

ISTIR 10.19.51

UDC 341.1/8

DOI: 10.54649/2077-9860-2026-1-85-91

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THE REGULATORY DILEMMAS AND RELIEF PATHS OF CROSS-BORDER DATA FLOW IN GENERATIVE AI

Abstract

This article mainly discusses the regulatory dilemmas and relief paths for cross-border data flow in generative artificial intelligence (AI). The global development of generative AI is highly reliant on the massive cross-border flow of data, with a structural coupling between the two. However, due to multidimensional challenges such as the absence of unified international rules and technical standards, Conflicts between countries arising from disparities in laws and data protection concepts, as well as disputes over data sovereignty and data freedom, the cross-border flow of data for generative AI is confronted with complex regulatory dilemmas. Observe the application of ChatGPT, DeepSeek and other series of models, starting from the essential connotation of generative AI and cross-border data flow and their positive interaction, there are three major relief paths: building unified international rules and technical standards, improving laws, regulations and compliance supervision mechanisms, and balancing data sovereignty and data freedom. In this way, a dynamic balance between data security (data sovereignty) and technological innovation (data freedom) is achieved, injecting strong impetus into the stable and sustainable development of the global artificial intelligence industry.

Key words: generative AI, cross-border data flow, data sovereignty, data security, data freedom, technological innovation, dynamic balance, international cooperation.

Introduction

Generative AI, also known as generative artificial intelligence, is a representative technology in the field of technological modernization, profoundly changing all areas and processes of the economy and society. Its rise marks a leap in artificial intelligence technology from the “perception” stage to the “creation” stage. Large-scale language models, such as DeepSeek and ChatGPT, achieve complex functions such as text generation, intelligent question answering, and code writing through training on massive amounts of data. However, the global development of generative AI heavily relies on massive cross-border data flows, involving the cross-border transfer and access of personal information, trade secrets, and algorithm models and resources. This has led to controversies surrounding the weakening of data sovereignty, the protection of personal and commercial information, and technological monopolies. Therefore, how to promote the free and efficient cross-border flow data in generative AI while ensuring data security (data sovereignty) has become an urgent problem to be solved.

Materials and Methods

This study employs a research methodology that combines literature analysis with comparative research. First, through a literature review, it defines the core concepts of generative AI and cross-border data flow, and their structural coupling relationship. Second, using typical large language models such as DeepSeek and ChatGPT as empirical examples, it examines their actual operational modes of cross-border data flow in scenarios including API (Application Programming Interface) Calls, Computing Power/Algorithm Calls, Outsourced Data Services, and International R&D Collaboration. Third, from the three dimensions of international rules, legal differences, and data sovereignty, it systematically analyzes the regulatory dilemmas currently faced by cross-border data flow in generative AI. Finally, based on the analytical framework of “data security—data freedom,” it proposes corresponding institutional solutions. Data sources include relevant international legal documents, data protection regulations of major countries, and publicly accessible journal articles and book literature.

Results and Discussion

3.1 Generative AI and Cross-border Data Flow

3.1.1 Conceptual definition and technical characteristics of generative AI

Generative AI is an important branch of artificial intelligence, with transformative potential to redefine the boundaries of innovation in the digital field. It is a technology that uses deep learning algorithms to learn from massive and complex data and generate new content or information such as text, images, audio, video and code¹ [1].

The key technical characteristics of generative AI mainly encompass the following three core aspects: Firstly, efficient data processing capabilities. Generative AI can process massive amounts of data, extracting valuable information and patterns from them. Secondly, powerful self-learning capabilities. Through continuous learning and optimization, generative AI can gradually improve the accuracy, objectivity, and diversity of its generated content. Thirdly, diverse application scenario capabilities. Generative AI demonstrates enormous commercial potential and application value in multiple fields such as content creation, cross-border e-commerce, intelligent customer service, education and tutoring, and medical consultation.

3.1.2 Multidimensional Application Scenarios of Cross-border Data Flow in Generative AI

Cross-border data flow, literally speaking, refers to the process of data moving from one country to another across national borders. However, there is no unified official definition of cross-border data flow in current domestic and international theoretical circles. Some scholars argue that cross-border data flow involves data transmission, storage, and processing across political boundaries between countries, regions, or international organizations [2][3][4]. Others propose that cross-border data flow should not be solely interpreted from the perspective of data crossing national borders but also from the dimension where data is accessible to other countries or other foreign entities without physically crossing borders [5][6]. Although there are differing academic opinions regarding the definition of cross-border data flow, there is consensus that data transfer across borders exists [7], whether in form or in substance. With the rapid growth of the global generative AI industry, the frequency of cross-border data flows related to it is also becoming increasingly complex. In other words, cross-border data flows have become an indispensable key element driving the development of generative AI.

