ARTICLE IN PRESS

Telecommunications Policy xxx (xxxx) xxx

Contents lists available at ScienceDirect

Telecommunications Policy

journal homepage: www.elsevier.com/locate/telpol

Strategic technology competition revisited: A National Innovation System rationale for China's artificial intelligence standardisation strategy

Junhua Zhu [a], Elina Sinkkonen [a,b], Mikael Mattlin [a,b,*]

[a] University of Turku: Turun yliopisto, FI-20014, Turku, Finland
[b] The Finnish Institute of International Affairs, P.O.Box 425, FI-00101, Helsinki, Finland

ARTICLE INFO

Keywords:
Standardisation
AI
National Innovation System
China
Open source
Technology diffusion

ABSTRACT

This article explains why and how China aims to set international standards in artificial intelligence (AI), by analysing AI standardisation's place within China's National Innovation System (NIS). Emerging technologies, such as AI, where global norms and governance institutions are yet to be established, offer greater possibilities for latecomers to set international standards. As areas of AI are general-purpose technologies, it matters what kind of standards are set, and who sets them. Building on arguments that domestic technology diffusion has become more important than innovation capacity, we contend that in strategic technology competition it is essential for great powers to diffuse their technology solutions internationally, for which standardisation is a key channel. Through a detailed analysis of China's AI innovation system, we argue that China's AI-related NIS is maturing. China has already developed national AI standards, and its standard-setting is internationalising, as our analysis of Chinese policy documents on AI standardisation shows. Lingering weaknesses in basic AI research, however, still limit the potential for Chinese firms to set *de facto* standards through market competition, beyond specific AI applications. Amid intense Sino-US strategic technology competition, China's possibilities to successfully pursue international committee- or government-led standardisation, and thereby technology diffusion, have also been restricted. Yet, the recent US turn away from promoting a rules-based order opens new possibilities for Chinese standardisation efforts. The Chinese government has promoted market- and firm-led standardisation around open-source solutions, while increasingly targeting its multilateral standard-setting towards the 'Global South', e.g. through its 2025 Action Plan for Global Artificial Intelligence Governance.

1. Introduction

China has emerged as a technological leader in several fields from 5G/6G (Buggenhagen & Blind, 2022), electric vehicles and battery technology to robotics and AI (Cantero Gamito, 2023). AI technologies made in China draw international attention due to their potentially profound influence and media hype. In late 2024, Chinese AI firm DeepSeek shocked the world with its V3 model providing performance comparable to OpenAI's ChatGPT with less hardware resulting in a significantly lower cost. While DeepSeek's products

* Corresponding author. The Finnish Institute of International Affairs, P.O.Box 425, FI-00101, Helsinki, Finland; University of Turku: Turun yliopisto, FI-20014, Turku, Finland.

E-mail addresses: mikael.mattlin@fiia.fi, mikael.mattlin@utu.fi (M. Mattlin).

https://doi.org/10.1016/j.telpol.2025.103114
Received 30 May 2025; Received in revised form 7 November 2025; Accepted 7 November 2025
0308-5961/

do not offer superior quality, their substantial affordability and accessibility will help to proliferate Chinese AI products and services and question the cost-efficiency of its US competitors (Huang, 2025). DeepSeek is a partially open-source solution that has the potential to upend the business plans of its American competitors. The Chinese Foreign Ministry quickly stressed this open-source mindset, advocated for inclusive development of AI, and pledged to help developing countries strengthen AI capacity building (Xinhuanet, 2025). Chinese researchers regard the birth of DeepSeek as China's 'Sputnik moment', shattering the West's monopoly on technological innovation and forging a new 'socialist' standard in global technology competition (Intercultural Communications Editorial Office, 2025).

However, this open-source emphasis did not come out of the blue. It had been quietly and gradually building already since the mid-2000s (Arcesati & Meinhardt, 2021). The open-source strategy serves multiple functions. It is a countermeasure to US export controls on hardware and aims to simultaneously decrease Chinese dependencies on US software. Chinese legislation restricts data transfers across borders limiting the use of ChatGPT, but domestic open-source options enable processing data locally using internal servers which helps firms in regulatory compliance. Chinese AI products must also respect 'socialist core values', making it mandatory to apply filtering tools to their models. In other words, a combination of internal and external factors makes promotion of open-source models a rational choice for Chinese leaders (Yang, 2025).

Technological leadership has enabled China to become an increasingly important participant in international standardisation. AI is an emerging technology, where global norms and standard institutions' governance are yet to be established. This leaves a window of opportunity for latecomers to realise their leapfrogging aspirations (Cheng & Zeng, 2023). Areas of AI, such as large-language models (LLMs), can be considered general-purpose technologies with potentially wide-ranging societal impacts (Eloundou et al., 2024). Therefore, it matters greatly what kind of standards, if any, eventually emerge in this field, and who sets them. A country with leading standard-setting power may possess robust innovation capabilities at home, gain competitive advantage in global markets, and can strategically advance its own norms (Zhu, 2024).

As attested by the 'China Standards 2035' –strategy released in 2018, China aspires to play a larger role in international standardisation, and transition from an exporter of made-in-China products to made-by-China global standards, especially in emerging technologies, such as AI and Internet-of-Things. China's AI standard-setting efforts have entered a new stage of internationalisation, as evidenced in policy documents analysed for this article. Under the belief that 'first-tier firms set standards, second-tier firms develop technologies, and third-tier firms sell products' (National Development and Reform Commission, 2023; Wang et al., 2014), Chinese policymakers and industry stakeholders are increasingly engaging in international technological standard-setting processes. Particularly, China's embrace of open-source AI aims to attract global developers to participate in, share, and improve technical standards-setting in a less capital-intense but more socially inclusive manner, within a China-centred AI innovation system.

However, since the US-China trade war erupted in 2018, the conditions for China's high-tech exports have been turbulent. First, restricted access to key technological components such as state-of-the-art semiconductors, have limited Chinese firms', including DeepSeek's, innovation and standard-making capabilities (Olcott & Wu, 2025). Second, as their high-tech products are blocked from entering the US and parts of Europe, Chinese firms' ability to influence standard-setting in foreign markets is weakened. Furthermore, standardisation proposals from China have received more scepticism in international standardisation organisations (Schott & Schaefer, 2023), resulting in constrained power to set international standards. Nonetheless, the recent US turn away from supporting a rules-based order and coercive language even against allies, opens new possibilities for Chinese standardisation efforts, as normatively the choice between American and Chinese standards has become less clear-cut. Against this background, China's standardisation goals and subscribed tools matter.

This article approaches the research questions of why and how China aims to set international standards in the field of AI by analysing the place of AI standardisation within China's National Innovation System (NIS). It examines empirically China's AI standardisation policies in the context of strategic technology competition, utilising NIS as an analytical framework. Strategic technology competition refers to geopolitical competition over technologies deemed critical for global political, economic and military power dynamics, such as AI, semiconductors and quantum. The article also aims to make a theoretical contribution by presenting a nuanced analysis of the standardisation strategy of China as a latecomer economy in one particularly central technology area. Building on earlier arguments that technology diffusion in the domestic market has become more important than innovation capacity, we argue that in strategic technology competition it is essential for great powers to diffuse their technology solutions internationally, and that standardisation is a key channel for doing this. Our analysis places China's innovation system and the role of state guidance into broader historical and international contexts.

We found that to overcome impediments, such as Chinese tech-firms increasingly restricted access to Western markets, the Chinese government has been putting more efforts into firm-led standardisation, while increasingly targeting its multilateral standard-setting efforts towards the 'Global South' in fora such as the BRICS and through China's Belt and Road Initiative (BRI). Moreover, we argue that while the Chinese model can be best described as *state-guided*, the state's role has evolved over time and firms have taken a stronger position in recent years both in innovation and standardisation. Finally, we highlight that the international context matters, as the second Trump administration's more aggressive trade and economic policies may provide a more fertile ground for international cooperation with China.

The article proceeds by first briefly discussing how standardisation has emerged as a critically important arena of great power politics that justifies using NIS as an appropriate analytical framework to analyse standardisation. We then conceptualise different standardisation strategies and discuss the co-evolution of China's NIS and standardisation strategy. In the fourth section, we present and analyse our research data. Our primary data encompasses all Chinese policies on AI standardisation and detailed information on the structure of China's AI innovation system. In the ensuing discussion, we argue that China's standardisation has turned from a state-led towards a more market- and firm-led strategy that emphasises internationalisation and open-source solutions but is still stumbling to go global. We conclude by recapping the article's argument and briefly pondering the effects of recent developments, such as the potential effects of the second Trump administration's 'America first' policies on China's international standardisation efforts, as well as noting some limitations of our study.

2. Analytical framework

Extant literature on standardisation approaches have predominantly focused on more economically developed countries in the 'Global North' since they have long been the dominant players. Previous studies have covered a small range of not only standardisation 'sectors' in IT and telecommunications, but also 'standardisation cultures' predominantly in Europe and the US (Wiegmann et al., 2017). Although research on China's standardisation is increasing (Cantero Gamito, 2023; Kim et al., 2020; Rühlig, 2020, 2023; Seaman, 2020; Yang et al., 2023; Zhu, 2024), as a relative newcomer in international standardisation, China remains an understudied case.

At least two gaps can be identified in the literature. First, there exists a general tendency, especially in Western media, think tanks, and political circles, when discussing its innovation system, to overemphasise and exaggerate the omnipotence of the Chinese state, and thus form a dichotomy pitting China (statism) against the West (free market) (Zhang & Lan, 2023). This seems ahistorical and poorly contextualised, given that a state-led approach in developing National Innovation Systems is not particularly 'Chinese' and China itself is now moving into a less state-dominated direction, while many other countries are using more state intervention than before. Similarly, China's standardisation system is also described as 'state-centric' and 'state-permeated', with the party-state effectively controlling all factors relevant to successful standardisation, including privately-owned firms considered as 'national champions' (Rühlig, 2023).

Second, while the modes of state intervention have gained importance amid intensified great power competition and techno-nationalism, the different ways in which the state can shape standardisation at the international level, remain insufficiently understood and conceptualised. As Rühlig has noted, it is not self-evident that technical standards are political. Indeed, given what standards are ("omnipresent product specifications that generate basic safety and interoperability"), how they are developed and by whom they are established, using standards for power purposes is somewhat counterintuitive (Rühlig, 2023, p. 56). This new intensified period of strategic technology competition between the US and China, that began during the first Trump administration, constitutes a new and important contextual element. For example, Yang et al. surveyed the policy measures used in three stages of China's overall standardisation strategy and concluded that the future development in standardisation in China may present an interesting area for future research with "new characteristics due to new institutional, technological, and economic contexts (e.g., due to tensions between China and the US in technology)." (Yang et al., 2023). Our article addresses both research gaps. Regarding the latter one, we argue that AI standardisation, although not necessarily representative of China's overall standardisation strategy, is a particularly important area of standardisation to explore, given its centrality to Sino-US strategic technology competition and the nature of AI as a general-purpose technology.

2.1. *Standardisation as an arena of great power politics*

In recent decades, standardisation has tended to be regarded as a highly technical area linked to innovation efficiency (Blind et al., 2017), reducing technical and legal uncertainties (Wen et al., 2022), ensuring compatibility and interoperability in industry, as well as enhancing network effects and market scale-up (Heikkilä et al., 2023). It would, however, be naive to describe international standardisation as an apolitical, scientific process of developing or identifying the technically optimal solution to a regulatory or technical challenge (Büthe & Mattli, 2011, p. 11). Standardisation is also an arena of politics. Historically, international standards have, from their very inception, also been related to great power politics, including protectionism. In wartime, technical standards have even at times given an edge to one warring party, e.g., when Great Britain took advantage of its monopoly of the radio telegraphy system and monitored German transmissions during the First World War (Brunnermeier et al., 2018, p. 165). In the past few decades, 'standard wars'—battles for market dominance between incompatible technologies (Shapiro & Varian, 1999)—took place predominantly between private firms as international standardisation had become an industry-driven process. China's growing global footprint, driven by the party-state and the character of its state-permeated economy (Rühlig, 2020), is challenging this order and transforming the main protagonists from firms back to states, and standardisation into an arena of power competition (Rühlig, 2023).

Governments can utilise standards as a protectionist tool to protect domestic markets in both hierarchical and non-hierarchical ways (Wiegmann et al., 2017), as well as more broadly to shield a country's NIS from foreign impact. For example, already in the 1990s, the Chinese government had used subsidies and preferential policies to support the development and diffusion of an indigenous 3G standard (Gao et al., 2014). The 2003 WAPI-WIFI dispute on wireless communication standards was an early sign of the brewing competition in strategic technologies between China and the US, and the role of standards in this. WAPI, which stands for Wireless Authentication and Privacy Infrastructure, developed by the China Broadband Wireless IP Standard Group (BWIPS), was backed by China as an alternative security protocol standard to WPA, WIFI Protected Access (IEEE, 802.11). WIFI standards embrace the notion of an Internet where users operate with greater freedom and anonymity, while WAPI operates with more state management and controls (Seaman, 2020). China was concerned that the US-led WIFI standards were subject to potential security risks including foreign surveillance and data privacy issues. Therefore, it planned to mandate that all devices sold in China needed to incorporate WAPI for security interests. This mandate, however, met with a global backlash and almost escalated into a WTO dispute, because the US and other international stakeholders accused it of being an anti-competitive mechanism for China to create a non-tariff trade barrier.

