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# Artificial intelligence regulation and its impact on science and higher education: A comparative analysis of the EU, the United States, and China

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## Abstract

Artificial intelligence (AI) is rapidly transforming scientific research and higher education, influencing how knowledge is created, evaluated, and applied. As AI adoption expands, regulatory frameworks are becoming a critical factor shaping innovation, governance, and institutional practices. This paper examines the impact of AI regulation on science and higher education through a comparative analysis of the European Union (EU), the United States (US), and China. The EU has adopted a comprehensive, risk-based regulatory framework through the Artificial Intelligence Act, emphasizing fundamental rights, transparency, and accountability. In contrast, the US follows a decentralized, innovation-driven approach grounded in executive actions, agency guidance, and market-oriented governance. China pursues a state-driven, development-focused model that combines strategic investment, targeted regulation, and strong institutional coordination. The analysis demonstrates that these differing approaches produce distinct outcomes in research freedom, innovation capacity, data governance, and institutional responsibility. While the EU promotes trust and ethical standards, it may introduce compliance burdens; the US enables rapid innovation but faces regulatory fragmentation; and China achieves coordinated growth with stronger state oversight. The study highlights that AI regulation actively shapes research environments and global academic competitiveness, underscoring the need for balanced governance frameworks.

**Keywords:** AI regulation, EU, US, China, science, higher education

## Introduction

Artificial intelligence (AI) is transforming scientific research and higher education by reshaping how knowledge is produced, evaluated, and disseminated. Universities are now both key sites of AI development and major deployers of AI in teaching, administration, research workflows, and institutional decision-making. This shift makes AI not only a technological change but also a governance challenge that touches academic freedom, research integrity, data protection, and institutional accountability.

As AI's societal and economic impact grows, governments are adopting regulatory frameworks that differ sharply by legal tradition, political priorities, and economic strategy. The EU has introduced a comprehensive, binding, risk-based framework through the Artificial Intelligence Act, emphasizing fundamental rights, transparency, and accountability (European Commission, 2024). The US relies on decentralized governance—executive actions, agency guidance, and voluntary standards—intended to preserve flexibility and innovation (NIST, 2023; NatLawReview, 2025). China pursues development-

oriented, state-coordinated models combining targeted regulation, strategic investment, and strong institutional control (Chen & Xu, 2025; Choi & Yoon, 2025).

These paradigms shape research conditions—data access, experimentation speed, ethical oversight, institutional governance, and academia–industry–state collaboration—thereby influencing global academic competitiveness.

This article compares the EU, US, and China approaches and assesses implications for research freedom, innovation capacity, ethical governance, and institutional responsibility. It argues that AI regulation is not neutral: it structures research environments and creates trade-offs between innovation, control, and accountability. While the EU prioritizes trust and rights protection, the US emphasizes innovation and market efficiency, and China favors strategic coordination and development. These differences are likely to yield uneven outcomes in scientific productivity, academic autonomy, and leadership in AI. Understanding these dynamics is essential for policymakers, academic leaders, and researchers navigating an increasingly competitive global landscape.

## The Study

### Purpose and objectives

Although AI regulation has become one of the most widely discussed policy topics, existing studies primarily examine individual jurisdictions or focus on legal compliance and governance mechanisms. Comparative analyses that specifically investigate how different regulatory models influence scientific research and higher education remain limited. Most previous research evaluates the legal characteristics of the EU AI Act, U.S. policy initiatives, or China's state-led governance independently, while comparatively little attention has been paid to their implications for universities, research institutions, academic freedom, innovation capacity, and research governance.

Furthermore, the rapidly evolving regulatory landscape has outpaced research on its practical consequences for higher education institutions, which increasingly rely on AI for teaching, research, administration, and decision support. Consequently, there is a need for a comprehensive comparative analysis linking regulatory philosophies to their institutional effects on science and higher education.

This study addresses this gap by pursuing the following objectives:

- to compare the AI regulatory frameworks of the European Union, the United States, and China;
- to identify the underlying regulatory philosophies and governance approaches adopted in each jurisdiction;
- to analyse how these regulatory models influence scientific research, academic institutions, innovation, and research governance; and
- to assess the implications of these regulatory differences for global academic competitiveness and future AI governance.