Cross-border data flows have multi-dimensional application scenarios in the field of generative AI (Table 1).

Table 1. Application Scenarios of Cross-border Data Flow in Generative AI

	Scenario 1: API Calls	Scenario 2: Computing Power/ Algorithm Calls	Scenario 3: Outsourced Data Services	Scenario 4: International R&D Collaboration
Data Flow	Domestic ↔ Overseas API Server (Bidirectional Transmission)	Domestic ← Overseas Cloud Platforms (Training/Interaction Data)	Domestic → Overseas Third-Party Service Providers (Training Datasets)	Domestic ↔ Overseas Inter-Organizational Sharing (R&D Data/Models)
Risk Characteristics	Real-Time Interaction Data Leaving the Country	Core Training Data Leakage	Full Lifecycle Data Exposure	Intellectual Property- Related Risks
Typical Examples	ChatGPT and Other API Calls	AWS/Azure Computing Power Leasing	Data Annotation Outsourcing	Open-Source Community Collaboration

Note: The table is self-created by the author

Firstly, there is the cross-border data flow caused by API calls. When enterprises or users directly use generative AI services provided overseas (such as ChatGPT, DeepSeek, etc.) [8], they need to transmit input data such as text and images to overseas servers for processing via API calls, generate results, and then return them to the domestic market via API calls.

Secondly, there is the cross-border data flow caused by the use of computing power or algorithms. The training and inference of generative AI models rely on high-performance computing power and

¹ IBM. What Is Generative AI? URL: <https://research.ibm.com/blog/what-is-generative-AI> (accessed: 25.05.2025).

algorithms. When the computing resources in the local area are limited and cannot meet the high requirements of the model for computing power and algorithm efficiency, some generative AI service providers/developers usually choose to use overseas cloud services to call for better computing power resources [9]. This leads to the cross-border transmission of training data or user interaction data.

Thirdly, there is the cross-border data flow caused by the use of outsourced training data services. In practice, many enterprises and organizations (including generative AI service providers/developers) tend to outsource model data training tasks (such as data collection, data annotation/labeling, data cleaning, etc.) to professional and mature overseas third-party service providers in order to save costs and improve efficiency. Admittedly, while this measure optimizes resource allocation and provides more efficient data processing services, it also brings a series of data security risks associated with cross-border data flows. In addition, generative AI service providers/developers are also involved in cross-border data flow issues to varying degrees when using overseas open-source code or models to build generative AI, and when sharing data in international cooperation and R&D processes.

3.2. Regulatory Dilemmas of Cross-Border Data Flow in Generative AI

3.2.1 Absence of unified international rules and technical standards

Currently, there is no unified global system of rules for cross-border data flows and technical standards adapted to generative AI, which is one of the core obstacles restricting the regulation of cross-border data flows in generative AI. At the same time, this regulatory vacuum is also the core bottleneck restricting technological iteration and industrial collaboration. Against the backdrop of a great era in which globalization and digital transformation are deeply intertwined, the research, application and promotion of generative AI have long transcended the barriers of traditional national borders and are spreading and penetrating the world at an unprecedented pace. Due to the significant differences and diversity in data governance concepts, interface standards and security protocols among different countries or regions, generative AI data faces many challenges when flowing across borders: Firstly, the lack of unified rules leads to a significant increase in the complexity and uncertainty of data flow, which makes sensitive information/data such as personal information and trade secrets contained in generative AI face serious risks of being leaked, tampered with and abused [10][11]. Secondly, the differences in standards lead to more complicated data conversion and adaptation work. In other words, in order to meet the interface standards and security protocol requirements of different countries or regions, generative AI service providers need to invest a lot of human, material and financial resources in technology research and development and system transformation. This measure not only severely hinders the efficiency of cross-border data flow in generative AI, but also significantly increases the operational cost burden on its service providers. Therefore, establishing a unified international system of rules for cross-border data flow and generative AI technology standards is now imperative.