At the national level, governments can end domestic standard wars with hierarchical interventions, like legislation mandating standardisation and making compliance with the resulting standard compulsory for market access. Alternatively, through non-hierarchical means authorities can also refer to standards in legislation, e.g., in public procurement, thus formalising the status of the standard in question and giving it significance as part of public law and administrative practices (Wiegmann et al., 2017). At the international level, governments can endorse one solution within their respective jurisdictive markets and accordingly give it an edge in international standard wars, especially when the domestic market is large, as in the US or China.

Eventually, following China's compromise, WIFI has become a global standard also used in China. That compromise reflects the dilemma that China has to balance the promotion of indigenous standards and compliance with international standards (Wang et al., 2014). However, WAPI is still the mandatory national standard at more securitised institutions such as government departments. This case, nonetheless, illustrates that China knows well how to leverage market entry as an imperative bargaining chip to obtain foreign firms' collaboration (Gao et al., 2014). More critically, scholars consider the WAPI-WIFI case a monument marking China's new techno-nationalist course to invest more actively in its standards-based technology policy (Suttmeier, 2005). The Chinese government places much emphasis on upgrading the country's innovation capacity, and views standardisation as a way to strengthen its research and development (R&D) capabilities by "elevating whole-sector capacities, particularly in critical and emerging industries like AI, quantum computing, and biotechnology" (Wu, 2022). However, recent research shows that national standards—contrary to what was previously thought—appear to localise economies and slow down innovation, rather than increase competitiveness, while international standardisation is positively correlated with both R&D expenditure and patenting (Blind & Münch, 2024).

After the WAPI-WIFI dispute, standardisation has emerged as an even more important arena of great power politics. This is especially true in emerging technologies with disruptive potential, such as AI. Standardisation can promote technological diffusion through creating lock-in effects and path-dependencies with significant monetary potential, and also allow for political influence (Mattlin & Nojonen, 2015; Rühlig, 2023; Seaman, 2020; Wigell & Hadi, 2026). International technology diffusion through standardisation is then a strategic objective for both the US and China, and a central field of strategic technology competition.

Threat perceptions play a pivotal role in incumbents' reactions to a latecomer's catching-up (Breslin & Mattlin, 2025). In the 1980s, for example, the US was concerned with Japan's rapid technological advances that were based on a different state-firm dynamic from what the US was accustomed to. In recent years, the US government has been similarly intensely focused on the threat posed by China's technological advances and has consequently actively tried to slow down these advances by a plethora of policy measures that have hit China's critical 'chokepoints', foremost access to advanced microchips, and semiconductor and lithography technology. A chokepoint refers to nodes in the global economy that major states can manipulate to deny access to important technologies or critical resources. The concept was made famous by Farrell and Newman (2019) in their 'weaponised interdependence' article. As almost all key firms in the AI value chain have been US-based, AI has been seen as the ultimate test case for whether the US strategy of targeting China's chokepoints to slow down its technological advancement would work (Baums & Butts, 2025, pp. 114–121). China has retaliated by targeting key US chokepoints, especially its reliance on critical mineral inputs from Chinese producers.

Unsurprisingly, the US government has also become more actively involved in standardisation. In May 2023, the Biden administration published the National Standards Strategy for Critical and Emerging Technology (White House, 2023). The strategy was the first of its kind and marked a shift in the thinking about standards, which were now seen through the security lens, while at the same time still supporting the expert-led approach to standardisation work (Wigell & Hadi, 2026). Analysts from the China Academy for Information and Communications Technology, a major government think tank under the Ministry of Industry and Information Technology (MIIT), concluded that the US has adopted a 'high-intensity government intervention model' in technical standardisation, which is reflected by the federal government's unprecedented funding to support international standardisation of critical and emerging technologies, closer cooperation between federal agencies, and efforts to remove obstacles to participating in international standardisation. Both Chinese and American observers now tend to perceive each other's technology policies more whole-of-nation in a perceived rivalry. Ding argues that this could be a misconception, as it has been the market-mediated and decentralised approach that enhances US advantages in standardisation (Ding, 2024b).

A rising power's innovation capacity must be separated from its diffusion capacity. Blind has argued that "The focus of innovation policies has shifted from knowledge creation and protection (e.g., by patents) to knowledge diffusion (via open access) in order to promote their implementation." He further argues that standardisation can be regarded as a new type of innovation indicator as standardisation is "a kind of open innovation process" (Blind, 2019, p. 1057). Ding translates the roles of innovations and their diffusion to the language of power politics and argues that diffusion power is more important than innovativeness when it comes to national power calculations. Using evidence from historical cases, he shows that when a rising power is innovative but weak in its diffusion capacity, it is more likely to suffer from an economic collapse compared to a country that is strong in its diffusion capacity, but weaker in innovativeness. While China's innovation power is strong, like the post-war Soviet Union it has lagged behind the US in its diffusion power (Ding, 2024a). Diffusing corporate technological solutions internationally, especially of general-purpose technologies, is then a potent geopolitical strategy to maintain leadership status (Baums & Butts, 2025, pp. 18–19).

In global governance, both the US and China are currently actively promoting their competing visions for AI governance. In July 2025, both governments published AI action plans aimed at an international audience. The US plan had an illustrative title "*Winning the Race. America's AI Action Plan*" (White House, 2025), as part of the content relates to ways in which the US can counter Chinese influence in international governance bodies. The plan builds on three pillars: innovation, infrastructure, and international diplomacy and security, and lists over 90 policy actions. It regards geostrategic value in open-source models that could spread globally, stating that the Federal government "should create a supportive environment for open models" (ibid. p. 4). Recommended policy actions in the plan include standardisation work to improve domestic AI adoption and ensuring data centre security and supporting "international AI governance approaches that promote innovation, reflect American values, and counter authoritarian influence" (ibid. p. 20). The US also actively carries out 'standard diplomacy' to strengthen its competitiveness and leadership in standardisation in tandem with close allies such as the UK, Australia, Canada, and Japan (Lu & Wang, 2024).

China's plan was titled *Action Plan for Global Artificial Intelligence Governance* (State Council, 2025) and comprises a 13-point roadmap for global AI coordination. Compared to the American action plan, the tone of the Chinese plan is more cooperative. It presents Chinese actions as enabling better access to AI in the 'Global South' in part via open-source solutions. The fifth point of the plan emphasises China's intention to build cross-border open-source communities and secure, reliable open-source platforms, promote the open sharing of basic resources, lower the threshold for technological innovation and application, avoid repetitive investment and resource waste, and enhance the inclusiveness and accessibility of AI technology services (ibid.). Key standard-related elements in the plan are: striving for an international consensus on standards and norms, e.g., by supporting dialogues among national standards bodies, and leveraging international Standard-Setting Organisations (SSOs), as well as digital infrastructure inclusivity and international capacity-building that prioritises support for developing countries, especially in the 'Global South'.

2.2. Standardisation in National Innovation Systems

Our article utilises National Innovation Systems as a broad analytical framework to analyse China's innovation and standardisation efforts. The NIS concept was developed by Christopher Freeman and Beng-Åke Lundvall in the 1980s, first used in a working paper for the OECD, and soon widely adopted by national governments in the 1990s, with China being the most prominent country to have adopted a NIS framework, utilising it e.g. to develop medium- and long-term plans (Lundvall, 2022). The concept was initially broadly defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987). In other words, the two pillars promoting indigenous innovation in a national context are a country's interactive learning and system efficiency, facilitated by network formation (Lundvall, 2022). Shifting thinking of innovations from linear to interactive (Lundvall, 2007), NIS is closely linked to other concepts that examine the relationship between innovation and institutional interactions, such as the National Innovation Ecosystem (Fukuda & Watanabe, 2008) and Triple Helix (Etzkowitz & Leydesdorff, 1995) and its derivative concepts. NIS regards the government's role in innovations not only as promoting science and technology but rather supporting a wider national environment conducive to innovation. This means that factors such as the educational system are important parts of the wider innovation environment (Kennedy, 2024).

However, unlike terminologies associated with neoliberalism, anti-statism and free markets, NIS theories object to the idea that innovation is the outcome of a natural evolution. Rather, various strands of NIS embrace statism and stress the active roles that nation-states play to build the institutional networks within their respective jurisdictions (Lundvall, 2016, 2023). The term 'national' is used to emphasise the government's role. This implies that all nation-states are techno-nationalist, at least to some extent. This is also the reason why we situate our understanding and analysis of China's AI standardisation practice under the NIS theoretical lens, given that the rising wave of techno-nationalism worldwide is 'inviting the state back'.

Because their available resources and knowledge fluctuate with technological development, especially when adapting to 'outside shocks', states' approaches to innovation and international standardisation are necessarily a dynamic process (Ernst et al., 2014; Wiegmann et al., 2017). Under NIS lenses, this process is often driven by a realist power balance that is deeply embedded in political economy, international relations, and world order. For latecomer economies aiming to achieve leapfrogging through disruptive innovation-led windows of opportunity, NIS theories offer a pertinent framework for designing and implementing national innovation capabilities, including standardisation (Lee & Lee, 2021).

The state's active role in innovation is clearly visible in China, as innovation policies were entirely government-based before the mid-1980s and the government continued to play pivotal roles after the opening and reform policy. Similar state-led policies were common in other Asian developmental states that achieved leapfrogging such as Japan, South Korea, and Singapore. China's later success in its innovation efforts can in part be explained by the fact that China has invested in what Wang and Kroeber (2025) call 'deep infrastructure', structures such as the electric grid and mobile internet, and human expertise such as a capable industrial workforce that jointly enable innovations and new product development.

In developing its NIS and improving its deep infrastructure, China has actively invested in education and R&D. Higher education opportunities were expanded already in 1999. In 1998 China's gross enrolment ratio in higher education was a meagre 5.88 percent. By 2009, the ratio had grown to 22.44 percent. In 2018, the ratio was already 50.6 percent, eight times higher than two decades before (Jiang & Ke, 2021). In the early 2000s, China was spending less than 1 percent of GDP on R&D, and as late as 2007 only 1.37 percent. The share of R&D spending began rising rapidly around the global financial crisis and had doubled by 2024 (National Bureau of Statistics of China, 2025; World Bank, 2025). China's rise in science can also clearly be seen in the annual Nature Research Leaders ranking of the best science institutions globally. In 2016, only two Chinese research institutions made the top-20. The number has steadily risen. On the newest list, no fewer than 13 out of the top-20 institutions are from China, including eight in the top-10 (Nature Research Leaders, 2016, 2025).

Seen through the NIS analytical framework, protectionist behaviour is also clearly reflected in the historical evolution of US innovation policies. The post-war US developed the world's most effective NIS—although the concept had not been coined yet and it was referred to as the 'hidden developmental state'—in which the government drafted a set of policies and invested vastly in R&D to maintain a technological and military advantage over the Soviet Union (Atkinson, 2020). To counter the challenge posed by China, American policymakers have now embarked on a transformation from policing a rules-based world economy to systematically breaking the rules that it formerly imposed on others (Lundvall, 2023). For instance, the technology export restrictions that the Trump administration has imposed especially on exports to China, as well as drastic policy measures *vis-à-vis* foreign students that restrict the access of American universities to international talent, indicate shrinking openness of the US NIS.

This leads to another critical observation: that state-coordinated innovation and decentralised market-driven approaches are not necessarily mutually exclusive. Rather, they can complement and enrich each other when understanding the role of innovation in low- and middle-income countries (Lundvall, 2022; Maloney, 2017). A hybrid of the best elements of different approaches could help latecomers to foster indigenous innovation while maintaining open markets (Ernst et al., 2014; see also Yang et al., 2023).

To evaluate NIS capabilities in a more systematic and operationalised manner, recent research has suggested focusing on the same five elements of a NIS as the Global Innovation Index, namely *institutions*, *human capital and research*, *infrastructure*, *market sophistication*, and *business sophistication* (Huang et al., 2024). As Table 1 illustrates, standardisation has positive impacts on all of the five incorporated elements.

Firstly, NIS functions are highly dependent on the exchange of information and technical know-how among incorporated institutions (Weerasinghe et al., 2024). By promoting sharing of technical know-how, standardisation offers greater institutional interconnectedness. Second, standardising technical industries leads to structured protocols that innovators agree upon, and further increases the training and learning efficiency in human capital development. Third, standards require infrastructure—be it IT networks, power grid, or communication systems—to use consistent materials during design, maintenance, and upgrading processes. Standardisation thus leads to a safer, more stable and sustainable infrastructure. Fourth, a more sophisticated market is driven by better interoperability among market participants, which is ensured by the network effect of standardisation (Gandal, 2002; Heikkilä et al., 2023). Finally, as technical standards always specify compliance guidance if incorporated into regulation, they elevate firms' risk management capabilities, leading to a higher level of business sophistication. Section 4.2. adopts these five NIS elements and applies them to our analysis of the structure of China's AI innovation system.

