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RESEARCH ARTICLE

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Navigating the AI regulatory landscape: Balancing innovation, ethics, and global governance

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ABSTRACT

The rapid development of artificial intelligence (AI) has generated transformative opportunities alongside significant ethical, societal, and regulatory challenges. In this paper, we analyse this issue by considering the different approaches and regulatory frameworks of three main actors: the European Union (EU), the United States (US), and China. The analysis shows how they are adopting different strategies: the EU proposes a stringent, risk-based framework to ensure accountability and transparency; the US, traditionally favouring minimal intervention, is moving towards more structured regulation out of ethical and security concerns; and China has integrated AI as a core component of its national strategy, aligning AI development with state objectives and social stability. These varied regulatory approaches shape global policies, influence international relations, and underscore the need for a new international pact that protects fundamental rights, mitigates the digital divide, and embeds sustainability at the core of AI-driven industrial development.

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Artificial intelligence; regulatory approaches; AI governance; EU's *AI Act*

Introduction

Artificial intelligence (AI) has become one of the most consequential technological advancements over the past decades. Its ability to process vast quantities of data, identify patterns, and make autonomous decisions positions it as a transformative force in sectors as diverse as healthcare, finance, energy, transportation, and public administration. Governments and private enterprises alike are investing heavily in AI, driven by the promise of economic competitiveness, national security, and societal efficiency. However, this increasing reliance on AI systems also raises profound questions about accountability, transparency, fairness, and human autonomy. A 'good society' in the age of AI is one that actively seeks to anticipate and manage the risks posed by algorithmic systems. These risks range from privacy violations and discrimination to the potential erosion of human rights and democratic values (Cath et al. 2018; Perboli and Arabnezhad 2021). For instance, AI-powered surveillance

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systems can infringe on individual freedoms, while biased algorithms in hiring or policing may entrench systemic inequalities (Pellegrino, Perboli, and Squillero 2019; Perboli et al. 2021). As such, AI regulation is not merely a technical challenge but a deeply political and ethical one. Indeed, the scale of investments in AI underscores the urgency of developing regulatory frameworks that are robust and innovation-friendly. The global AI market is projected to reach approximately US$407 billion by 2027, driven by a compound annual growth rate (CAGR) of 36.2% (Grand View Research 2023). In 2022 alone, global AI research spending was estimated at US$77.5 billion (PwC 2023), with leading technology firms at the forefront: Google invested US$39.5 billion in AI R&D, Microsoft allocated US$34.2 billion to AI technologies, and Meta spent US$26.8 billion on AI innovation. This rapid expansion is further reflected in the intellectual property landscape, with over 65,000 AI-related patents filed globally in 2022 (WIPO 2024). However, as innovation accelerates, so do regulatory costs. Estimates suggest that AI compliance expenditure now ranges between US$1.2 billion and US$1.5 billion annually, while the global AI governance market is projected to reach US$5.776 billion by 2029, with a CAGR of 45.3% (Gartner Research 2024).

On the other hand, the global landscape of AI governance is fragmented and heterogeneous, reflecting a multiplicity of legal traditions, cultural norms, and political ideologies. In this complex environment, three actors have emerged as global leaders in the regulation of AI: the European Union (EU), the United States (US), and China. Each of them offers a distinct regulatory philosophy. The EU's approach is characterised by its commitment to fundamental rights, risk-based categorisation, and ethical oversight, encapsulated in the proposed *Artificial Intelligence Act* (*AI Act*, see Heymann et al. 2023). The US, by contrast, favours a market-driven model with minimal federal intervention, though recent developments show increasing recognition of the need for ethical and legal frameworks (Chun, Schroeder de Witt, and Elkins 2024). China, meanwhile, adopts a centralised, state-led approach that integrates AI development with national objectives and social governance (Huang et al. 2024).

This paper contributes to the growing body of literature on AI governance by offering a comparative analysis of these three regulatory frameworks. Drawing on primary sources such as legislative texts, strategic policy documents, and technical standards, as well as secondary analyses from scholarly and institutional publications, we map the contours of each actor's approach. We pay particular attention to how these frameworks address key dimensions of AI governance: risk classification, ethical principles, enforcement mechanisms, and international coordination.

Furthermore, we argue that the future of AI governance lies not only in national or regional efforts but also in the development of a globally coordinated framework. The transnational nature of AI technologies, whose impact often transcends borders, requires harmonised standards and cooperative mechanisms. Without such coordination, two risks will arise: one is regulatory arbitrage, whereby companies exploit jurisdictional loopholes, and the other is normative fragmentation, whereby conflicting legal systems undermine the protection of fundamental rights.

The need for international governance is underscored by several pressing issues. First, the digital divide risks deepening if regulatory frameworks are developed without considering the needs and capacity of developing countries. Second,

sustainability must become a central tenet of AI policies, given the environmental footprint of large-scale AI models and infrastructures. Third, geopolitical competition, particularly between China and the US, could stymie efforts to develop inclusive and democratic standards for AI.

The remainder of this paper is structured as follows. First, we analyse regional approaches to AI regulation, focussing on the EU, the US, and China. Each subsection explores the legal, ethical, and operational dimensions of the respective frameworks. Next, we consider the issue of balancing innovation and regulation. We then shift the focus to global governance, evaluating the prospects and challenges of harmonising standards and building multilateral cooperation. In the following section, we provide a proposal for a global strategy. Finally, we conclude this paper with reflections on the future of AI governance and recommendations for policymakers, regulators, and industry leaders.

Regional approaches to AI regulation

The governance of AI is being shaped by the complex interplay of national priorities, legal traditions, and economic strategies. As AI technologies advance and become embedded in critical sectors such as healthcare, defence, education, and finance, the need for structured, enforceable, and adaptable regulatory frameworks has grown exponentially. Different jurisdictions have responded to this need in markedly different ways. While some have chosen to emphasise innovation and industrial competitiveness, others have prioritised human rights, ethical safeguards, and central control. In this section, we conduct an in-depth comparative analysis of three geopolitical actors that are actively developing and exporting AI governance models: the EU, the US, and China. Following the LETO methodology (which will be explained in more detail below), we analyse these regulatory models through legal, ethical, operational, and geopolitical axes to show not only their internal logic but also their broader implications for global coordination (Perboli, Borroni, and Bruni, forthcoming). This comparison provides insights into how these frameworks function domestically and how they are shaping international standards, technical interoperability, and the emerging global AI order.

AI regulation in the EU

The regulation of AI in Europe is a complex and evolving field, with the EU leading the way in establishing comprehensive legal frameworks. The EU's approach to AI regulation is characterised by a risk-based framework, emphasising transparency, accountability, and ethical considerations. This approach is primarily encapsulated in the *AI Act*, which sets out harmonised rules for AI system classification and ethical principles. This regulatory framework aims to balance innovation with ethical oversight, ensuring that AI benefits society while minimising potential negative impact.

Legal frameworks

As mentioned above, the regulation of AI in Europe is anchored in the EU's *AI Act*, the first comprehensive legal framework of its kind globally. This act establishes

a risk-based classification system for AI systems (Figure 1), covering unacceptable, high, limited, and minimal risk (Enqvist 2023; Pagallo, Ciani Sciolla, and Durante 2022; Pehlivan 2024) as follows:

- Unacceptable-risk systems: These are banned due to their potential to cause significant harms. Examples include real-time biometric identification in public spaces.
- High-risk systems: These are subject to stringent oversight and must comply with specific requirements, such as conformity assessments and human oversight. Examples include AI systems used in critical infrastructures, employment, and law enforcement.
- Limited-risk systems: These must maintain transparency, informing users when they are interacting with AI. Examples include chatbots and AI systems used in customer services.
- Minimal-risk systems: These are subject to minimal regulation but still require transparency. Examples include AI spam filters.

The *AI Act* is complemented by other directives, such as Directive (EU) 2019/770, which ensure legal coherence across digital products and services. This act also addresses issues of intellectual property and generative AI by requiring transparency in training datasets and strict adherence to copyright laws. Sanctions for non-compliance can reach up to €35 million or 7% of global annual turnover (Pehlivan 2024).