The study contributes to the growing debate on AI governance by demonstrating that regulation is not merely a legal framework but an important institutional factor shaping scientific research and higher education. As universities increasingly integrate AI into research, teaching, and administrative processes, understanding how regulatory choices influence innovation, academic autonomy, ethical governance, and institutional responsibility becomes increasingly important.

The findings provide useful insights for policymakers designing AI regulation, university leaders developing institutional AI governance strategies, and researchers investigating the relationship between technology regulation and knowledge production.

## Methodology

This research employs a qualitative comparative policy analysis to examine AI regulatory approaches in the European Union, the United States, and China. The three jurisdictions were selected because they represent the world's most influential and contrasting AI governance models: the EU's comprehensive rights-based regulation, the U.S. innovation-oriented and decentralized approach, and China's state-driven development model.

The analysis is based on a review of primary and secondary sources, including legislation, government policy documents, regulatory guidelines, international reports, and recent academic literature. Primary sources include the EU Artificial Intelligence Act (EY 2024), U.S. executive orders, NIST guidance (2023), Chinese AI governance policies, and related regulatory documents. Secondary sources consist of peer-reviewed publications, institutional reports, and policy analyses addressing AI governance and regulation.

The study applies a comparative analytical framework focusing on several dimensions, including regulatory philosophy, legal structure, governance mechanisms, risk management, enforcement, innovation policy, and the implications of regulation for scientific research and higher education. The comparison further evaluates the impact of each regulatory model on research freedom, institutional governance, ethical oversight, innovation capacity, and global academic competitiveness.

Rather than evaluating legal compliance, the study adopts an institutional and policy perspective to understand how different regulatory models shape research environments and HE systems.

## Regulatory Trends and Viewpoints on AI

### Regulatory Trends and Viewpoints on AI in the EU

The EU has adopted the world's first comprehensive and legally binding framework for the regulation of artificial intelligence through the AI Act (European Parliament & Council of the European Union. (2024). Rather than treating AI solely as an engine of economic growth, the EU positions it as a transformative technology that must be developed in accordance with European values, including human dignity, transparency, accountability, non-discrimination, and the protection of fundamental rights (European Commission, 2020, 2024). This policy orientation is embedded within the European Digital Strategy, which seeks to strengthen the Union's technological competitiveness while simultaneously establishing a predictable and trustworthy regulatory environment for AI development and deployment. In this respect, the EU approach differs from innovation-first regulatory models by explicitly integrating economic, ethical, and societal objectives into a single governance framework.

The AI Act operationalizes these principles through a harmonized, risk-based regulatory model that links legal obligations to the potential societal risks associated with AI systems (European Commission, 2024; [artificialintelligenceact.eu](https://artificialintelligenceact.eu)). AI applications are classified into four categories: unacceptable-risk systems, which are prohibited; high-risk systems, which are subject to extensive requirements concerning data governance, documentation, transparency, human oversight, robustness, and conformity assessment; limited-risk systems, which are primarily subject to transparency obligations; and minimal-risk systems, which remain largely unregulated. To ensure consistent implementation across Member States, the Act establishes a coordinated governance architecture involving national supervisory authorities, conformity

assessment procedures, and the newly created European AI Office. Furthermore, the AI Act is designed to operate alongside existing EU legislation, particularly the General Data Protection Regulation (GDPR), the Digital Services Act (DSA), the Digital Markets Act (DMA), and cybersecurity legislation, thereby reducing regulatory fragmentation and promoting legal coherence (European Commission, 2024; EY, 2024).

The EU regulatory strategy extends beyond legal oversight by combining regulation with substantial public investment in AI research, innovation, infrastructure, and digital skills. Initiatives such as the AI Innovation Package and the AI Continent Action Plan aim to strengthen European research capacity, facilitate AI adoption across sectors, and improve global competitiveness while maintaining high ethical standards (European Commission, 2024). This dual strategy reflects the EU's broader objective of fostering responsible innovation, recognising that long-term technological leadership depends not only on investment but also on public trust and legal certainty. Consequently, AI governance is viewed as an enabling framework that supports sustainable innovation rather than merely restricting technological development.

Despite broad international recognition of the EU model as a benchmark for trustworthy AI governance, considerable debate remains regarding its potential impact on innovation. Critics argue that extensive documentation requirements, conformity assessments, and compliance costs may disproportionately burden smaller firms and research organisations, potentially slowing experimentation and reducing Europe's competitiveness in comparison with less regulated jurisdictions (Financial Times, 2024). Industry stakeholders have also expressed concerns regarding the implementation timetable, voluntary Codes of Practice for general-purpose AI, and the administrative complexity associated with compliance. At the same time, proponents contend that a stable regulatory framework enhances legal certainty, facilitates cross-border deployment of AI systems, and strengthens public confidence in AI technologies, thereby supporting their wider adoption over the long term (European Commission, 2024; EY, 2024).

