Transatlantic tech de-risking from China: The case of technical standard-setting

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Introduction: identifying tech risk profiles

- In adapting to the geopolitical risks that stem from deep technological engagement with China, both transatlantic partners should pursue a de-risking strategy that differentiates between and takes account of at least four risk dimensions: risks to global supply chain resilience, risks to national security, risks to normative aspirations and risks to competitiveness.
- Technical standardization, although not usually a subject of geopolitical contestation, is an important factor in all three risk dimensions.

The United States and the People's Republic of China (PRC) have entered an era of strong competition for global power. At the heart of this power rivalry is a struggle over technology leadership in several strategic technologies, notably wireless infrastructure, semiconductors, Artificial Intelligence (AI), the Internet of Things (IoT), quantum technologies and blockchain. The underlying assumption is that command of these technologies is vital to national competitiveness, national security and the ability to shape global affairs. In 2016, the Central Committee of the Chinese Communist Party (CCP) and the State Council summarized this when stating that "the emergence of disruptive technologies is reshaping global competition and the balance of power. […] Our nation has a rare historic opportunity to catch up and leapfrog ahead but is also confronting the severe challenge of a widening technological gap".[1] This international technology competition is not least about the ability to set the technical norms that create interoperability and enable the integration of highly complex technologies into global value chains. In other words, it is a competition over setting technical standards and controlling their underlying intellectual property (IP).[2]

The European Union (EU) and its member states cannot stand idly by as China's footprint grows in disruptive technologies and international technical standardization. Europe is concerned not only that it could suffer a loss of its substantial influence on global standard-setting, but also that the politicization of technical standardization and a fragmentation of technical standards could undermine European interests.[3] A comparison of recently published EU and the US technical standardization strategies illustrates that both transatlantic partners share these concerns.[4]

Gone might be the days when increasing interdependence and globalization were interpreted as irreversible.[5] Concerned about Western influence, China is promoting indigenous innovation and technological self-reliance under its paramount leader Xi Jinping and his "dual circulation" policy. While the idea of technological decoupling has emerged from China, it has also been the subject of discussions on both sides of the Atlantic. European Commission President Ursula von der Leyen has made clear,

however, that the EU is not aiming to decouple from China but striving to reduce the strategic risks that result from economic and technological reliance on the PRC.[6] This allows technological cooperation and economic interaction to continue while increasing European resilience to looming risks. Such "de-risking" has found widespread support in Europe.[7] It has also been picked up by the US administration.[8] Europe's commitment to de-risking instead of decoupling is understandable not least in light of the enormous costs of various decoupling scenarios that would have a far more damaging impact on Europe than on the US.[9]

While neither the US nor the EU has a clearly identified, concrete risk profile—the EU is currently working on an economic security strategy that should provide a classification—any such approach should differentiate between at least four types of risk:[10]

1. *Risks to global supply chain resilience:* The global value chains of many, if not all, emerging and foundational technologies are characterized by a transnational division of labor. No region is in control of all production steps or its supplier markets. Thus, to strengthen security of supply it will be necessary to strengthen the resilience of global value chains in order to reduce second- and third-order negative impacts on EU and US industries in case of supply disruptions. Strategies to strengthen resilience vary greatly between specific global value chains, such as semiconductors, batteries or quantum computing, depending on their individual characteristics.
2. *Risks to national security:* Failure to reduce strategic dependency or loss of strategic capacity might have (in)direct negative impacts on national security. Of the four dimensions, assessing the potential impact on national security is the one with which policymakers are traditionally the most familiar. However, strategic dependencies in foundational technologies, such as semiconductors, or general-purpose technologies, such as AI, might have an indirect impact on national security. The national security risks that stem from dependence on Chinese mobile network equipment vendors are different from the national security risks to member states that rely heavily on drones, surveillance cameras or AI chips from Chinese vendors. Some of these risks can be mitigated at the technical level, while others come down to the trustworthiness of the technology provider.
3. *Risks to normative aspirations:* Strategic dependency or technology cooperation can also conflict with values. Like implementation of export restrictions to protect human rights, strategic dependency can also be scrutinized according to the human rights violations that such technology would enable. One example is the increased scrutiny of Hikvision surveillance cameras in Europe and the company's ban in the US due to its involvement in human rights violations against Uyghurs in the PRC.[11] Thus, reducing dependency on Chinese surveillance cameras could be based on European values rather than solely national security concerns. Similarly, sustainability is a growing concern in which emerging and foundational technologies play an increasingly important role. While all sides emphasize its importance, the priority attributed and approaches to sustainability vary, which has implications for global goods such as combating climate change.
4. *Risks to competitiveness:* Europe might invest in strategic capacities or try to reduce strategic dependencies to be able to compete internationally in the long term if a certain technology or market is deemed highly important in the future. Current examples include European investments in quantum computing and photonics. The Dutch government, for example, has invested heavily in the PhotonDelta consortium to strengthen the long-term competitiveness of its domestic photonics ecosystem.[12] In light of the intensifying US-China technological rivalry, government incentives to support the technological competitiveness of a specific domestic industry or technology provider can also be motivated by maintaining "strategic indispensability"; that is, ensuring that a company continues to play an indispensable role in the

global value chains in the long term.[13] Technological competitiveness therefore creates geopolitical leverage.

Once risks have been defined, the EU and the US will have to weigh the risks of disengaging from Chinese technology, which comes with costs. Based on this risk assessment and cost calculations, concrete instruments will need to be adopted to tackle specific risks.

How such strategies on adaptation to the ongoing "weaponization of interdependence" (Farrell/Newman)[14] might shape technical standardization, a central field of tech competition, is less obvious than one might think. To those who have set technical standards for decades, the assumption that technical standards are an integral part of a power competition is anything but a given. If one considers what a technical standard is, how it is developed and by whom it is established, the use of standards for power purposes is indeed counterintuitive. Standards have always been a subject of competition, but in essence technical standards are non-binding private self-regulation over which commercial competition exists, but which require broad market acceptance. In other words, a minimum degree of cooperation and inclusion is essential for technical standards to be effective.

It is possible to argue that technical standards could be treated as a metric for the innovation of an economic entity. From this perspective, the study of technical standards is a proxy for measuring the technological innovativeness of a country. If one further assumes that technological leadership is in itself a crucial source of state power, advances in technical standards indicate state power. However, technical standard-setting is treated as far more than a proxy for technological strength. Instead, technical standards are central to all four of the risk dimensions outlined above.

In providing answers to the questions of the US-China Economic Security Review Commission (USCC), this written testimony first lays out the current practice of international standard-setting, which is shaped by US and European systems. This is compared with China's strategic, state-centric approach to technical standard-setting. Next, China's engagement in international standardization is discussed. This includes an assessment of China's practices and its limited international successes. The testimony then returns to the four risks outlined above to explain how the role of technical standardization is crucial, and in what ways China's state-centric approach presents a challenge for the transatlantic partners. The testimony closes with policy recommendations.

Ideal type and current practice: Transatlantic on standard-setting

- Despite significant differences in their respective systems, commonalities in transatlantic standardization practices have shaped international standard-setting.
- Practice might differ, but the ideal type of standardization as a form of private, non-binding, inclusive and technology-focused specification for a common purpose has served global standard-setting well for many decades.

Geopolitical discussions around technical standard-setting are in stark contrast to the ideal-type perception of standardization that has had enormous utility and long served international standardization. This ideal type that has been largely shaped by the standardization practice and standardization influence of Europe and the United States is characterized by several features:

- *Standards are highly technical and serve common purposes not political goals:* Standards are highly technical documents whose political relevance is not eye-catching. Technical standards are omnipresent product specifications that generate basic safety and interoperability. For example, USB is a standard for cables, connectors and protocols that enables charging and the exchange of data on a wide range of devices. Similarly, Wi-Fi is a family of radio technologies built on technical standards that allow for wireless local area networking of a wide range

of technological equipment. Technical standards allow products of all kinds to be applicable in a wide range of contexts across countries and manufacturers. Without technical standards, the technologies of two suppliers would not be complementary. Technical standards create markets and thereby facilitate international trade. Standards also have a positive effect on economic growth and innovation.[15] Technical standards help to scale-up innovations and reduce costs. To the extent that technical standards create larger market scope, they also generate larger revenue streams that are available for investment in innovation. Standardization is also conducive to diversification as standards increase the interoperability of products from different suppliers, which makes subcontracting easier.

- *Technical standards are voluntary and consensual:* Technical standards are voluntary technical specifications. They carry enormous commercial force. Products that do not comply with technical standards work only in isolation and not in concert with other products. In an increasingly interconnected world of products, they run the risk of capturing only niche markets. Nonetheless, technical standards are voluntary by definition. For example, the World Trade Organization's (WTO) Agreement on Technical Barriers to Trade (TBT Agreement) defines a standard as a "document approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, *with which compliance is not mandatory*".[16] Furthermore, technical standards are an unlikely candidate for domination as many national, regional and international standards are adopted on a consensus basis. Two European standardization organizations, the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC), include consensus in their definition of a standard.[17]
- *Standards are inclusionary:* Technical standardization follows an inherently inclusionary logic. Technical standards aim to harmonize products and technologies. In sharp contrast to intellectual property rights and patents, a good standard is available and accepted globally.[18] Where technical standards consist of patented technologies, patent holders are obliged to license their patents under fair, reasonable and non-discriminatory terms (FRAND). Courts around the globe are enforcing FRAND terms on patent holders. In contrast to the other means of global technology competition, such as export controls or punitive tariffs, technical standards are not intended to exclude competitors. It is true that technical standards can create barriers to market access if they deviate from international norms.[19] Standards can also further cement monopolization, opt for and lock-in to premature technology choices.[20] However, by their very nature, standards are designed to provide an inclusionary basis that facilitates competition.
- *Standards are developed by private sector not public sector actors:* Technical standards are non-binding and a form of private sector self-regulation. Formal technical standards are developed in standard-developing organizations (SDOs) that overwhelmingly consist of representatives of private industry. Global industry consortia developing technical standards for information and communication technologies (ICT), for example, predominantly consist of vendors and other commercial entities. These make up 93.6% of participants, followed by consumer groups (3.8%) and university and research institutions (2.5%). Government agencies comprise just 0.2% of participants.[21] Even when technical standardization is interpreted as a form of "hybrid" authority that includes both private and public sector actors, the empowerment of private sector actors is at the core.[22] SDOs exist at the national, regional and international levels. De facto standards are the result of market dominance by one or just a few technology suppliers of a product that is of cross-cutting importance.[23] For example, Windows and Apple dominate the global market for operating systems and a wide range of

software products needs to be compatible with Windows and iOS to avoid becoming a niche product.