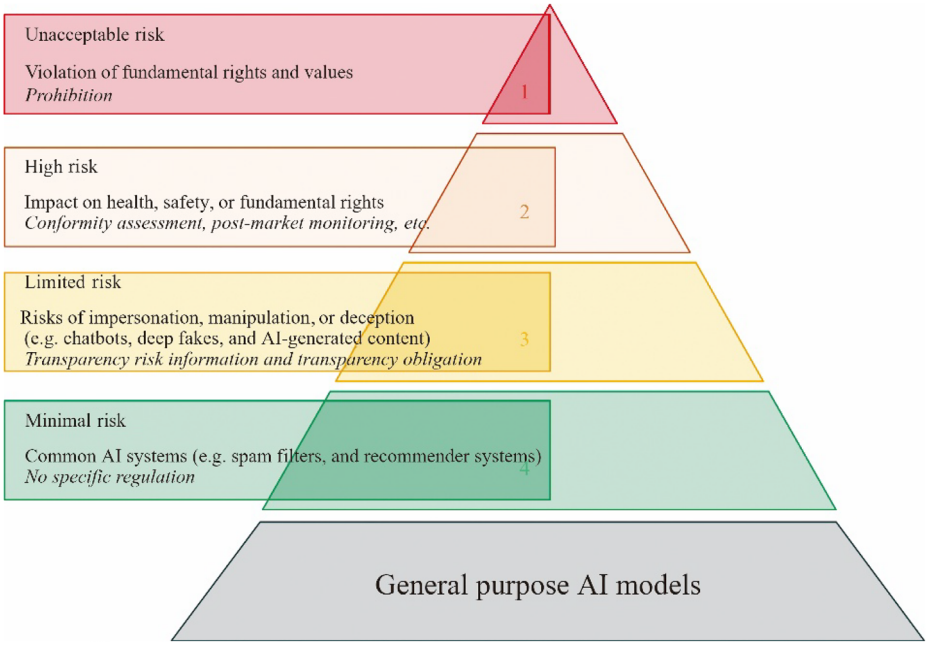


Figure 1. The risk pyramid of the EU's *AI Act*.
Data source: The website of the European Union, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689.

Ethical, social, and environmental considerations

Ethical values such as transparency, non-discrimination, accountability, and human agency are core to the EU's regulatory philosophy (Smuha 2019). The *AI Act* integrates these principles into binding obligations, ensuring that systems align with European democratic values and fundamental rights (Enqvist 2023). Special emphasis is placed on preventing algorithmic bias, reinforcing human control, and protecting vulnerable groups.

From a social and environmental perspective, the EU promotes sustainable AI development. The regulation calls for transparency in energy-intensive models and encourages climate-resilient AI design. These provisions link AI governance to broader EU goals on sustainability and digital inclusion (Yigitcanlar, Mehmood, and Corchado 2021). Unfortunately, those aspects are just sketched. In particular, the energy fingerprinting of AI is not explicitly defined.

Technological and operational aspects

The *AI Act* tackles complex technological concerns, including algorithmic explainability, data governance, and cybersecurity. It mandates that AI systems, particularly high-risk ones, undergo systematic testing and validation, maintain detailed documentation, and provide clear audit trails. Interoperability with the *General Data Protection Regulation* (*GDPR*) is ensured by requiring 'privacy by design' in AI system architecture.

In more detail, the EU's *AI Act* sets out specific compliance standards for AI systems. These standards are designed to ensure that AI systems are developed and deployed in a way that respects fundamental rights and values. Key compliance requirements (see Bhouri 2025; Pehlivan 2024) include:

- Transparency and explainability: AI systems must be transparent and provide clear information about their functionality and decision-making processes. This is particularly important for high-risk systems.
- Data governance: The *AI Act* emphasises the importance of data governance, requiring AI systems to be designed and developed with data protection and privacy in mind. This includes ensuring that personal data are processed following the *GDPR*.
- Human oversight: High-risk AI systems must be subject to human oversight, ensuring that decisions made by AI systems are reviewed and corrected by humans when necessary.
- Conformity assessments: High-risk AI systems must undergo conformity assessments to ensure compliance with the *AI Act*'s requirements. These assessments may involve third-party verification.

To support compliance, this act introduces conformity assessments and requires providers to monitor post-market performance. These mechanisms help ensure traceability, safety, and accountability, while the framework's adaptability enables it to address future technological developments.

Challenges and future directions

Despite its pioneering role, the EU's AI regulation faces several implementation challenges. Enforcement across 27 member states may create inconsistencies, and small and medium-sized enterprises (SMEs) could face disproportionate compliance costs (Walters et al. 2024). Regulatory arbitrage remains a concern, as firms may shift operations to jurisdictions with looser requirements (Aloisi and De Stefano 2023). Internationally, this act's extraterritorial scope may generate frictions with trade agreements like the 'General Agreement on Trade in Services' and 'Technical Barriers to Trade'. These frictions could arise from the prohibition of certain AI systems, such as real-time biometric identification (Soprana 2024). Global organisations such as the Organisation for Economic Co-operation and Development (OECD) are working to harmonise AI principles, but discrepancies remain (Cyman, Gromova, and Juchnevicius 2021; Huang et al. 2024). Nonetheless, the *AI Act* sets a global benchmark for trustworthy AI governance. Its holistic integration of legal, ethical, and technical control demonstrates the EU's ambition to lead in regulating emerging technologies while reinforcing democratic values and societal resilience (Veale and Borgesius 2021; Walter 2024). On the other hand, the EU approach of regulating a priori and in a centralised way the different matters (AI, data, and digital services, just to cite a few) affects the development of AI-based services and products, specifically creating obstacles for the presence of EU companies in the global landscape.

AI regulation in the US

The AI regulation in the US represents a markedly different model of AI governance. In contrast with the EU approach, the US has historically embraced a more flexible, innovation-driven approach. This model is rooted in a market-oriented legal culture and strong emphasis on technological leadership. In recent years, growing public concerns over algorithmic discrimination, data misuse, and national security threats have triggered a shift towards more structured governance. However, the US regulatory landscape remains fragmented, characterised by voluntary standards, agency-specific rules, and an increasing number of state-led legislative efforts.

Legal frameworks

The US employs a decentralised and sector-oriented methodology for the regulation of AI. Instead of instituting an all-encompassing federal statute comparable to the EU's *AI Act*, the US depends on a diverse array of pre-existing laws, agency recommendations, executive directives, and initiatives at the state level. Key developments include the Executive Order on the safe, secure, and trustworthy development and use of artificial intelligence, which outlines strategic goals for responsible AI innovation, and the 'National Artificial Intelligence Research and Development Strategic Plan'. Federal agencies such as the Federal Trade Commission (FTC), Food and Drug Administration (FDA), and the Department of Defence (DoD) play critical roles in overseeing AI applications within their respective domains (Scarpellino 2024). Notably, the National Institute of Standards and Technology

(NIST) has developed the AI Risk Management Framework, a voluntary guideline aimed at helping organisations assess and manage AI risks (Davtyan 2024).

At the state level, California has pioneered AI legislation addressing algorithmic accountability, consumer privacy, and bias mitigation. State-level regulations often create commissions or task forces to study AI-related issues, address ethical and economic considerations, such as bias and discrimination, and provide support for AI research and industry development (DePaula et al. 2024; Parinandi et al. 2024).

Ethical, social, and environmental considerations

Ethical considerations in US AI regulation are increasingly prominent, though often expressed through non-binding frameworks and policy statements. The White House's 'Blueprint for an AI Bill of Rights' emphasises principles such as privacy, algorithmic fairness, explainability, and alternatives to automated decision-making (Luckett 2023). Civil society organisations and academic institutions play a strong role in shaping public discourse around AI ethics, including issues of racial and gender bias, surveillance, and disinformation.

However, environmental and social dimensions of AI regulation remain underdeveloped. While some research institutions are advocating for carbon-conscious AI development, there is no formal federal guidance on sustainability in AI deployment. Also, due to general legal fragmentation, the environmental impact of AI is an almost unexplored venue. In comparison, social equity is addressed more robustly in state-level policies, particularly regarding automated hiring and lending practices.

Technological and operational aspects

The US approach to operationalising AI regulation leans heavily on technical standards, private sector self-regulation, and public–private partnerships. The NIST and other bodies promote standards for robustness, reliability, and transparency of AI systems, with a focus on explainability, security, and resilience. Industry consortia and major technology firms often develop their own internal auditing tools, ethics boards, and impact assessment models.

Interoperability and innovation are prioritised over uniform compliance mechanisms, allowing rapid prototyping and deployment of new AI tools. However, this flexibility also exposes gaps in risk oversight, especially in high-impact areas like facial recognition and predictive policing. As AI applications proliferate, agencies are increasingly called upon to standardise definitions, risk categories, and documentation protocols.