3. Standardisation strategies in the Chinese NIS

3.1. Conceptualising standardisation strategies

Different countries design and adjust strategically their innovation policymaking approaches to international standardisation, with varying levels of cooperation or competition, in different sectors and at different stages. A 'standardisation strategy' can be based on one of three different ideal-typical standardisation modes that depend on who takes part in initiating, implementing, and leading the standardisation effort. First, the committee-led standardisation mode is usually in a form of collective self-governance within SSOs. Second, the market-led mode is driven by competition, network effects, free market mechanisms, and standard wars (Simcoe, 2012). Finally, there is the government-led approach, with which governments mandate the diffusion of standards made by other actors in the industry (Greenstein, 1992; Lee & Oh, 2008; Wiegmann et al., 2017). Any standardisation process in a given technological sector and a geographical region will be based on one or more of the modes (see Table 2), whose mechanisms are respectively referred to as cooperation, competition, and hierarchy.

These ideal-typical mechanisms lead into three different kinds of standards that share varying levels of legitimacy and validity. Market-based standard wars produce *de facto* standards that function without being written in any official documents, while committee-based and government-based standardisation produce respectively voluntary *de jure* standards (or formal standards in Greenstein, 1992; Lee & Oh, 2008) and compulsory *de jure* standards that are often imposed by law. Moreover, different modes have different procedures for developing standards. For example, according to the International Standardisation Organisation (ISO), a committee-based standardisation approach involves proposal, preparatory, committee, enquiry, approval, and publication stages (ISO, 2025). The Standardisation Administration of China (SAC) divides the procedure of China's national standards development into nine stages: preliminary, proposal, preparatory, committee, voting, approval, publication, review, and withdrawal stages (SAC, 1997). Nonetheless, existing scholarly work tend to classify these phases into two overarching categories, *standard development* where governments could decide who is allowed to participate in standardisation and how they support or oppose the process; and *standard diffusion* in which governments might play pivotal roles in vetoing or endorsing standards made via committees or markets (e.g., Botzem & Dobusch, 2012; Wiegmann et al., 2017).

Whether governmental intervention is conducive to standardisation is highly contentious in existing literature (Greenstein, 1992; Meyer, 2012; Wiegmann et al., 2017). Nonetheless, for latecomer economies aiming at advancing their innovation capabilities, government interventions, especially those implemented with 'standardisation foresight', such as early market entry control, are considered critical (Gao, 2014; Gao et al., 2014; Lee & Oh, 2008). Indeed, the effectiveness of government intervention in the free market is timing-sensitive. Standard wars producing *de facto* standards consist of three chronological periods: a fluid period where many standards compete, a transition period where dominant standards take expanding market share, and a specific period where standards are consolidated and become entrenched *de facto* standards (Wang & Kim, 2007). Government interventions can only be effective when they are implemented during the fluid period, i.e., early enough. China's failure to make WAPI the national standard, e.

Table 1
The positive impacts of technical standards on NIS elements.

NIS element	Technical standard	Positive impact
Institutions	Technical know-how sharing	*Institutional interconnectedness*
Human capital & research	Structured protocols	*Training and learning efficiency*
Infrastructure	Design consistency	*Safety, stability and sustainability*
Market sophistication	Network effect	*Market interoperability*
Business sophistication	Compliance specifications	*Business and risk management*

Table 2
The government's role in ideal-typical standardisation strategies.

	Mechanism	Government's roles	Outcome standards
Market-based	Competition	*In standard development:* Market entry requirement Standard wars intervention *In standard diffusion:* Authority interruption Authority endorsement	*De facto*
Committee-based	Cooperation	*In standard development:* Committee inclusivity Cooperation facilitation *In standard diffusion:* Authority review Authority endorsement	Voluntary *de jure*
Government-based	Hierarchy	*In standard development:* Private consultation Hierarchical decisionmaking *In standard diffusion:* Piloting Regulatory compliance	Compulsory *de jure*

g., can be attributed to the wrong timing, given that WI-Fi was already at its transition period to become a *de facto* global standard (Büthe & Mattli, 2011, p. 38; Lee & Oh, 2008).

In the NIS framing, such contrasting views are rooted in an incumbent-latecomer positioning. Incumbents with better NIS capabilities tend to strengthen their position by arguing for open market entry in the name of techno-globalism. Techno-globalism based on the free market can be deemed as a strategy of techno-nationalism for incumbents to stay in power when there is no perceived threat. Latecomers typically aspire to alter their position with protectionist and more closed strategies that feature more government intervention. However, latecomers that manage to upgrade to an incumbent might adopt contrasting standardisation strategies. Since this positioning is far from a static process, a nation's standardisation strategy is dynamic by nature. Therefore, a national standardisation strategy can be *opening*, which stands for an approach that is transforming its mechanisms from government intervention into a more market-led approach, or *closing*, which denotes the opposite.

In European and American ICT standardisation, despite the lack of enforcement power, the committee-based approach has been the most common, warranting the critical role SSOs play. There is an increase in citations to standards-related patents after they are disclosed to an SSO, validating the endorsement effect that generates substantial rents (Rysman & Simcoe, 2008). Standards become means with which standard essential patent (SEP) holders can harvest technological rents from other firms. For some telecommunications firms these fees form a substantial share of their revenue (Rühlig, 2023, p. 61; Wigell & Hadi, 2026). This applies particularly to fields of enabling and general-purpose technologies with a wide set of applications across ICT industries, e.g., 5G and AI. Besides, participating in an SSO with a broader membership base will bring more access to additional knowledge and technology. Meanwhile, the developed standards are likely to be more competitive.

Nonetheless, disclosing IP during standard-setting also generates negative returns. Driven by self-interest maximisation, IPR holders might act strategically to either under-disclose or over-disclose their standard-essential IPR. Firms may then fight for a long time over distributional conflicts before reaching consensus on standardisation (Simcoe, 2012). Rent seeking, as a specific type of distributional conflict, denotes that individuals or groups use political or regulatory means to shift wealth or resources in their favour, without contributing to overall economic growth. While rent seeking is usually considered detrimental to the economy, other forms of distributional conflict may arise from different processes like bargaining, competition, or collective action (e.g., protest). In other words, standards-related patent disputes politicise standardisation processes in the committees and potentially make them less capable of producing timely standards. This is the main trade-off of this committee-based approach that potentially constrains individual firm's power because it has to compromise its interests amid negotiations with other SSO members (Wiegmann et al., 2022). Standardisation, therefore, becomes an arena of politics when stakeholders defer from cooperation. This is an obvious phenomenon in international standardisation processes. Since no supranational authority exists to mandate a universal standard that all nations must comply with, international standardisation follows committee-based and market-based approaches. However, this does not mean the absence of government influence. If committee-based cooperation is abandoned, standardisation is destined to be a battlefield of standard wars.

Just as firms in national standardisation, state representatives also vary in the selection and implementation of their approaches in international standardisation. Committee-based standardisation coordination facilitates interoperability in borderless industries and a more interconnected global market, within which countries wield supreme standard-setting power over the development trajectory of those industries in their favour. However, countries bear the potential risks of undue expropriation of IPRs, spill-over of knowledge to rivals, conflicts and delays in the standardisation process, and the loss of ability to block or slow rivals' development along a similar technological trajectory (Miller & Toh, 2022).

In an era when calls for reducing dependency on, and interconnectedness with China are growing, it is expected that European and American standardisation will involve more state considerations and intervention and adopt more closing standardisation strategies. As a result, international standardisation turns into an arena of strategic technology competition when states prioritise competition over cooperation, and preventing the strategic competitor's prevailing in a standard war is more important than setting an international standard, which may lead to sub-optimal outcomes, such as bifurcation or fragmentation, or no globally shared standards (Baums & Butts, 2025; Rühlig, 2023; Wigell & Hadi, 2026), where no shared standard is preferable to a standard that the strategic competitor has been instrumental in setting.

3.2. The co-evolution of China's NIS and standardisation strategy

China's general post-opening standardisation policy development can be divided into three stages: the *following-up* stage (1978–2001), the *catch-up* stage (2001–2015), and the *upgrading* stage from 2015 onwards (Yang et al., 2023). The *following-up* stage started with the opening-up and reform in the late 1970s, which implied an opening standardisation strategy. In China's initial standardisation system established in the 1980s, national standards (both compulsory and voluntary), industry standards, and local standards were all formulated by the government (Wiegmann et al., 2017). The other two types of standards developed by private stakeholders, namely association standards and firm standards, were marginalised. Association standards, despite being widely accepted internationally, had no legal status in China; and even firm standards, developed by firms themselves and used internally, had to undergo reviewing and registering processes at government departments (State Council, 2015). As a result, firm initiative and contribution was inhibited, hindering seriously the utilisation of innovative resources.

China's first Standardisation Law was enacted in 1989. It sought to "…promote technological progress, improve product quality, raise social and economic benefits, safeguard the interests of the country and the people, and adapt standardisation work to the needs of socialist modernisation and the development of economic relations with foreign countries" (Standing Committee of the National People's Congress, 1988). Standardisation then was specifically designed for joining global markets and boosting international trade, although that might pave the way for importing unconditionally foreign standards.

However, the following-up stage did not result in upgraded innovation capabilities in Chinese firms, which contrasted with the economic development history of the US and Japan that saw innovation capabilities grow after a manufacturing phase (Gu & Lundvall, 2006). Rather, China was stuck in a so-called 'patent trap', in which a developing country pays more royalties to more advanced countries when consuming or exporting more products (Wang et al., 2014). To solve these issues, some argued that increasing investment in fostering domestic and independent innovative capabilities was vital for specific national needs, while others argued for neoliberal methods to buy or borrow technologies from abroad. As a result, considering that the free market alone has its limits in guiding socio-economic development, policymakers landed on 'indigenous innovation[1]' (Gu & Lundvall, 2006). 'Indigenous innovation' was formally launched in 2005 when the Central Committee of the Communist Party of China (CCCPC) released the Guidelines for the 11th National Economic and Social Development Programme (2006–2010) (CCCPC, 2005). It has been continued and stressed in the later Guidelines for the Medium- and Long-term Science and Technological Development (2006–2020), 'Made in China 2025' launched in 2015, and the 13th Five-year Plan for the National Science and Technology Innovation (2021–2025). This new orientation implies that China aims to manage its innovation policies, e.g., standardisation strategy, differently (Lundvall, 2023).

As exemplified by the WAPI-WIFI dispute, a closing standardisation strategy involves more government intervention. The transition from socialism towards a (socialist) market economy during the post-opening era has diversified the interests among and even within standard stakeholders. China's policymaking, therefore, had to accommodate that level of heterogeneity of interests to pursue techno-nationalist standardisation in a (then) globalising world (Suttmeier, 2005).

In the *upgrading stage*, in addition to continuing strengthening of domestic standardisation capabilities, another essential goal of China is to increase its presence and influence in international standard-setting. Under the banner of 'China Standards 2035', China reveals great ambitions to advance international standardisation targets. According to the National Standardisation Development Outline, China aimed to align 85 percent of its domestic standards with international standards by 2025 (State Council, 2021). Although this specific number lacks meaning because what counts as 'alignment' can be easily manipulated, it does indicate a general push towards greater international synchronisation (Sheehan et al., 2021). The National Standardisation Law was revised in 2017 to facilitate a paradigm shift towards an opening strategy that fully mobilises standardisation knowledge and resources in the private sector, warranting a transfer of standard-setting power from the government to the non-governmental sector. For instance, Article 7 declares that "the State encourages firms, public organisations and educational and scientific research institutions to carry out or participate in national and international standardisation work"; and Article 8 announces that "the State actively promotes participation in international standardisation activities, carries out standardisation cooperation with foreign countries, participates in the formulation of international standards, adopts international standards in light of national conditions, and promotes the conversion and application of Chinese standards with foreign standards" (The National People's Congress, 2017).

China's push for a larger role in international standardisation has, nonetheless, encountered significant resistance as it is under more rigid scrutiny by Western countries. Bans on Chinese technology products, e.g., by Huawei, in the US and partially EU markets, have significantly restricted Chinese firms' ability to advance their *de facto* standards via a market-based approach. China's participation in the committee-based international *de jure* standardisation is also affected. After Huawei, together with ZTE, was added to the US Entity List in May 2019, its activities were shortly restricted in several standard-setting industry associations including IEEE (Institute of Electrical and Electronics Engineers), WIFI Alliance, SD Association, and JEDEC (Joint Electron Device Engineering Council), and it became legally risky for Western firms to cooperate with Huawei on standardisation, until the matter was resolved a

[1] 自主创新 (*Zizhu chuangxin*), originally in Chinese, has often been translated as 'independent innovation' in English, which can be misleading. The NIS literature often used the term 'endogenous innovation', which is interchangeable with indigenous innovation, despite their literal divergence.

few years later (Baums & Butts, 2025, pp. 65–66). Additionally, partially due to quality-related reasons (Baron, 2020), standardisation proposals from China are also much less likely to be accepted in those international SSOs, such as 3GPP (Schott & Schaefer, 2023). Consequently, China increasingly positions itself as the leader of the 'Global South' and aims to advance its standardisation regime via channels such as the BRICS, the BRI and the Digital Silk Road (Rühlig, 2023; Seaman, 2020; Wigell & Hadi, 2026).

'China Standards 2035' and the corresponding Western pushback are fuelling disputes over international standardisation, which raises the question of whether technical committees—the approach that SSOs rely on—will still be the preferred channel for international standardisation in the strategic technology competition context. In other words, China's ambitions during the upgrading stage are challenged by a serious outside shock, which may result in a new configuration of policy tools. States are prone to adjust their NIS openness and standardisation strategy depending on their positioning in the incumbent-latecomer power relations. Effective global participation in international standardisation requires effective mechanisms for broad preference aggregation at the domestic level (Büthe & Mattli, 2011, p. 147). The state's role in facilitating that aggregation thus becomes critical amid spreading techno-nationalism.