Granted, technical standardization practice does not fully conform to this ideal type. As one standardization expert has put it: "How do standards impact our ability to compete internationally? What is needed is that our domestic standards experts aggressively participate in international standards development to get domestic standards accepted. The first to propose a standard for adoption at the international level will most likely succeed. Thus, it is necessary to get to the international arena ahead of standards experts from other countries".[24] In other words, standardization practice has always been more competitive than the ideal type's focus on cooperative self-regulation might suggest. However, the fact that, in the absence of a systemic competitor, the EU and the US as the most influential standardization powers have approached standard-setting as a non-binding form of private sector self-regulation has shaped the international standardization system.

While technical standard-setting is driven by private sector actors in both the US and the EU, their approaches differ substantially. The European standard-setting system is a private sector-driven public private partnership, in which the technical standards of private SDOs support economic integration, innovation and competition within the European Single Market, as well as European regulation. Three characteristics define the European approach.[25] First, technical standards are developed by private standardization bodies. The state is involved only insofar as it identifies a few organizations as national standard bodies (NSBs) at EU member state level and three European Standardization Organizations (ESOs) at the EU level to develop technical standards. Technical standards can be developed outside of this system, but in practice the technical standards developed by NSBs and ESOs are by far the most influential.

Second, technical standardization is hierarchically structured within this system of NSBs and ESOs. If a technical standardization issued nationally contradicts a technical standard developed at the European level, the national standard is automatically invalidated. The European standardization bodies CEN and CENELEC have codified their close coordination with two international standardization bodies, the International Standardization Organization (ISO) and the International Electrotechnical Commission (IEC), in two agreements.[26] The third ESO, the European Telecommunications Standards Institute (ETSI), is one of only seven organizational partners of its global equivalent, the Third Generation Partnership Project (3GPP), and is therefore also closely interwoven with global standardization.

Third, technical standards can support regulation. Technical standards can be referenced in regulations as a method of implementing the requirements of that regulation, carrying the presumption of conformity. The European Commission can request the development of technical standards where it sees a need for technical specifications on the implementation of its regulations. The development of such technical standards, known as harmonized European Norms (hENs), is not mandatory.

In some regards, the US approach to technical standardization is even more market-driven. While the EU follows the principle of "one standard, one test, accepted everywhere", the US cherishes what could be summarized as a "blossoming of solutions". Most fundamentally, in the US, a number of competing consortia are developing technical standards in any given economic sector. Almost 300 SDOs are accredited. The result is a competition of overlapping and potentially mutually contradictory technical standards; and it is left to the market to pick the winning technical standards. That is not to say that demand plays no role at all in Europe. Technical standards are voluntary and if the licensed technical standardization bodies do not develop technical standards that conform to the needs of the market, the likelihood is that their practical relevance will be low.

In ISO and IEC, the US is represented by the American National Standards Institute (ANSI). ANSI, however, has no authority over the multitude of national standardization bodies. In fact, many US

standardization bodies consider themselves international if some of their members are international companies. Hence, the US does not accept ISO and IEC as a priority compared to what appear from a European viewpoint to be domestic standardization organizations with international participants.

Despite its generally market-driven approach, the US will spend $ 1.24 billion in 2023 for the National Institute of Standards and Technology (NIST) to conduct research and promote US standardization.[27] Europe does not possess an equivalent. Hence, in some way, the US system is more state-led European's.

Ideal type practice of standardization shaped by the commonalities and differences of transatlantic approaches has served international standard-setting well. China's standardization system and practice shows similarities but is also characterized by different features.

Systemic competition: China's state-centric technical standardization approach

- Recent reforms have transformed China's standardization approach from being state-controlled to being state-centric. China's technical standard-setting still deviates significantly from the ideal type and transatlantic and international standardization practices.
- Party-state actors play a significant role in standardization, and standard-setting is closely embedded in Chinese strategic political ambitions.
- Underlying this is a fundamentally different understanding of technical standards as a means of implementing industrial policy that improves product quality and supports China's move up the global value chain.

To assess China's role in and impact on international standardization requires an understanding of China's domestic standard-setting approach. At least if compared to the ideal type, China's state-centric technical standardization system stands out in sharp contrast. A number of documents and statements provide evidence of the strategic importance that the PRC political leadership attributes to technical standardization. Setting the technological rules, including on technical standards, is explicitly integrated into political ambitions to shape international affairs.[28] In 2020, for example, Shu Yinbiao, a leading Chinese technical standardization official, argued that the ability to shape international technical standard-setting is a reflection of a nation's power and competitiveness.[29] Similarly, technical standardization has been an integral part of macro-economic planning in the PRC for quite some time.[30]

In recent years, China has made tremendous changes to its domestic standardization system and managed to increase its international influence. For decades, technical standards had been developed by public- and private sector actors, but only within state institutions under national ministries or local governments. Many of these standards were not voluntary but mandatory, and thereby not even technical standards according to the WTO definition. In a nutshell, technical standard-setting in China was state controlled.

Following informal consultations in 2014, China launched a standardization reform on March 11, 2015,[31] which has been gradually implemented in the intervening years.[32] At the core of the reform is the new Standardization Law, which took effect on January 1, 2018,[33] replacing the previous law from 1989. The most impactful of several changes has been the introduction of a market-tier and the reorganization of the Chinese standardization system from state-controlled to state-centric.

Since 2018, the PRC system has comprised five types of standards (see Figure 1). The state-tier continues to be national, sector and local standards developed under the umbrella of state institutions; national standards can still be mandatory or voluntary but the number of mandatory standards has

been cut by around 75%.[34] All local standards and the overwhelming majority of sector standards are now voluntary.

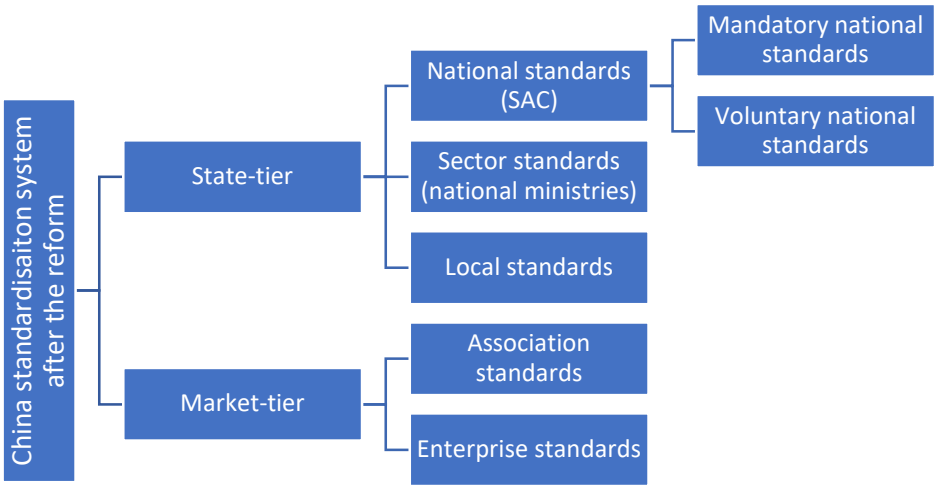
National and sector standards are developed in Technical Committees (TCs), Sub-Committees (SCs) and Working Groups (WGs), with members from privately and state-owned enterprises, research institutions, think tanks, state regulators, consumer organizations, testing and certifying entities, and industry associations. China's technical standardization work involves both civilian organizations and the defense sector.[35] While this generally resembles international standardization practices, development of these standards is carried out under the framework of state ministries.[36] In many cases, research institutes that are an integral part of these national ministries host the secretariats of the TCs, SCs and WGs.

The new market-tier sets two types of standards. Association standards are issued by a rapidly growing number of competing industry associations. Since their introduction, association standards have become the most dynamic standard type in China. In contrast to state-tier standards, association standards are supposed to be fully autonomous of party-state influence. Associations do not require a license to develop such standards. All private entities in China with the status of an NGO, acquired from the Ministry of Civil Affairs under the Chinese State Council are all encouraged to develop technical association standards. On paper, this provides very little party-state control over the development of association standards. However, European and Chinese practitioners alike report in private conversations that there is party-state steering of association standardization. For example, association standards have increased force when referenced in national regulation or are a response to a request for standard-setting by party-state institutions, or if developed by an industry association to which the party-state had granted a license to do so in the pilot period before 2018. In other words, a multitude of associations may be developing technical standards in China, but party-state endorsement is what increases their impact. In addition, there are plenty of reports of informal guidance from party-state institutions encouraging private industry associations to develop certain technical standards.[37]

The fifth and final standard type is enterprise standards, which are specifications developed by individual companies. Unless these achieve the informal status of a de facto standard, enterprise standards only apply within a given company. Party-state interest in and influence over enterprise standardization is limited, but even enterprise standards are not completely free from party-state oversight and guidance. Enterprises are encouraged to declare their enterprise standards with the state authorities, thereby providing public agencies with a better overview of product characteristics.

Party-state guidance on enterprise standards is mostly exercised through a national competitive 'top runner / front runner' system initiated in 2018, which awards prizes to those standards considered the best by the party-state.[38] The system is refined every year, and both national and regional systems coexist. This tool provides party-state authorities with the ability to use industry-driven standardization in its industrial policy and maintain a guidance function, even in supposedly market- and industry-driven sections of the technical standardization system. Several of the practices of party-state engagement with steering effects discussed below help the party-state to shape domestic standard-setting.