Overall, the EU has developed a distinctive model of AI governance that combines binding regulation, ethical principles, and strategic investment within an integrated digital policy ecosystem. Unlike regulatory approaches that prioritize either innovation or state control, the European framework seeks to balance technological progress with accountability and the protection of fundamental rights. As implementation continues through delegated acts, harmonized technical standards, Codes of Practice, and guidance issued by the European AI Office, the practical effectiveness of the AI Act will depend on its ability to preserve innovation while ensuring trustworthy AI governance (Siddharth, 2025). This evolving balance is particularly relevant for scientific research and higher education, where regulatory certainty, research integrity, and responsible AI adoption are becoming increasingly important determinants of institutional competitiveness.

### **Regulatory Trends and Viewpoints on AI in the US**

The regulatory approach to artificial intelligence (AI) in the United States differs fundamentally from the European Union by prioritizing innovation, market flexibility, and technological competitiveness over comprehensive ex ante regulation. Rather than establishing a single, binding AI statute, the United States has developed a decentralized governance framework that combines federal legislation, executive action, agency guidance, voluntary standards, and an expanding body of state laws (Congressional Research Service, 2025; Recording Law, 2026). This regulatory architecture reflects the U.S. legal tradition of addressing emerging technologies through existing legal authorities while encouraging private-sector innovation and maintaining global leadership in AI research and commercialization. Consequently, AI governance in the United States continues to evolve through multiple institutions rather than through a unified regulatory regime.

Federal AI policy has focused primarily on coordination, research investment, and responsible innovation. The National Artificial Intelligence Initiative Act of 2020 established the institutional foundations for a coordinated national AI strategy by creating the National AI Initiative Office, strengthening interagency collaboration, and supporting advisory structures for AI research and policy (The White House, 2021; National AI Advisory Committee, n.d.). Subsequent initiatives, including the CHIPS and Science Act, further expanded federal investment in AI research infrastructure, semiconductor manufacturing, and National Science Foundation AI Research Institutes, reinforcing the strategic importance of AI for economic growth and national competitiveness. Additional legislation, including the AI in Government Act and the Advancing American AI Act, has focused primarily on improving federal capacity for AI adoption, procurement, and governance rather than imposing comprehensive regulatory obligations.

Executive action has become a central instrument of AI governance in the absence of comprehensive federal legislation. Executive Order 14110 on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence established government-wide priorities for AI safety, risk management, civil rights protection, transparency, and interagency coordination (Executive Office of the President, 2023). More recent federal guidance, including the Office of Management and Budget Memorandum M-25-21, encourages agencies to accelerate AI adoption while strengthening governance, public trust, and oversight across a broad range of technical and societal risks (OMB, 2025). These initiatives are closely aligned with the NIST Artificial Intelligence Risk Management Framework, which provides voluntary guidance for identifying, assessing, and mitigating AI-related risks while supporting innovation (NIST, 2023). Although executive measures offer considerable flexibility, their long-term stability depends on changing political administrations and policy priorities.

In the absence of a comprehensive federal AI law, state governments have emerged as important regulatory actors. States increasingly regulate AI applications in areas such as employment, credit, housing, consumer protection, and public services, creating a complex and fragmented regulatory landscape (CRS, 2023; NCSL, 2024). Examples include Colorado's AI Act and New York City's legislation (2021) governing automated employment decision tools. While these initiatives provide legally binding safeguards in high-impact domains, they also increase compliance complexity for organizations operating across multiple jurisdictions and have intensified calls for greater federal harmonization (Glacis, 2024; Bryan Cave Leighton Paisner LLP, 2024; Holland & Knight LLP, 2024). Enforcement of AI-related risks continues to rely largely on existing legal authorities, particularly consumer protection and civil-rights legislation. The Federal Trade Commission has consistently emphasized that there is no 'AI exemption' from existing law and has actively pursued enforcement actions against deceptive AI claims and unfair commercial practices (FTC, 2024).