4. The NIS rationale for China's AI standardisation strategy

To understand China's new AI standardisation strategy in the context of strategic technology competition, in Section 4 we offer empirical findings on what China's standardisation goals and subscribed tools are, through an analysis of China's AI standardisation policies and the structure of its AI innovation system. Three reasons justify choosing AI as a key case to study. First, parts of AI are general-purpose technologies with disruptive potential and security repercussions. Second, AI has therefore become a major battleground of technological great power rivalry that impacts deeply on China's NIS. Finally, China's AI ambitions were revealed in the seminal National Development Plan for A New Generation of AI that was released in July 2017, shortly before the first trade war with the US erupted. This overlapping time span indicates a more comprehensive and credible case for analysis, in the sense that nearly all of China's AI standardisation efforts have been made in this new context. Our analysis explains the NIS rationale for China turning more towards firms, markets and open-source solutions in its efforts to promote its AI standards internationally.

Our contention is that China's AI innovation system is now maturing, a fact that is reflected by China's growing competitive advantages in both AI innovation inputs and outputs. From the perspective of innovation inputs, China has a competitive advantage in its large AI talent pool. According to MacroPolo's Global AI Talent Tracker, China held the most AI researchers in 2022, accounting for 47 percent of the global AI talent pool. The significant gain from the 29 percent in 2019 is a result of the 2000 newly established AI majors in Chinese universities. In the talent pool of elite AI researchers, Chinese researchers accounted for 26 percent, showcasing a significant gain from 10 percent in 2019. Meanwhile, the US figure decreased from 35 percent to 28 percent (MacroPolo, 2023). Large increases in innovation inputs also show up in innovation outputs. China's output growth in scientific publications and granted patents has accelerated, making it the world leader in both (Lundvall & Rikap, 2022). China's global share of research papers in the field of AI vaulted from 4 percent in 1997 to 27 in 2017 (Li et al., 2021) and more than 41 percent in 2024 (Normile, 2025), whereas in 2022, 61 percent of global AI patents originated from China, nearly three times those from the US (Maslej et al., 2024).

However, there are substantial divergences in research preferences between the US and China. Compared with their counterparts in the US, the leading Chinese AI institutions have not published as much in the field of basic AI technological layers. A gap exists especially in processor architecture and machine learning (Yang et al., 2024). This resonates with a widely held view that Chinese firms are more inclined to invest in more defined application scenarios, such as image recognition and speech recognition, rather than basic technologies with more lasting impact. This is driven by both faster commercial returns from the applications and the open scientific nature of the AI industry. Besides, despite leading in quantity, China still lags the US in patent quality, measured by the number of patent citations. The US is still the undisputed home of the most-cited AI models, with altogether three times more citations than China (Maslej et al., 2024). Both weakness in basic research and limited patent citations lead to lack of adequacy in standard development capabilities. Hence, to seize the opportunity and realise leapfrogging, Chinese policymakers need to address issues particularly with sustaining top AI talents, strengthening basic research, accessing basic software and hardware, and increasing standard development capabilities (Allen, 2019).

Finally, China's released list of remaining technological chokepoints also indicates signs of maturing. The US is expanding the Entity List to implement stronger control of high-tech exports to China, aiming to prevent Chinese firms from evolving into global leaders. However, the export controls might paradoxically help China advance its indigenous innovation capabilities. An adage says that "necessity is the mother of innovation". A topical illustration of this is how DeepSeek ostensibly was able to develop a generative AI product that delivered comparable performance to OpenAI's app on a shoestring budget and in far shorter time, by circumventing constraints with innovative solutions. As displayed in Table 3, *Science and Technology Daily*, a government-run newspaper, in 2018 identified 35 technological chokepoints in China's NIS, of which the ones marked with an asterisk are relevant for the AI industry (Murphy, 2022). According to another government-run media outlet, China has made indigenous breakthroughs in 21 chokepoints, and there were only 14 left in 2023 (Youth.cn, 2023). Although such claims should be considered critically, what they indicate is an awareness of remaining chokepoints and a systematic effort to solve them.

Nonetheless, although 21 chokepoints were 'released', not all of them are necessarily utilised in the market, due to, for instance, lower quality standards or incompatibility with other market standards (Hui, 2024). Despite these breakthroughs, China is forced to reallocate more innovation resources into basic research such as semiconductors, to be fully capable of developing its own standards. It is stressed in multiple policy documents that indigenous innovation is vital to enhancing China's 'standard discursive power'.

Table 3
China's technological chokepoints in 2018 and 2023.

Chokepoints in 2018	Chokepoints in 2023
1. photoetching machine*	1. photoetching machine*
2. high-end capacitance resistance*	2. high-end capacitance resistance*
3. core algorithms*	3. core algorithms*
4. photoresist*	4. photoresist*
5. core industrial software*	5. core industrial software*
6. high-strength stainless steel*	6. high-strength stainless steel*
7. aeronautical engine nacelle	7. aeronautical engine nacelle
8. iCLIP	8. iCLIP
9. airworthiness standard	9. airworthiness standard
10. aeronautical design software	10. aeronautical design software
11. matte	11. matte
12, medical imaging equipment components	12. medical imaging equipment components
13. transmission electron microscope	13. transmission electron microscope
14. epoxy resin	14. epoxy resin
15. chip*	
16. operating system*	
17. tactile sensor*	
18. mobile phone frequency transmitter*	
19. laser radar*	
20. key materials for fuel cells*	
21. database management system*	
22. ultra precision polishing process*	
23. vacuum evaporation machine	
24. heavy duty gas turbine	
25. microsphere	
26. ITO target	
27. aviation steel	
28. high-end bearing steel	
29. high pressure plunger pump	
30. boring machine main bearing	
31. high pressure common railway system	
32. high-end welding power supply	
33. potassium cell separator	
34. underwater connector	
35. scanning electron microscope	

Sources: Murphy, 2022; Youth.cn, 2023.

4.1. *China's AI standardisation policy documents*

In this sub-section, we first present data on China's AI standardisation policies through a content analysis of policy documents. Policy documents provide a starting point for our analysis by identifying the Chinese government's targets in AI standardisation and the tools used to achieve them. However, by itself content analysis of official documents is not enough, as it may be subject to various biases. For example, a lack of diversity in sources of collected policy documents may lead to an inadvertent sample bias, neglecting influential documents from other semi-official institutions serving as governmental think tanks. A common mixed-methodology approach is to combine document analysis with interviews. However, conducting interviews as foreign-based scholars on politically sensitive topics in China is currently fraught with methodological, data use and ethical challenges. We therefore instead supplement our document analysis with a detailed analysis of the structure of China's AI innovation system, utilising the NIS elements in Table 1 and autonomous driving as an illustrative case study (see 4.2.).

To collect all relevant documents, with the key term 'AI standardisation' (人工智能标准化), we first searched pkulaw.com, a Peking University-affiliated website that hosts online databases that contain Chinese laws, regulations, and other legal materials (Yang et al., 2023). Until October 2024, the result showed five policy documents (01–05). Second, with those five policies, we operated a 'snowballing' method. In other words, all the other policies referred to in the original five policy documents, if relevant to AI standardisation and issued by Chinese authorities,[2] were added iteratively and coded accordingly. As a result, 38 policy documents were collected and listed in the Appendix and their relations were mapped out in Fig. 1.

All the policies were uploaded into NVivo 14 for coding. Although originally written in Chinese, they were not translated because we have full language proficiency. The documents were read verbatim and analysed carefully in an inductive manner (Hall & Steiner, 2020). Since our study aim is to identify the spectrum of policy targets and the subscribed tools, two top-level nodes (A NVivo-specific terminology) were developed, namely '*Target*' and '*Tool*'. With these two categories as key areas of interest, the initial five documents

[2] Standards or standardisation policies issued by foreign governments or international standardisation bodies were not collected. Furthermore, those targeting specific fields other than AI, such as Measures for the Management of Air Traffic of Civil Drones, were also excluded. Lastly, those not yet published by the time of reference were also overlooked.

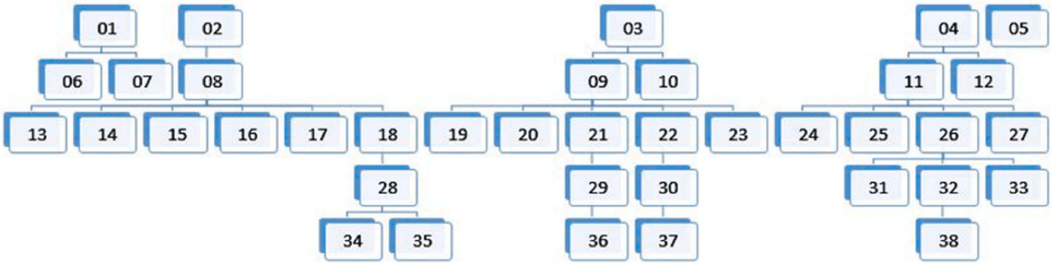

Fig. 1. Snowballing of China's AI standardisation policy documents.

collected from pkulaw.com were searched as a minor pilot exercise to ensure relevance. Then, all documents were read to find relevant excerpts. All the relevant excerpts were collected and then categorised inductively into sub-nodes that were mentioned by at least one document. In total, as displayed in Table 4, we identified ten sub-nodes, with four under '*Target*' and six under '*Tool*'. To ensure consistent coding criteria, a brief definition of each sub-node is also provided. The definitions were based on the excerpts incorporating overlapping content, some of which are also attached in the same table. The next sections display our analysis.

Previous research has indicated that in technologically uncertain fields, the market-based mode of standardisation may gain a more prominent role. The rapidly evolving field of AI as a new general-purpose technology fits this description (Wiegmann et al., 2017). As shown under *Code Marketisation* (see Table 4), nearly half of the collected policies support the reform. The main targets include:

1) switching to a firm-led and state-guided standardisation system
2) giving greater importance to association standards made by firms, most of which are not state-owned, and
3) enhancing the role of the market.

Consequently, the Chinese state encourages its firms to actively participate in international SSOs, even rewarding them financially for distinguished contributions to standardisation (Wigell & Hadi, 2026). This reform, however, raises the level of heterogeneity in stakeholders' interests that needs to be accommodated by institutional cooperation and careful policy design. For example, AI firms, especially those developing generative AI, do not generally share Chinese authorities' interest in maintaining social stability, making it intractable, if not impossible, to standardise content moderation requirements (Zhu, 2024). It is likely that the Chinese AI standardisation approach will be two-pronged, where government-led standards focus on maintaining basic standards, while market-based standards focus on improving competitiveness.

Methodologically, China has issued a series of industrial policies as different tools to achieve the goals, such as building the 'national AI team' that we will analyse in more detail below. This is also reflected by the excerpts under the *Code Industrial Chain* that appeal for deep integration of industry, academia, and research institutions. That is, China's AI innovation system is transitioning into a quasi-market-based system, in which the roles that the state plays are declining and focusing on coordinating and guiding. Moreover, fostering more standardisation talent, developing testing mechanisms for standard implementation, and facilitating better patent application are three other tools mentioned in the policies, with close ratios that are coded respectively under *Talent Training*, *Testing Platform*, and *IPR*. They are all tools to boost the standardisation agenda by enhancing the standard supply.

4.2. China's AI innovation system

In this sub-section, we analyse the structure of China's AI innovation system in more detail, utilising the breakdown into five NIS elements that we presented in Table 1, to shed light on the NIS rationale for China's efforts to promote its AI standards internationally. There is a lack of clear research evidence that active industrial policies, such as the 'Made in China 2025' initiative, would have improved Chinese firms' innovation capability (Li & Branstetter, 2024). Nevertheless, in recent years firms have taken a larger role in innovations. They are also the main source of R&D expenditure in China, accounting for some 78 percent in 2024, above the latest OECD average (World Intellectual Property Organization WIPO, 2024. p. 143; OECD, 2025).

As illustrated in Fig. 2, China's AI innovation system is centred around building the 'national AI team'. This is an initiative jointly made by 15 influential governmental departments in technology innovation, including but not limited to the MIIT, the Ministry of Science and Technology, the National Development and Reform Commission, the Ministry of Education, the Ministry of Finance, and the Chinese Academy of Science. Selected by the government, each national AI team member is responsible for constructing a national Open Innovation Platform (OIP) in one specific AI application scene. Since the selection process is highly competitive, selected members are mostly existing dominant players in their respective application scenes (Zhu & Mattlin, 2024). In 2017, Baidu, Alibaba, and Tencent, then the most successful tech-giants, were among the first group selected to construct OIPs respectively in autonomous driving, smart city, and medical imaging. Once selected, the government grants access to critical R&D resources to the firms, such as public space for training autonomous vehicles to Baidu, city transportation data to Alibaba, and access to medical records to Tencent. Meanwhile, via OIPs, the national team provides open access to data, toolkits, frameworks, and computing resources to other firms specialising in the same application scene (Zhu, 2024; Larsen, 2019).

However, risks are also that open-source sharing is not strictly implemented due to leading firms' self-interested motivations. That

Table 4
Coded targets and tools.