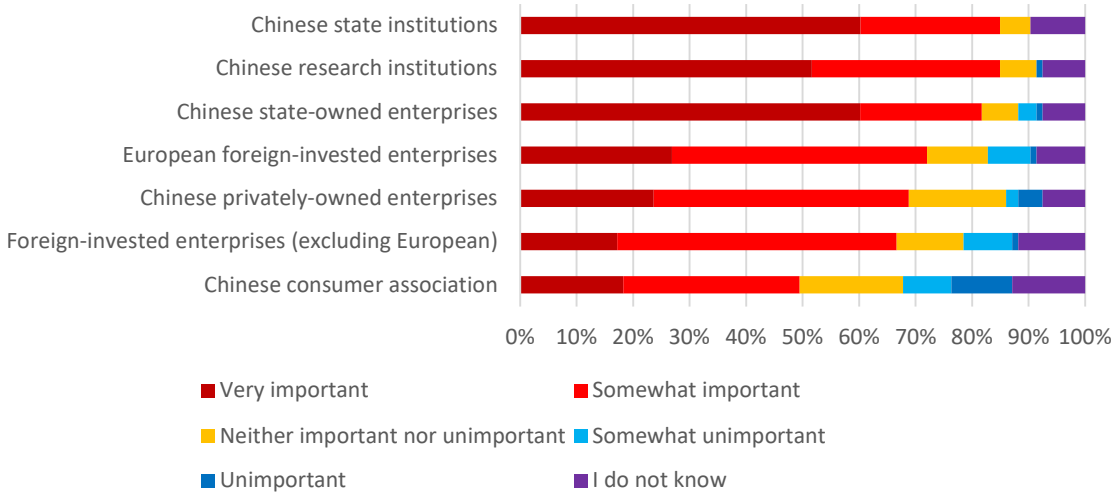
Figure 1: China's two-tier standardization system since reform



Source: Own graphic

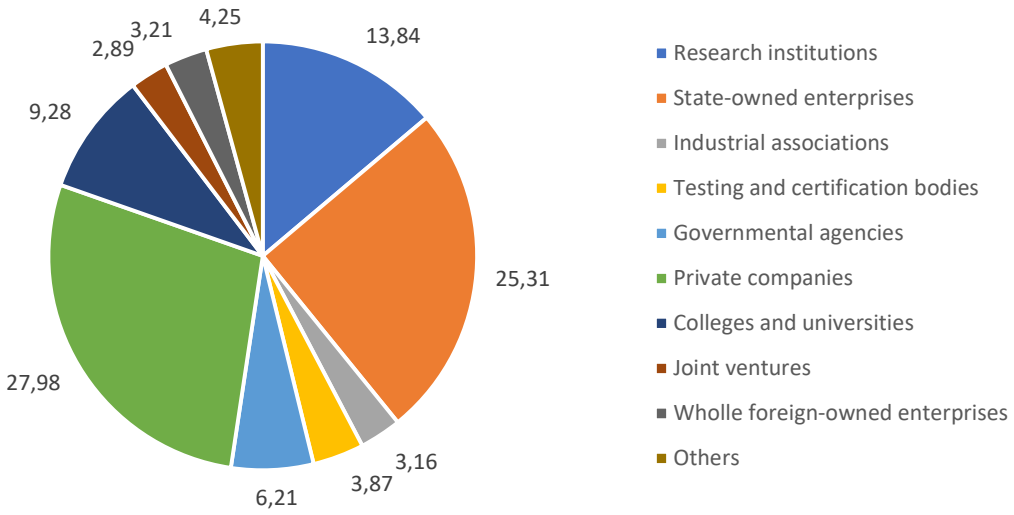
Given the changing but persistently strong role of the party-state in technical standard-setting, it is little wonder that European businesses engaged in domestic standard setting in China identify state institutions as the most impactful (see Figure 2). Chinese research institutions, ranked second, are often an integral part of national ministries. China's state-owned enterprises (SOEs) are named as having the third largest impact on technical standard setting in China, well ahead of private and foreign invested companies.[39]

Figure 2: How important are the following types of participants for the development of technical standards in the committees that your company participates in (in %)?



Although not displaying quite the same level of dominance, statistics on standardization experts registered in China also demonstrate that party-state actors play an important role. Privately owned Chinese companies employ less than 28% of the registered experts. Joint ventures and fully foreign-owned companies have a combined share of only slightly more than 6% (see Figure 3).[40]

Figure 3: Employers of registered standardization experts in China



The steering role of the party-state is rooted in a fundamentally different understanding of technical standardization in China. For the Chinese party-state, technical standards are a means of implementing industrial policy. To some extent, domestic standards can serve as technical barriers to trade for protectionist purposes, although this was more the case in the past. Today, technical standardization has primarily become a means for industrial policy to facilitate improvement of product quality and China's move up the global value chain.

China is undergoing an economic transformation with the aim of mitigating lower growth rates (the 'new normal') and avoiding the middle-income trap.[41] With hardly any urbanization potential left, China is striving to compete not on low labor costs, but on quality and innovation, which further increases the focus on standardization.[42]

All in all, China's standardization reform has aligned the PRC's standardization more closely with the ideal type and practice of international standard-setting, which is substantially shaped by transatlantic actors. However, even after the reform, China's approach remains state-centric and deviates from the existing international system. Accordingly, while foreign-invested businesses have profited from recent reforms they continue to face discrimination.[43]

State-centric technical standardization in China: A strategic choice

China's state-centric approach to technical standardization is by no means accidental but reflective of the strategic importance attributed to it. In March 2021, the National People's Congress adopted the 14th Five-Year Plan (FYP). Technical standards are mentioned in some form or another in around a quarter of all its chapters, indicating the high priority that China gives to technical standard setting.[44] Equally, the 14th FYP for National Informatization makes reference to standard-setting throughout the discussion of the technologies covered.[45] However, while the strategic value China attributes to standardization is clear, the National Standardization Outline published by the CCP Central Committee together with the State Council in October 2021 is more important.[46] The Outline was followed by a specific Five-Year Plan on technical standardization.[47]

The Outline characterizes technical standards as central to China's economic transformation. The PRC is explicit that it will increase the citation of standards in regulations, certification, accreditation and

public procurement, thereby linking technical standards more closely to legally binding policy. The application of standards will also be broadened to China's governance system and, for the first time, will include administrative management and social governance.

The Outline demonstrates a further shift in China's ambition. Standardization is not just seen in a domestic context. Equal weight is given to international standard setting. This includes the allocation of more resources, an ambition to invite international professional standards organizations to base themselves in China (in a similar way to industry consortia based in the US) and the aim that technical standards should help the PRC to increase supply chain security. China's international standardization ambitions are coupled with a commitment to increase synchronization of international and Chinese standards. The Outline speaks of an adoption rate of 85% of international standards, but such an ambition appears to be far from reality (see below).

The Outline announces improved cooperation with the ISO and sets the goal of increasing international cooperation with countries along the Belt and Road Initiative (BRI), the BRICS (Brazil, Russian, India, China and South Africa) and the Asia-Pacific Economic Cooperation (APEC). This could be interpreted as an attempt to internationalize Chinese technical standards.

Domestically, China is committed to increasing the openness of its standard-setting system to foreign-invested enterprises as promised in the Foreign Investment Law (FIL).[48] The Outline identifies a number of economic sectors as being of strategic priority for China's standardization activities: digital (AI, wireless networks, big data, blockchain and quantum technologies); mobility, such as smart ships, high-speed rail and new energy vehicles; green transformation, including energy efficiency and renewable energies; health; finance; trade, including e-commerce; construction; rural development; and urbanization.

The Outline also emphasizes the importance of the market-tier standards, primarily association standards. The dual system of state- and market-tier standardization will remain in place. The CCP is committed to strengthening the market-tier but has also emphasized that its leadership and coordination of the party-state institutions will persist. Other reforms include the ambition to shorten the time frame for developing standards to less than 18 months, digitalize standardization, strengthen standardization research and improve the governance of standard-essential patents (SEPs) and IP protection.

The Outline was developed in response to a recommendation by a broad research project known as China Standards 2035 (CS2035), which garnered wide attention and speculation. Some western observers have characterized CS2035 as a new 'masterplan' following on from the China's Made in China 2025 strategy.[49] Others are skeptical of such an interpretation,[50] referring to the cooperative nature of technical standardization, which makes it difficult to dominate standard setting.[51]

Some of the results of CS2035 were deemed controversial within the Chinese party-state and some of its recommendations did not make it into the national technical standardization strategy. However, this does not make those recommendations irrelevant to China's future standard setting approach. Instead, they should be regarded has not yet having achieved consensus, and whether they will be implemented in the future remains to be seen. Initiated as a research project by the SAC and the Chinese Academy of Engineering, CS2035 was a tool for pushing further standardization reform in China. The fact that some of the recommendations, such as a reduction to only two types of standards, were not included in the Outline is illustrative that there are different visions for the future development of China's technical standardization system within the PRC.

Of particular interest is CS2035's proposal to establish a BRI Regional Standards Forum.[52] This proposal, which did not make it into the Outline, could have led to a new institution being registered as an NGO open to technical standardization experts from BRI countries. This Forum would have not only facilitated coordination among its members in preparation for standardization in the ISO and the IEC, but also developed BRI regional standards. This would have become an alternative institution, undermining existing standardization organizations. It remains to be seen whether the idea will resurface.

All these documents, initiatives and statements give a clear indication that technical standard-setting is of strategic and political relevance for China. The PRC's leadership strives to leverage technical standards for technological upgrading, as well as to reinforce national comprehensive competitiveness, advance economic development and support technological innovation. Internationally, China strives to secure supply chains and create global and regional markets for its products, and thereby also generate lock-in dependencies. Implicitly, technical standardization could also serve China's national security.

China's international standardization activities

- The PRC has adopted seven established standardization practices of US and EU actors but amended them to the conditions of its state-centric approach to standard-setting. The result is competing standardization systems.
- China's influence on international standardization has grown but varies greatly across SDOs and sectors. The PRC has not achieved a dominant position.
- The BRI is a crucial vehicle for the spread of de facto standards. This is by far the most concerning development for the transatlantic partners.
- Robust institutions limit China's influence on formal European standardization. In reaction to concerns about growing Chinese influence in ETSI, the EU controversially amended the standardization regulation. This has been strongly criticized by US companies.
- Any assessment of strategies to limit Chinese influence must consider alternative scenarios, in which China might exercise its objectively existing standard influence outside existing SDOs.
- China's adoption ratio of international standards does not match its declared ambitions.

