These design constraints are mandatory, not voluntary, shaping AI system architecture at a foundational level.

Codes such as 'technical documentation' and 'oversight mechanisms' frequently co-occur, illustrating how legal instruments shape infrastructure.

Market vector

Economic incentives are structured through differentiated compliance costs. As highlighted by the High-Level Expert Group on AI: "The tiered compliance requirements will likely shift investment toward AI applications classified as lower risk under the AI Act ..." (European Commission, 2019, p. 14).

This segmentation redirects investment and raises entry barriers for high-risk domains. From an economic regulation theory lens, this strategy increases short-term transaction costs while potentially reducing long-term social externalities.

Yet, concerns about 'compliance overload' and 'barrier to startups' were recurrent in industry feedback, especially for SMEs lacking compliance infrastructure: "The conformity assessment requirements could create disproportionate burdens for SMEs and startups without established compliance infrastructure" (European Commission, 2019, p. 18).

Social norms vector

Unlike models that rely on voluntary principles, the EU codifies normative expectations into enforceable rights. Values such as privacy, accountability, and fairness are translated into binding legal instruments, reflecting a societal consensus that AI must serve democratic ideals.

This normative formalization contrasts sharply with U.S. voluntary norms or China's ideological alignment, reinforcing the EU's identity as a global standard-setter in ethical technology governance.

Critical assessment

The EU model offers legal certainty, normative coherence, and a structured regulatory environment through its AI Act. It is the most comprehensive framework among the jurisdictions analyzed. However, this sophistication creates complexity that challenges even EU member states, especially in institutional coordination, oversight, and private-sector compliance.

In countries like Brazil, which emulate the EU approach, these challenges intensify. The lack of equivalent infrastructure and enforcement mechanisms increases the risk of symbolic adoption, where legal convergence fails to produce practical outcomes. While the EU exerts global influence through the Brussels Effect, applying dense regulatory models in weaker institutional settings may lead to implementation gaps.

Unlike the U.S.' market-driven system, the UK's flexible guidance, or China's centralized control, the EU prioritizes uniformity and rights protection. Its long-term success depends on whether national actors can translate formal requirements into effective outcomes amid evolving conditions.

The regulatory burden's impact is evident in investment patterns: despite its economic scale, the EU attracted only $8 billion in AI investments in 2024, compared to $67.9 billion in the U.S., suggesting that compliance costs may deter startup formation and investor confidence (TechCrunch, 2025).

Adaptive principles in the United Kingdom

As shown in Figure 1, the UK represents an adaptive and harmonized regulatory model, balancing state oversight with market dynamics. Rather than relying on rigid rules, the UK emphasizes flexible, sector-specific regulation. Its National AI Strategy focuses on strengthening the AI ecosystem, promoting adoption, and ensuring effective governance.

Legal vector

The legal foundation of the UK model is principle-based rather than rule-based. It avoids centralized risk classification and delegates regulatory oversight to sector-specific agencies such as the Financial Conduct Authority (FCA), the Information Commissioner's Office (ICO), and the Medicines and Healthcare Products Regulatory Agency (MHRA). These bodies are tasked with interpreting high-level principles within their domains, enabling sectoral adaptation over legislative uniformity. As stated in the strategy: "AI regulation should be context-specific, with sectoral regulators best placed to oversee the impact of AI in their respective domains" (National AI Strategy, 2021, p. 21).

This principles-first architecture is guided by broad commitments — such as safety, fairness, accountability, and contestability — outlined in government policy rather than enforced through binding law. The *Pro-Innovation Approach to AI Regulation* emphasizes that "the UK's approach relies on principles that guide sectoral regulation rather than imposing detailed legal obligations applicable across all contexts" (Department for Science, Innovation & Technology; Office for Artificial Intelligence, 2023, p. 8). This scaffolding allows regulators to respond rapidly to emerging technologies while avoiding the rigidity of risk-tiered frameworks like the EU's.

Document coding from our analysis surfaced categories such as 'soft law governance,' 'regulatory sandbox,' and 'innovation incentives,' capturing a legal regime oriented toward adaptation rather than codification.

Architectural vector

The architectural configuration of UK AI governance emerges through experimental mechanisms such as regulatory sandboxes. These allow developers and regulators to jointly explore the implications of AI deployment in controlled environments before committing to formal standards. As explained in the government's 2023 white paper, "Regulatory sandboxes provide safe spaces for testing innovative AI applications and gradually developing appropriate safeguards based on empirical evidence rather than theoretical concerns" (Department for Science, Innovation & Technology; Office for Artificial Intelligence, 2023, p. 24).