Targets (times mentioned)	in Policies
Internationalisation (x19) To internationalise Chinese standards	01, 06, 08, 09, 10, 11, 14, 15, 19, 21, 22, 24, 25, 26, 27, 29, 30, 32, 33 ● '中国标准走出去 (exporting Chinese standards)': through overseas project contracts, export of major equipment and equipment, and foreign construction assistance, to promote Chinese standards, and use Chinese standards to drive our products, technologies, equipment, and services to 'go global' (25). ● '标准话语权 (standards as discursive power)': to promote international and domestic standardisation work, and strengthen China's discursive power in ISO, IEC, and ITU (29). ● '深化国际交流与合作 (deepening international exchanges and cooperation)': to encourage exchanges and cooperation across disciplines, fields, regions, and borders, and to promote coordination and interaction among international organisations, government departments, scientific research institutions, educational institutions, firms, social organisations, and the public in AI development and governance (09). ● '接轨一致性 (synchronisation)': adhere to international standards, overall planning to introduce and go out, and improve the degree of synchronisation between our standards and international standards (26). ● To further relax the threshold of foreign firms participating in making Chinese standards (25).
Marketisation (x18) To promote a larger role for the private sector and markets in domestic standardisation	01, 06, 08, 11, 12, 13, 15, 16, 17, 18, 21, 23, 24, 25, 26, 27, 29, 36 ● '企业为主 (firm-led)': adhere to the 'firm-led and state-guided' principle (01). ● '团体标准 (association standards)': to encourage social organisations such as societies, associations, chambers of commerce, federations and industrial technology alliances with corresponding capabilities to coordinate with relevant market entities to jointly develop standards that meet the needs of the market and innovation for voluntary selection by the market and increase the effective supply of standards (26). ● '市场主导 (market-driven)': to follow the law of the market, strengthen the main role of firms in standard development, accelerate the commercial application of technological achievements, and form a competitive advantage (12).
Empowerment (x6) To strengthen China's standardisation capabilities in both domestic and international spheres	12, 16, 19, 22, 24, 30 ● '新机遇 (new opportunity)': AI has a significant spill-over effect that can further drive the overall industry breakthrough of other technologies. It is becoming a new driving force to promote supply-side structural reform, a new opportunity to revitalise the real economy, and a new opportunity to build a powerful manufacturing state (19). ● '机会窗口 (window of opportunity)': the international standardisation work of AI is still in the beginning process, has not yet formed a perfect standard system, China is basically at the same starting line with foreign countries, there is a rapid breakthrough window of opportunity (22).
Green Transition (x3) To facilitate a green industrial transition via standardisation	06, 24, 27 ● '绿色转型 (green transition)': to support firms to implement green strategies, green standards, green management and green production. To strengthen green supervision, improve laws and standards for energy conservation and environmental protection, strengthen supervision over energy conservation and environmental protection, introduce a corporate social responsibility reporting system, and carry out green evaluation (24).
Tools (times mentioned)	**in Policies**
BRI (x11) To utilise the BRI to expand China's impact in international standardisation	06, 12, 21, 24, 26, 27, 29, 32, 33, 37, 38 ● '互利共赢 (win-win partnership)': to actively promote cooperation with countries that jointly build the Belt and Road in the field of standards, strengthen standardisation dialogues among BRICS and APEC countries, deepen standardisation cooperation in Northeast Asia, Asia-Pacific, Pan-America, Europe and Africa, promote standard information sharing and services, and develop mutually beneficial and win-win standardisation cooperation partnerships (06). ● '国际市场 (international market)': to encourage Internet firms with competitive advantages to join forces with firms in manufacturing, finance, information and communication industries to take the lead in going global and leverage each other to jointly explore the international market through overseas mergers and acquisitions, joint operations, and the establishment of foreign branches (29).
Talent Training (x7) To foster a specific talent pool for standardisation	01, 06, 09, 26, 27, 32, 33 ● '人才培养 (talent training)': to carry out special training for standardisation talents, especially in small and medium-sized enterprises, to improve the professional level and comprehensive quality of standardisation talents and enhance the ability and level of firms to participate in international standardisation activities. To strive to build Qingdao and Shenzhen bases for international standardisation personnel training and Hangzhou base for international standardisation conference (33). ● '人才输出 (talent export)': to make full use of cooperation projects in science, technology and business to strengthen coordination with relevant departments of BRI countries. To meet the needs of standardisation development and exchange of BRI countries, to carry out standardisation expert exchange and personnel training projects in Asia and Africa in various ways and hold targeted standardisation training courses in comprehensive knowledge and professional fields. High-level advisers and experts in relevant fields will be dispatched to support the standardisation capacity building of BRI countries to enhance the overseas influence of China's standards (32).

(*continued on next page*)

Table 4 (*continued*)

Targets (times mentioned)	in Policies
Testing Platform (x7) To construct shared platforms for testing new standards	04, 09, 19, 22, 26, 27, 32 ● To improve the pilot mechanism of AI safety standards, select a number of pilot firms, carry out the applicability of standards and implementation effect evaluation, and establish the rational of "practice tracking, problem discovery, experience summary, improvement of standards, feeding the next step of standardisation work" in application practice, and promote the high-speed and high-quality development of AI safety standardisation work (09).
IPR (x6) To encourage firms to obtain more standard-related IPRs	06, 12, 19, 21, 26, 27 ● To encourage firms to strengthen patent distribution in key AI technologies and application fields. To strengthen research on AI intellectual property policies and enhance the effective connection between standards and patent policies.
Industrial Chain (x5) To build a better industrial chain and ecosystem to connect standardisation stakeholders	01, 06, 22, 30, 32 ● '产学研 (industry-academia-research)': to establish AI standardisation organisations, to coordinate the strengths of all stakeholders involved in industry, academia and research institutions, and all links of the industrial chain, jointly promote the construction of AI standards, and jointly build an advanced and applicable AI standardisation system (01). ● '开放生态 (open ecosystem)': to form an open AI ecosystem and promote the coordinated development of up- and downstream industrial chain, large, small, and micro firms to ensure standard guarantee the quality of products and services (30).
Propaganda (x4) To stress the importance of standardisation work	01, 06, 09, 26 ● To carry out extensively mass standardisation promotion activities such as World Standards Day, Quality Month and Consumer Rights and Interests Protection, to popularise standardisation knowledge in firms, party organs, schools, residential complexes, and villages, to promote standardisation concepts to create a good atmosphere for standardisation work (26).

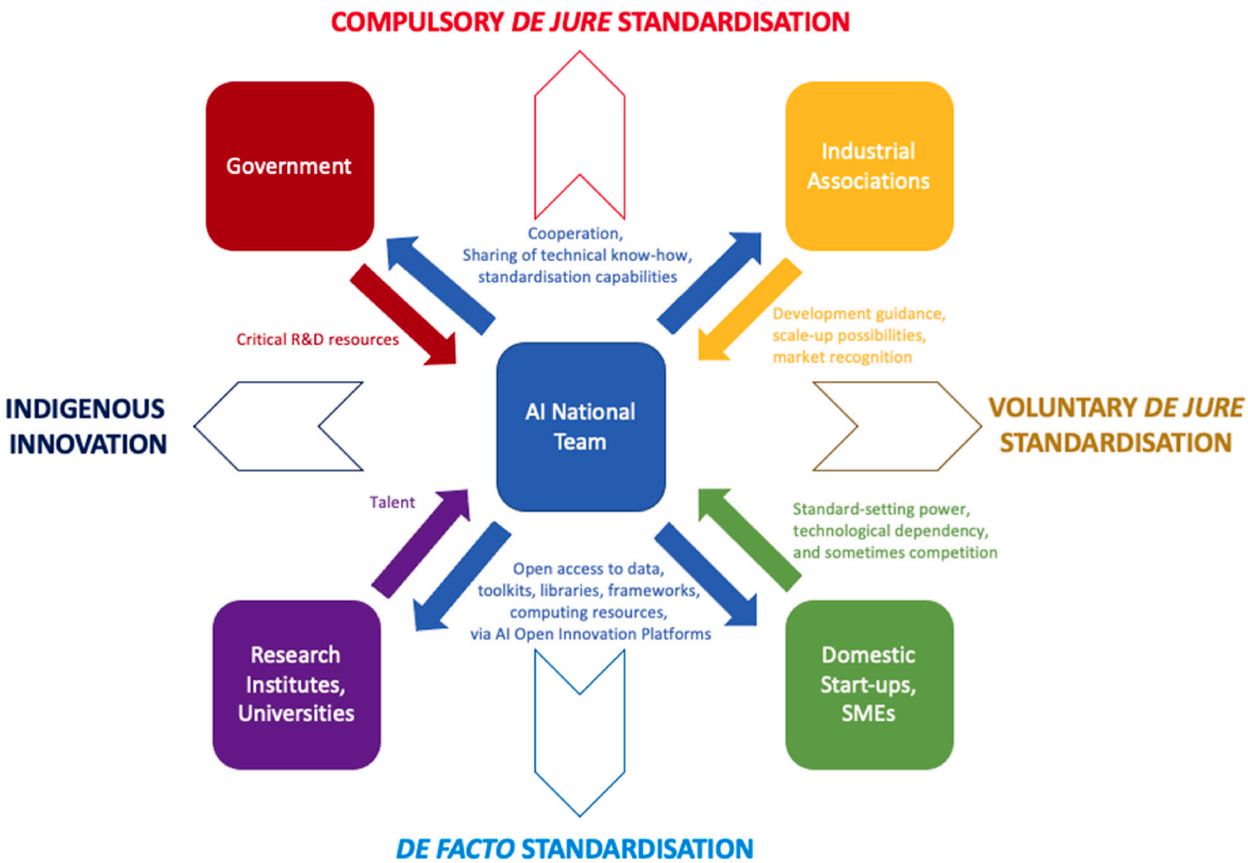

Fig. 2. China's AI innovation system.

would lead team members to effectively become government-endorsed monopolies, and the entire AI industry to become less competitive (Zhu & Mattlin, 2024). To balance these potential risks, the government strives to boost industry associations, research institutes and universities (see Fig. 2). One professional industrial association is the AI Industrial Alliance. Founded by a MIIT-affiliated think tank China Academy of Information and Communications, it actively monitors if there are anti-competitive practices in the market. Closely connected to both authorities and firms, it creates a common ground, where interests of both parties can be aligned, and conflicts can be cushioned. Bridged by the AI Industrial Alliance, Chinese authorities and private tech-giants often draft national AI standards together. For instance, the first national standard on facial recognition technologies, Security Requirements of Face Recognition Data, was drafted in tandem with SenseTime, Yitu, Megvii, and HikVision, all members of the national AI team leading respectively in smart vision, vision computing, image perception, and video perception. Technical know-how sharing is thus promoted even between the public and private sectors, elevating substantially the standardisation capabilities of the government. Besides, industrial associations incorporate other AI start-ups and small and medium-sized firms into committee-based standardisation processes to keep the leading firms from manipulating the market. On the other hand, research institutes and universities are also expected to enhance the vibrancy and competitiveness of China's AI innovation system. In principle, once AI innovation resources are shared with research institutes and universities via OIPs, training and learning efficiency will increase, making it significantly easier to develop more AI talent. Also, researchers do not necessarily need to innovate from scratch but instead stand 'on the shoulders of giants'. Potentially, they evolve into other 'giants' that bring more competition in the industry, facilitating China's indigenous AI innovation.

We illustrate this innovation system with a concrete case: Baidu and the development of autonomous driving technology and standards. After being selected as a national AI team member in 2017, Baidu has been responsible for constructing the national AI OIP in autonomous driving, Apollo. It first built Apollo Park—the then globally largest testing site for autonomous driving—in Beijing with local government endorsement. By 2023, Apollo Park had expanded to Shanghai, Guangzhou, and Wuhan, covering major cosmopolitan cities in Northern, Eastern, Southern, and Central China. In other words, Baidu's OIP can radiate to nearly all of China and becomes a semi-infrastructure for all autonomous driving-related innovations. Indeed, core figures of over 30 fast-growing autonomous driving firms such as Horizon Robotics, WeRide, and Pony.ai had working experience with Baidu's Apollo (Xinhua Daily, 2025). This strategic geographical distribution is also due to the fact that these cities are home to most of China's prestigious research institutes and universities. They export sufficient talent into the industry and meanwhile make full use of innovation resources provided by Apollo. According to Apollo's EDU Project, Baidu has shared autonomous driving-related resources with more than 240 Chinese universities. After joining Apollo EDU, universities get online learning, offline training, support in setting up autonomous driving lectures and competitions. In Beijing, students from partner universities can even visit Apollo Park and test Baidu's driverless vehicles (Apollo).

As this case attests, rather than being clearly either a government-led or market-led process, standards are set in a process, where the state first selects a firm to lead the OIP (and provides it with resources). The leading firm then develops the standards (in this case for autonomous driving) in close cooperation with other firms and researchers that all utilise the same sets of software and hardware provided by Apollo. Serving as the enabling innovator fostering various complimentary innovators, Apollo helps to build a larger and deeper market network for autonomous driving in China. Also, by adopting the same structured protocols embedded in the software and hardware, training AI talent becomes much more efficient. This significantly promotes the demand for domestic AI standards developed by the leading AI firms and facilitates the formation of *de facto* national standards.