Challenges and future directions

The primary challenge in AI regulation in the US is the lack of cohesive federal legislation. This results in overlapping jurisdiction, regulatory ambiguity, and uneven accountability. The patchwork nature of the US's AI governance has led to concerns about regulatory arbitrage and the weakening of public trust.

Additionally, efforts to introduce federal AI laws have encountered political and ideological obstacles. Bipartisan proposals such as the *Algorithmic Accountability Act* remain stalled in the Congress. Meanwhile, AI's geopolitical implications, particularly

regarding national security and global competitiveness, complicate domestic policymaking.

Looking forward, the US approach may converge more closely with international frameworks as pressures for global interoperability intensify. Continued collaboration with allies through initiatives like the Global Partnership on Artificial Intelligence (GPAI) and the OECD AI Principles may provide pathways towards a more harmonised approach that retains American strengths in innovation while addressing ethical and societal risks more comprehensively.

Despite these efforts, the absence of strong, binding, and cross-sectoral federal legislation has led to fragmented enforcement. On the other hand, however, this lack of regulatory efforts has favoured the US companies and start-ups, allowing them to make use of this fragmentation to speed up their market presence.

AI regulation in China

China presents a distinct model of AI governance, shaped by its centralised political system, rapid industrial policy cycles, and the integration of digital technologies into national development strategies. Unlike the EU's legalistic model or the US's market-driven approach, China's framework is guided by state-centric principles where regulatory, strategic, and political goals are closely aligned. China adopts a distinctive approach to market oversight, wherein it retains the authority to intervene from a regulatory perspective whenever necessary to ensure the stability and functionality of its economic landscape. Over the past decade, China has enacted a series of national strategies and binding laws that consolidate its management of AI development and deployment, particularly in sectors deemed critical to national security and economic competitiveness. The following analysis examines how China governs AI across legal, ethical, technological, and strategic dimensions.

Legal frameworks

China's AI governance model is deeply embedded in its national strategic agenda. The cornerstone of this strategy is the 'New Generation Artificial Intelligence Development Plan' (2017), which sets the goal of global AI leadership by 2030. This country has implemented specific legal instruments, such as the *Personal Information Protection Law*, *Cybersecurity Law*, and *Data Security Law*, which are cornerstone laws that govern the collection, storage, and use of data in AI systems (Franks, Lee, and Xu 2024; Shen and Liu 2022). Additionally, the Cyberspace Administration of China has introduced specific regulations for generative AI services, requiring providers to label AI-generated content and protect against illegal or harmful content. Meanwhile, regulations governing algorithmic recommendations, including the 2022 *Provisions on Algorithmic Recommendation Services*, impose algorithm registration and disclosure obligations on internet platforms, prohibiting discriminatory user tags and the spread of fake news through algorithms (Zhu and Ma 2023).

The State Administration for Market Regulation and the Cyberspace Administration of China play key roles in AI oversight, and the government maintains strong control over compliance. Regulatory requirements are enforced through licencing systems

and real-time auditing, especially in critical areas such as fintech, surveillance, and autonomous mobility.

Ethical, social, and environmental considerations

Ethical considerations in AI regulation are deeply integrated into China's legal frameworks. The Chinese government has emphasised the need for AI systems to align with socialist values and moral principles. For example, the *Interim Administrative Measures for Generative Artificial Intelligence Services* explicitly requires AI services to comply with legal and ethical standards, preventing the spread of content that violates social morality (Franks, Lee, and Xu 2024; Zhu and Ma 2023). China's approach to ethical AI is iterative and adaptive, allowing for continuous refinement of regulations as technologies evolve. This is evident in the 'Notice of the State Council on Issuing the New Generation Artificial Intelligence Development Plan', which outlines goals for establishing ethical norms and policy frameworks by 2030 (Shen and Liu 2022). The government has also fostered a community of practice involving academia, industry, and policymakers to address ethical risks proactively (Qiao-Franco and Zhu 2024).

While the primary focus of China's AI regulation has been on legal and ethical considerations, there is growing attention to environmental aspects, particularly energy consumption. The rapid development of AI technologies, large language models and generative AI in particular, has raised concerns about their environmental impact. China has acknowledged the need for sustainable AI development, emphasising the importance of balancing technological advancements with environmental responsibility (Jia 2023). The Chinese government has promoted the development of energy-efficient AI technologies and encouraged the use of renewable energy sources in data centres. However, the environmental impact of AI, as in many other regulatory frameworks, remains a relatively less explored area in Chinese regulation compared to data privacy and ethical considerations. However, as AI technologies continue to advance, environmental sustainability is likely to become a more prominent focus in future regulatory efforts.

Technological and operational aspects

China's AI regulation is operationalised through mandatory technical standards, platform accountability, and government access to algorithmic logic and data. Firms are required to submit algorithms for review, label synthetic content, and establish internal compliance teams. The government's *AI Standardisation White Paper* promotes national standards in algorithm security, robustness, and ethical evaluation.

China has made significant strides in establishing technical standards for AI safety and transparency. The *Interim Administrative Measures for Generative Artificial Intelligence Services* includes provisions for algorithmic transparency, requiring service providers to disclose the basic principles and purposes of their AI systems (Zhu and Ma 2023). Additionally, the regulation mandates the establishment of oversight mechanisms to ensure compliance with safety and security standards. Similarly to other Asian countries, there is also a high level of state–industry coordination, with public–private partnerships driving rapid implementation. While this enables agile

deployment, it reduces space for public scrutiny and limits independent auditing. As a result, regulatory sandboxes and pilot zones are used to test emerging technologies, particularly in sectors such as smart cities and autonomous transportation.

Challenges and future directions

China's AI governance model is effective in ensuring swift policy execution, but faces significant criticism from international observers. Concerns include a lack of transparency, weak judicial oversight, and limited stakeholder participation. Despite these concerns, China is increasingly active in shaping global AI norms. It engages with international bodies such as the International Telecommunication Union (ITU) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO), and promotes its regulatory standards through initiatives like the Digital Silk Road.

Unfortunately, the liberal Western principles and the Chinese approach are often divergent, posing challenges for international harmonisation. However, by engaging with global organisations and adopting international best practices, China aims to promote the development of ethical and safe AI technologies (Ashraf and Mustafa 2024; Jia 2023). This practice reflects China's commitment to fostering innovation while mitigating the risks associated with advanced AI systems.

As China continues to invest in foundational AI technologies and infrastructures, it is likely to refine its regulatory approach. Nevertheless, whether its model can be adapted to align with broader global norms remains an open question and a central issue in the debate on global AI governance.

Balancing innovation and regulation

As AI regulations become more defined and binding across jurisdictions, companies are increasingly required to internalise compliance as a core component of their innovation strategy. Regulatory obligations are no longer limited to legal departments, but extend across product development, risk management, and strategic governance. However, the implementation of AI compliance varies significantly depending on the organisational scale, geopolitical context, and market exposure. This section examines the evolving landscape of corporate and institutional responses to AI regulation by analysing the way in which companies of different sizes adapt to compliance demands, the emergence of smart regulatory principles, the role of technical standards in shaping safe AI deployment, the influence of international governance frameworks, and the centrality of ethical considerations. These perspectives reveal critical patterns in global AI governance, including rising compliance costs, varied regulatory adaptation strategies, and persistent asymmetries in ethical accountability and regulatory capacity.

Corporate responses to AI regulation

In 2023, the global spending on AI compliance was estimated to range between US$1.2 billion and US$1.5 billion, reflecting the growing importance of governance

in AI system development. Large multinational technology firms allocated approximately 4–6% of their AI development budgets specifically to compliance, with some directing up to 5% of their broader R&D expenditure to governance-related functions (Gartner Research 2024; McKinsey Global Institute 2023). In contrast, SMEs, constrained by more limited resources, dedicated only 1–2% of their overall technology budgets to AI compliance. These figures underscore a structural disparity in regulatory capacity, highlighting how compliance obligations may disproportionately affect smaller actors while consolidating the regulatory leadership of major platforms (Deloitte Consulting 2024).