Overall, the U.S. approach represents an innovation-oriented governance model that seeks to preserve regulatory flexibility while promoting technological leadership. Compared with the EU's comprehensive, rights-based framework, the United States relies on distributed governance mechanisms that encourage experimentation, industry collaboration, and rapid commercialization but also generate regulatory fragmentation and uneven oversight across sectors. As AI technologies continue to mature, the principal policy challenge will be to balance innovation, public trust, and legal certainty without undermining the flexibility that has historically characterized the U.S. innovation ecosystem (Congressional Research Service, 2025; NatLawReview, 2025).

### **Regulatory Trends and Viewpoints on AI in the US**

China has developed a distinctive model of artificial intelligence (AI) governance that combines strategic industrial policy with centralized regulatory oversight. Unlike the European Union's comprehensive legal framework or the decentralized regulatory approach adopted by the United States, China's governance

model integrates technological development, national security, and economic modernization within a coordinated state-led strategy (Choi & Yoon, 2025; Chen & Xu, 2025). AI is viewed as a strategic technology that supports economic transformation, industrial upgrading, and geopolitical competitiveness. Consequently, Chinese AI policy simultaneously promotes innovation, strengthens regulatory control, and aligns technological development with broader national objectives. This long-term vision is reflected in the New Generation Artificial Intelligence Development Plan (AIDP), which aims to position China as a global AI leader by 2030 while promoting domestic innovation, international standard-setting, and technological sovereignty (Choi & Yoon, 2025).

Rather than relying on a single AI statute, China has established a multi-layered governance framework that combines foundational legislation with targeted AI-specific regulations. The Cybersecurity Law (CSL), Data Security Law (DSL), and Personal Information Protection Law (PIPL) constitute the core legal framework governing cybersecurity, data governance, and privacy protection (Chen & Xu, 2025; Hu & Au, 2025). These laws are complemented by regulations addressing recommendation algorithms, deep synthesis technologies, generative AI, and online content governance, thereby enabling differentiated oversight according to the risks associated with specific AI applications (Cheng, 2025; Ravia & Hammer, 2025). Recent amendments to the Cybersecurity Law, effective from 2026, further reinforce ethical governance, risk monitoring, penalties for non-compliance, and selected extraterritorial provisions while explicitly supporting AI innovation within a secure regulatory environment (Herbert Smith Freehills Kramer, 2026; Sheehan & Singer, 2025).

China's AI governance extends beyond regulation to include coordinated investment in research, education, infrastructure, and technical standardization. National initiatives—including the Guidelines for National New Generation Artificial Intelligence Open Innovation Platforms, AI Innovation and Development Pilot Zones, the Code of Ethics for the New Generation Artificial Intelligence, the Measures for the Review of Scientific and Technological Ethics, and the Framework for AI Safety Governance 1.0—illustrate the progressive institutionalization of AI governance (Batool et al., 2025; Corrêa et al., 2023; Chen & Xu, 2025). More recent policy initiatives, such as the Action Plan for “Robot+” Applications and the Guidelines for the Construction of a Comprehensive Standardization System for National AI, demonstrate China's commitment to integrating AI across manufacturing, education, healthcare, scientific research, and public administration while simultaneously strengthening national standards and governance capacity (Chan et al., 2025; Cheng, 2025).

A defining characteristic of the Chinese approach is the close integration of AI governance with cybersecurity, data sovereignty, and social stability. Regulatory measures emphasize responsible data processing, protection of sensitive information, algorithmic accountability, and state supervision of AI systems that may influence public opinion or national security (Hu & Au, 2025; Chen & Xu, 2025). Compared with Western governance models, ethical oversight is closely linked to national strategic priorities rather than primarily to individual rights or market regulation. Although this centralized model may constrain openness in certain research domains and limit cross-border data exchange, it also enables rapid implementation of national AI strategies, coordinated infrastructure investment, and accelerated deployment of AI technologies in priority sectors (Choi & Yoon, 2025; Tobin & Wu, 2026).

Overall, China's AI governance represents a development-oriented model that combines regulatory intervention with active state support for innovation. The integration of industrial policy, cybersecurity regulation, ethical governance, and long-term strategic planning has enabled the country to establish one of the world's most comprehensive AI policy ecosystems. While the model raises important questions regarding transparency, academic autonomy, and international data collaboration, it also illustrates how coordinated governance can accelerate technological development and strengthen national competitiveness.