The PRC's influence on technical standard-setting has increased significantly. This is a natural reflection of its strong level of innovativeness and is neither surprising nor alarming as such. However, just as in its domestic reform, China has selectively adopted best practices from the West and combined these with the characteristics of its own party-state permeated economy. The result is a systemic competition between different approaches to standardization. Strikingly, seven of the most important practices supporting China's international standardization influence are not markedly different from Western standardization. However, the PRC has adapted these practices to its state-centric approach, thereby externalizing its domestic standardization.[53] Four of these practices apply mostly in formal standardization; another three are central to the spread of Chinese de facto standards:

- *Increasing technical expertise:* Technical standardization is the result of meetings and discussions among engineers. Hence, technical expertise is a crucial prerequisite for influencing standard setting. Ideally, technical merit is the sole criterion for standard-setting. Technological innovation is the result of research and development (R&D). In both Europe and the United States, public funds are vital, particularly for basic research, but most of the innovation that reaches the level of maturity to be subject to standard setting is industrial. The PRC has adopted a state-centric approach to catch up with technological innovation in

fields considered strategic. Industrial policies connected to 'Made in China 2025' have been accompanied by additional state funding, allowing China to spend 2.2% of its GDP on R&D in 2019. One example is Huawei, which has reportedly benefited massively from tax breaks, soft loans and export credits.[54] R&D investments alone do not result in innovativeness and the sums invested by Huawei and other Chinese tech companies might exaggerate technical capability. However, substantial R&D funding is a prerequisite for standardization.

Party-state support for innovation goes beyond public spending. As the author has argued elsewhere in more detail, five features have been decisive for China's growing innovativeness:[55] partial protection, allowing new technology trends from the West to be absorbed while protecting Chinese firms;[56] learning from Western innovation ecosystems, attracting talent back to China by such means as the party-state's Thousand Talents Program; targeted acquisition of missing technical expertise by legal (e.g., M&A) and illegal (e.g. cyberespionage) means, often using state funds; competition over innovation to attract party-state support but also to meet consumer demands; and party-state steering by means of Five-Year Plans without detailed planning, unleashing funds from the state-controlled financial sector for priority projects. Strikingly, the party-state is a central feature of all five of these features.

- *Exploiting first-mover advantage:* First-mover advantage is crucial for influencing standard setting because once established, international standards are slow to change. Cutting edge innovation is a precondition, but early demonstration of a technology's utility, proving the value of innovation in real-world conditions is also important. Hence, private sector industry aiming to set technical standards often strives for early commercialization of a certain technology to gain first-mover advantage. This is particularly effective in large markets such as the Chinese as market size can provide for testing under a greater variety of conditions; market size also has some force as it locks-in early commercial revenue for industry.

  In China, early commercialization is also a core dimension of standard setting, but is not left to private sector industry. Instead, a central feature of the party-state's industrial policy has been to establish regulatory and financial conditions to facilitate early commercialization of key enabling technologies, such as 5G.[57] In 5G, for example, the PRC has sponsored the world's largest 5G trial area in the Yangtse River Delta,[58] and the state-controlled mobile operators have been instructed to roll out the most innovative version of 5G, known as standalone 5G. In both the EU and the US, by contrast, operators tend to opt for the less innovative update of 4G/LTE networks to non-standalone 5G because private sector industry has identified that this path requires less investment and is therefore more economical in the short and medium term.[59] In short, China's state-centric approach supports standardization by socializing the financial liability of early commercialization and technological trials. Internationally, China is striving to gain first mover advantage by proposing new standardization items at an early stage and applying for technical leadership positions. To some extent, this is proving effective, but ultimately technical standardization is only positive, and quickly and widely accepted when many actors from several countries have an interest in a standard.
- *Supporting active participation in standardization bodies:* Having voting rights in SDOs requires active and regular contributions to standard development. Academic research has repeatedly emphasized the crucial importance of financial resources in this context.[60] In the US and in Europe, firms with stakes in standardization must meet this requirement with little if any state support, such as partial coverage of travel expenses. The most influential European SDO, the German DIN, receives around 10% of its budget from public authorities. The sale of standards and membership fees are the DIN's main sources of funding.

  China, by contrast, adopts a state-centric approach to increasing engagement in formal international standardization. The party-state issues quantitative benchmarks and supports its ambitions with funding.[61] This can be direct and indirect financial support. For example, many

municipalities offer stipends to Chinese firms if they develop technical standards. Such financial support is available for the development of national as well as international standards. In March 2022, Chaoyang District in Beijing offered payments for different standards. International standard contributions could be awarded by the local government with up to RMB 30,000.[62] Examples from other parts of the country demonstrate that financial support can amount to as much as RMB 1 million.[63] China's quantitative approach can have distorting effects as it incentivizes split standard contributions, increasing the quantity but not the quality of the submissions. However, there are quantitative caps to standardization subsidies, which put some limits to such distortions.[64]

- *Speaking with one voice:* Practitioners from all countries confirm that conflicts of interest among industry representatives from one country are the rule rather than the exception. At the same time, coordination to ensure that participants speak with one voice helps to establish support around a given standard proposal. In the EU and the US, such coordination is left to industry or to committees within private SDOs. While China's unity is often overestimated, the party-state actively facilitates coordination in fields of national priority. For example, in 2013 the PRC founded the IMT 2020 (5G) Promotion Group, which comprises Chinese public agencies (the Ministry for Industry and Information Technology, Ministry of Science and Technology and the National Development and Reform Commission), research institutes (Beijing University of Posts and Telecommunications) as well as all sorts of Chinese tech companies.[65] China regarded coordination within the group a success, so launched the IMT-2030 (6G) Promotion Group based on the organizational structure of the previous group in June 2019.[66]
  This is not to say that state institutions define standardization priorities, but they facilitate coordination within the country prior to engaging in international standardization. Standardization coordination can be particularly successful for a large economy like China's and is more effective in SDOs that do not operate on a one country, one vote basis. One example of coordinated voting is Huawei's Polar Code proposal in the Third Generation Partnership Project (3GPP).[67] A Chinese academic recalls this case of bloc voting at a meeting in Reno when, "almost all Chinese companies coordinated tacitly to support the polar code led by Huawei as a control channel coding standard. […] This shows strong nationalism. While on the surface, the 5G international standard competition is a competition between technical solutions, at a deeper level, it is dominated by nationalism. […] This is particularly obvious among Chinese companies".[68]
  Central coordination can further support the practice of forum shopping when a given standard contribution is rejected in one SDO and then put forward under different names in others. One such case is China's proposal for a new internet protocol that was first introduced and rejected at the International Engineering Task Force (IETF) before it was taken to the International Telecommunications Union (ITU) and later reappeared in some limited form in ETSI.

China's growing ability to shape international de facto standardization is also not the result of practices that are fundamentally different to those in the US and the EU, but rather a state-centric variant of existing approaches. This can be illustrated with reference to three influence factors:

- *Building large companies:* Large companies with a significant market share, such as Microsoft, were a prerequisite for setting de facto standards. This holds true for Chinese firms too. In China, however, the party-state proactively facilitates the creation of national champions. The reason may not be standardization power, but the policy is strengthening the PRC's ability to set technical standards.
  In recent years, the average size of SOEs has grown considerably.[69] For example, the current

structure of the state-controlled Chinese railway sector is the result of reforms. In 2013, the Ministry of Railways was dismantled and divided into the State Railway Administration (SRA) and the China Railways Corporation (CRC) under the Ministry of Transportation (MoT) and the National Development and Reform Commission (NDRC). The CRC is not a normal company but is responsible for railway development, pricing and infrastructure building. It performs a coordinating function in China's railway industry. This has implications for strategic R&D investment and standardization targets. China has not only established state control over manufacturing and the operation of the railway sector, but also directs the technological innovation and R&D required for standards development. At least 25 research universities, 11 research institutes and 51 national engineering and research centers with more than 10,000 researchers receive direct instructions from the party-state to achieve national goals. The CRC also has its own engineering and research branches: the China Railway Design Corporation (CRDC) and the China Academy of Railway Sciences (CARS).[70] This illustrates that some of China's large companies have enormous resources and coordinative competences that they can leverage for R&D – and ultimately also for their standardization influence. This is particularly effective where China possesses unmatched industrial capacity, such as in the telecommunications industry.

- *Strengthening international presence and package deals.* Domestic market dominance is not sufficient for setting de facto standards. The globalized world requires companies to compete with technological solutions from abroad. While export subsidies are a global phenomenon, China has adopted a distinctly state-centric approach to achieving international market presence in some critical sectors, particularly as part of the BRI in the infrastructure sector. China has promised to spend USD 1 trillion building new roads, railways and other infrastructure beyond its borders in the BRI.[71]

  Again, the railway industry is a case in point. China is promoting the railway industry to export as part of the 'Made in China 2025' initiative. By 2020, the export quota had increased to 25% of the CRC's business. In the context of the BRI, the concept of the 'Railway Economic Belt' (REB) was established to boost both the buildout of railway infrastructure and the promotion of trade through the railways.[72] China's "going out" strategy is heavily subsidized by state-owned banks. Experts have estimated subsidies (including from local government) for the REB connecting China with Europe to be as high as US$ 300 billion. The Postal Savings Bank of China alone announced in May 2017 that it would provide loans worth RMB 200 billion for REB projects.[73]

  Such export subsidies as part of larger package deals are crucial for the internationalization of domestic Chinese railway standards because they are very often an integral part of specific infrastructure development projects. For example, the Jakarta-Bandung high-speed railway is being constructed by the CRC and financed by loans from the China Development Bank on the basis of Chinese technical standards. Similarly, the Abuja-Kaduna Railway constructed by the China Civil Engineering Construction Corporation is based on Chinese standards. Chinese standards are also being used in the Ethiopia-Djibouti railway, constructed by the China Railway Group and the CRCC, and the China-Laos Railway.[74]

  These examples demonstrate that the PRC is seeking to spread its technical standards as part of package deals to BRI countries that include the financing, design and construction of railway infrastructure.[75] China provides loans and construction firms but requires the recipient countries to accept Chinese technical standards as a precondition for Chinese engagement.
- *Creating long-term liabilities:* De facto standards are particularly important because in many cases, they lock customers into specific products from one specific supplier. The maintenance of products or their use for related products relies, in many cases, on established technical standards. Microsoft's Windows operating system, for example, requires regular updates that

users can only receive from Microsoft. Companies' practices show that this asset is being strategically used by companies. The PRC is no exception.