This iterative model stands in contrast to the prescriptive technical requirements mandated in the EU framework. UK documents frequently combined codes such as 'sandbox experimentation' and 'technical agility,' emphasizing a learning-by-doing approach to infrastructure governance.

Market vector

Market incentives under the UK model are designed to stimulate responsible innovation by minimizing uncertainty and regulatory burden. This light-touch approach is intended to promote early-stage experimentation and attract investment while preserving ethical oversight. In the policy literature, themes such as competitive advantage through regulatory clarity and innovation-friendly oversight are prominent (Aitken et al., 2022, p. 43). The logic is that enabling firms to anticipate regulatory expectations without mandating rigid obligations lowers compliance costs and accelerates innovation cycles.

This strategy aligns with economic regulation theory by reducing transaction and compliance costs while relying on market-driven ethics as a form of informal constraint.

Social norms vector

Rather than codifying normative expectations into binding law, the UK embeds social norms into sectoral principles. Values such as fairness, transparency, and accountability are presented as shared goals rather than enforceable mandates, allowing flexible interpretation across industries. This model presumes a high degree of professional convergence and public trust in regulators.

While this approach fosters adaptability, it also creates challenges in addressing cross-sectoral risks. Civil society organizations have warned that "without coordinated enforcement mechanisms, the principles-based approach may result in inconsistent protection across sectors" (Centre for Long-Term Resilience, 2023, p. 17).

Our coding identified frequent associations with 'institutional fragmentation' and 'lack of centralized oversight,' highlighting concerns about enforcement consistency, especially in the context of general-purpose AI systems.

Critical assessment

The UK model provides a pragmatic balance between innovation and governance, offering an attractive alternative to jurisdictions constrained by either rigid regulation or fragmented enforcement. Compared to the EU, the UK forgoes uniform risk categorization and ex-ante conformity assessments in favor of scalable, context-aware oversight. While it shares the U.S. emphasis on flexibility and sectoral autonomy, it differs by embedding clearer ethical guidance and coordinated regulatory goals.

Nonetheless, its success depends heavily on the institutional capacity of sector-specific regulators and the normative alignment of industry actors. For emerging economies like Brazil, the UK model offers a potentially replicable structure — provided that sufficient regulatory professionalism, inter-agency coordination, and transparency mechanisms are in place.

The UK's balanced approach has yielded positive investment outcomes, attracting $25.5 billion in AI funding over the 2019–2023 period, demonstrating that principle-based regulation can successfully support innovation while maintaining oversight (AIPRM, 2024).

State control and algorithmic governance in China

As shown in Figure 1, China follows a centralized and state-controlled regulatory model. Its approach combines political goals, national planning, and algorithmic control under strong state authority. Instead of balancing innovation and rights, the model aligns AI development with regime stability, economic strategy, and digital sovereignty through binding rules and centralized enforcement.

Legal vector

China's regulatory structure is grounded in enforceable, detailed legal mandates that explicitly incorporate ideological goals. A foundational instrument is the Cyberspace Administration of China et al. (2021), which states that "algorithmic recommendation service providers shall adhere to mainstream value orientations and actively disseminate positive energy" (Article 5). This requirement establishes not only legal boundaries for algorithmic services but also reinforces normative compliance with party-defined values.

The 2023 *Generative AI Interim Measures* reinforce this model, mandating that generative systems must not produce content that "undermines state authority" and must align with "core socialist values" (Article 7). Unlike the risk-based categorization in the EU or the flexible guidelines in the UK, China's legal framework embeds political objectives directly into regulatory obligations. Our qualitative analysis surfaced dominant codes such as algorithmic control, state-led governance, and ideological enforcement, confirming that legal mechanisms are used to discipline the technological field in service of the state.

Architectural vector

Technical design requirements in China are not merely safety mechanisms; they operationalize political oversight. Regulations mandate content filtering, user profiling, and real-time monitoring, with algorithmic transparency required for state authorities — but not for the public (Toner et al., 2023, pp. 8-11). These obligations represent a top-down architectural control that enables surveillance capabilities while constraining design autonomy.