As China's regulatory framework continues to evolve through new standards, sectoral regulations, and governance guidelines, it is likely to remain an influential alternative to both the European rights-based model and the market-oriented approach pursued in the United States (Chen & Xu, 2025; Choi & Yoon, 2025; Sheehan & Singer, 2025)

## **Comparative Perspective: AI Governance in the EU, the US, and China**

The European Union (EU), the United States (US), and China have developed distinct approaches to AI governance that reflect different legal traditions, political systems, and economic priorities. Although all three jurisdictions recognize AI as a strategic technology, they differ substantially in their understanding of regulatory objectives, the role of the state, and the balance between innovation and risk management. Consequently, AI regulation has become not only a legal instrument but also a strategic policy tool influencing technological competitiveness, industrial development, and geopolitical positioning (European Commission, 2024; Congressional Research Service, 2025; Chen & Xu, 2025).

The EU adopts a precautionary, rights-based model centred on the protection of fundamental rights, transparency, accountability, and legal certainty. Through the AI Act, regulatory obligations are proportionate to the level of societal risk, creating a harmonized framework applicable across the internal market (European Commission, 2024; Scarpellino, 2024). This approach seeks to enhance public trust while reducing legal fragmentation. In contrast, the US follows a decentralized governance model that relies on federal legislation, executive action, voluntary standards, sector-specific regulation, and state initiatives. Rather than imposing comprehensive ex ante regulation, U.S. policy emphasizes innovation, market flexibility, and ex post enforcement under existing legal authorities (Congressional Research Service, 2025; NatLawReview, 2025; OMB, 2025). China represents a third model in which AI governance is integrated into long-term national development strategies. Regulation combines industrial policy, cybersecurity, data governance, and state oversight, reflecting broader objectives related to technological sovereignty, economic modernization, and social stability (Choi & Yoon, 2025; Chen & Xu, 2025).

These contrasting governance philosophies produce different regulatory trade-offs. The EU offers the highest degree of legal certainty through harmonized legislation and clearly defined compliance obligations. However, extensive documentation requirements, conformity assessments, and regulatory oversight may increase compliance costs and slow innovation, particularly for smaller organizations and emerging enterprises (Legal Curated, 2025; Financial Times, 2024). The U.S. model encourages experimentation, entrepreneurship, and rapid commercialization by maintaining regulatory flexibility. Nevertheless, the coexistence of federal guidance and diverse state legislation creates regulatory fragmentation, legal uncertainty, and uneven protection across sectors (CRS, 2023; NCSL, 2024). China's centralized governance enables rapid implementation of national AI strategies, coordinated infrastructure investment, and large-scale deployment of AI technologies. At the same time, strong state oversight, restrictions on data governance, and extensive cybersecurity controls may constrain openness, transparency, and international collaboration (Hu & Au, 2025; Sheehan & Singer, 2025; Tobin & Wu, 2026).

Differences are also evident in regulatory architecture and enforcement. The EU relies on binding legislation supported by supervisory authorities, conformity assessment procedures, and significant administrative sanctions comparable to the GDPR (European Commission, 2024; Scarpellino, 2024). The United States primarily enforces AI-related risks through existing consumer protection, competition, and civil-rights legislation, with agencies such as the Federal Trade Commission playing a central role (FTC, 2024). In China, enforcement is embedded within a broader governance framework that integrates AI regulation with cybersecurity, data protection, and administrative supervision, enabling coordinated

implementation across multiple sectors (Chen & Xu, 2025; Herbert Smith Freehills Kramer, 2026). These institutional differences influence not only regulatory effectiveness but also the adaptability of governance to rapidly evolving AI technologies.

Despite these differences, the three governance models share several common objectives. Each seeks to promote AI innovation while addressing concerns relating to safety, security, transparency, and public trust. Increasing attention is also being devoted to technical standards, AI risk management, ethical principles, and international cooperation, although these objectives are pursued through different institutional mechanisms (OECD, 2019; Batool et al., 2025). As AI technologies continue to evolve, complete regulatory convergence appears unlikely. Instead, global AI governance is expected to remain pluralistic, with jurisdictions adapting regulatory frameworks to their own political institutions, economic strategies, and societal values. The comparative analysis therefore suggests that no single governance model is universally optimal. Rather, each represents a different balance between innovation, accountability, market efficiency, and state intervention, illustrating that AI regulation has become a central component of contemporary technology policy and international competitiveness.