Meanwhile, committee-based standardisation also takes off when national AI leaders and other private firms are brought together at government-supported industrial associations. Guided by China Intelligent Transportation Systems Industrial Alliance (supported by the Ministry of Transportation, MIIT, and the Standardisation Administration of China), Baidu led the drafting of the first two standards of automated driving buses in China: Vehicle Operation Technical Requirements and Test Methods and Requirement of Automated Driving Feature (Yicai, 2022). These are two committee-based association standards, standardising mainly the technical requirements for autonomous driving buses in terms of vehicle basic safety, information security, operational safety, and autonomous driving capability testing.

This is not to claim that all three standardisation processes lead to identical standards. Rather, it is amid the dynamic interactions between the five sectors in Fig. 2 that these processes in theory would reach an equilibrium where heterogeneous interests are aligned. Reflecting on the linkages between standardisation and NIS discussed in previous sections, China's AI innovation system indeed co-evolves with domestic standardisation processes, which can be demonstrated by the strengthening of the five NIS elements. By establishing national AI OIPs, institutional interconnectedness across different sectors is enhanced as various key innovation stakeholders in China's AI innovation system are united in a 'community of practice' (Qiao-Franco & Zhu, 2024). Ideally, although not necessarily in practice, waste of innovation resources is avoided when leading AI firms do not compete simultaneously in all application scenes but rather focus on one in which they do best. Meanwhile, OIPs' sharing of innovation resources diffuses standardised structured protocols among research institutes and universities, training and learning efficiency in AI human capital development becomes more efficient. All leaders are required to adopt the open-source principle thus lowering the threshold for other AI start-ups to participate in innovative activities. The network effect then starts to function and levels up market interoperability in all the AI application scenes, leading to a more sophisticated Chinese AI innovation system. Additionally, if voluntary association standards developed by leading AI firms are further adopted as compulsory national standards, compliance costs for the leading firms and OIP-based firms are significantly reduced due to their expected familiarity with compliance specifications. This way, risk management becomes smoother for the firms, resulting in a higher level of business sophistication in the AI industry. Ideally, cooperation between different innovation stakeholders is facilitated, each AI application scene is standardised, and the Chinese AI innovation system is more efficient and stable.

5. Discussion: From domestic AI standards to international diffusion

As Ding has argued, a rising power's innovation capacity must be separated from its diffusion capacity. Diffusion power may count more than just innovation power for countries' technological power. We argued that China's AI innovation system is now maturing, with more efficient domestic technology diffusion, aided by national AI standards, along the lines that Ding pointed out. However, in the strategic technology rivalry between the USA and China, we contend that it is essential for both governments to also diffuse their technology solutions internationally, and that standardisation is a key channel for doing this.

So far, China's AI-related standards are mainly concentrated in application fields such as biometric identification and autonomous driving, as well as supporting safety standards such as big data security and personal information protection, while there are relatively few basic safety standards directly related to AI's own safety or basic qualities. This is arguably a result of the relatively weak basic research capabilities. Even if high-quality standards are developed within China, and technologies are successfully diffused domestically, the limited access to global markets and constrained cooperation in international standardisation may hinder their international diffusion possibilities. Successful internationalisation of Chinese standards then is dependent on the degree of openness in China's NIS, which is increasingly intertwined with geopolitics (Lundvall & Rikap, 2022).

Internationalisation, as mentioned in 19 out of 38 policies we analysed, is the most important target of China's AI standardisation policy. Originally under the Chinese term 走出去 (*zou chu qu*), it incorporates a series of ambitions including but not limited to more Chinese institutions participating in international standardisation, more Chinese experts serving at important positions in international standardisation and organising more international standardisation fora. Nonetheless, as mentioned already in the introduction, the committee-based efforts to make international *de jure* standards are facing more scrutiny by the incumbent states in the 'Global North'.

In the context of great power competition, the scope for market-based approaches to make global *de facto* standards is also shrinking. Standards made by China are more often examined through the lens of strategic technology competition in the US. China is increasingly portrayed as not only a challenger to American technological competitiveness, but also a threat to American values and national security. China's first regulation on generative AI, for instance, mandates that the training data and generated content must not violate the 12 socialist values with Chinese characteristics (Cyberspace Administration of China, 2023). The same mandate has been incorporated into the national standard of basic security requirements for generative AI service (TC260, 2024). Although China does not necessarily have the will or ability to push this national standard into the international sphere, it creates a potential barrier preventing Chinese and American generative AI products and services from accessing each other's markets. Furthermore, this ideological difference is stressed and used as a major justification for blocking China from the American AI ecosystem. As the National Security Commission on AI (NSCAI) emphasised in its final report on how to ensure US leadership in AI, "the AI competition is also a values competition" (NSCAI, 2021).

That said, the incumbent 'Global North' does not have a consensus on the evaluation of technology imports from China. While the US has chosen a protectionist approach to preserve the competitiveness of the American NIS, Europe shows a high level of fragmentation in China-related policies, judging by for instance the final vote on tariffs on Chinese electric vehicles.[3] Strategic autonomy (from China) and strategic entanglement (with China) are two poles on a continuum. The former aims to increase European security by reducing Europe's dependence and vulnerability, while the latter creates security through 'reverse dependencies' that keeps the cost of conflict very high for China. This balance varies across technology ecosystems but also depends on the level of European ambitions (Rühlig, 2024, p. 20). Theoretically, European policymakers could imitate the US and close the European NIS from Chinese firms. Alternatively, they could keep it conditionally open and follow what China did at the catching-up stage to leverage market entry for technology transfer.

China's internationalisation of high-tech products and standards are increasingly directed towards the 'Global South', in particular the BRI and BRICS countries. The utilisation of BRI is the most frequently mentioned tool in the policies, as if China has envisioned that the 'Global South' would have less resistance to importing standards made by China. Many BRI projects also *de facto* disseminate Chinese technical standards, even making loans conditional on adoption of Chinese technical standards, while bypassing SSOs. As part of the BRI, China has also signed a great number of bilateral agreements on technical standardisation with BRI countries, although the practical effects of these agreements are meagre so far (Rühlig, 2023, pp. 60–61, 67). The Action Plan for Standard Uniting Belt and Road (2015–2017) (Appendix, policy 32) clearly pointed out that China seeks converging interests with BRI countries and aims to construct a stable and smooth standardisation cooperation mechanism. The later National Standardisation Development Outline (Appendix, policy 06) stressed the need to strengthen win-win partnership in standardisation collaboration with states in Northeast Asia, Asia-Pacific, Pan-America, Europe, and Africa. China's *Action Plan for Global Artificial Intelligence Governance* continues the trend of earlier documents in its emphasis on cooperation and coordination with the 'Global South'. Particularly, the tension between the latecomers and the incumbents is more directly reflected in the BRICS-G7 bloc rivalry in international AI governance. It is important also to note that the National Innovation Systems within the blocs are not necessarily mutually open either, for instance between India and China, which economically are far more decoupled from each other than China and the USA.

Facing a closed US, a hesitant Europe, and a not-fully-allied 'Global South', China stumbles to internationalise its standards via a market-based approach. Nevertheless, anecdotal reporting suggests that open-source solutions likely help China spread its AI solutions, as price-conscious developing countries and Western startups are unwilling to pay for the best solutions when they can get a good-enough option for free.

[3] In the vote, 10 EU member states backed the proposed tariffs, five voted against, and 12 abstained.

6. Conclusions

Standardisation has emerged as a central arena of great power politics. Both the USA and China now regard technology diffusion through standardisation, especially in emerging technologies, as essential to their ambitions, with AI at the core of strategic technology competition, making AI standardisation a particularly important case to research. This article has endeavoured to explain why and how China aims to set international standards in AI by analysing the place of AI standardisation within China's AI innovation system, a subset of the broader NIS. As states are returning as the main protagonists of standardisation, NIS with its more state-oriented approach, provides an appropriate analytical framework to analyse the relationship between the innovation system, standardisation and technology diffusion. The five elements of NIS—institutions, human capital and research, infrastructure, market sophistication and business sophistication—all benefit from standardisation.

We argued that AI—a set of emerging technologies, some of which are general-purpose—offers China (a strong latecomer), a window of opportunity to set international standards, as global norms and standard institutions' governance are yet to be established. However, the global spread of techno-nationalism and tightening Western market and technology restrictions limit Chinese firms' access to global markets and constrain cooperation in international SSO standardisation, which has also hampered the international adoption of AI standards originated in China. Based on our analysis of Chinese policy documents and the structure of China's AI innovation system, we contend that China's AI innovation system is maturing and transitioning into a more market-based system, in which the roles the state plays are relatively declining, and focusing primarily on coordination and guidance. While still state-guided, China's AI standardisation strategy increasingly relies on firms and markets to internationalise Chinese standards, both aided by, and contributing to, the rapid diffusion of China-originated open-source solutions, thereby attempting to overcome Western technology restrictions. China's strong domestic AI innovation system ('the national AI team') and domestically developed standards provide a foundation for this strategy. However, lingering weaknesses in basic AI research and limited patent citations lead to lack of adequacy in China's standard development capabilities beyond AI applications, such as autonomous driving, biometric identification, and LLMs.

Two recent developments open new possibilities for China's AI standardisation efforts. The drastic turn away by the US from enforcing a rules-based order, and the open-source AI model launched by DeepSeek and Chinese authorities' active embrace of open-source solutions, may open new vistas for China's AI standard-setting, thus helping it diffuse technology, which is central for technological power. The capriciousness of Donald Trump's second presidency brings uncertainties to the US approach to standardisation, although the administration's new AI Action Plan, published in July 2025, brought more clarity on this. Instead of pushing for Chinese-made closed standards, open-source solutions may offer a more promising route for China that circumvents the business model of those American competitors that have better access to high-performance graphics chips. With the Trump administration seemingly turning 'predatory' even towards its strongest allies, Chinese low-cost open-source options may make significant inroads, particularly in the 'Global South'. Unsurprisingly, in multilateral fora, China's standard-setting efforts gravitate towards the 'Global South', particularly the BRICS and BRI countries, to which China's recently released Action Plan on Global AI Governance attests. However, should the US re-centre itself as the leader of a 'rules-based order', China's efforts to internationalise its own standards, are expected to be effective primarily within the 'Global South'.

Finally, we acknowledge some limitations of this study. China's standardisation policymaking is highly adaptive to the positioning of its NIS in the international context. Given the fast-changing nature of the AI industry, interim national policies are likely subject to major revisions in the future (Zhu et al., 2025). A deeper exploration of the challenges and limitations China faces in effectively disseminating its standards was also outside the scope of this article. Future empirical studies could complement our analysis with interviews and data on standards adoption rates, which are notoriously difficult to collect in a reliable way (Blind, 2019), thereby adding external perspectives, stakeholder viewpoints, and comparative benchmarks.

CRediT authorship contribution statement

Junhua Zhu: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Elina Sinkkonen:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization. **Mikael Mattlin:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Funding acquisition, Conceptualization.

Funding sources

The research for this paper has been supported by a grant from Business Finland [grant decision 4367/31/2023] for the project 'Technical standards as critical intangible capital for Finnish companies in an era of strategic competition' (StandardEdge). The authors have also benefited from institutional support provided by The Finnish Institute of International Affairs and the University of Turku during the time of research design, research and writing.

Declaration of competing interest

The authors have no competing interest to declare.

Acknowledgements

The authors would like to thank the six anonymous reviewers, as well as Jean-Marc Blanchard, Peter Buhanist, Roberta Haar, Jussi Heikkilä, Jyrki Kallio, Liisa Kauppila, Juha Käpylä, Vili Lehdonvirta, Tuomas Mylly and Olli Ruohomäki for comments on earlier drafts that helped improve the article. An earlier version of this article was presented at the 18th EISA-PEC conference in Bologna, August 29, 2025.