Multinational technology companies have adopted diverse regulatory adaptation strategies, characterised by high financial investments and jurisdiction-specific compliance infrastructures. The literature focusses on China's detailed and comprehensive AI regulatory frameworks, including specific obligations on algorithm transparency, data handling, and generative AI services. On the other hand, the rapid evolution of the landscape, as well as the differences in financial statement regulation makes it difficult to extract quantitative data from the annual reports (Franks, Lee, and Xu 2024). Baidu, operating under the Chinese governance model, has implemented a state-collaborative AI governance strategy. This includes investments in regulatory technology infrastructures, focussing on algorithmic bias detection, real-time compliance verification, and transparent AI decision-making protocols. The company's proactive engagement with state authorities and development of dynamic ethical risk management platforms underscore a uniquely embedded approach to China's national AI policies. After being fined US$2.8 billion by China's competition authority, Alibaba has since mirrored Baidu's state-integrated model, albeit with distinct cross-border compliance algorithms and embedded internal auditing systems (Xiao 2022). Collectively, these strategies reflect an emergent model of transnational AI governance characterised by regulatory flexibility, high compliance costs, and the institutionalisation of ethical risk protocols. These investments are not merely reactive; they function as strategic assets aimed at maintaining market access, mitigating legal risks, and signalling leadership in responsible AI development.

In contrast, the US- and EU-based corporations such as Microsoft and Google employ adaptive compliance frameworks. Microsoft has established a centralised Office of Responsible AI, supported by a global Responsible AI Impact Assessment tool and regional adaptation modules. Its annual compliance expenditure is estimated at US$80 million, with US$22.3 million dedicated to infrastructure development and US$15.6 million to regulatory adaptation technologies (Microsoft 2025). Google, meanwhile, has adopted a modular approach, embedding tiered compliance layers and localised ethics committees, with a total investment of US$500 million in regulatory adaptation technologies in ten years (*Financial Times* 2025) (see Table 1 for a comparison of the large companies' approaches).

As regulatory frameworks for AI continue to evolve across jurisdictions, companies are increasingly required to integrate compliance mechanisms into their development processes. Their responses vary significantly by firm size, governance model, and geopolitical context. Large technology firms have developed sophisticated regulatory architectures, while SMEs face structural disadvantages in absorbing the financial and organisational costs of compliance. We summarise the main compliance costs

in Table 2, which presents the main thematic areas of the regulatory and compliance costs and their key components. For SMEs and AI start-ups, the regulatory landscape presents a markedly different set of challenges. Unlike large firms, SMEs lack dedicated compliance departments and the financial buffers to absorb ongoing regulatory costs. Moreover, due to accounting standards that do not require explicit reporting of compliance costs unless material, these expenses are often hidden within R&D or administrative budgets, complicating macroeconomic assessments of regulatory impact (PwC 2024).

A 2024 European Commission impact assessment of the *AI Act* estimated the average compliance cost of a single AI product at €29,277 against a baseline of mean development cost at €170,000 (Haataja and Bryson 2021; Laurer, Renda, and Yeung 2021). A more detailed table of the percentage impact of the different elements is given in Table 3. The impact is computed by considering the EU's *AI Act* only. The product used in the impact assessment is intended as a customisation of an existing AI tool to be deployed in a third-party company. Table 3 also considers the human oversight costs, i.e. mechanisms and procedures that ensure a qualified human can effectively monitor, understand, and intervene in the functioning of an AI system. The column 'Initial' considers the costs (in euros) in the initial phase of the application of the EU's *AI Act*, while the column 'BAU' presents the impact in the business-as-usual case. This assumes that some proportion of the requirements laid out by the new law would already be implemented by AI providers as a standard business practice. The compliance with the EU AI regulation (without considering other regulatory schemes, such as the *GDPR*) can account for up to 17.22% of the costs in the initial phase and 8.60% in the BAU scenario. The relative burden of compliance may thus be proportionally greater for SMEs than for multinational firms, exacerbating inequalities in innovation capacity and market participation. The

Table 1. Large companies' responses to AI regulation.

Companies	Regulatory focuses	Compliance methodologies
Microsoft	Multi-jurisdictional compliance	Office of Responsible AI
Google	Regionalised approach	Responsible Innovation Framework
Alibaba	State-aligned compliance, after the US$ 2.8bn fine	Embedded regulatory checks
Baidu	AI safety and ethical compliance, and proactive compliance adaptation	State-collaborative governance model

Table 2. Regulatory and compliance costs.

Thematic areas	Key components
Regulatory technology infrastructures	Compliance software development, infrastructure scaling, and technological integration systems
Ethical risk management systems	Bias detection algorithms, ethical decision mapping, and continuous monitoring protocols
Compliance monitoring tools	Real-time compliance tracking, cross-jurisdictional verification systems, and automated reporting mechanisms
Training and organisational adaptation	Employee training programmes, organisational policy redesign, and cultural transformation initiatives

Table 3. The impact of the EU's *AI Act* on compliance costs.

Compliance costs	Initial (%)	BAU (%)
Training data	1.63	1.03
Documentation and traceability	2.58	1.64
Provision of information	2.13	1.36
Robustness and accuracy	6.31	0.00
Total compliance costs for providers	12.65	4.03
Human oversight	4.57	4.57
Total	17.22	8.60

Data source: Wu and Liu (2023a).

compliance costs associated with AI deployment can be particularly challenging for start-ups, which often have limited resources and budgets. The complex and varying regulatory processes across different regions can create a 'compliance trap', where smaller firms are unable to cope with the financial burden of regulatory requirements, giving an advantage to well-established companies (Wu and Liu 2023a).

The intricate and often contentious relationship that exists between innovation and regulatory frameworks represents a fundamental and pressing challenge within the evolving landscape of AI governance and oversight. Policymakers must consider this complex terrain in such a manner that not only promotes and encourages the rapid advancement of technological capabilities and innovation but also effectively addresses and mitigates the various risks and potential hazards that are inherently associated with the deployment and utilisation of AI systems across diverse sectors.

The need for smart regulation

Excessively rigid or precautionary frameworks risk hampering technological progress by creating barriers to entry, slowing the pace of innovation, and discouraging experimentation, particularly among smaller firms and early-stage ventures, as observed in the case of the EU's highly prescriptive *AI Act*. Conversely, overly lenient or fragmented regulatory environments may fail to prevent significant societal harms, including algorithmic bias, violations of individual privacy, misinformation, discrimination, and safety failures in critical sectors such as healthcare or mobility. A prominent example is the 'Big Beautiful Bill' proposed by President Donald Trump, which seeks to ban US states from enacting AI-related legislation for ten years (White House 2025). While designed to reduce regulatory fragmentation, such a measure could de facto suppress any meaningful public oversight at the state level, raising serious concerns about democratic accountability and consumer protection.

To navigate these competing imperatives, a balanced regulatory approach, often named smart regulation, is increasingly advocated. This paradigm aims to safeguard public interests and fundamental rights without undermining the economic and scientific potential of AI. At its core, smart regulation emphasises proportionality, adaptability, and technological neutrality. It incorporates regulatory intensity, sectoral risk alignment, and institutional capacity as key dimensions in evaluating the appropriateness of a given framework. For instance, jurisdictions with limited enforcement capacity or early-stage AI ecosystems may prioritise transparency and soft law mechanisms, while advanced AI economies may impose more stringent rules for high-risk applications (Carvao 2024).

A key challenge in AI governance lies in defining what constitutes an 'appropriate' regulatory approach across highly diverse jurisdictions. While there is currently no universal standard for measuring regulatory adequacy, a context-sensitive framework grounded in the principle of regulatory proportionality should be adopted. This principle recognises that regulatory models should be tailored to national and regional conditions, particularly with respect to a country's technological maturity, institutional capacity, and governance infrastructures. For instance, countries with nascent AI ecosystems and limited enforcement capabilities may prioritise baseline requirements, such as algorithmic transparency, public awareness, and participatory oversight, over complex certification regimes. In contrast, more technologically advanced nations with strong regulatory institutions may be equipped to enforce high-risk classifications, pre-market conformity assessments, and international interoperability mechanisms.

In emerging economies, a lean regulatory approach to AI governance should prioritise low-to-moderate regulatory intensity, emphasising broad ethical principles, such as transparency, non-discrimination, and human oversight, rather than complex procedural requirements. To avoid stifling innovation or overburdening limited institutional capacity, this model should favour transparency measures over exhaustive compliance documentation. In terms of sectoral risk alignment, regulation should initially focus on high-risk domains like health, public services, and security, while applying lighter, simplified requirements to low-risk applications (e.g. agriculture or logistics). Regulatory sandboxes should be used to allow safe experimentation and collaborative development. Given typically constrained institutional capacity, emerging economies should also invest in regulatory capacity building, establish agile oversight structures within existing agencies, and adopt digital tools, such as automated risk classification systems and AI-based monitoring platforms, to support efficient and scalable governance.