**Table 1. Summary of Key Findings: EU vs. US vs. China AI Regulatory Frameworks**

| Dimension                | EU                                                                                                    | US                                                                                                         | China                                                                                                          |
|--------------------------|-------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Regulatory Philosophy    | Precautionary, rights-based approach emphasizing safety, trust, and protection of fundamental rights. | Innovation-driven, market-oriented approach emphasizing flexibility, economic growth, and competitiveness. | Sovereignty- and development-oriented approach balancing innovation with state control and societal stability. |
| Legal Structure          | Single, binding EU AI Act applicable across all Member States.                                        | Fragmented framework of federal laws, executive orders, agency guidance, and state laws.                   | Multi-level framework: foundational laws (CSL, DSL, PIPL) + targeted AI regulations.                           |
| Risk Management          | Formal risk-based classification (unacceptable, high, limited, minimal).                              | No unified system; voluntary frameworks (e.g., NIST) and sector rules.                                     | Sector-specific and contextual risk control; stronger focus on high-impact areas.                              |
| Enforcement & Compliance | Mandatory compliance, strong supervision, and high fines (up to 7% global turnover).                  | Enforcement via existing laws (FTC, civil rights); limited AI-specific penalties.                          | State-centered enforcement; strong penalties in China.                                                         |
| Regulatory Uniformity    | Highly harmonized with extraterritorial reach.                                                        | Decentralized and fragmented across states and agencies.                                                   | China is centralized but layered.                                                                              |
| Governance Model         | Centralized EU-level coordination and national authorities.                                           | Distributed across agencies and states.                                                                    | China is centralized.                                                                                          |
| Innovation Strategy      | Regulated innovation combining safeguards and investment.                                             | Innovation-first approach prioritizing rapid development.                                                  | State-driven innovation and development-focused strategies.                                                    |
| Impact on Innovation     | Builds trust but may increase compliance costs.                                                       | Encourages speed but may leave safety gaps.                                                                | Strong growth but control constraints and inconsistency.                                                       |
| Ethical Orientation      | Human-centric, rights-based (dignity, privacy, fairness).                                             | Market-oriented with emphasis on efficiency and competition.                                               | State-centric and societal stability-focused; development and sovereignty priorities.                          |

Table 1 provides a comparative overview of the key characteristics of AI regulatory frameworks in the EU, the US, and China. It highlights the fundamental differences in regulatory philosophy, legal architecture, governance, enforcement mechanisms, and approaches to balancing innovation with risk management.

These distinctions reflect broader political, economic, and societal priorities that shape the development and deployment of AI technologies in each jurisdiction.

Overall, the comparison demonstrates that the EU's binding, risk-based model contrasts with the more fragmented and market-driven US framework and China's centralized, development- and sovereignty-oriented approach. These different regulatory models illustrate the trade-offs between protecting fundamental rights, fostering rapid innovation, ensuring legal certainty, and maintaining state oversight. Understanding these differences provides an important foundation for assessing their implications for AI research, HE, and international scientific collaboration.

## **The Impact of AI Regulation on Science and HE**

### **AI Regulation as a Determinant of Research Ecosystems**

Artificial intelligence (AI) regulation has evolved from a legal compliance issue into a strategic determinant of scientific research and higher education. Regulatory frameworks influence the conditions under which knowledge is produced, shared, commercialised, and governed by defining requirements for data access, experimentation, accountability, transparency, and institutional responsibility. Consequently, AI governance increasingly shapes national research ecosystems rather than merely regulating individual technologies. The EU, the US, and China illustrate three contrasting governance paradigms. The EU emphasises legally binding, risk-based regulation designed to safeguard fundamental rights (European Commission, 2024). The US relies on decentralized governance, voluntary standards, and market-oriented innovation (NIST, 2023; NatLawReview, 2025). China integrates AI governance into long-term industrial policy, cybersecurity, and technological sovereignty (Chen & Xu, 2025; Choi & Yoon, 2025). These approaches influence not only technological development but also the organisation of universities, research institutes, funding systems, and international scientific collaboration.

### **Research Freedom and Scientific Innovation**

Research freedom depends upon the ability of scientists to access data, develop algorithms, collaborate internationally, and translate research into practical applications. Regulatory design therefore affects both the pace and direction of scientific discovery. The EU model offers comparatively high legal certainty by establishing harmonised obligations for high-risk AI systems, transparency, and data governance. Such certainty facilitates responsible research involving sensitive datasets and human participants while strengthening public trust. However, documentation requirements, conformity assessments, and interactions with GDPR increase administrative complexity and may delay experimentation, particularly for smaller research groups and interdisciplinary projects (European Commission, 2024). Although exemptions exist for certain research activities, universities developing deployable AI systems must still establish comprehensive compliance mechanisms.