Our coding frequently paired 'technical specifications' with 'compliance by design,' indicating that architecture is treated as a mechanism for embedding legal and ideological constraints into the functionality of AI systems. Unlike the UK's experimental sandbox model or the EU's emphasis on human oversight, China's architecture is designed for central monitoring and information control.

Market vector

China's market regulation is structured through industrial policy rather than free-market incentives. The *New Generation Artificial Intelligence Development Plan* integrates AI innovation into the broader strategy for national development and security, calling AI "a strategic technology that will lead in the future" (State Council of the People's Republic of China, 2017). It defines national investment priorities and directs private sector participation accordingly, using state funding and procurement to shape market direction.

From an economic regulation theory perspective, this model reduces coordination costs through centralized mandates but imposes opportunity costs by limiting market pluralism and cross-border collaboration. The regulatory role of the Cyberspace Administration of China (CAC), which oversees algorithm registration and compliance, consolidates authority and ensures vertical integration of political objectives into the AI market (China Law Translate, 2023).

Social norms vector

In contrast to the EU's emphasis on individual rights or the UK's pluralistic norm-building, China codifies collective ideals and ideological loyalty as enforceable expectations. Regulatory language refers to 'mainstream value orientations' and 'social harmony,' prioritizing national cohesion over democratic deliberation (Dorwart et al., 2025, Article 5). Content generated by AI must conform to socialist principles, and companies must proactively establish mechanisms to prevent ideological deviation (China Law Translate, 2023, Article 12).

These expectations are formalized not only in regulatory texts but also in strategy documents such as the 2017 AI Development Plan, which frames AI as an 'instrument of national competitiveness' and explicitly links it to political and social stability (State Council of the People's Republic of China, 2017).

Critical assessment

China's AI governance represents the strongest form of state-centric regulation among the jurisdictions in Figure 1. It achieves rapid implementation, policy coherence, and high compliance through centralized institutions and ideological alignment. However, this model also sacrifices transparency, limits market autonomy, and creates barriers to international interoperability.

In contrast to the EU's rights-based approach, the U.S.'s market-driven governance, and the United Kingdom's flexible and adaptive model, China stands out for combining technical regulation with political doctrine. While this model may be attractive to states prioritizing control and accelerated development, it challenges global norms of openness, accountability, and human rights. For countries like Brazil, adopting this approach would require a degree of centralization and institutional unity that is unlikely and potentially incompatible with democratic principles.

The constraints of centralized control are reflected in declining private investment: AI funding fell to $15.1 billion in 2023, significantly below historical levels, illustrating how excessive state intervention can discourage private sector innovation despite large market potential (AIPRM, 2024).

Federated, risk-calibrated governance in India

As shown in Figure 1, India follows a federated and risk-calibrated regulatory model. Instead of a single AI law, it uses existing legal tools, voluntary guidelines, and sector-specific oversight. This flexible approach allows regulation to adjust to different risk levels while supporting innovation in low-risk areas.

Legal vector

India's statutory framework relies primarily on the Information Technology Act (2000) — particularly Sections 66D, 67A–B, and the Government of India, Ministry of Law and Justice (2023) — to govern AI-related harms such as misinformation, impersonation, and data misuse. Additionally, the Digital Personal Data Protection Act (Government of India, Ministry of Law and Justice, 2023) establishes obligations for the training, sharing, and storage of personal data, applicable to AI developers and deployers.

Rather than crafting AI-specific legal mandates, India has taken a layered approach in which statutory authority is distributed across multiple ministries and regulators, including MeitY, DARPG, RBI, and TRAI. This federated legal model enables calibration according to sectoral priorities — such as financial stability in banking or network integrity in telecom — without imposing blanket AI restrictions.

Our document coding confirmed themes like 'legal layering,' 'intermediary responsibility,' and 'data fiduciary obligations,' reinforcing the interpretation that India's legal model prioritizes incremental adaptation of existing frameworks over new codifications.

Architectural vector

India's architectural governance relies on sandbox experimentation and controlled testbeds, notably promoted by MeitY and the proposed Digital India Act. AI sandboxes in healthcare (Maharashtra) and agriculture (Andhra Pradesh) enable pilot deployment of high-risk AI systems in live environments under regulatory monitoring. These initiatives operationalize architectural oversight without introducing rigid technical mandates.

The 'sandbox governance' and 'testing-before-scaling' codes were frequently observed in our analysis, particularly in MeitY's Responsible AI reports and implementation notes from state-level experiments. These environments serve as adaptive infrastructures where safeguards can be tailored to use cases, facilitating technical innovation with context-aware oversight.