Countries that build their railways using Chinese technical standards will be dependent on Chinese manufacturers for decades to come. Examples of technical standards in the railway sector range from track gauge, through traction of technical parameters and digital signaling systems, to voltage. If exclusively Chinese vendors produce according to Chinese technical standards in a specific country, potential competitors, including from Europe and the US, are essentially excluded from markets in BRI countries since their products are not compatible with the existing technology. Chinese experts are aware of these effects.

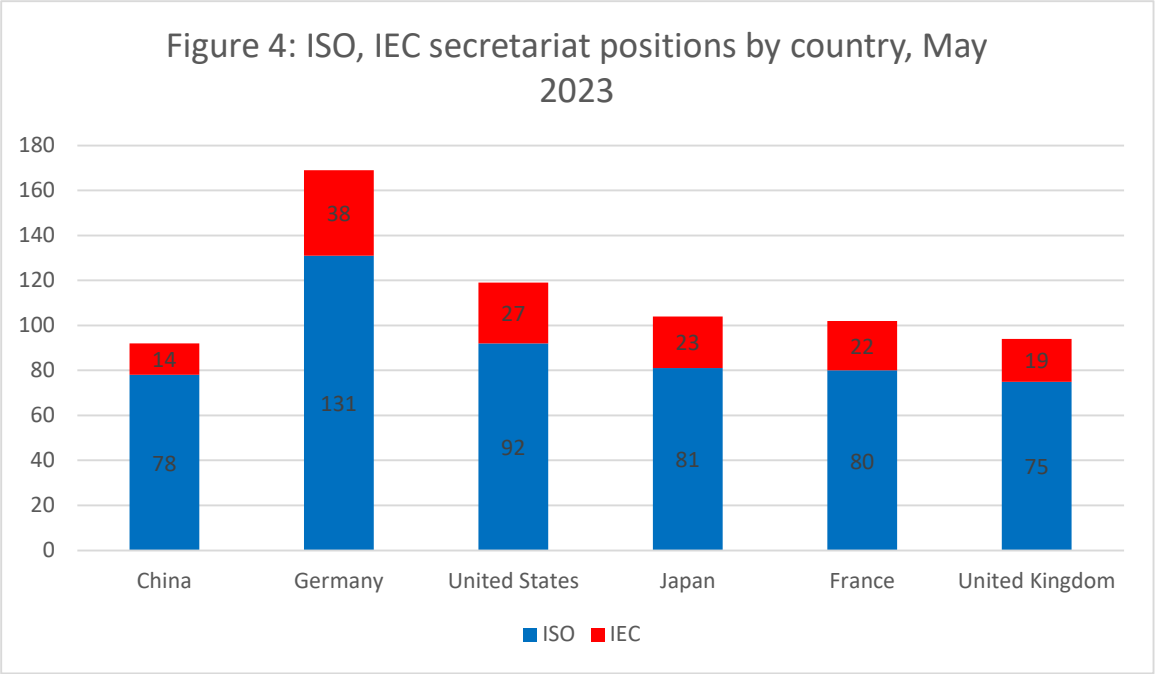
While being locked into de facto standards is not a new phenomenon, China's state-centric approach involves more than just economic dependencies. Railways are a critical infrastructure and their functioning is crucial for supply reliability, the logistics of production, people's mobility, including cultural and social participation, and thus public stability and security. If countries build critical infrastructure based on Chinese standards, there are strings attached. In a nutshell, China offers a cheaper build-out of railway infrastructure along the Belt and Road and asks for the adoption of technical standards in return. The political effects of such economic dependencies are far from an unintended side-effect. China's approach to standardization creates even stronger lock-in effects because Chinese technical standards are often less flexible in their application.[76] This makes adaptation and variation of Chinese technical standards harder compared with international or European standards.[77]

All these examples demonstrate that China's practices on influencing international formal and de facto standards do not radically deviate from those of EU and US actors. However, the PRC has developed a state-centric approach that has entered into systemic competition with the private sector-driven models originating in Europe and the United States.

Measuring China's international standardization power

China's efforts to increase its influence over international standardization have yielded divergent degrees of success. Assessing the PRC's ability to shape international standards is complicated. To some extent, quantitative measures can provide some indication, but technical relevance remains subject to dispute. Furthermore, the multitude of international SDOs makes it complex to grasp a full picture. There are around 200 SDOs for ICT standard-setting alone.[78] This testimony focuses on three influential SDOs: the ISO, the IEC and the ITU which together form the World Standards Cooperation.[79]

China's influence in ISO, the IEC and the ITU varies greatly as several quantitative indicators suggest. In terms of technical leadership positions that are crucial to setting the agenda and shaping the standardization process, the PRC has gained influence in ISO and the IEC but has not achieved a dominant position. Figure 4 summarizes the composition of secretariat positions in both organizations of selected countries that have the highest share of such positions. While secretariats are supposed to be neutral, some studies suggest that bodies led by China publish a significantly higher share of standards with Chinese backing. In 2019 and 2020, 50% of all published standards by Working Groups with a Chinese secretariat were recommended by the PRC. The overall rate is around 25%.[80]



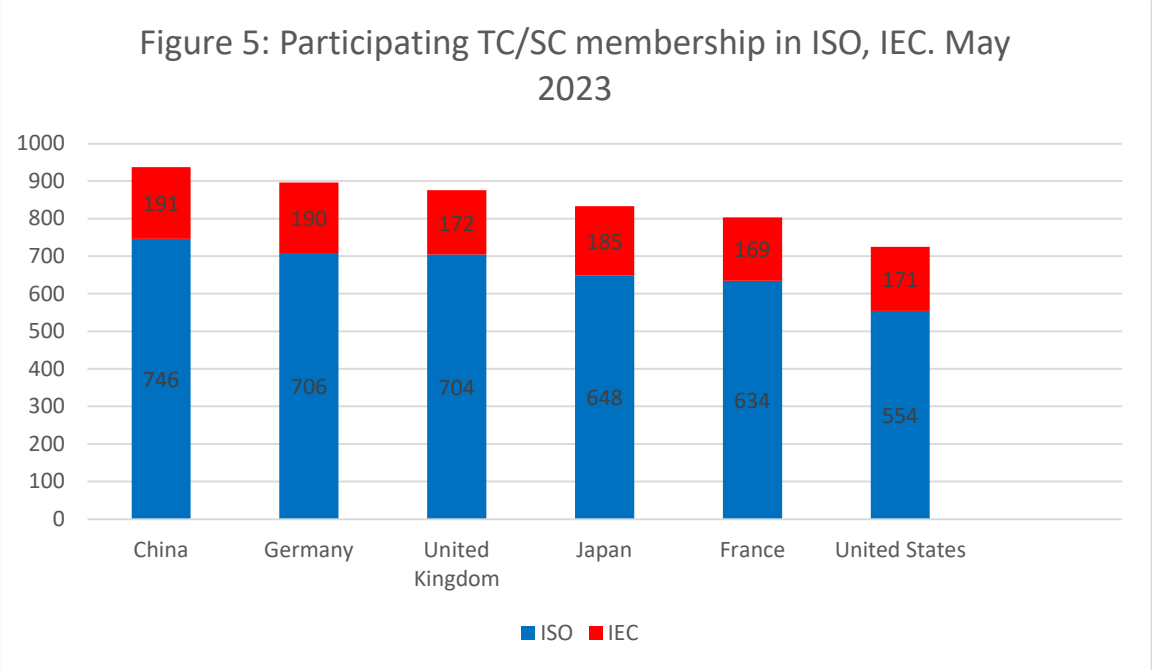
While China's share of leadership positions in ISO and the IEC is still below that of leading European countries and the US, the PRC's proportion is constantly growing. Between 2011 and 2018, the proportion of China's ISO secretariats in TCs and SCs increased from 5.0% to 8.2%. By 2022, this share had risen again to 9.4%.[81] The PRC's growing representation in ISO leadership positions contrasts with falling or constant shares of European countries and the US. A decade ago, the US held 119 TC/SC secretariats in ISO; today it leads 92 secretariats.

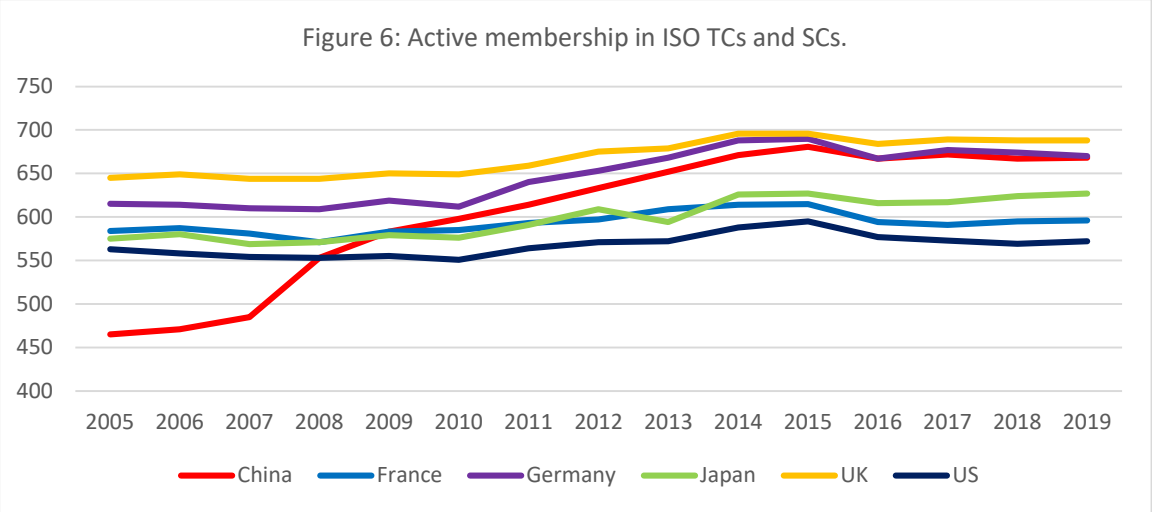
China's share of ISO technical leadership positions varies further across sectors. According to information obtained by DIN, China has more TC and SC secretariats in metallic materials (24.1%, well ahead of Germany's share of 15.2%), and in chemicals, chemical process technology and food (13.1%, slightly outperforming France's share of 12.7%). China ranks second behind the United States in ISO standardization of transport carriage and packaging, with 15.5% compared to 17.1%, and behind Japan in non-metallic materials (10.8% compared to Japan's 12.1%). In ISO standardization of household appliances and leisure products, China has a 10.1% share, behind Germany (22.8%) and the United States (17.7%). In machinery standardization at ISO, China ranks fourth with a share of 8.1% behind the US (21.5%), Germany (20.3%) and France (12.4%). In other sectors, however, the PRC does not live up to its own ambitions. For example, while China's Standardization Outline names health, security and environmental standards as among its priorities, the PRC's share in ISO leadership positions in health, environmental and medical equipment is a mere 0.8%, far behind Germany with a share of 26.1% or the United States (21.5%).