Flexible compliance with technical standards

Technical standards play a crucial role in ensuring the safe and ethical development of AI systems. Organisations such as the International Organisation for Standardisation (ISO) and the Institute of Electrical and Electronics Engineers (IEEE) have established standards for AI development, focussing on aspects such as transparency, accountability, and privacy (Ashraf, and Mustafa 2024; Gaurav et al. 2024). A specific effort is made in particular by the Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI), the international, unaffiliated, non-profit organisation developing standards for AI-based data coding with clear intellectual property rights licencing frameworks. The MPAI approach integrates ethical considerations, bias mitigation, performance metrics, and legal aspects into its international standards, as in the case of MPAI-CUI, the standard dedicated to the evaluation of company risks and performance, which has also been adopted as an IEEE standard (IEEE 2023). These standards provide a foundation for regulatory frameworks and facilitate international collaboration.

International frameworks

International frameworks such as the UNESCO's 'Recommendation on the Ethics of Artificial Intelligence' play a pivotal role in shaping the foundational principles of global AI governance. These frameworks establish normative baselines by emphasising core ethical imperatives including respect for human rights, transparency in algorithmic decision-making, accountability for harms caused by AI systems, and the promotion of inclusive and sustainable development. By articulating a shared vision of responsible AI, they offer a reference point for national and regional regulators seeking to design coherent and legitimate governance models. Importantly, such frameworks also underscore the need for democratic oversight, the protection of cultural and linguistic diversity, and equitable access to AI technologies across different socio-economic contexts (Natorski 2024).

Although these instruments are not legally binding, their soft-law status does not diminish their influence. They serve as critical tools for norm diffusion, capacity building, and institutional alignment, particularly in jurisdictions where formal regulatory infrastructures are still emerging. Additionally, they foster multilateral dialogue and international cooperation, helping reduce the risk of regulatory fragmentation and mitigate jurisdictional conflicts over data flows, intellectual property, and liability. As AI technologies become increasingly transnational in their design and impact, the role of such ethical frameworks is likely to grow, acting as a compass for harmonisation efforts and a safeguard against the erosion of fundamental rights in the face of rapid technological advancements.

Ethical considerations in AI governance

Ethical considerations are at the heart of AI governance, with fairness, transparency, accountability, and privacy being the key principles that should underpin regulatory frameworks:

- Fairness and non-discrimination: AI systems must be designed to avoid bias and discrimination. This requires robust testing and validation processes to ensure that AI algorithms do not perpetuate or amplify existing bias.
- Transparency and explainability: The 'black box' phenomenon, where AI decisions are opaque, poses significant ethical challenges. Regulatory frameworks must ensure that AI systems are transparent and explainable, enabling users to understand how decisions are made.
- Accountability: Establishing accountability for AI-related harms is a critical ethical consideration. This involves identifying responsible parties when AI systems cause harms and ensuring that mechanisms are in place to address such incidents.
- Privacy: The use of personal data in AI systems raises significant privacy concerns. Regulatory frameworks must ensure that data collection, processing, and sharing practices are compliant with privacy standards.

Towards the global governance of AI

As AI becomes an integral part of economic, political, and social systems, the question of how to govern its global development becomes increasingly urgent. Unlike traditional technologies confined to local or national impact, AI transcends borders, creating externalities that no single country can effectively address. In fields from the governance of autonomous weapons to cross-border data flows and global surveillance infrastructures, international cooperation is essential to ensure AI's alignment with democratic values, sustainable development goals, and equitable access.

A cross-border general vision

While regional regulations provide valuable foundations, they are insufficient in addressing transboundary issues such as data flows, cybersecurity threats, and algorithmic bias. The current landscape of fragmented AI governance risks exacerbating global inequalities, creating regulatory arbitrage opportunities, and undermining efforts to establish ethical standards and accountability mechanisms. Against this backdrop, a new phase of governance is required, which fosters coherence across jurisdictions while embracing diversity in normative traditions.

The EU, the US, and China are central to this global debate. Their differing regulatory models – precautionary, market-driven, and state-centric – reflect underlying legal cultures and political economies. Yet, despite these differences, there is growing recognition among policymakers, academics, and industry stakeholders of the need for a shared governance framework (see Table 4 for a comparison of the different regulatory approaches).

The EU is actively promoting its regulatory model as a global benchmark. The *AI Act* has already influenced international discourse through its risk-based approach and emphasis on fundamental rights (Heymann et al. 2023). The EU's regulatory diplomacy is evident in its engagement with the OECD, G7, and the United Nations (UN). Initiatives like the *Digital Markets Act* and the *GDPR* support a rule-based digital environment embedded in European values. While the EU's model is normatively ambitious, its applicability in non-European contexts remains complex. Critics argue that stringent ex-ante regulation may hinder innovation, particularly in fast-evolving fields such as generative AI.

The US remains a global AI leader through its technological capabilities and influence on standard-setting bodies. The NIST's AI Risk Management Framework has gained traction internationally as a reference point for voluntary governance (Davtyan 2024). The US soft power in AI governance stems from its open research ecosystem, academic leadership, and public–private collaboration. Despite the lack of binding legislation, the US supports global initiatives like the GPAI and is increasingly engaging in multilateral fora to shape ethical AI standards. Its multi-stakeholder model promotes innovation and agility but also contributes to normative fragmentation.

China's global AI strategy is tightly aligned with its domestic objectives. The Belt and Road Initiative extends Chinese AI technologies and regulatory logic to partner countries. China also participates in international institutions such as the ITU and

Table 4. A comparative summary of three regulatory models.

Dimensions	EU	US	China
Legal frameworks	*AI Act* (risk-based, harmonised)	Fragmented federal/state systems, and sectoral laws	Centralised, state-driven, and strategic legislation
Ethical orientation	Human rights, transparency, and accountability	Innovation-first ethical guidelines (non-binding)	Collectivist values, stability, and social harmony
Environmental considerations	Sustainability and digital inclusion prioritised	Emerging awareness, with little formal integration	Green AI initiatives, and limited regulation
Technological regulation	Mandatory conformity assessments, and being aligned with the *GDPR*	Technical standards, and self-regulation	State control over algorithms, and national standards
Operational enforcement	Independent audits, with cross-border challenges	Agency-led, and industry-driven	Real-time state auditing, and high compliance pressures
Global strategies	Regulatory diplomacy, and normative leadership	Standard export, via GPAI and OECD	Digital Silk Road, and ITU influence
References	Ashraf and Mustafa 2024; Sharma 2024	Chun, Schroeder de Witt, and Elkins 2024; Weismann 2024	Chun, Schroeder de Witt, and Elkins 2024; Weismann 2024

the AI for Good Summit. China promotes a vision of AI governance rooted in state sovereignty and developmental priorities.

Assessing whether one regulatory model for AI is superior to others is complex, given the diversity of legal systems, political cultures, and economic priorities. Nonetheless, comparative insights reveal distinct structural advantages and limitations. The federal system of the US results in a fragmented and often incoherent regulatory landscape. While this decentralisation grants considerable flexibility to AI companies and affords them a competitive edge globally, it also risks creating regulatory vacuums. If enacted, this would effectively shield American firms from state-level constraints, potentially fostering unchecked innovation at the expense of public interests and democratic oversight. In contrast, the EU has adopted a top-down regulatory approach, which has unintentionally rendered some national AI strategies redundant, such as in the case of Germany. The centralised model has also imposed disproportionately high compliance costs, especially on start-ups, where regulatory burdens can be more than double the R&D expenditure (Wu and Liu 2023b). The EU is in practice blocking its start-ups and innovative companies with a plethora of regulations which increase the costs and, in some cases, fail to protect its citizens. Meanwhile, China's collectivist orientation, while distinct from the individualist models of the US and the EU, is tempered by a 'wait-and-regulate' approach. This model balances state observation with delayed intervention, offering useful insights for an international framework that respects national specificities while ensuring collective oversight. However, the effectiveness of such a model depends critically on the state's ability to observe without overreaching, avoiding a descent into intrusive control. Notably, all current frameworks partially address broader societal impact, particularly concerning social equity, labour displacement, and environmental sustainability. The disruptive nature of AI, much like the rapid and unplanned rollout of electric mobility in Europe, demands anticipatory infrastructure planning and socially responsive policies to prevent systemic inequities and economic dislocation.