Appendix. Collected policy documents

No.	Date	Title
01	07.2024	国家人工智能产业综合标准化体系建设指南 Guidelines for the Construction of the National AI Industry Comprehensive Standardisation System
02	08.2023	网络安全标准实践指南——生成式人工智能服务内容标识方法 Cybersecurity Standards Practice Guide - Generative AI Service Content Identification Method
03	01.2021	网络安全标准实践指南——人工智能伦理安全风险防范指引 Cybersecurity Standards Practice Guide - Guidelines for the Prevention of AI Ethical Security Risks
04	07.2020	国家新一代人工智能标准体系建设指南 Guidelines for the Construction of a New Generation of AI Standardisation System
05	10.2019	关于成立人工智能等3个医疗器械标准化技术归口单位的公告 Announcement on the Establishment of Three Standardised Technical Focal Points for Medical Devices (including AI)
06	10.2021	国家标准化发展纲要 National Standardisation Development Outline
07	10.2023	全球人工智能治理倡议 Global AI Governance Initiative
08	07.2023	生成式人工智能服务管理暂行办法 Interim Measures for the Administration of Generative AI Services
09	10.2019	人工智能安全标准化白皮书 White Paper on AI Security Standardisation
10	06.2019	新一代人工智能治理原则 Governance Principles of a New Generation of AI
11	06.2017	国家机器人标准体系建设指南 Guidelines for the Construction of the National Robot Standardisation System
12	07.2017	新一代人工智能发展规划 Development Plan for a New Generation of AI
13	11.2016	中华人民共和国网络安全法 Cybersecurity Law of the People's Republic of China
14	08.2021	中华人民共和国个人信息保护法 Personal Information Protection Law of the People's Republic of China
15	09.2021	中华人民共和国数据安全法 Data Security Law of the People's Republic of China
16	12.2021	中华人民共和国科学技术进步法(2021年修订) Science and Technology Progress Law of the People's Republic of China (Revised in 2021)
17	01.2023	互联网信息服务深度合成管理规定 Internet Information Service Deep Synthesis Management Provisions
18	03.2022	互联网信息服务算法推荐管理规定 Internet Information Service Algorithm Recommendation Management Provisions
19	12.2017	促进新一代人工智能产业发展三年行动计划(2018-2020年) Three-year Action Plan to Promote the Development of A New Generation of AI Industry (2018–2020)
20	08.2019	国家新一代人工智能创新发展试验区建设工作指引 Guidelines for the Construction of A New Generation of AI National Innovation and Development Pilot Zone
21	05.2016	"互联网+"人工智能三年行动实施方案 "Internet+" AI Three-year Action Implementation Plan
22	01.2018	人工智能标准化白皮书 (2018) White Paper on AI Standardisation (2018)
23	04.2019	人工智能伦理风险分析报告 Report on AI Ethical Risk Analysis
24	05.2015	中国制造2025 Made in China 2025
25	03.2015	深化标准化工作改革方案的通知 Notice on Deepening the Reform Plan of Standardisation Work
26	12.2015	国家标准化体系建设发展规划(2016-2020年) Construction and Development Plan for the National Standardisation System (2016–2020)
27	08.2016	装备制造业标准化和质量提升规划 Standardisation and Quality Improvement Plan for Equipment Manufacturing Industry
28	09.2000	互联网信息服务管理办法 Internet Information Service Management Measures
29	07.2015	关于积极推进"互联网+"行动的指导意见 Guiding Opinions on Active Promotion of the "Internet+"

(*continued on next page*)

(*continued*)

No.	Date	Title
30	07.2021	人工智能标准化白皮书 (2021) White Paper on AI Standardisation (2021)
31	11.2015	关于制定国民经济和社会发展第十三个五年规划的建议 Proposals for Formulating the 13th Five-Year Plan for National Economic and Social Development
32	10.2015	标准联通'一带一路'行动计划(2015–2017) Action Plan for Standard Uniting Belt and Road (2015–2017)
33	01.2018	标准联通共建"一带一路"行动计划 (2018-2020年) Action Plan for Standard Uniting Belt and Road (2018–2020)
34	09.2000	中华人民共和国电信条例 Telecommunications Regulations of the People's Republic of China
35	12.1997	计算机信息网络国际联网安全保护管理办法 Administrative Measures for Security Protection of International Networking of Computer Information Networks
36	03.2015	关于深化体制机制改革加快实施创新驱动发展战略的若干意见 Opinions on Deepening Institutional Reform and Accelerating the Implementation of the Innovation-Driven Development
37	03.2021	国民经济和社会发展第十四个五年规划和2035年远景目标纲要 The 14th Five-Year Plan for National Economic and Social Development and the Outline of Vision Targets for 2035
38	03.2015	推动共建丝绸之路经济带和21世纪海上丝绸之路的愿景与行动 Promoting the Vision and Actions of Co-building the Silk Road Economic Belt and the 21st Century Maritime Silk Road

Data availability

Data will be made available on request.

References

Allen, G. C. (2019). *Understanding China's AI strategy: Clues to Chinese strategic thinking on artificial intelligence and national security*. Center for a New American Security. https://www.cnas.org/publications/reports/understanding-chinas-ai-strategy.

Apollo Studio. (2024). An introduction to Apollo's EDU project. https://apollo.baidu.com/community/article/1120.

Arcesati, R., & Meinhardt, C. (2021). China bets on open-source technologies to boost domestic innovation. https://merics.org/en/report/china-bets-open-source-technologies-boost-domestic-innovation.

Atkinson, R. D. (2020). Understanding the U.S. national innovation system. https://www.ssrn.com/abstract=3079822.

Büthe, T., & Mattli, W. (2011). *The new global rulers: The privatization of regulation in the world economy*. Princeton University Press.

Baron, J. (2020). Counting standard contributions to measure the value of patent portfolios - A tale of apples and oranges. *Telecommunications Policy, 44*(3). https://doi.org/10.1016/j.telpol.2019.101870. Article 101870.

Baums, A., & Butts, N. (2025). *Tech cold war: The geopolitics of technology*. Lynne Rienner Publishers.

Blind, K. (2019). Standardization and standards as science and innovation indicators. In W. Glänzel, H. F. Moed, U. Schmoch, & M. Thelwall (Eds.), *Springer handbook of science and technology indicators. Cham: Switzerland* (pp. 1057–1068).

Blind, K., & Münch, F. (2024). The interplay between innovation, standards and regulation in a globalising economy. *Journal of Cleaner Production, 445*. https://doi.org/10.1016/j.jclepro.2024.141202. Article 141202.

Blind, K., Petersen, S. S., & Riillo, C. A. F. (2017). The impact of standards and regulation on innovation in uncertain markets. *Research Policy, 46*(1), 249–264. https://doi.org/10.1016/j.respol.2016.11.003

Botzem, S., & Dobusch, L. (2012). Standardization cycles: A process perspective on the Formation and diffusion of transnational standards. *Organization Studies, 33*(5–6), 737–762. https://doi.org/10.1177/0170840612443626

Breslin, S., & Mattlin, M. (2025). Bundling threats: Why dominant perceptions of China changed in Europe. *The Chinese Journal of International Politics, 18*(2), 196–219. https://doi.org/10.1093/cjip/poaf003.

Brunnermeier, M., Doshi, R., & James, H. (2018). *Beijing's bismarckian ghosts: How great powers compete economically. Washington Quarterly*, Fall 2018.

Buggenhagen, M., & Blind, K. (2022). Development of 5G – Identifying organizations active in publishing, patenting, and standardization. *Telecommunications Policy, 46*(4). https://doi.org/10.1016/j.telpol.2022.102326. Article 102326.

Cantero Gamito, M. (2023). The influence of China in AI governance through standardisation. *Telecommunications Policy, 47*(10). https://doi.org/10.1016/j.telpol.2023.102673. Article 102673.

CCCPC. (2005). 中华人民共和国国民经济和社会发展第十一个五年规划纲要. *(The Outline of the Eleventh Five-Year Plan for National Economic and Social Development)*. https://www.gov.cn/gongbao/content/2006/content_268766.htm.

Cheng, J., & Zeng, J. (2023). Shaping AI's future? China in global AI governance. *Journal of Contemporary China, 32*(143), 794–810. https://doi.org/10.1080/10670564.2022.2107391

Cyberspace Administration of China. (2023). 生成式人工智能服务管理暂行办法. *(Interim Measures for the Administration of Generative Artificial Intelligence Services)*. https://www.gov.cn/zhengce/zhengceku/202307/content_6891752.htm.

Ding, J. (2024a). The diffusion deficit in scientific and technological power: Re-assessing China's rise. *Review of International Political Economy, 31*(1), 173–198. https://doi.org/10.1080/09692290.2023.2173633

Ding, J. (2024b). *ChinAI #292: The Misperception Spiral in US-China tech policy competition [substack newsletter]*. ChinAI Newsletter. https://chinai.substack.com/p/chinai-292-the-misperception-spiral?publication_id=2660&utm_campaign=email-post-title&r=bubnr&utm_medium=email.

Eloundou, T., Manning, S., Mishkin, P., & Rock, D. (2024). GPTs are GPTs: Labor market impact potential of LLMs. *Science, 384*(6702), 1306–1308. https://doi.org/10.1126/science.adj0998

Ernst, D., Lee, H., & Kwak, J. (2014). Standards, innovation, and latecomer economic development: Conceptual issues and policy challenges. *Telecommunications Policy, 38*(10), 853–862. https://doi.org/10.1016/j.telpol.2014.09.009

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix-university-industry-government relations: A laboratory for knowledge-based economic development. *EASST Review, 14*(1), 14–19.

Farrell, H., & Newman, A. (2019). Weaponized interdependence: How global economic networks shape state coercion. *International Security, 44*(1), 42–79. https://doi.org/10.1162/ISEC_a_00351. Summer 2019.

Freeman, C. (1987). *Technology, policy, and economic performance: Lessons from Japan*. Pinter Publishers.

Fukuda, K., & Watanabe, C. (2008). Japanese and US perspectives on the national innovation ecosystem. *Technology in Society, 30*(1), 49–63. https://doi.org/10.1016/j.techsoc.2007.10.008

Gandal, N. (2002). Compatibility, standardization, and network effects: Some policy implications. *Oxford Review of Economic Policy, 18*(1), 80–91. https://doi.org/10.1093/oxrep/18.1.80

Gao, X. (2014). A latecomer's strategy to promote a technology standard: The case of Datang and TD-SCDMA. *Research Policy, 43*(3), 597–607. https://doi.org/10.1016/j.respol.2013.09.003

Gao, P., Yu, J., & Lyytinen, K. (2014). Government in standardization in the catching-up context: Case of China's mobile system. *Telecommunications Policy, 38*(2), 200–209. https://doi.org/10.1016/j.telpol.2013.10.002

Greenstein, S. M. (1992). Invisible hands and visible advisors: An economic interpretation of standardization. *Journal of the American Society for Information Science, 43*(8), 538–549. https://doi.org/10.1002/(SICI)1097-4571(199209)43:8<538::AID-ASI4>3.0.CO;2-2

Gu, S., & Lundvall, B.-Å. (2006). Introduction: China's innovation system and the move towards harmonious growth and endogenous innovation. *Innovation, 8*(1–2), 1–26. https://doi.org/10.5172/impp.2006.8.1-2.1

Hall, D. M., & Steiner, R. (2020). Policy content analysis: Qualitative method for analyzing sub-national insect pollinator legislation. *MethodsX, 7*. https://doi.org/10.1016/j.mex.2020.100787. Article 100787.

Heikkilä, J., Rissanen, J., & Ali-Vehmas, T. (2023). Coopetition, standardization and general purpose technologies: A framework and an application. *Telecommunications Policy, 47*(4). https://doi.org/10.1016/j.telpol.2022.102488. Article 102488.

Huang, K.-S. (2025). *China's AI shock? What DeepSeek disrupts (and doesn't)*. The Diplomat. https://thediplomat.com/2025/01/chinas-ai-shock-what-deepseek-disrupts-and-doesnt/.

Huang, Y., Li, S., Xiang, X., & Huang, L. (2024). Analyzing the configuration of the national innovation System for innovation capability: Evidence from global innovation index reports. *Humanities & Social Sciences Communications, 11*(1). https://doi.org/10.1057/s41599-024-03792-x. Article 1266.

Hui, M. (2024). Checking China's chokeholds [substack newsletter]. *a/symmetric*. https://theasymmetric.substack.com/p/checking-china-chokeholds-chokepoints.

Intercultural Communications Editorial Office. (2025). 西方对中国AI的一个误判,如何扭曲了全球技术竞争格局?(How has the West's misjudgment of China's AI ecosystem distorted the global technology competition landscape). *Intercultural Communications, 2025*(4). https://mp.weixin.qq.com/s/-EdQrXwBRBqMpkDSmnOU1g.

International Standardisation Organisation. (2025). Stages and resources for standards development. https://www.iso.org/stages-and-resources-for-standards-development.html.

Jiang, J., & Ke, G. (2021). China's move to mass higher education since 1998: Analysis of higher education expansion policies. *Higher Education Quarterly, 75*(3), 418–437. https://doi.org/10.1111/hequ.12313

Kennedy, A. B. (2024). The process of paradigm change: The rise of guided innovation in China. *Review of International Political Economy, 31*(4), 1220–1244. https://doi.org/10.1080/09692290.2023.2280974

Kim, M., Lee, H., & Kwak, J. (2020). The changing patterns of China's international standardization in ICT under techno-nationalism: A reflection through 5G standardization. *International Journal of Information Management, 54*, Article 102145. https://doi.org/10.1016/j.ijinfomgt.2020.102145

Larsen, B. (2019). Drafting China's national AI team for governance. *DigiChina*. https://digichina.stanford.edu/work/drafting-chinas-national-ai-team-for-governance/.

Lee, J., & Lee, K. (2021). Catching-up national innovations systems (NIS) in China and post-catching-up NIS in Korea and Taiwan: Verifying the detour hypothesis and policy implications. *Innovation and Development, 11*(2–3), 387–411. https://doi.org/10.1080/2157930X.2021.1932062

Lee, H., & Oh, S. (2008). The political economy of standards setting by newcomers: China's WAPI and South Korea's WIPI. *Telecommunications Policy, 32*(9), 662–671. https://doi.org/10.1016/j.telpol.2008.07.008

Li, G., & Branstetter, L. G. (2024). Does "Made in China 2025" work for China? Evidence from Chinese listed firms. *Research Policy, 53*(6). https://doi.org/10.1016/j.respol.2024.105009. Article 105009.

Li, D., Tong, T. W., & Xiao, Y. (2021). Is China emerging as the global leader in AI? *Harvard Business Review*. https://hbr.org/2021/02/is-china-emerging-as-the-global-leader-in-ai.

Lu, Y., & Wang, W. (2024). 美国实施关键和新兴技术战略的主要举措、进展及特点分析 (analysis of the main measures, progress and characteristics of the United States' implementation of key and emerging technology strategies). *Communications World, 955*. https://www.eefocus.com/article/1771820.html?utm_source=substack&utm_medium=email.