Market vector

From a market standpoint, India adopts a differentiated incentive structure. Low-risk AI applications, particularly in consumer sectors, are encouraged to operate under self-regulation and voluntary codes of conduct. In contrast, critical sectors like banking and telecommunications are governed by targeted circulars and advisories from the RBI and TRAI. For instance, the RBI mandates algorithmic auditability and model risk management in financial services.

This two-speed market model was reflected in the frequent recurrence of codes such as 'risk-proportional incentives,' 'voluntary compliance,' and 'prudential oversight.' Economic regulation theory suggests that India's structure reduces market entry barriers while maintaining safeguards for high-impact domains. Such calibration enables greater inclusivity and economic agility.

Social norms vector

India's AI regulation is explicitly grounded in constitutional values such as equality, autonomy, and justice. These principles are codified in the AI for All framework, developed through NITI Aayog's Approach Documents for Responsible AI and multi-stakeholder consultations involving over 200 experts. These documents emphasize transparency, explainability, safety, and inclusiveness, shaping the ethical contours of AI deployment.

Unlike the EU's legal codification of rights or China's ideological enforcement, India embeds social norms into governance through public deliberation and consultation-based soft law instruments. Our qualitative analysis highlighted codes such as 'participatory norm-setting' and 'value-driven design,' confirming the centrality of inclusive norms in India's regulatory architecture.

Critical assessment

India's federated, risk-calibrated model reflects a pragmatic adaptation of Lessig's four vectors to a multi-tiered federal system. It allows for adaptive, sector-specific governance while preserving room for experimentation and innovation. The model avoids premature legal rigidity, relying instead on iterative refinement through pilot projects and collaborative norm-building.

As noted in the G20 New Delhi Leaders' Declaration (2023), India has championed 'risk-based AI classification and capacity-building' as global governance priorities. This was further evidenced by successful state-level pilots in healthcare and agriculture, which demonstrated the feasibility of privacy-preserving analytics under real-world conditions.

Compared to the EU's centralized legality or the UK's decentralized principles, India's model blends decentralization with strategic coordination. It avoids the regulatory voids seen in the U.S. sectoral model while preserving more institutional autonomy than China's central authority. However, the success of this model will depend on inter-regulatory coherence, resource investment, and the continued development of enforcement capacity at both central and state levels.

India's federated approach has demonstrated positive momentum in attracting investment: AI funding reached $780 million in 2024, representing a 39.9% increase from the previous year, with over 100 GenAI startups collectively raising $1.5 billion since 2020 (AIM Research, 2025; Inc42, 2024). This growth trajectory suggests that risk-calibrated, adaptive regulation can effectively balance innovation promotion with governance oversight in resource-constrained environments.

FRAGMENTED, FEDERATED EXPERIMENTATION IN MEXICO

As represented in Figure 1, Mexico illustrates a fragmented and federated experimentation model. Rather than codifying artificial intelligence regulation under a unified legal structure, Mexico operates through a multiplicity of legislative initiatives, constitutional reform proposals, voluntary standards, and sectoral pilots. This configuration produces experimentation across jurisdictions and domains but also reveals significant coordination challenges and normative ambiguity.

Legal vector

Mexico's legal trajectory in AI regulation is characterized by high legislative activity with limited consolidation. Since 2020, over 60 AI-related bills have been introduced in Congress, culminating in a February 19, 2025 proposal to amend the Constitution. The amendment would grant Congress explicit authority to enact a General Law on the Use of Artificial Intelligence and harmonize secondary legislation within 180 days. As the proposal states, the aim is to "foster responsible innovation while protecting human rights, privacy, and national security." However, this constitutional change remains pending, underscoring the legal fragmentation and institutional uncertainty that characterize Mexico's AI governance model.

Until now, regulatory authority remains dispersed across ministries, with inconsistent mandates and overlapping bills. Our coding identified themes such as 'legislative dispersion,' 'constitutional uncertainty,' and 'regulatory backlog,' pointing to a system that recognizes AI's significance but has yet to operationalize coherent legal safeguards.

Architectural vector

Mexico's regulatory architecture is scaffolded by strategic planning instruments such as the *Estrategia Digital Nacional* (Gobierno de los Estados Unidos Mexicanos, 2013) and the *Agenda Nacional Mexicana de IA 2030* (Gobierno de México, 2023), which outline high-level goals in interoperability, data openness, and AI skills development. However, these documents do not translate into enforceable technical standards for AI systems.