The PRC is keen to lead ISO standardization work in strategic economic sectors. Between 2015 and 2020, China gained ISO and IEC secretariats for standardization of rare earths (ISO/TC 298), foundry machinery (ISO/TC 306), karst (ISO/TC 319),[82] transaction assurance in e-commerce (ISO/TC 321), smart grid user interface (IEC/PC 118), high voltage direct current transmission for DC voltages above 100 kV (IEC/TC 115), low-voltage auxiliary power systems for electric power plants and substations (IEC/PC 127) and equipment for electrical and electromagnetic quantities (IEC/TC 85).[83] In light of the ten key sectors of the Made in China 2025 plan, it is apparent that the PRC has gained ISO and IEC secretariats in fields corresponding to its overall industrial policy strategy. In 2022, China obtained five out of nine new TC, SC and Project Committee (PC) leadership positions. China was given the secretariat positions on brain-computer interfaces (ISO(IEC/JTC1/SC43), enhanced oil recovery

(ISO/TC67/SC10), heat supply networks (ISO/TC341), management consultancy (ISO/TC342) and small hydropower plants (ISO/TC339).[84]

While technical leadership positions are important, however, they are not a necessary requirement to impact standardization. Participation in standard developing committees captures which actors can submit proposals to and comments on the standardization process. Figure 5 demonstrates that China is a participant in more standard developing committees in ISO and the IEC than any other country. Figure 6 demonstrates that China's participation has grown enormously since 2007.[85]

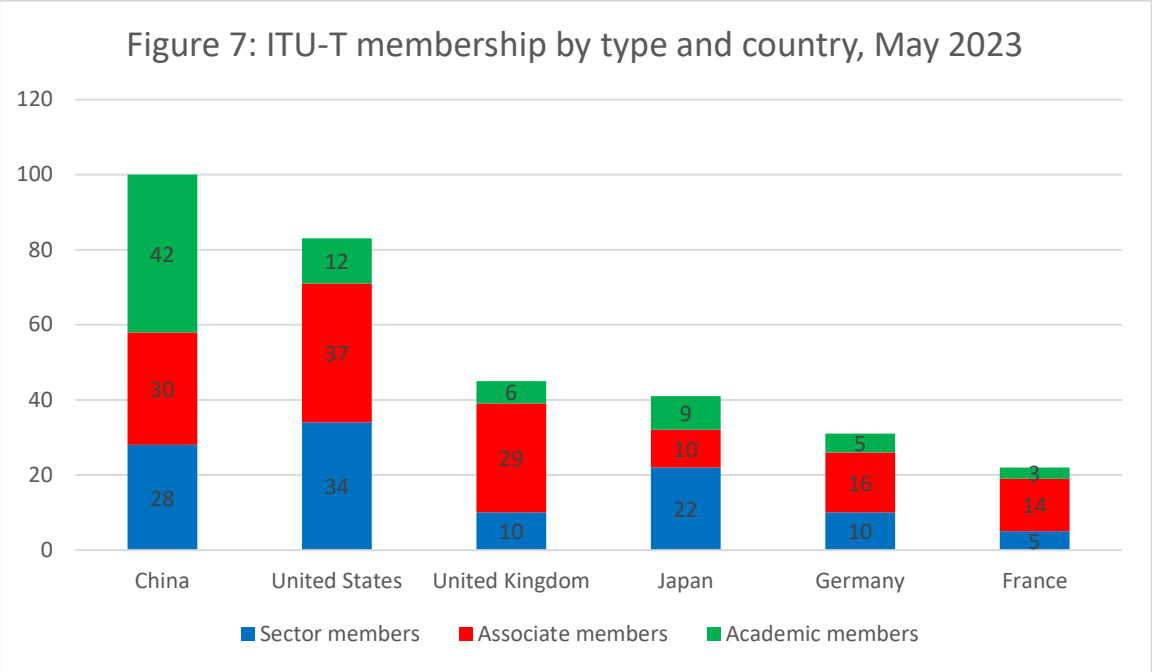




Source: AFNOR.

Although China has increased its presence in ISO and the IEC, the PRC is far from dominating the two organizations. In the ITU Telecommunication Standardization Sector (ITU-T), however, China's influence is more apparent. In terms of sector members, the most influential type of ITU-T membership, and associate members, China ranks second behind the US. The PRC is outcompeting all other ITU members in terms of academic membership, which is a membership type with reduced fees and less influence in the ITU (Figure 7). Even more impressive is the enormous *growth* in the PRC's

membership. In late-2012, China had just 15 ITU-T members. By July 2019, membership had grown to 46.[86] At the time of writing, China has 100 registered ITU-T members.



In terms of technical leadership positions, China has gained a strong role in ITU-T as well. Study Group chair positions are almost equally distributed among leading ITU-T members. In the study period 2022–2024, the PRC fills one of 11 chair positions. Only Japan and South Korea have gained two seats each. In the previous study period of 2017–2021, China was one of a few countries that held two such chair positions. Of the much higher number of study group vice-chairs, China secured 8.7%, ahead of South Korea (7.7%), Argentina, Japan and India (5.8% each) in the current study period. In the previous study period, it had a slightly higher share of 9.1%. China's share of leadership positions in the ITU-T working groups (including the Conformity Assessment Steering Committee) is even higher. In the study period 2022–2024, China has the largest share of chairmanships (24.2%), followed by Japan (15.2%) and South Korea (12.1%). This is a slight increase over China's 23.3% share in the study period prior to 2022. If the vice-chairs are taken into account, China's lead becomes even clearer. While China's share amounts to 23.5%, the UK (9.8%), as well as Argentina and Tunisia (7.8% each) follow at a great distance. In 2021, China held 18.4% of these vice-chair positions.

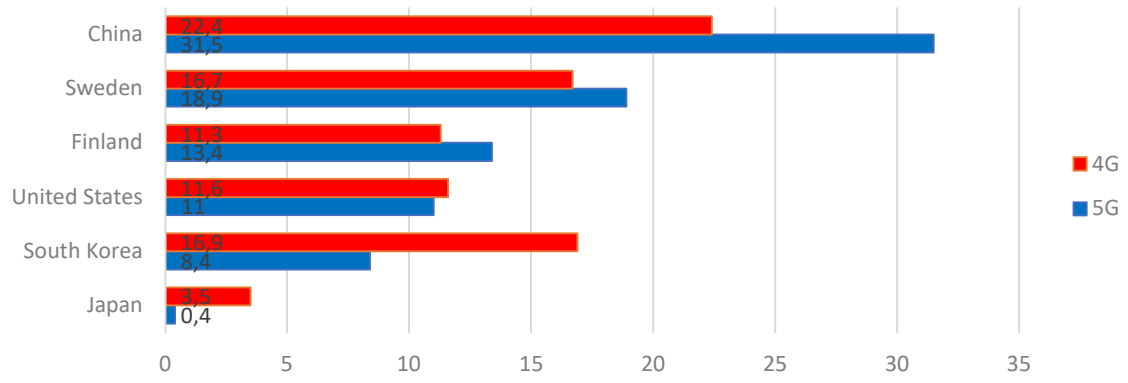
If contributions to and work items submitted to ITU-T study groups are considered, China's engagement appears dominant. In 2021, Chinese entities submitted 54.4% of all contributions to ITU-T Study Groups. In terms of work items, Chinese companies were involved as supporting members in around 23%. If just work items that cite any supporting members are considered, China's share increases to more than 65%. These numbers are even more impressive given that contributions of PRC members stood at "only" 28.8% in 2012.[87]

Just like in ISO and IEC, China's influence on ITU standardization varies across technology sectors. As a relative latecomer to international standardization China is focusing its efforts on strategic sectors and new technologies that are yet to be standardized.[88] Examples include drones,[89] lithium batteries,[90] 5G,[91] data security[92] and AI.[93] The PRC has dominant positions in ITU-T in the standardization of IoT and smart cities. China submitted 42% of all IoT contributions to ITU-T. The PRC may not quantitatively dominate IoT standard-setting in ISO and the IEC, but it has reportedly shaped several seminal IoT standards. As of March 2019, China had proposed no less than 11 standards for the Internet of

Things within the ISO/IEC framework, of which almost half have been approved and none have been rejected.[94]

China does not numerically dominate ITU-T smart city standardization but in drafting some of the most seminal documents, Chinese participants where influential, not least by outnumbering those of other countries by far: "Chinese editors took the lead for all standards related to Key Performance Indicators (KPIs) for smart cities. Controlling the metrics by which smart cities are understood and compared gives China a significant degree of power over the expectation for smart cities, including allowing them to guide acceptable levels of security and data sharing".[95] China has also proved highly influential in ITU-T AI standardization and standard-setting for 5G. The PRC was able to secure several technical leadership positions in the ITU-T, shaping 5G standardization. Even more importantly, China has become influential in 5G standardization within the 3GPP. Figure 8 shows that China's share in 5G standard contributions ranks first and has increased from the previous generation of mobile technology, 4G/LTE.[96]

Figure 8: Share of standardization contributions (in %) to 4G and 5G by country.



Source: Wall Street Journal, based on IPlytics data.