3.2.2 Conflicts between countries arising from disparities in laws and data protection concepts

The different data governance paradigms upheld by different countries or regions have resulted in a fragmented “Balkanization” of international rules governing cross-border data flows, which has become one of the major regulatory challenges facing the cross-border flow data in generative AI. For example, the General Data Protection Regulation (GDPR), which was formally implemented in the European Union in 2018, puts forward extremely strict requirements for data protection, especially emphasizing the right to protect personal data and the right to privacy, and has built a complete set of strict data protection frameworks [12]; In contrast, the United States focuses more on the free flow and commercial use of data. There is a lack of a unified data protection law at the federal level [13], and it relies on state legislation and industry laws such as the California Consumer Privacy Act (CCPA). Its data protection regulatory environment is relatively relaxed, and it tends to promote the free flow of data to support technological innovation and the development of the digital economy. This differentiated governance paradigm leads to a complex compliance environment for generative AI in the process of cross-border data flows, and may even fall into a “compliance paradox” due to legal conflicts [14], that is, data processing behavior that is legal in one country may be considered illegal in another country. Therefore, generative AI service providers/developers must act cautiously within the legal frameworks of different countries and handle data compliance. This move not only greatly increases the complexity of its operation but also raises the corresponding operating costs, posing a significant obstacle to the global development and application of generative AI technology.

3.2.3 Disputes over data sovereignty and data freedom

With the booming development of the digital economy, data has become a strategic resource that countries are vying for, and the concept of data sovereignty is gradually emerging. Different countries or regions have vastly different understandings and claims regarding data sovereignty, which brings another layer of complex regulatory dilemmas to the cross-border data flow in generative AI. On the one hand, some countries (represented by developing countries such as Russia and India) emphasize

the importance of data sovereignty, advocating that data generated in their own countries should be regarded as national assets and that strict restrictions should be imposed on its cross-border flow. This move aims to protect the personal information of its citizens, safeguard national security, and promote the development of the country's digital economy. However, excessive data localization requirements may prevent generative AI from accessing diverse data resources globally, thereby limiting its potential for technological innovation and development. On the other hand, those advocating for the free flow of data (represented by developed countries such as the United States and Japan) believe that cross-border data flow is a key factor in promoting global economic integration, driving technological innovation, and improving social welfare. Restricting the free flow of data may hinder international trade, suppress innovation, and reduce the overall efficiency of the global economy. For generative AI, the inability to freely access and utilize global data resources will severely limit the training effectiveness and application scope of its models. The conflict between data sovereignty and data freedom creates a dilemma for generative AI data when it flows across borders.

3.3 Relief Paths of Cross-Border Data Flow in Generative AI

3.3.1 Building unified international rules and technical standards

Firstly, the international community should formulate unified rules for cross-border data flows. Governments of all countries should strengthen international exchanges and cooperation in the field of cross-border data flows and jointly promote the improvement and formulation of international rules. For example, drawing on international regulatory experience such as the "Adequacy Decision mechanism (also known as the "data whitelist")" jointly recognized and implemented by developed economies such as the United States, Japan, and New Zealand with the European Union [15], the cross-border data flow provisions in regional trade agreements such as the Regional Comprehensive Economic Partnership (RCEP), the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), and the Digital Economy Partnership Agreement (DEPA), a unified and credible cross-border data flow cooperation mechanism can be constructed. By formulating unified international rules, the compliance costs and risks of cross-border data flow in generative AI can be effectively reduced, the coverage of regulation of cross-border data flow in generative AI can be significantly enhanced, and thus the efficient, convenient, and secure data sharing and cooperation can be powerfully promoted globally.

Secondly, the international community should establish unified standards for generative AI technologies. The deepening of technology is further driving the accelerated transformation of traditional geopolitics into technopolitics. Globally, the process of unifying generative AI technology standards should be accelerated, and a series of technical standard frameworks, including unified data formats, interface standards, and security protocols, should be developed to adapt to technological iterations and evolving security needs. This will ensure seamless linking and efficient interaction of cross-border generative AI data across different systems and platforms. These measures not only help reduce the costs and risks of cross-border data flow in generative AI and improve the efficiency of data flow, but also promote the exchange and cooperation of generative AI technologies between different countries and regions through unified technical standards, break down technical barriers, eliminate the digital divide, and promote the global popularization and in-depth application of generative AI technologies.