Architectural oversight remains confined to limited sectoral experiments, such as the January 26, 2024 law on alternative dispute resolution (ADR), which in-

troduced the first regulatory mentions of 'automated decision systems' and required basic algorithmic transparency mechanisms. While important, these measures are circumscribed to ADR settings and do not extend to broader domains like health or finance. Our analysis revealed frequent codes such as 'pilot-based governance' and 'non-binding architecture,' emphasizing the experimental and narrow scope of Mexico's current technical regulation landscape.

Market vector

In the absence of centralized oversight, economic actors, particularly data controllers and service providers, play a substantial role in shaping governance practices. Voluntary standards, such as the *2024 Recommendations on Personal Data Processing for AI* issued by the INAI (Red Iberoamericana de Protección de Datos, 2019), promote privacy-by-design, transparency, and algorithmic fairness checklists. These guidelines aim to "promote the use of AI without undermining data-protection duties," but they are non-binding and lack enforcement mechanisms.

Our document coding identified codes such as 'self-regulation,' 'compliance gap,' and 'industry-led initiatives.' While such efforts may foster best practices in some sectors, uneven implementation and weak accountability limit their systemic impact. From an economic regulation theory standpoint, the absence of clear legal incentives or penalties undermines predictability and may deter responsible innovation in sensitive areas.

Social norms vector

Social norm construction in Mexico's AI governance is driven largely by multi-stakeholder engagement and civil society advocacy. A notable example is the creation of the *Alianza Nacional de Inteligencia Artificial* (ANIA), a working group convened in 2023 with support from UNESCO and local partners. ANIA has conducted thematic diagnostics on topics such as education, gender, and transparency through online participatory sessions. However, these outputs remain informal and non-binding, reflecting a normative orientation that lacks policy crystallization.

In addition, civil society organizations such as HIIG and GIZ have published position papers on ethical AI design and gender inclusion. These documents influence discourse but do not translate into enforceable obligations. Our coding surfaced recurring references to 'consultative governance,' 'normative pluralism,' and 'symbolic participation,' suggesting that while participatory values are present, they have limited regulatory materialization.

Critical assessment

Mexico's fragmented experimentation model reflects both the potential and the limits of federated AI governance. The high number of legislative proposals and participatory processes signals institutional engagement, yet the absence of legal consolidation and binding instruments undermines regulatory coherence and limits implementation capacity.

Compared to centralized regimes like the EU or China, Mexico presents a more pluralistic but less effective configuration. In contrast with the United Kingdom's principle-based coordination or India's risk-calibrated sectoral integration, Mexico lacks the institutional mechanisms to connect local initiatives into a unified strategy. The reliance on pilot projects and voluntary guidelines may foster innovation in specific areas but risks producing uneven regulation and limited rights protection.

For Brazil, which faces similar governance challenges, Mexico's experience underscores the need to align legal authority, institutional architecture, and social norms to avoid regulatory fragmentation. The 2025 constitutional reform initiative may become a turning point if it succeeds in linking dispersed efforts into an integrated framework. Without institutional coordination, however, experimentation may remain isolated, reducing both the effectiveness and legitimacy of AI governance.

Mexico's fragmented regulatory approach is reflected in its investment patterns: while total venture capital reached $1.67 billion in 2024 (59% growth), AI-specific investment remains limited at approximately $508 million, with 60% of funding concentrated in fintech rather than core AI development (Alcor BPO, 2024; Mexico Business News, 2025). The country hosts 214 AI startups, but regulatory uncertainty and patchwork governance appear to limit sector-specific growth despite broader investment attraction.

Collaborative, multi-actor governance in Chile

As shown in Figure 1, Chile exemplifies an ethical and participatory regulatory archetype, positioned between coordinated state oversight and international normative alignment. Rather than relying on a single AI law, Chile structures its governance through national strategies grounded in democratic values, institutional coordination, and inclusive consultation processes (see Supplementary Material A, Table SP1).

Legal vector

Chile's legal approach is guided by the *Política Nacional de Inteligencia Artificial*, formally endorsed by the *Comisión de Futuro, Ciencia, Tecnología, Conocimiento e Innovación* of the Chamber of Deputies. Instead of imposing binding legal requirements, the policy adopts

a rights-based framework emphasizing transparency, non-discrimination, and proportionality in AI development. The country's commitment to international ethical standards, including those from UNESCO, reinforces its normative orientation without resorting to rigid legislative codification (Gobierno de Chile, 2024).