While standard essential patents (SEPs) are not the best way to calculate influence on standard setting, SEPs indicate the distributary effects of standardization.[97] IPlytics data shows that Chinese companies hold around one-third of 5G SEPs, more than any other country. In comparison, observers estimate that China held around six per cent of the SEPs in the previous mobile technology generation, 4G/LTE, in 2011.[98] However, if proxies for the technological relevance of SEPs are considered, the IPlytics database finds Chinese patents to be the least important compared with those filed by companies from other major 5G technology leaders in Europe, the US, South Korea, Japan, Taiwan and Canada.[99]

Despite all these Chinese successes, the PRC is not dominant in all technical standardization within the ITU. For example, China was a latecomer to the standardization of quantum technologies and failed with its "New IP" proposal in the ITU. Similarly, it took the SAC around four years, until May 2020, to propose the establishment of a national blockchain standardization TC that mirrors the ISO's TC 307, in order to domestically prepare contributions to be submitted at the international level.[100] ISO/TC 307 was established in 2016.

While it is beyond question that China has increased its influence on international standardization, the quality, value and therefore also the precise degree of impact of the PRC's contributions are contested. Because technical standardization spans a wide range of products and technologies, and is itself a highly technical process of negotiation among specialized engineers in which one single

proposal seldom fully prevails, measuring China's footprint in international standardization is a complex process that must remain an approximation. For many years, European and US participants in international standardization reported that Chinese actors were submitting a high number of often low-quality contributions that were regularly rejected. In some cases, not even the technical relevance of the submissions was clear.[101] The PRC itself focuses its policy documents on quantifiable measures of success, which incentivizes the submission of a high number of contributions.

While some of the quality concerns might still hold true, it cannot be denied that the PRC's standardization contributions have improved.[102] China has arguably asserted its influence not only through the number of its contributions, but also in the importance of steering foundational standards work. In the ITU specifically, China has been steering the development of roadmaps, overviews, reference architectures, terminologies and general specifications in a number of foundational and emerging technologies.[103]

Even harder to assess is China's success in spreading de facto standards internationally. There is no registry of such standards from which to deduce statistical overviews. One crucial mechanism for the dissemination of Chinese standards is likely the BRI, which has an explicit standardization dimension.[104] In 2015, the NDRC issued its first *Action Plan for the Harmonization of Standards along the Belt and Road*.[105] In late-2017, the NDRC published another action plan setting further benchmarks.[106] As part of the plan, China began to translate its domestic technical standards into foreign languages to facilitate their adoption in third countries.[107] Similarly, China proudly reports that association standards for export goods have been developed in Chinese and English to spread along the BRI.[108] By September 2019, China had signed 90 bilateral agreements on technical standardization cooperation with 52 countries and regions.[109] China has also concluded 16 memoranda of understanding with BRI countries with regard to digital standard setting as part of the Digital Silk Road.[110] Chinese experts acknowledge, however, that these agreements are vague and it is unclear how meaningful they really are.

More important than such agreements might therefore be concrete BRI projects that incorporate Chinese technical standards. One case is the registration and authorization of 83 Chinese standards in Turkmenistan, which reportedly helped the China National Petroleum Corporation save 15% in investments in the South Yolotan gas fields.[111] It is through these projects that the PRC disseminates its domestic technical standards to third countries without submitting them to international SDOs. Other sectors in which China aims to spread its standards to BRI countries reportedly include ultra-high voltage (UHV) transmission technologies and AI.[112]

Another prominent example is the promotion of railway standards in BRI projects. For a long time, in the absence of a comprehensive set of international standards, China was mostly an adopter of European standards on railways, ranging from rolling stock to signaling for both mainlines and metros.[113] In recent years, China has not only developed standards that are not identical to European, Japanese and US ones, but also started to promote its own standards in BRI countries. China offers funding, mostly as loans, for the development of railways if they are constructed by the CRC or other Chinese manufacturers based on Chinese standards.[114] In addition, China is also striving to take the lead in the development of international railway standards in the ISO (ISO/TC 269) and the IEC (IEC/TC 9).

As China dominates the rollout of other critical infrastructures in BRI countries, it is likely that Chinese technical standards will spread implicitly to third countries. The PRC's large exports of smart city technology[115] are rightly identified as a vehicle for spreading sensitive de facto standards.[116] Equally, China

is a technology leader in digital solutions for seaports. Several of the PRC's largest ports are leading not only in terms of global cargo throughput, but also among the most efficient. While the author is not aware of a comprehensive study analyzing China's role in smart seaport standardization, the country's dominance is likely to have translated into the dissemination of related standards.[117] The underlying logic of action is that Chinese-funded projects are mostly executed by Chinese companies.[118] These offer technological solutions based on Chinese standards. No formal contract and no formal adoption of these standards is necessary for them to become effective. China also holds the secretariat of ISO/TC 8, "Ships and marine technology", while Huawei has become successful at developing smart port systems based on its ICT, IoT and 5G technologies. In Europe, there is currently no standardization activity that specifically targets smart seaports, but horizontal work is being carried out with regard to smart cities, AI, blockchain, cybersecurity, drones and 5G that will have implications for smart seaports.

Limited influence of Chinese standards in Europe

As Europe is an open economy, international actors can have an influence on European standardization. This includes companies from both democratic and non-democratic countries, including China. Firms with legal representation in Europe can participate in European NSBs, including those with headquarters outside of Europe. In CEN and CENELEC, non-European actors can only participate as part of European NSB delegations. This system has been tried and tested for decades and provides robust safeguards against malign influence. Most importantly, standardization in Europe is a consensus building process. European law requires that small and medium-sized enterprises (SMEs), consumer organizations, trade unions and environmental organizations all participate in the standard-setting process. These safeguards minimize the risk of domination by one or a few actors from any country, including from China.

In light of these safeguards, increased participation by experts from Chinese companies in the development of European standards is not necessarily alarming, although one would need to carefully review the sensitivity of standards developed in specific sectors. In CEN and CENELEC, standardizers in Chinese companies participate primarily in electrical energy supply, power electronics, communication cables, power systems management and associated information exchange, electrotechnical aspects of telecommunications equipment, smart grids, electric vehicles, cybersecurity and AI. Overall, experts from Chinese-based companies contribute to around 40 CEN and CENELEC TCs.

The influence of non-European actors in ETSI is more prominent. In essence, ETSI has developed into a dual institution, serving both as one of Europe's three ESOs but with the de facto status of an international SDO. Recent amendments to European standardization regulation 1025/2012 are intended to reduce the influence of Chinese multinationals including Huawei. Voting rights on harmonized European Norms (hENs) that support European legislation lie with NSBs not individual company members. Non-public analyses prior to the amendment had demonstrated a high concentration of voting rights among the largest 20 firms participating in ETSI, many of which are Chinese. Until recently, ETSI's TC dealing with Cybersecurity had been led by Huawei. While the recent regulation amendment only applies to the development of hENs, which makes up less than 5% of ETSI's work, critics fear that it could only be the beginning of a process dismantling ETSI's status as a well-established international SDO. In fact, the reform emphasizes ETSI's function as an ESO over its status as an international SDO.

Ironically, these reforms have triggered criticism not only from China, but mostly from US companies.[119] The US government has also voiced concerns in the US-EU Trade and Technology Council

(TTC). The latter is remarkable given that the European Commission just published a Standardization request for AI to support the EU's upcoming AI Act. To meet this request, ISO/IEC Joint Technical Committee 1, Subcommittee 21 has concluded an agreement on collaboration with the US-based Institute of Electrical and Electronics Engineers (IEEE). This is indicative of the fact that the EU's policy is not primarily targeting US involvement, but aligned with the interests of transatlantic collaboration.

When assessing the effects of Chinese participation in European and international standard-setting organizations, one must consider the alternatives. China has developed into a highly innovative country and it is natural that it should gain influence over international standardization. If the PRC is not accommodated in existing institutions that follow established rules with a strong presence of European and US actors alongside like-minded partners, the PRC is likely to establish rival institutions that could undermine the existing system. In its Standardization Outline, China announced its intention to set up industry consortia in China to work in the English language in order to attract international companies and challenge existing standard-setting industry consortia, most of which are based in the US, such as the IEEE or the Internet Engineering Task Force (IETF). In September 2022, the first of such associations, the WLAN Application Alliance (WWA), was founded in Shenzhen.[120] Rumors speak of at least five more such industry alliances that are currently in preparation and could be launched soon. This development could also weaken ETSI if China established a rival institution.

Another potential inroad for Chinese influence is the adoption in Europe of de facto standards from China. The tracking de facto standards is difficult, and no proper analysis exists to the knowledge of the author. However, some mechanisms of potential influence can be identified. For example, Chinese investors in European infrastructure projects might require the use of Chinese standards. These standards need to be compatible with European legislation, but risks could still result if standards compliant with regulation had inherent security risks or fragmented the Single Market, or if deficient market surveillance allowed non-compliant standards to exist in practice. However, the author is not aware of such cases.

Another potential mechanism of Chinese de facto standard influence in Europe emerges from European firms' R&D engagement with the PRC. For example, substantial innovation in fields such as autonomous driving and electric vehicles is carried out in China. It is not unlikely that such innovation influences Chinese standardization and by extension is also utilized in Europe. Ultimately, such innovation could become part of European standards. It should be borne in mind, however, that innovation is by its very nature transnational and the spillover of technical specifications to other countries is the rule rather than the exception. In line with the risk profiles discussed below, it is worth monitoring the concrete effects of standards instead of taking issue with their origin by default.

Limited adoption of international standards in China

China's increasing activity in international SDOs might be daunting to some international observers but it is generally a positive trend. It is no surprise that economic transformation in the PRC is being accompanied by increased impact on international standardization. Integration of the PRC into existing institutions, however, is in contrast to adoption ratios of international standards. Calculating adoption ratios is anything but straightforward, so assessments vary. Rhodium Group and BusinessEurope, for example, identify a continuous downward trend from an adoption ratio of 69 per cent in 1998 to just 21 per cent in 2017.[121] The European Union Chamber of Commerce in China has "observed that the overall percentage of new international standards issued by China has slightly increased since 2017, it also notes a general downward trend in the past decade, and that a number of these standards are not identical to their international counterparts".[122]

There are two possible explanations for the China's low adoption ratio of international standards despite increasing engagement in international SDOs. First, China's engagement could reflect the fact that the PRC is seeking to increase its international influence but does not accept the merit of the institutions as such. From this perspective, international SDOs are merely instrumental for China. Second, domestic factors might be negatively impacting China's adoption ratio. The SAC aims to keep the number of national standards relatively low, which implies that it would probably be reluctant to approve a high number of standardization initiatives. Therefore, faced with the need to prioritize the development of some national standards over others, Chinese standardizers have a self-interest in developing their own standards instead of filling their quota through the adoption of international standards. An underlying reason is that the development of standards requires more work, and also generates and safeguards employment, while the adoption of standards does not to the same extent.[123]

If the latter interpretation holds true, China's Standardization Outline, which has set ambitious benchmarks for the adoption of international standards at 85%, could serve as a means to break domestic resistance and increase Chinese adoption of identical international standards.