In the US, comparatively limited ex ante regulation encourages rapid experimentation and shorter innovation cycles. Universities benefit from strong federal R&D programmes, industry partnerships, venture capital, and technology-transfer ecosystems that facilitate commercialisation. Ethical oversight is primarily exercised through institutional review boards, funding conditions, and voluntary frameworks such as the NIST AI Risk Management Framework (NIST, 2023). This flexibility supports frontier research but produces uneven governance standards because institutional practices differ substantially and state legislation is becoming increasingly fragmented (Congressional Research Service, 2025).

China combines large-scale public investment with strategic coordination. National AI programmes support infrastructure, talent development, and mission-oriented research in priority sectors, enabling rapid scaling

of scientific capacity (Choi & Yoon, 2025). Simultaneously, cybersecurity regulation, data sovereignty, and ethical review impose restrictions on sensitive research, cross-border data exchange, and international collaboration (Hu & Au, 2025; Sheehan & Singer, 2025). Research freedom is therefore balanced against national security and strategic development objectives.

## **Institutional Governance and Organizational Transformation**

Universities are increasingly required to function as AI-governing organisations rather than simply AI users. Institutional governance now encompasses procurement, risk assessment, model validation, ethics review, data governance, cybersecurity, procurement policies, staff training, and continuous monitoring of AI systems. The EU AI Act accelerates this transformation by requiring formal governance structures for institutions deploying regulated AI systems, particularly in areas such as admissions, assessment, learning analytics, and human-resource management. Compliance becomes an organisational capability requiring legal, technical, and managerial expertise.

The U.S. model provides institutions with greater autonomy to develop internal AI governance frameworks. Universities frequently adopt AI technologies before comprehensive regulation emerges, relying on institutional policies, professional ethics, and research governance procedures. While this flexibility encourages organisational learning and innovation, it also creates variation in governance quality and accountability. Chinese universities occupy a different position. As major actors within national innovation policy, they integrate AI deployment with government priorities while operating under comprehensive cybersecurity, data-governance, and administrative oversight. Institutional autonomy therefore exists within a coordinated national governance architecture.

## **Academic Practice and Knowledge Production**

AI regulation increasingly influences everyday academic practice. Universities must develop policies governing generative AI in teaching, assessment, research, scholarly publishing, and supervision. Regulatory environments shape expectations concerning transparency, disclosure, research integrity, algorithmic accountability, and responsible AI use. Within the EU, regulation encourages the institutionalisation of AI ethics, digital governance, interdisciplinary education, and responsible innovation. Compliance requirements also stimulate investment in AI literacy among researchers, administrators, and students.

In the US, academic practice remains more innovation-oriented. Faculty members often integrate generative AI rapidly into research design, software development, teaching, and administrative processes, while governance evolves through institutional guidance rather than comprehensive legislation. China has embedded AI education within national workforce strategies, promoting specialised degree programmes, interdisciplinary curricula, and large-scale AI literacy initiatives to support industrial transformation (Cheng, 2025; Chan et al., 2025). These contrasting approaches influence not only graduate competencies but also future scientific capacity and the production of new knowledge.

## **Comparative Implications for Global Competitiveness**

The three regulatory models illustrate that AI governance has become an important source of international competitiveness. The EU seeks competitive advantage through trustworthy AI, legal certainty, and harmonised regulation; the United States through entrepreneurial innovation, investment, and flexible governance; and China through coordinated state investment, industrial policy, and technological sovereignty. Each model produces different trade-offs. Greater regulation enhances accountability and public trust but may reduce organisational agility. Greater flexibility accelerates innovation but can generate fragmented governance and uneven ethical safeguards. Centralised coordination enables rapid technological scaling but may constrain openness and international collaboration.

These differences extend beyond legal compliance to influence talent attraction, international partnerships, research funding, technology transfer, and participation in global research networks. Universities increasingly compete not only on scientific excellence but also on their capacity to operate effectively within complex AI governance environments. Consequently, AI regulation should be understood as a structural component of research policy that shapes institutional resilience, innovation ecosystems, and long-term scientific competitiveness rather than merely a mechanism for controlling technological risk.