Architectural vector

Institutional implementation is structured by the updated *Plan de Acción 2024*, which outlines concrete initiatives led by 14 ministries. These include investments in digital infrastructure, interoperability systems, public data repositories, and curricular reforms to promote AI literacy and capacity building. The plan details 177 actionable items, each assigned to responsible agencies with timelines and performance indicators, supporting gradual and accountable institutional transformation (Gobierno de Chile, 2024).

Market vector

Chile encourages AI development through soft coordination of public and private actors. The government provides funding mechanisms, promotes entrepreneurship, and supports public-private partnerships while avoiding prescriptive regulation. Firms operate in a context of guided experimentation, where innovation is incentivized but not strictly enforced through compliance structures. This flexible approach balances economic dynamism with ethical safeguards.

Social norms vector

The development of Chile's AI policy has been shaped by public consultations, expert workshops, and collaborative drafting processes. Civil society organizations, academic institutions, and international bodies such as UNESCO contributed to shaping priorities related to fairness, inclusion, and sustainability. These participatory mechanisms reinforce public trust and help align AI governance with societal expectations, even in the absence of binding mandates (Gobierno de Chile, 2024).

Critical assessment

Chile's model shows that emerging economies can pursue responsible AI governance through ethical orientation and institutional coordination instead of relying on centralized legal formalism. By emphasizing phased implementation, multisectoral collaboration, and adherence to international principles, Chile builds legitimacy through procedural inclusion rather than prescriptive lawmaking. This approach enables adaptive learning and stakeholder trust, even in the absence of binding legislation.

Compared to the EU, which centralizes control through a detailed legal framework, Chile privileges flexibility and institutional experimentation. Unlike the United States or the United Kingdom, Chile anchors its AI governance in democratic deliberation and international ethical norms, such as those promoted by UNESCO. While this model may lack enforceability and technical standardization, it offers a scalable path for countries with constrained regulatory capacity.

For Brazil, Chile's experience highlights the value of participatory design and gradual implementation in contexts where enforcement is limited and legal replication may lead to misalignment. Rather than importing rigid external models, countries in similar conditions could benefit from prioritizing normative clarity, public dialogue, and institutional adaptability in shaping their AI strategies.

Chile's collaborative governance model has positioned the country as a regional AI leader despite its smaller scale. With $116 million allocated for government AI research over the next decade and a projected market growth to $2.6 billion by 2030, Chile demonstrates how strategic coordination and infrastructure investment can create competitive advantages (InvestChile, 2025; Statista Market Forecast, 2025). The country's 58 data centers and status as the only nation in Latin America with a National Data Center Plan exemplify this coordinated approach to AI ecosystem development.

Brazil: Hybrid rights-based regulation under structural constraints

As represented in Figure 1, Brazil exemplifies a hybrid regulatory archetype: it formally aligns with the European Union's rights-based, risk-tiered model but is constrained by institutional fragmentation, limited implementation capacity, and legal uncertainty. This combination generates tensions between normative ambition and practical feasibility, especially in the deployment of complex AI oversight mechanisms.

Legal vector

Bill 2338/2023, currently under legislative review, introduces a risk-based regulatory framework similar to the EU AI Act. It establishes ex-ante obligations for high-risk systems, such as transparency, documentation, and oversight requirements. However, unlike the European Union, Brazil lacks the institutional infrastructure needed to enforce such mandates effectively. The proposed AI regulatory authority remains underfunded and underdefined, while the National Data Protection Authority (ANPD) operates with limited resources and jurisdiction. MAXQDA codes such as 'institutional gap,' 'regulatory transfer,' and 'fragmented governance' highlight structural obstacles that may hinder the bill's implementation.

Architectural vector

The architectural dimension is underdeveloped. Although the bill mandates documentation and human oversight for high-risk applications, it does not specify technical standards or implementation mechanisms. Regulatory bodies lack the tools and expertise to assess algorithmic systems, and there is no established certification infrastructure. This gap raises concerns about symbolic compliance, as technical obligations may be fulfilled on paper without real oversight capacity.