3.3.2 Improving laws, regulations and compliance supervision mechanisms

Firstly, all countries should improve their relevant data protection laws and regulations. Governments of all countries should review and update existing data protection laws and regulations to ensure that they are in line with the pace of technological development in relation to the cross-border data flow in generative AI. On the one hand, it is necessary to clarify the legal status of cross-border data flow, clarify the rights and obligations of data subjects, and strictly regulate the legality and compliance requirements of cross-border data transmission; on the other hand, it is also necessary to strengthen the protection of personal privacy and data security, establish a "full responsibility" legal responsibility system that integrates ethics, civil, criminal, administrative and social responsibilities [16], and effectively punish violations and illegal acts to form a strong legal deterrent and effectively maintain the order and public interest of cross-border data flow. In addition, cross-border data flow has transnational attributes, and the legal supervision of a single country is often difficult to produce a comprehensive regulatory effect. Therefore, strengthening international legal exchanges and cooperation is also crucial to promote mutual trust and connection of data protection regulations.

Secondly, all countries should establish and improve compliance and regulatory mechanisms. Governments of all countries should establish or designate special regulatory agencies to supervise and manage cross-border flows data in generative AI. These regulatory agencies should have sufficient powers (investigative powers, inspection powers, punitive powers, etc.) and resources (funds, personnel, equipment, etc.) to effectively enforce laws and regulations and conduct regular inspections and assessments of the compliance of data processors. Correspondingly, generative AI service providers/

developers should also build a sound full-chain risk prevention and control system to conduct comprehensive compliance reviews and risk assessments of cross-border data and avoid falling into the trap of “technologism” [17]. Through compliance assessment mechanisms, compliance issues in cross-border data flows can be identified and resolved in a timely manner, reducing compliance risks and costs, thereby promoting the healthy development of the entire industry.

3.3.3 Balancing data sovereignty and data freedom

Firstly, all countries should clarify the principle of data sovereignty. Governments of all countries should firmly uphold the principle of data sovereignty, which means that each country has the highest jurisdiction and control over the data within its territory. In other words, a country has the right to comprehensively manage all types of data generated, stored and processed within its territory – including formulating relevant laws and regulations, regulatory policies and technical standards, etc. – in order to block the long-arm jurisdiction under the name of “data freedom” in advance [18], and in this process, the country retains exclusive rights and is not subject to illegal interference from other countries. However, this does not mean restricting the cross-border flow of data, but rather reasonably regulating the cross-border transmission and use of data under the premise of safeguarding national security, personal privacy and public interests. At the same time, all countries should respect the data sovereignty of other countries through international consultation and cooperation, avoid unilaterally taking measures to restrict the flow of data, and jointly maintain the stability and order of global data flow.

Secondly, all countries should actively promote the free flow and cooperation of data. On the basis of adhering to the principle of data sovereignty, countries should actively promote the free flow and cooperation of data. By signing bilateral or multilateral data flow agreements/treaties, the conditions, procedures and safeguards for cross-border data flow should be clarified, providing a solid legal guarantee for the legal, orderly and free cross-border flow of data. At the same time, it is important to emphasize the complementary advantages and collaboration of multiple entities such as enterprises, research institutions and academia. They should be encouraged to strengthen international cooperation and exchanges in generative AI algorithm optimization, model training and other technical work, and jointly promote the sharing and utilization of generative AI data and promote the research and development and application of global generative AI technology. At that time, the continuous breakthroughs and innovations in generative AI technology will greatly reduce the “alignment cost” and make what once seemed like an “impossible task” a reality [19].

Conclusion

Driven by both digital transformation and the paradigm shift of generative AI, cross-border data flows are undergoing a transformation from the circulation of production factors to the cornerstone of intelligent civilization. In the future, with the accelerated global digitalization process and the continuous innovation of generative AI technology, cross-border data flows will increasingly highlight their important role as a core driving force for global technological innovation and economic cooperation. In light of this, at the global level, unified international rules and technical standards should be established to provide consistent and predictable international guidance for the Cross-border Data Flow in Generative AI. At the national level, countries should continuously improve relevant laws, regulations, and compliance supervision mechanisms, and achieve a dynamic balance between data sovereignty and data freedom, this will both safeguard national security and public interests and promote the efficient allocation of data elements and the full release of their innovative value. Furthermore, all countries should continue to strengthen cooperation and exchanges to jointly build an open, collaborative, win-win, and secure cross-border data flow ecosystem, injecting strong momentum into the healthy development of generative AI technology.