Challenges to global convergence

Despite the need for international cooperation, several challenges hinder the development of a unified global regulatory framework. These include:

- Jurisdictional issues: The global nature of AI technologies often leads to conflicts of jurisdiction, with different countries having varied regulatory requirements.
- Geopolitical competition: Strategic rivalries between the US and China risk politicising technical standards.
- Competing interests: The interests of different countries and regions may conflict, with some prioritising innovation over regulation and others emphasising safety and ethical considerations.
- Enforcement difficulties: Ensuring compliance with regulatory frameworks across jurisdictions is a significant challenge, particularly in the absence of a centralised enforcement mechanism.

Promising avenues for international coordination include:

- Principle-based frameworks: Initiatives like the OECD AI Principles and the UNESCO's 'Recommendation on the Ethics of Artificial Intelligence' provide high-level normative alignment.
- Standardisation bodies: The ISO and the IEEE play critical roles in enabling technical interoperability.
- Multi-stakeholder platforms: The GPAI and similar initiatives foster inclusive dialogues across sectors and regions.
- Development aid for governance capacity: International organisations should support regulatory capacity building in the Global South.

A pluralist approach to AI governance recognises regulatory diversity while pursuing convergence on core issues: safety, fairness, and sustainability. Global frameworks should be adaptive, inclusive, and transparent. Civil society, academia, and marginalised communities must be central participants in shaping AI futures.

Institutional mechanisms for global AI governance

The governance of AI at the supranational level presents a complex challenge, requiring a delicate balance between innovation, ethics, and economic considerations. Decentralised governance frameworks are increasingly being explored to address the global nature of AI development and deployment (Frenette 2025; Kiden et al. 2024).

A core challenge for global governance is the lack of institutional infrastructures that can coordinate AI policies across jurisdictions. While several organisations are engaging with AI issues, such as the UN, the OECD, the World Economic Forum (WEF), and the UNESCO, none has formal authority or enforcement power over AI development. This leads to a reliance on soft law instruments such as ethical guidelines, non-binding agreements, and voluntary codes of conduct. One proposed solution is the creation of an international AI agency, like the International Atomic Energy Agency

(IAEA), which could oversee compliance, facilitate cooperation, and promote the peaceful and beneficial use of AI technologies. While politically ambitious, such an initiative would fail due to the use of a top-down approach. In fact, it would need to be complemented by bottom-up institutional development, capacity building in emerging economies, and ongoing global dialogue to ensure fairness, legitimacy, and accountability in the governance of AI.

Addressing this gap requires moving beyond traditional national-centric models and towards governance architectures that reflect the realities of global interdependence and sectoral diversity. Theories of multi-level governance suggest that authority and decision-making can be effectively distributed across overlapping jurisdictions and networks of public and private actors, enabling more adaptive and inclusive regulatory responses (Hooghe and Marks 2001). Such a polycentric structure would support coordination while allowing for variation across sectors and regions, reducing regulatory frictions and enabling context-sensitive policymaking (Ostrom 2010). Decentralised governance approaches, which emphasise subsidiarity and localised legitimacy, are particularly relevant in the context of AI, where risks and applications vary widely across domains such as healthcare, mobility, and public administration. Empowering local institutions and domain-specific bodies can increase responsiveness and regulatory relevance while maintaining alignment with global principles (Abbott and Snidal 2021; de Búrca, Keohane, and Sabel 2014). Moreover, insights from experimentalist governance offer further guidelines by promoting flexible, iterative policymaking based on real-time feedback, empirical learning, and stakeholder participation. Mechanisms such as regulatory sandboxes, cross-sectoral convergence platforms, and technical working groups help regulators and developers co-create rules in uncertain or fast-moving environments, reducing the risk of premature or misaligned regulation (Sabel and Zeitlin 2011).

Global data governance and digital sovereignty

Data constitute the foundational resource of AI, underpinning the development, training, and deployment of intelligent systems across sectors. As such, the governance of data is not merely a technical or operational concern but a core component of any coherent global regulatory strategy for AI. Without effective and harmonised data governance, the promises of AI risk being undermined by fragmentation, inefficiency, and legal uncertainty. Current international frameworks regulating cross-border data flows illustrate the stark divergences in national approaches to digital sovereignty, privacy, and state surveillance. For instance, the EU relies on mechanisms such as adequacy decisions under the *GDPR*, which permit data transfers only to countries with data protection standards deemed equivalent to those of the EU. In the meanwhile, the EU is working towards a data space environment with a specific, EU-centric vision of data sovereignty, providing uniquely suitable infrastructures and services to scientists and professionals for running computationally intensive and complex algorithms on a commercial cloud interface. An example of this effort is the NOUS project,[1] which aspires to create a comprehensive blueprint for implementing a cloud service where each implementation is interconnected with other EU platforms. By contrast, the US emphasises law enforcement access under

the *Clarifying Lawful Overseas Use of Data (CLOUD) Act*, which mandates compliance by US-based technology firms even when data are stored abroad. Meanwhile, China's *Cybersecurity Law* and the subsequent *Data Security Law* and *Personal Information Protection Law* impose stringent localisation requirements and assert state control over both domestic and foreign data flows. These regimes reflect fundamentally different conceptions of rights, jurisdiction, and governance, creating a complex and often contradictory environment for multinational AI systems.

These difficulties are compounded by deeper systemic challenges in global data governance. First, the absence of a unified international framework has resulted in fragmented, incomplete protection of personal data and inconsistent rules for cross-border flows (Kuzio et al. 2022). The rapid pace of technological evolution, particularly in AI and cloud computing, further complicates enforcement and accountability. Second, geopolitical frictions have led to competing governance models that hinder consensus building (Atkinson and Cory 2021). Third, emerging data collection methods pose novel threats, ranging from opaque algorithmic profiling to the exploitation of behavioural data, increasing the risk of manipulation and loss of autonomy (Kuzio et al. 2022; Tang 2022).

From a sovereignty perspective, many countries, particularly those in the Global South, face structural disadvantages due to their dependence on foreign technology providers and platforms, which undermines their strategic autonomy and governance capacity (Vardanyan and Kocharyan 2022). The need to reconcile national control with international cooperation presents a paradox for policymakers, who must simultaneously protect domestic interests and participate in global digital frameworks (Iakhiaev et al. 2023). The rise of transnational cloud platforms capable of circumventing national laws further challenges efforts to maintain meaningful oversight (Tang 2022).

Amid these complexities, various proposals have emerged to rebalance data governance. Legal instruments such as data trusts and regulatory mechanisms like global data stewardship offer alternative pathways emphasising collective responsibility, transparency, and fairness. Technical solutions such as federated learning provide a means to process data locally while preserving global collaboration and minimising privacy risks. Yet, implementing these models requires strong governance, robust access and usage control, and iterative regulatory structures capable of adapting to emerging technologies and risks (Hellmeier et al. 2023).

As a result, developers and operators of cross-border AI applications face significant compliance challenges. They must reconcile overlapping and sometimes conflicting obligations concerning data access, storage, processing, and consent. Issues such as whether user data can be transferred internationally, how they must be anonymised, and under what conditions they can be shared with third parties, vary significantly across jurisdictions. The absence of harmonised standards not only increases legal and operational risks but may also hinder innovation and restrict the scalability of AI technologies. To address these tensions, scholars and policymakers have advanced several proposals for a global data governance framework capable of balancing the needs of innovation with the imperatives of privacy, security, and ethical oversight. One approach is the creation of data trusts, i.e. legal structures that manage data on behalf of individuals or communities, ensuring that data usage aligns with collectively defined principles and benefits. Another promising model is about global

data stewardship, which focusses on shared responsibility and accountability among stakeholders for the custodianship and ethical use of data (de Sherbinin et al. 2021; Gregory et al. 2021). A further technical solution lies in federated learning, a machine learning paradigm that allows AI models to be trained across decentralised devices or servers holding local data samples, without requiring the data to be transferred or centrally stored. This approach not only enhances privacy and security but also offers a practical mechanism for collaborative AI development across borders in a way that respects national regulatory constraints (Sprenkamp et al. 2023; Yang et al. 2019).

The role of stakeholders

Stakeholder engagement is essential for ensuring that ethical considerations are integrated into AI governance. This involves academia, industry, civil society, and policymakers working collaboratively to develop ethical AI policies. Public participation is also crucial, as it ensures that the ethical implications of AI are understood and addressed from a societal perspective. The global governance of AI is characterised by both opportunities and challenges, with international cooperation being essential to address the cross-border implications of AI technologies. A special role is played by specific stakeholders: civil society, academia, and compute providers.