Market vector

The proposed framework may generate uneven economic impacts. While international companies can absorb compliance costs due to global infrastructure, domestic startups may face burdensome obligations that deter innovation. Brazil's AI market, valued at $3 billion in 2023 and projected to reach $49.2 billion by 2030, faces significant competitive challenges. The projected $4 billion investment through the AI Plan 2024–2028 represents only 6% of annual U.S. investment levels, highlighting the scale disparity that regulatory complexity may exacerbate (Grand View Research, 2024; UNCTAD, 2024). Estimated compliance costs for high-risk applications could represent up to 25% of operational expenses for Brazilian firms, while remaining below 5% for multinational actors. This asymmetry creates entry barriers and risks regulatory capture, where well-resourced firms shape interpretations of the law in their favor. The bill also fails to account for Brazil's underdeveloped AI computing infrastructure, limiting the viability of local foundation model development.

Social norms vector

Brazil's AI debate has mobilized civil society, academia, and advocacy groups, reflecting an emerging normative consensus on the need for rights protection. However, public awareness remains limited, and normative alignment has not translated into robust public engagement or social consensus. Norms around AI governance are still evolving, creating difficulties for the articulation of shared expectations and enforceable ethical standards.

Critical assessment

Brazil's regulatory model reflects strong legal ambition but reveals significant gaps in institutional capacity and policy integration. Inspired by the European Union's rights-based framework, Brazil has pursued normative alignment without consolidating the technical infrastructure and interinstitutional coordination necessary for effective enforcement. This disconnect between regulatory design and operational capacity increases the likelihood of symbolic compliance and limited practical outcomes.

In contrast to India's gradual, sector-specific guidance, Mexico's federated experimentation, and Chile's ethically grounded and participatory strategy, Brazil adopts a centralized legislative approach with limited emphasis on adaptive mechanisms. The focus on legal transposition, in the absence of broad stakeholder engagement and robust monitoring systems, may lead to regulatory overload and fragmented implementation.

Brazil's experience illustrates the challenges that arise when comprehensive legal frameworks are introduced in environments with uneven institutional maturity. Advancing toward functional AI governance in such contexts may depend less on legal sophistication and more on coordination, incremental rollout, and capacity-building across sectors. Without greater alignment between regulatory ambition and institutional readiness, the impact on innovation and rights protection may remain constrained.

DISCUSSION AND FINAL REMARKS

Although this study examines eight jurisdictions, Brazil remains the analytical centerpiece. The discussion therefore emphasizes how the findings inform both the diagnosis and future design of AI governance in Brazil, considering its unique institutional constraints and innovation needs.

This study indicates that AI regulation cannot be fully understood through normative principles alone; instead, its effectiveness hinges on the interaction between legal mandates, institutional capacities, infrastructural readiness, and regulatory architectures. While global debates often promote convergence around algorithmic accountability and human rights, comparative evidence reveals that regulatory outcomes vary sharply across contexts, not by divergence of intent, but by disparities in operational capacity and institutional coherence (Levi-Faur, 2011).

Table 2 illustrates this variation. The United States, China, and Chile exhibit greater regulatory functionality despite ideologically distinct models. Sectoral agility (U.S.), centralized enforcement (China), and multi-actor coordination (Chile) create environments where regulatory objectives can be pursued with institutional credibility. Conversely, Brazil, India, and Mexico face mimetic isomorphism challenges, formally adopting global templates without adequate local adaptation (DiMaggio & Powell, 2000; North, 1991). This creates 'paper tiger' regimes where laws exist formally but lack operational substance (Bardach, 1977; Gilardi, 2005).

Table 2. Comparative overview of AI regulation.

Country/Bloc	Regulatory approach	AI investment (2023)	Market share (%)	Innovation impact	Key challenges
USA	Sectoral and flexible	$67.9 billion	76% (global funding)	High — 4,633 startups (2013–2022); 524 new in 2022	Fragmented oversight; inconsistent enforcement
European Union	Risk-based (AI Act)	~$8 billion	8.5% (global funding)	Moderate — Compliance costs deter startups	High barriers for SMEs; slow adaptation
United Kingdom	Moderate and sectoral	$25.5 billion (2019–2023)	5.2% (global funding)	High — Regulatory sandboxes promote innovation	Potential guidance ambiguity
China	State-controlled	$15.1 billion (declining)	14.8% (global funding)	Low — Severe restrictions limit private sector	Overregulation stifles entrepreneurship
Brazil	EU-inspired (Bill 2338)	$4 billion (projected 2024–2028)	5.6% (regional leader)	Uncertain — Market growing but regulatory burden unclear	Enforcement capacity gaps; SME compliance costs

Note. Sources: AIPRM (2024); CB Insights (2025); TechCrunch (2025); AIPRM (2024) cumulative period; UN Trade and Development (2024); AIM Research (2025); Inc42 (2024); Mexico Business News (2025); Alcor BPO (2024); InvestChile (2025); Statista Market Forecast (2025).