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ГЕНЕРАТИВТІ ЖАСАНДЫ ИНТЕЛЛЕКТТЕГІ ТРАНСШЕКАРАЛЫҚ ДЕРЕКТЕР АҒЫНЫНЫҢ РЕТТЕУШІ ДИЛЕММАЛАРЫ ЖӘНЕ ЖЕҢІЛДЕТУ ЖОЛДАРЫ

Аңдатпа

Мақалада генеративті жасанды интеллекттегі (ЖИ) трансшекаралық деректер ағындарын жеңілдетудің реттеушілік дилеммалары мен жолдары қарастырылады. Генеративті ЖИ-тің жаһандық дамуы кең ауқымды трансшекаралық деректер ағындарына қатты тәуелді және екеуінің арасында құрылымдық өзара байланыс бар. Дегенмен, бірыңғай халықаралық ережелер мен техникалық стандарттардың болмауы, заңдар мен деректерді қорғау тұжырымдамаларындағы сәйкессіздіктерден туындайтын елдер арасындағы қақтығыстар, сондай-ақ деректердің егемендігі мен деректер бостандығы туралы даулар сияқты көп өлшемді қиындықтарға байланысты генеративті ЖИ үшін деректердің шекарааралық ағыны күрделі реттеушілік дилеммаларға тап болуда. ChatGPT, DeepSeek және басқа да модельдерді қолдануды, генеративті ЖИ мен трансшекаралық деректер ағындарының негізгі тұжырымдамасына, сондай-ақ олардың оң өзара әрекеттесуіне негізделгенін ескере отырып, үш негізгі тәсілді анықтауға болады: бірыңғай халықаралық ережелер мен техникалық талаптарды жасау; заңдарды, ережелерді және сәйкестік механизмдерін жетілдіру; және деректердің егемендігі мен бостандығын теңестіру. Бұл деректер қауіпсіздігі (деректер егемендігі) мен технологиялық жаңашылдық (деректер

бостандығы) арасындағы динамикалық тепе-теңдікке қол жеткізіп, жаһандық жасанды интеллект индустриясының тұрақты дамуына күшті серпін береді.

Түйін сөздер: генеративті ЖИ, трансшекаралық деректер ағыны, деректер егемендігі, деректер қауіпсіздігі, деректер бостандығы, технологиялық инновация, динамикалық тепе-теңдік, халықаралық ынтымақтастық.

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РЕГУЛЯТОРНЫЕ ДИЛЕММЫ И РЕШЕНИЯ ДЛЯ ТРАНСГРАНИЧНЫХ ПОТОКОВ ДАННЫХ В ГЕНЕРАТИВНОМ ИСКУССТВЕННОМ ИНТЕЛЛЕКТЕ

Аннотация

В данной статье в основном рассматриваются регуляторные дилеммы и пути облегчения трансграничного потока данных в генеративном искусственном интеллекте (ИИ). Глобальное развитие генеративного ИИ в значительной степени зависит от масштабного трансграничного потока данных, при этом существует структурная взаимосвязь между ними. Однако из-за многосторонних проблем, таких как отсутствие единых международных правил и технических стандартов, конфликты между странами, возникающие из-за различий в законодательстве и концепциях защиты данных, а также споры о суверенитете и свободе данных, трансграничный поток данных для генеративного ИИ сталкивается со сложными нормативными дилеммами. Рассматривая применение ChatGPT, DeepSeek и других моделей, исходя из основной концепции генеративного ИИ и трансграничного потока данных, а также их позитивного взаимодействия, можно выделить три основных пути решения проблемы: создание единых международных правил и технических стандартов, совершенствование законов, нормативных актов и механизмов контроля за соблюдением требований, а также балансирование суверенитета и свободы данных. Таким образом достигается динамическое равновесие между безопасностью данных (суверенитетом данных) и технологическими инновациями (свободой данных), что дает мощный импульс стабильному и устойчивому развитию мировой индустрии искусственного интеллекта.

Ключевые слова: генеративный ИИ, трансграничный поток данных, суверенитет данных; безопасность данных, свобода данных, технологические инновации, динамическое равновесие, международное сотрудничество.