Lundvall, B.-Å. (2007). National Innovation Systems—Analytical concept and development tool. *Industry & Innovation, 14*(1), 95–119. https://doi.org/10.1080/13662710601130863

Lundvall, B.-Å. (2016). The learning economy and the economics of hope. In B.-Å. Lundvall (Ed.), *The learning economy and the economics of hope* (pp. 377–394). London: Anthem Press.

Lundvall, B.-Å. (2022). National systems of innovation. In *Elgar encyclopedia on the economics of knowledge and innovation* (pp. 350–357). Edward Elgar Publishing. https://vbn.aau.dk/en/publications/national-systems-of-innovation.

Lundvall, B.-Å. (2023). Development strategies in a context of world system disorder. *Lund Papers in Economic History, 2023*, 248. https://portal.research.lu.se/en/publications/development-strategies-in-a-context-of-world-system-disorder.

Lundvall, B.-Å., & Rikap, C. (2022). China's catching-up in artificial intelligence seen as a co-evolution of corporate and national innovation systems. *Research Policy, 51*(1). https://doi.org/10.1016/j.respol.2021.104395. Article 104395.

MacroPolo. (2023). *The Global AI Talent Tracker 2.0*. MacroPolo. https://macropolo.org/digital-projects/the-global-ai-talent-tracker/.

Maloney, W. F. (2017). *Revisiting the National Innovation System in developing countries*. Washington, DC: World Bank. https://doi.org/10.1596/1813-9450-8219

Mattlin, M., & Nojonen, M. (2015). Conditionality and path dependence in Chinese lending. *Journal of Contemporary China, 24*(94), 701–720. https://doi.org/10.1080/10670564.2014.978154.

Maslej, N., Fattorini, L., Perrault, R., Parli, V., Reuel, A., Brynjolfsson, E., Etchemendy, J., Ligett, K., Lyons, T., Manyika, J., Niebles, J. C., Shoham, Y., Wald, R., & Clark, J. (2024). AI Index Report 2024 – Artificial Intelligence Index. https://aiindex.stanford.edu/report/.

Meyer, N. (2012). *Public intervention in private rule making: The role of the European Commission in industry standardization*. The London School of Economics and Political Science.

Miller, C. D., & Toh, P. K. (2022). Complementary components and returns from coordination within ecosystems via standard setting. *Strategic Management Journal, 43*(3), 627–662. https://doi.org/10.1002/smj.3143

Murphy, B. (2022). Chokepoints: China's self-identified strategic technology import dependencies. *Center for Security and Emerging Technology*. https://doi.org/10.51593/20210070

National Bureau of Statistics of China. (2025). China's expenditure on research and experimental development (R&D) exceeded 3.6 trillion yuan in 2024. https://www.stats.gov.cn/english/PressRelease/202502/t20250207_1958579.html.

National Development and Reform Commission. (2023). 登高望远 以品牌建设推动质量强国建设的稳与进. *Promote the stability and progress of the construction of quality-empowered state with brand building)*. https://www.ndrc.gov.cn/fgsj/tjsj/cyfz/zzyfz/202305/t20230515_1355773.html.

Nature Research Leaders. (2016). 2016 Research leaders: Leading institutions. https://www.nature.com/nature-index/research-leaders/2016/institution/all/all/global.

Nature Research Leaders. (2025). *Nature index, institution tables*. https://www.nature.com/nature-index/institution-outputs/generate/all/global/all.

Normile, D. (2025). China tops the world in artificial intelligence publications, database analysis reveals. *Science Insider*. https://www.science.org/content/article/china-tops-world-artificial-intelligence-publications-database-analysis-reveals.

NSCAI. (2021). Final report. https://assets.foleon.com/eu-central-1/de-uploads-7e3kk3/48187/nscai_full_report_digital.04d6b124173c.pdf.

OECD. (2025). R&D spending growth slows in OECD, surges in China; government support for energy and defence R&D rises sharply. https://www.oecd.org/en/data/insights/statistical-releases/2025/03/rd-spending-growth-slows-in-oecd-surges-in-china-government-support-for-energy-and-defence-rd-rises-sharply.html.

Olcott, E., & Wu, Z. (2025). *DeepSeek's next AI model delayed by attempt to use Chinese chips*. Financial Times, 14 August.

Qiao-Franco, G., & Zhu, R. (2024). China's artificial intelligence ethics: Policy development in an emergent community of practice. *Journal of Contemporary China, 33*(146), 189–205. https://doi.org/10.1080/10670564.2022.2153016

Rühlig, T. (2020). Technical standardisation, China and the future international order: A European perspective. https://eu.boell.org/en/2020/03/03/technical-standardisation-china-and-future-international-order.

Rühlig, T. (2023). Chinese influence through technical standardization power. *Journal of Contemporary China, 32*(139), 54–72. https://doi.org/10.1080/10670564.2022.2052439

Rühlig, T. (2024). Reverse dependency: Making Europe's digital technological strengths indispensable to China. *Digital Power China*, 1–212. https://dgap.org/en/research/publications/reverse-dependency-making-europes-digital-technological-strengths.

Rysman, M., & Simcoe, T. (2008). Patents and the performance of voluntary standard-setting organizations. *Management Science, 54*(11), 1920–1934. https://doi.org/10.1287/mnsc.1080.0919

Schott, L., & Schaefer, K. J. (2023). Acceptance of Chinese latecomers' technological contributions in international ICT standardization—The role of origin, experience and collaboration. *Research Policy, 52*(1). https://doi.org/10.1016/j.respol.2022.104656. Article 104656.

Seaman, J. (2020). *China and the New Geopolitics of Technical Standardization*. Notes de l'Ifri, Ifri. https://www.ifri.org/en/papers/china-and-new-geopolitics-technical-standardization.

Shapiro, C., & Varian, H. R. (1999). The art of standard wars. *California Management Review, 41*(2), 8–32. https://faculty.haas.berkeley.edu/shapiro/wars.pdf.

Sheehan, M., S Blumenthal, M., & R Nelson, M. (2021). *Three takeaways from China's new standards strategy*. Carnegie Endowment for International Peace. https://carnegieendowment.org/research/2021/10/three-takeaways-from-chinas-new-standards-strategy?lang=en.

Simcoe, T. (2012). Standard setting committees: Consensus governance for shared technology platforms. *The American Economic Review, 102*(1), 305–336. https://doi.org/10.1257/aer.102.1.305

Standardisation Administration of China. (1997). 国家标准制定程序的阶段划分及代码 (the stage division and codes of the national standard formulation procedure). https://openstd.samr.gov.cn/bzgk/gb/newGbInfo?hcno=DFC30628F1D2A6B6370968F15529AFDC.

Standing Committee of the National People's Congress. (1988). Standardization law of the people's Republic of China. https://www.lawinfochina.com/display.aspx?lib=law&id=1197&CGid=.

State Council. (2015). 深化标准化工作改革方案 (the plan for deepening the reform of standardisation work). https://www.gov.cn/zhengce/content/2015-03/26/content_9557.htm.

State Council. (2021). 国家标准化发展纲要 (National standardisation development outline). https://www.gov.cn/zhengce/2021-10/10/content_5641727.htm.

State Council. (2025). 人工智能全球治理行动划 (Action plan for global artificial intelligence governance). https://www.gov.cn/yaowen/liebiao/202507/content_7033929.htm.

Suttmeier, R. P. (2005). A new technonationalism?: China and the development of technical standards. *Communications of the ACM, 48*(4), 35–37. https://doi.org/10.1145/1053291.1053313

TC260. (2024). 生成式人工智能服务安全基本要求 (Basic requirements for security of generative artificial intelligence services). https://www.tc260.org.cn/upload/2024-03-01/1709282398070082466.pdf.

The National People's Congress. (2017). 中华人民共和国标准化法 (The standardisation law of the People's Republic of China). https://www.samr.gov.cn/zw/zfxxgk/fdzdgknr/bzcxs/art/2023/art_31bb6057c05a40338876f385c1f47f1f.html.

Wang, J., & Kim, S. (2007). Time to get in: The contrasting stories about government interventions in information technology standards (the case of CDMA and IMT-2000 in Korea). *Government Information Quarterly, 24*(1), 115–134. https://doi.org/10.1016/j.giq.2006.04.001

Wang, D., & Kroeber, A. (2025). The real China model. Beijing's enduring formula for wealth and power. *Foreign Affairs*. September/October 2025 https://www.foreignaffairs.com/china/real-china-model-wang-kroeber.

Wang, P., Kwak, J., & Lee, H. (2014). The latecomer strategy for global ICT standardization: Indigenous innovation and its dilemma. *Telecommunications Policy, 38*(10), 933–943. https://doi.org/10.1016/j.telpol.2014.09.001

Weerasinghe, R. N., Jayawardane, A. K. W., & Huang, Q. (2024). Critical inquiry on National Innovation System: Does NIS fit with developing countries? *Sustainable Technology and Entrepreneurship, 3*(1). https://doi.org/10.1016/j.stae.2023.100052. Article 100052.

Wen, W., Forman, C., & Jarvenpaa, S. L. (2022). The effects of technology standards on complementor innovations: Evidence from the IETF. *Research Policy, 51*(6). https://doi.org/10.1016/j.respol.2022.104518. Article 104518.

White House, The. (2023). National standards strategy for critical and emerging technology. https://bidenwhitehouse.archives.gov/wp-content/uploads/2023/05/US-Gov-National-Standards-Strategy-2023.pdf.

White House, The. (2025). Winning the race. America's AI action plan. https://www.whitehouse.gov/wp-content/uploads/2025/07/Americas-AI-Action-Plan.pdf.

Wiegmann, P. M., De Vries, H. J., & Blind, K. (2017). Multi-mode standardisation: A critical review and a research agenda. *Research Policy, 46*(8), 1370–1386. https://doi.org/10.1016/j.respol.2017.06.002

Wiegmann, P. M., Eggers, F., De Vries, H. J., & Blind, K. (2022). Competing standard-setting organizations: A choice experiment. *Research Policy, 51*(2). https://doi.org/10.1016/j.respol.2021.104427. Article 104427.

Wigell, M., & Hadi, M. S. (2026). *The age of geoeconomics*. London: Bloomsbury.

World Bank. (2025). Research and development expenditure (% of GDP) - China. https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=CN.

World Intellectual Property Organization WIPO. (2024). *Global Innovation Index*.

Wu, Y. (2022). China standards 2035 strategy: Recent developments and implications for foreign companies. *China Briefing*. https://www.china-briefing.com/news/china-standards-2035-strategy-recent-developments-and-their-implications-foreign-companies/.

Xinhua Daily. (2025). 百度: 中国自动驾驶的黄埔军校 (Baidu: The Whampoa military academy of autonomous driving in China). https://www.xhby.net/content/s68afe434e4b073aed0a2d50c.html.

Xinhuanet. (2025). 外交部:中方主张开源人工智能技术,实现各国共享智能红利 (Foreign Ministry: China advocates open source artificial intelligence technology to realize the sharing of intelligence dividends among all countries). http://www.news.cn/world/20250210/f502f3c9a1854d3abff631071ffcb23f/c.html.

Yang, G. X. (2025). (preprint) the openness paradox: Open-source AI and China's quest for cyber sovereignty. *Dialogues on Digital Society, 1–4*. https://journals.sagepub.com/doi/10.1177/29768640251376497#core-bibr500-29768640251376497-1.

Yang, Y., Gao, P., & Zhou, H. (2023). Understanding the evolution of China's standardization policy system. *Telecommunications Policy, 47*(2). https://doi.org/10.1016/j.telpol.2022.102478. Article 102478.

Yang, X., Jia, J., Zhou, X., & Wang, S. (2024). 中美两国人工智能头部企业研发和创新的比较分析与启示 (A comparative analysis and implications of R&D and innovation of leading artificial intelligence enterprises in China and the United States). *The Chinese Academy of Sciences Bulletin, 39*(6), 1084–1096. https://doi.org/10.16418/j.issn.1000-3045.20240119003

Yicai. (2022). 百度牵头发布行业首个自动驾驶公交车系列标准 (Baidu took the lead in releasing the industry's first series of standards for automated driving buses). https://www.yicai.com/news/101280296.html.

Youth.cn. (2023). 五年过去了,你知道35项"卡脖子"技术我们攻破了多少项吗? (Five years have passed. Do you know how many of the 35 "chokepoint" technologies we have broken through?). https://finance.youth.cn/finance_gdxw/202306/t20230608_14572443.htm.

Zhang, L., & Lan, T. (2023). The new whole state system: Reinventing the Chinese state to promote innovation. *Environment and Planning A: Economy and Space, 55*(1), 201–221. https://doi.org/10.1177/0308518X221088294

Zhu, J. (2024). *China's approach to AI standardisation: State-guided but enterprise-led. FIIA Briefing Paper 391*. Helsinki: The Finnish Institute of International Affairs.

Zhu, J. & Mattlin, M. (2024). The Chinese AI innovation ecosystem: Spurring innovation or consolidating monopolies? ReConnect China Policy Brief 11. ReConnect-China_Policy-Brief-11_The-Chinese-AI-Innovation-Ecosystem.pdf.

Zhu, Y., He, B., Fu, H., Hu, N., Wu, S., Zhang, T., … Zhou, H. (2025). China's emerging regulation toward an open future for AI. Science, 390(6769), 132-135. 9 October 2025 https://www.science.org/doi/10.1126/science.ady7922.