The quantitative evidence presented before validates the institutional analysis framework: jurisdictions with flexible regulatory approaches (U.S.: $67.9B; UK: $25.5B) demonstrate superior investment attraction compared to prescriptive frameworks (EU: $8B) or excessive state control (China: $15.1B, declining). For Brazil, these patterns underscore the competitive risk of adopting European-style regulatory complexity without corresponding institutional capacity, as its projected $4B investment represents only 6% of annual U.S. levels.

Lessig's (1999) four vectors — law, architecture, market, and norms — provide a useful lens for interpreting these patterns. Jurisdictions like the UK and Chile achieve better regulatory alignment by integrating legal principles with experimentation tools (e.g., sandboxes), technical standards, and participatory norms. In contrast, Brazil's fragmented agencies and overlapping mandates weaken feedback mechanisms, raise transaction costs for firms, and erode regulatory legitimacy. These dynamics emphasize the limits of legal transplantation and the need for context-sensitive innovation governance.

The implications for global developers are significant. The analysis reveals that compliance strategies cannot be one-size-fits-all. In low-regulation environments like the U.S., firms benefit from agility but must self-regulate to manage reputational and ethical risks (Ayres & Braithwaite, 1992). In contrast, the EU's AI Act, while offering predictability, imposes high compliance costs that may deter smaller actors (Smuha, 2021). Countries like the UK and Chile offer middle-ground models that support experimentation without sacrificing oversight. For emerging economies, regulatory fragmentation generates uncertainty — necessitating modular design, early engagement with regulators, and adaptive governance models.

Brazil's trajectory exemplifies these tensions. Its hybrid convergence model, drawing on EU-inspired norms, lacks an operational AI authority, presents regional disparities in sandbox access, and suffers from legislative incoherence (ANPD, 2024; Santos & Santos, 2024). Phased implementation strategies, beginning with LGPD rights, followed by algorithmic audit trails and bias mitigation, could align ambition with feasibility (Marchant et al., 2011). A dedicated AI regulatory unit within the ANPD and a national sandbox observatory could coordinate learning and reduce fragmentation, drawing inspiration from Chile's coordinated governance and the UK's adaptive instruments (Proyecto de Ley 15869-19, 2023; Department for Science, Innovation & Technology; Office for Artificial Intelligence, 2023).

The findings show that legal convergence does not ensure regulatory effectiveness. Successful models activate all regulatory vectors through integrated institutions, responsive instruments, and iterative enforcement, resonating with smart regulation approaches advocating layered, adaptive governance involving state and non-state actors (Gunningham et al., 1998; Yeung, 2018).

Brazil exemplifies legal transplantation pitfalls without institutional alignment, deepening understanding of mimetic isomorphism and transaction cost dynamics in middle-income democracies. The study offers concrete policy pathways for Brazil's transition from symbolic adoption to functional AI governance through phased implementation, targeted institutional investment, and coordinated regulatory sandboxes.

The study's limitations include a reliance on public documents and formal regulation, which may underrepresent informal practices and subnational disparities, especially in federated systems like Brazil and India. Future research should include empirical evaluations of sandbox performance, enforcement behavior, and sector-specific compliance challenges. Comparative case studies could further refine the typology and deepen understanding of implementation dynamics.

As AI regulation continues to evolve, emerging economies must resist the temptation of symbolic convergence and instead invest in capacity-building, coordination, and stakeholder engagement. Rather than merely mimicking advanced regimes, countries like Brazil can build credible and contextually relevant governance through gradual, inclusive, and adaptive regulatory design. Aligning innovation with public accountability will remain a central challenge, and opportunity, for national and global policy agendas.

Brazil seems to stand at a critical regulatory crossroads: insisting on legal convergence without institutional adaptation risks adopting a rigid, high-cost framework that may inhibit innovation, marginalize local actors, and deepen technological dependence. Brazil's regulatory choices will determine whether AI governance becomes a catalyst for inclusive development or a barrier to national competitiveness.

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