- Civil society: A truly global governance system cannot rely solely on governments and corporations. Civil society organisations and grassroots movements are essential actors in promoting democratic accountability, ethical innovation, and social justice. Their involvement ensures that the governance of AI reflects a plurality of perspectives, particularly those of underrepresented groups. Mechanisms to institutionalise civil society participation include consultative bodies, citizen assemblies, and participatory regulatory sandboxes.
- Academia: Academia is a key actor in conducting independent audits, assessing AI impact, and educating future regulators and developers. Moreover, it is a key player in driving innovation and fostering the development of sustainable and inclusive AI.
- Compute providers: Compute providers play a crucial role in the regulatory ecosystem, serving as intermediaries for AI regulation. They can act as securers, safeguarding AI systems and critical infrastructures; record keepers, enhancing visibility for policymakers; verifiers of customer activities, ensuring oversight; and enforcers, taking actions against rule violations. Their role is essential for ensuring compliance with regulatory requirements and mitigating risks associated with AI systems.

Towards just, inclusive, and resilient governance

Global AI governance requires more than principles – it requires a coordinated, institutionally supported, and politically feasible architecture. As AI technologies increasingly influence democratic processes, economic systems, and personal freedoms,

there is a moral imperative to design frameworks that reflect pluralistic values, protect vulnerable communities, and prevent a technological divide between the Global North and South. The concentration of AI expertise, infrastructures, and investments in a handful of countries raises concerns about technological dependency and global inequalities. Countries in the Global South often lack the regulatory capacity, computing power, and skilled workforce needed to engage in AI development on equal footing. Global governance must therefore incorporate redistributive mechanisms, including technology transfer, capacity-building programmes, and equitable access to AI research resources. Institutions like the World Bank and the ITU have critical roles to play in ensuring that the benefits of AI are shared globally.

It is not enough to regulate AI where it is developed; we must also consider where it is deployed, and the unequal conditions under which it may affect different societies. This calls for a multi-layered approach that blends national sovereignty with international cooperation. Key components of this architecture could include binding treaties on algorithmic accountability, shared enforcement protocols among trusted jurisdictions, and global funding instruments to support low-income countries in building AI regulatory capacity. Moreover, the role of emerging technologies such as quantum computing, synthetic data, and neurosymbolic AI must be anticipated within these governance debates, avoiding a reactive stance and instead embedding foresight in institutional design. Finally, governance must be not only reactive to threats but also proactive in shaping the kind of future that societies envision with AI. The question is not simply how to govern AI, but what kind of world we want to build through it. Whether the international community can rise to this challenge depends on its capacity for political imagination, ethical resolve, and collective action. AI governance, therefore, is not merely a technical project; it is a democratic one.

The environmental impact of AI, particularly large-scale machine learning models, is gaining attention in global governance discussions. Training state-of-the-art models such as GPT-4 requires significant computational resources and energy consumption. Without international standards for energy efficiency and sustainability, AI development could undermine climate goals. Green AI initiatives advocate for carbon-aware design, the optimisation of computational processes, and the integration of environmental metrics into AI regulation (Walters et al. 2024). Global frameworks could mandate environmental impact assessments for high-consumption AI systems and encourage the development of low-carbon AI infrastructures.

Global AI governance stands at a crossroads. The next decade will determine whether AI technologies contribute to inclusive and sustainable development or exacerbate inequalities and erode democratic norms. The path forwards requires bold institutional imagination, political will, and a shared commitment to fairness, safety, and human dignity. While challenges abound, the convergence of interests among states, institutions, and publics around the world creates a unique opportunity. A global governance framework for AI, anchored in ethical principles and operationalised through inclusive institutions, offers the best chance of navigating the risks and maximising the rewards of the AI revolution. Multiple pathways exist for the future of global AI governance:

- Fragmentation scenario: Countries continue to develop incompatible regulatory systems, leading to a splintered AI ecosystem with restricted interoperability and increased regulatory arbitrage.
- Convergence scenario: Incremental harmonisation through bilateral and multilateral agreements leads to a set of shared principles and partially mutual recognition of standards.
- Global institutionalisation scenario: A new multilateral body emerges with the mandate to oversee AI development, akin to the World Trade Organisation (WTO) or the World Health Organisation (WHO), backed by a binding international treaty.
- Platform-led governance scenario: Large technology firms, particularly compute providers, take on quasi-regulatory functions by enforcing ethical standards through infrastructure control.

Each scenario presents trade-offs between feasibility, inclusivity, and effectiveness. The optimal outcome likely lies in a hybrid model that combines national sovereignty with multilateral coordination, technical standardisation, and stakeholder participation.

A multi-level regulatory scheme for AI governance

This section introduces a comprehensive multi-level governance framework for AI (see Figure 2), designed to respond to the evolving demands of technological regulation in a globally fragmented yet increasingly interdependent context. The framework is grounded in three normative pillars that serve as its ethical and functional compass. First, the 'ethical' perspective, emphasising the primacy of human rights, democratic values, and sustainability, ensures that AI governance remains aligned with fundamental social principles. Second, the 'ecumenical' perspective, promoting harmonisation across jurisdictions, absorbs the richness of different cultures, and addresses the challenges of regulatory divergence by fostering interoperability and cross-border coherence. Third, the 'explainable' perspective, which prioritises transparency and accountability, underlines the necessity for both AI systems and regulatory instruments to be intelligible, auditable, and socially legible to stakeholders, including end users, regulators, and civil society.

These normative foundations are translated into policy and institutional design through a modular, multi-layered architecture that operationalises the LETO methodology, an integrated framework tailored to the systemic nature of digital transformation. This methodology breaks down AI governance into four dimensions: (1) Legal, focussing on compliance, liability, and rights protection; (2) Ethical, encompassing social responsibility, environmental impact, and fairness; (3) Technological, addressing algorithmic robustness, data governance, and infrastructure resilience; and (4) Operational, which covers scalability, lifecycle monitoring, and organisational integration. This multidimensional schema not only aligns innovation trajectories with societal expectations but also provides a strategic blueprint for embedding AI systems within a broader governance ecosystem that is both adaptable and anticipatory (Perboli, Borroni, and Bruni, forthcoming). By bridging normative

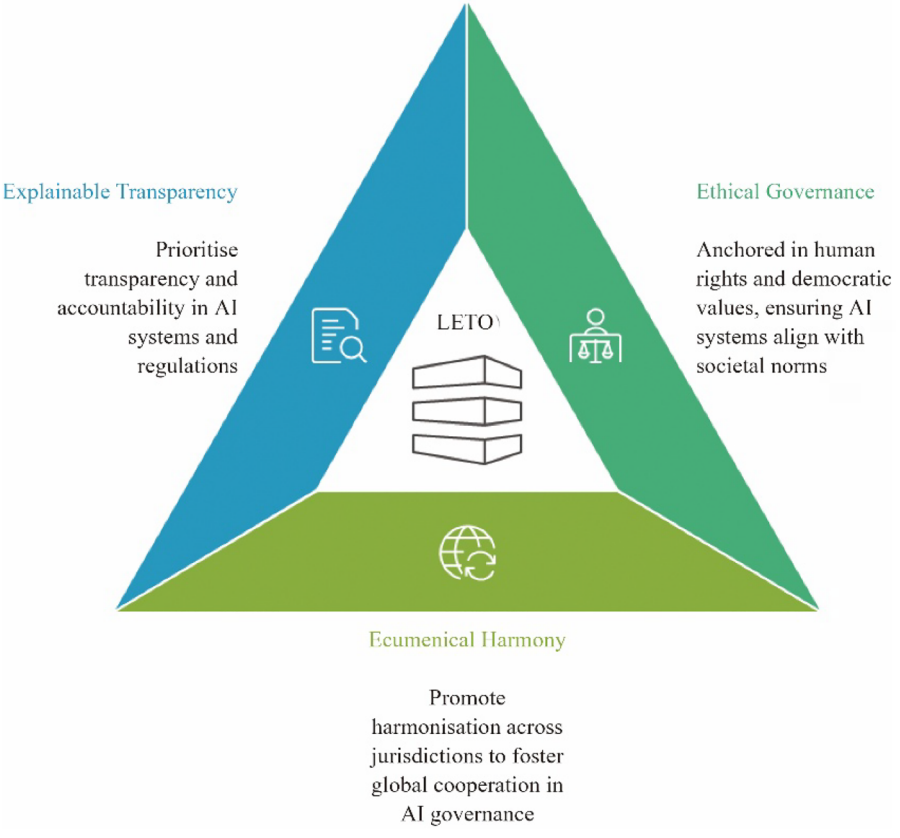


Figure 2. Foundations of the AI governance model.

ideals with pragmatic implementation pathways, the framework aims to reconcile the competing demands of innovation, equity, and control in the age of algorithmic decision-making.