**Table 2: Comparative Impact of EU, US, and China AI Regulation on Science and HE**

| Dimension                   | EU                                                               | US                                                              | China                                                                          |
|-----------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------|
| Research Freedom            | Structured, compliance-oriented with partial research exemptions | High flexibility with minimal ex ante constraints               | State-coordinated; strong support but subject to political and data controls   |
| Ethical Governance          | Strong, legally enforced (AI Act, fundamental rights)            | Primarily voluntary, guided by frameworks (NIST, IRBs)          | State-defined ethics, integrated with cybersecurity and social stability goals |
| Speed of Innovation         | Moderate due to compliance and risk management requirements      | High due to market-driven and flexible regulation               | High in priority sectors due to state investment, but controlled               |
| Data Accessibility          | More constrained due to strict data protection (GDPR)            | Broad and flexible, especially in private-sector partnerships   | Strategically managed; strong data control with restricted cross-border flows  |
| Industry Influence          | More limited; balanced with public interest and regulation       | Strong industry–university collaboration and VC influence       | Strong state–industry coordination aligned with national priorities            |
| Institutional Risk Exposure | High regulatory accountability and compliance obligations        | Diffuse responsibility across institutions and legal frameworks | Centralized accountability under state oversight                               |
| Global Academic Positioning | Ethical and regulatory leadership                                | Frontier research and innovation leadership                     | Rapidly emerging leader in scale, infrastructure, and applied AI               |
| Governance Model            | Centralized, rules-based governance with oversight bodies        | Decentralized, multi-level governance                           | Centralized, state-driven governance.                                          |
| Innovation Model            | Regulated innovation with trust emphasis                         | Innovation-first, market-driven                                 | State-led innovation tied to economic and strategic goals                      |

Table 2 summarizes the main differences between the AI regulatory approaches of the EU, the US, and China, highlighting how each model shapes scientific research and higher education. The comparison demonstrates that regulation influences not only legal compliance but also the broader research environment, including the speed of innovation, access to data, ethical governance, institutional responsibilities, and collaboration between academia, industry, and government. Overall, the comparison illustrates that each regulatory model reflects different policy priorities and governance philosophies. The EU emphasizes responsible innovation and public trust, the US prioritizes technological competitiveness and market dynamics, and China focuses on strategic national development under centralized state coordination. These differences have important implications for universities and research institutions operating in international environments, influencing research collaboration, funding opportunities, regulatory compliance, knowledge exchange, and global academic competitiveness.

## Conclusion

AI regulation is shaping scientific research, HE, and global technological competition. This study compared the EU, US, and China governance models and showed how differing priorities—rights protection, innovation speed, and state-coordinated development—produce distinct research and institutional environments. This study extends the literature on AI governance by integrating comparative regulatory analysis with research on science policy and higher education. While previous studies have largely focused on legal interpretation or ethical aspects of AI regulation, this paper demonstrates how different governance models influence research ecosystems and institutional behaviour. The study proposes a comparative framework linking regulatory philosophy with outcomes in scientific research and higher education. It highlights the trade-offs between innovation, accountability, academic autonomy, and institutional governance across three distinct AI regulatory models.

The EU's precautionary, rights-based approach embeds ethical principles into binding law but can increase compliance burdens that slow fast-moving research. The US model supports rapid experimentation and strong industry-academia ties but risks fragmented oversight and uneven safeguards. China's state-driven model can accelerate scaling through coordination and investment, yet raises concerns about transparency and academic autonomy.

These contrasts underscore a core tension: balancing innovation with control and accountability. Because regulation structures research conditions and institutional behavior, universities must navigate trade-offs between compliance, speed, and academic values, and global governance is likely to remain pluralistic amid geopolitical competition.

The central challenge is to design AI governance that fosters innovation while ensuring accountability and preserving academic freedom.

The findings provide practical guidance for policymakers, university leaders, and research organisations seeking to develop AI governance strategies that balance innovation with responsible AI use. The comparative analysis helps higher education institutions anticipate regulatory requirements, design appropriate governance mechanisms, and strengthen institutional preparedness for AI adoption.

For policymakers, the study illustrates the advantages and limitations of different regulatory approaches and identifies lessons that may inform future AI governance reforms. For universities and research institutions, the results support strategic planning related to AI deployment, research governance, compliance, and academic integrity.

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