From an organisational point of view, this framework is structured across decentralised interrelated components: glocal orchestration (i.e. a dual governance model mixing global and local entities), and dynamic regulation. This hybrid architecture supports vertical flexibility through domain-specific regulation, horizontal coherence via glocal coordination, evolvability through adaptive mechanisms, and legitimacy by embedding stakeholder engagement at every level. It offers a scalable, inclusive, and resilient model for AI governance in a rapidly evolving global ecosystem.

Glocal orchestration

At the heart of this framework lies a dual orchestration model that balances horizontal coherence with vertical specialisations (Figure 3). It is based on a mix of global and local orchestration, with a bottom-up approach that starts from the experience of local innovation tables and then moves the findings and the needs to the second tier: the global one. The reason for such an approach relies on the fact that there is a need

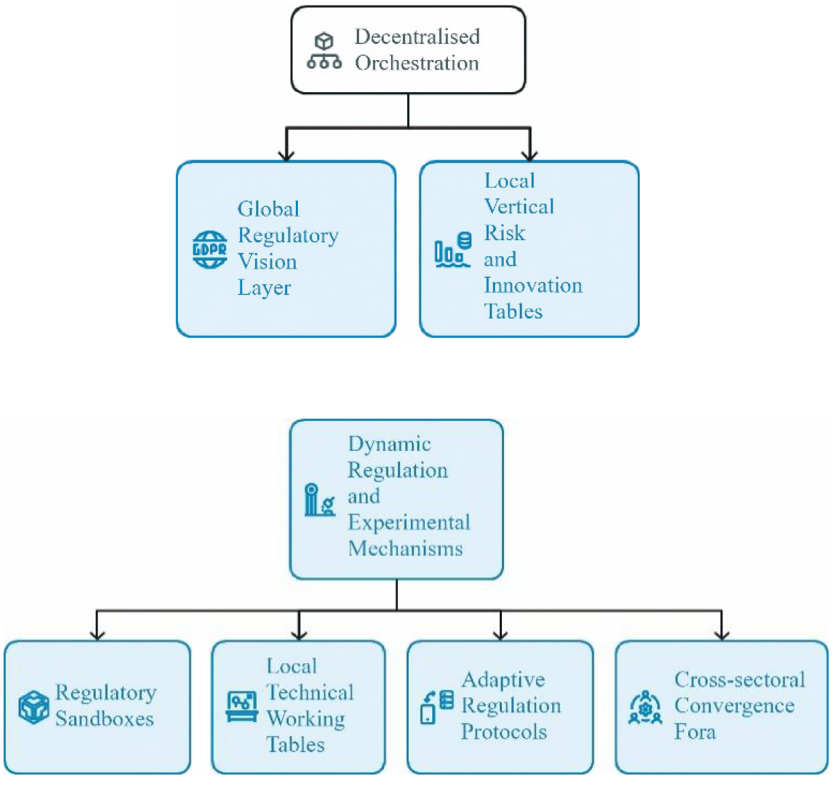


Figure 3. A decentralised regulatory framework for AI governance.

for a global strategy, but this strategy cannot come from high-level institutions and then be pushed to the individual geographic areas and nations. The top-down approach, in fact, has already proved its ineffectiveness in the EU. On the contrary, an agile approach, based on local regulation with global oversight and then, if needed, global harmonisation, such as the Chinese lean approach, would benefit from the specific geographical or industrial peculiarities while ensuring a global vision.

In more detail, the first tier is composed of Local Vertical Risk and Innovation Tables (LVRITs). These are domain-specific bodies, e.g. for healthcare, finance, energy, mobility, and public services, that perform granular risk assessments, develop tailored regulatory paths, and evaluate the technical and economic feasibility of compliance strategies, particularly for SMEs. They are locally established (at the national or regional level) to incorporate regional peculiarities and needs. Each LVRIT is embedded within a network of stakeholders, including regulatory agencies, industry leaders, civil society organisations, academic institutions, and standardisation experts. This structure ensures continuous bottom-up knowledge transfer to the global vision layer, fostering regulations that are both grounded in practical realities and aligned with overarching normative objectives.

The second tier is the Global Regulatory Vision Layer, which operates as the normative and strategic coordinator of AI governance. Its primary role is to synthesise regional and sector-specific insights into a globally coherent architecture grounded in democratic values, human rights, and sustainability. This layer is tasked with

drafting high-level AI principles aligned with multilateral initiatives such as the OECD AI Principles and the UNESCO's 'Recommendation on the Ethics of Artificial Intelligence'. It also supports the facilitation of technical standardisation through international bodies like the ISO and the IEEE, while working to harmonise national and sectoral regulation to mitigate jurisdictional conflicts and regulatory arbitrage. It is fundamental that, from an orchestration point of view, this is based on a decentralised and distributed regulatory system inspired by the recent advances in smart governance and blockchain-based notarisation systems. This would enhance the trust among the involved countries, fostering cooperation among the partners.

To ensure forward-looking and reflexive governance, this model incorporates mechanisms for continuous feedback and long-term foresight. Foresight labs composed of interdisciplinary experts would explore frontier technologies such as neurosymbolic AI, artificial general intelligence (AGI), and quantum-enhanced machine learning, identifying regulatory blind spots and pre-empting emerging risks.

Dynamic regulation and experimental mechanisms

To maintain regulatory agility in the face of fast-moving technological change, the framework incorporates a suite of dynamic instruments designed to promote innovation without compromising oversight.

Regulatory Sandboxes allow AI developers to test high-risk or emergent systems under controlled conditions, offering a space for co-developing metrics, risk thresholds, and compliance protocols in collaboration with auditors and regulators. These sandboxes also serve to lower market entry barriers for SMEs by simplifying initial regulatory burdens.

Local Technical Working Tables act as regulatory laboratories, hosted by public agencies or international consortia. Their role is to monitor technological trends, deliberate on technical standards, and translate high-level governance principles into enforceable norms and sector-specific documentation requirements.

To support continuous adaptation, this model integrates Adaptive Regulation Protocols, including sunset clauses, versioning mechanisms, and mandatory post-market reviews. These tools allow legal instruments to evolve in tandem with technological developments, ensuring that AI systems remain compliant throughout their lifecycle.

Finally, Cross-sectoral Convergence Fora convene stakeholders across different LVRITs and the global coordination body. These periodic gatherings foster alignment on transversal issues such as algorithmic discrimination, misinformation, and bias mitigation, and enable the dissemination of best practices in risk management and compliance efficiency.

Conclusions

This paper has examined the complex and rapidly evolving landscape of AI regulation, comparing the approaches of the EU, the US, and China. Navigating the AI regulatory landscape requires a delicate balance between innovation, ethics, and global governance. The EU's risk-based approach, the US's sector-specific framework, and China's state-led direction each offer valuable insights into the complexities of AI

regulation. Ethical considerations such as fairness, transparency, accountability, and privacy must be at the heart of regulatory frameworks, ensuring that AI technologies are developed and deployed responsibly. International cooperation is essential to address the global implications of AI, with international frameworks providing a foundation for harmonised regulatory approaches. As AI continues to evolve, ongoing dialogue and adaptive frameworks will be crucial to ensure that the benefits of AI are maximised while its risks are minimised.

Our analysis shows that regional frameworks not only reflect different legal cultures and political economies but also shape the international debate on AI ethics, interoperability, and accountability. As AI systems increasingly affect global markets, democratic processes, and personal liberties, it becomes clear that no single country or jurisdiction can govern them in isolation.

The call for global governance is therefore not only a normative aspiration but a practical imperative. Fragmented approaches risk creating regulatory loopholes, exacerbating inequalities, and undermining public trust. Coordinated governance mechanisms supported by international institutions, shared technical standards, and inclusive stakeholder engagement are essential to ensure that AI serves collective human values.

Furthermore, at the organisational level, the emergence of the Chief AI Officer (CAIO) signals a shift towards more structured and accountable internal governance. The CAIO role embodies the convergence of strategic foresight, legal compliance, ethical responsibility, and technological control. It demonstrates how private actors are also becoming central to the practical implementation of AI policies.

Note

1. See the website of NOUS: https://nous-project.eu/.

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