De-risking China's growing standardization power

- China's growing international standardization power is not a problem as such but reflects the country's level of innovation.
- Nonetheless, the EU and the US should not stand idly by while Chinese standardization power grows. Both transatlantic partners should invest in their own standard-setting capabilities to maintain a competitive advantage.
- Lock-in dependencies could lead to technology fragmentation and undermine supply chain resilience.
- Standardization can increase security but has the potential to spread vulnerabilities. China's civil-military fusion in standardization is a source of concern to the EU and the US.
- Chinese standards can undermine fundamental human rights. The predominant role of the party-state in Chinese standardization is accelerating concerns that China's standardization might normalize Chinese authoritarian norms in third countries.
- Competition over SEPs and SEPs pricing have enormous effects on competitiveness. An uneven playing field is a major risk to the US and the EU.

China's increasing footprint in international technical standardization is neither extraordinary and surprising nor a threat. The PRC has developed into a global powerhouse and thus naturally also into an international standardization power. Standard-setting has always been cooperative and competitive: "We must clearly understand the fundamental law of standard development which is that standards are never neutral. They reflect the strength and innovations of those who offer them to the committees. Not participating in standardization abdicates the decision-making to the competition, whether it be by company or nation".[124] China's influence is not negative – at least as long as China is integrating into existing international SDOs.

That is not to say that the EU and the US can stand idly by while Chinese standardization power grows. Both transatlantic partners should invest in their own standard-setting capabilities with the aim of maintaining a competitive advantage.

It is also not to say that China's growing footprint in technical standard-setting is without risks. These risks arise not least from China's state-centric approach, which closely links standard-setting and strategic political goals. To de-risk, the United States and the European Union must properly understand

the risk profiles that mirror the four general risks outlined above. Simply pushing back against any Chinese influence will only make the existing standardization system dysfunctional and incentivize China to spread its technical standards outside established SDOs. The following lays out the standards dimension of the four risks and explains how China's state-centric approach adds to the challenge.

- *Risks to supply chain resilience:* Technical standards create markets by means of interoperability. When technical standards are global in scope, they facilitate international trade and help to increase the resilience of global supply chains. The underlying mechanism is simple: When technologies and products share standardized features that make them interoperable, they are easier to exchange with the technologies and products of a competitor. Hence, sourcing from a variety of suppliers gets easier. However, standards can also be hurdles to trade and create distinct technological spheres because they generate interoperability only in the geographical area where they are applied. This means that technical standards can create geographically bifurcated or fragmented technological corridors. Competing contradictory standards result in a lack of global interoperability, potentially creating 'lock-in' effects that can come with political costs that reach far beyond the field of technical standardization. Chinese railway standards in the BRI countries are a case in point. The respective countries will need Chinese suppliers to maintain and further build out their railway networks for the foreseeable future, as the standards are not compatible with those of non-Chinese competitors.
  The resultant risk is that of a fragmented technology world with distinct standard spheres. This double-edged sword is neither China-specific nor new. Economists have been studying lock-in effects resulting from dominant technologies for decades, particularly if they enable complementary technologies as network effects/externalities.[125] Such studies have convincingly demonstrated that the obstacles to changing such dominant technical standards are high, particularly since this comes with enormous adaptation costs.[126] Particularly in the digital components of critical infrastructure, maintenance and expert knowledge are becoming essential, and lock countries into the products of specific suppliers. 'Early mover advantage' can also result in a technologically inferior solution remaining dominant.[127]
  Politically, this remains largely unproblematic as long as the respective technology/product is not sensitive for the well-being of society and no political strings are attached. Railways, however, are critical infrastructure, enabling the flow of goods and people. A lock-in effect in such a critical sector has the potential to lead to political blackmail. Even the threat of blackmail might contribute to third countries carefully considering whether to challenge the core interests of the PRC.[128] As many Chinese companies operating in critical sectors are state-owned or closely aligned with the party-state, the risks of political interference increase.
- *Risks to national security:* Technical standards also have the potential to impinge on what is often regarded as the crown jewels of state power: security narrowly defined as risks resulting from military and intelligence capabilities. Some observers argue that those who develop a technology are likely to have a deeper knowledge of how it works, including its vulnerabilities. Once internationally standardized, this technology spreads globally. When this concerns critical digital infrastructure, the developer of the technology in question possesses prime knowledge of its flaws, which has the potential to be used to undermine an adversary's (cyber)security.[129]
  Many experts within the Chinese defense industry argue that the use of standards from overseas competitors in strategic sectors of communication creates critical vulnerabilities for the PRC. From this perspective, technical standardization becomes a subject of civil and military network security.[130] Following a similar logic, observers from the US defense sector have

been discussing the implications of Chinese strengths in 5G standards for the low-frequency spectrum. This led them to consider strengthening the millimeter spectrum (mmWave) to ensure that US military communication in operations abroad have reliable infrastructure where foundational technical standards are shaped more by US companies than those for the 5G low-frequency spectrum.[131]

Standardization can increase security. It is a process of maximum transparency as it is essentially a process of international peer review. Indeed, it is difficult to hide security-relevant flaws from the engineers of potential adversaries. A high degree of standardized technology increases the (cyber)security of products by providing international transparency. Agenda-setting power over which components of a given technology are the subject of standardization becomes highly security relevant. Whichever perspective is more accurate, however, technical standardization influences the degree of (cyber)security in critical digital technologies.[132] This explains why it is not only the content of adopted standard contributions that is important, but also the definition of the components and how the contribution is to be implemented by means of certification.[133] This applies particularly in cases of dual-use goods when technical standards are relevant not only for civilian but also for military purposes.[134]

China's party-state has a steering function within the Chinese system, interferes formally and informally and has openly declared civil-military fusion to be one of its policy goals in technical standardization. The PRC's growing footprint in standard-setting therefore carries risks to the national security of the EU and the US. A recently published report provides examples of the involvement in standardization of Chinese actors that are sanctioned by the United States for their close ties to the PRC's military sector or for facilitating the violation of fundamental human rights.[135]

- *Risks to normative aspirations:* The design of technology is highly political because it inscribes ethical values. Technology does not exist in a vacuum divorced from the political. Technical standards are important in this regard since they formulate a "basic recipe" that sets the general rules by which different manufacturers develop specific products. They therefore shape the physical world around us and contribute to the constitution of our social lives. The necessity and omnipresence of standards make us barely question them.[136] Hence, technical standards shape what is perceived as "normal" technology. This does not just hold true for consumers; companies also "socialize" into the technological world shaped by technical standards and develop new applications based on existing standards.[137] This has led several scholars to describe technical standards as social institutions in their own right.[138]

  For instance, while we are used to Wi-Fi as the dominant standard for wireless area networking (WLAN), this was by no means a given. Shortly after Wi-Fi was adopted as the international standard, China proposed wireless authentication and privacy infrastructure (WAPI) technology as a new standard. Although it promised better performance, WAPI provided worse privacy compared to Wi-Fi.[139] WAPI met considerable resistance and finally failed to become an international standard, due to procedural issues,[140] and because China would not release WAPI's security algorithm.[141]

  This is not an isolated example. At a time when emerging technologies are increasingly penetrating all spheres of public and private life, ethical, political and security concerns are playing a growing role in technical standardization. Algorithmic bias and data privacy are just two examples of ethical underpinnings in technical standardization.[142] The EU recognizes the importance of AI's ethical implications and has drafted guidelines that found a wide international resonance, not least among Organization for Economic Co-operation and Development

(OECD) countries.[143] However, such guidelines need to be standardized if they are to become effective. EU officials openly admit that this is where the EU risks failure due to its relatively low presence in international AI standardization.[144]

China is well aware of the "normalizing" effects of technical standards. For example, the PRC rejected the standardization of Cantonese writing on western keyboards, which would have eased the use of the southern Chinese dialect. The weakening of Mandarin Chinese would have only been marginal, but the Chinese leadership was concerned about the symbolic importance of such a standard.[145]

International standards are also useful normative tools as they have enormous legal implications. Standards may be voluntary by definition but standards can become part of international trade law through the backdoor. The TBT Agreement, the Agreement on Government Procurement, the review of the Agreement on Sanitary and Phytosanitary Measures and the General Agreement on Trade in Services (GATS) under the framework of the World Trade Organization (WTO) all treat international standards as crucial benchmarks for the facilitation of international trade and as important qualifications of what counts as a legitimate exception, for example under the pretext of basic safety requirements.[146] This is more crucial than one might think given that around 80% of trade is affected by technical standards and associated technical regulations.[147] The normative implications of standards are not China-specific. However, the predominant role of party-state actors in China's standardization system is accelerating concerns that Chinese standard-setting activities foster the spread of Chinese authoritarian norms to third countries.

- *Risks to competitiveness:* The effects of technical standards on the competitiveness of companies are well-known and widely discussed. However, the growing importance of ICT in a broad set of economic sectors is only accelerating these effects. In many cases, patents implement standards. An estimated 55% of all ICT standards are patented technology. This includes a wide variety of applications in fields as varied as telecommunications, e-commerce, electronics, life sciences, healthcare, manufacturing and the automotive industry.[148]

  While SEPs are available to all suppliers and not just to the patent holder under FRAND terms, the licensing of SEPs comes with enormous amounts of royalty fees that manufacturers must pay to the inventors of the underlying innovative technologies. For example, US high-technology company Qualcomm earned €5.2 billion by licensing technology in 2017, accounting for more than 20% of the company's revenue; and Finnish telecommunications vendor Nokia generated €1.65 billion the same year in the same way, which was 7% of its total revenue.[149] Having been the second largest payer of license fees in the past 15 years,[150] China has identified the impact on competitiveness. The country is now striving to increase its share of SEPs or to develop its infrastructure and technology projects without Western standards, while also spreading Chinese standards by means of the BRI.

  At a time when digital connectivity affects more and more sectors that used to be non-digital, such as the automotive, home appliances and healthcare sectors, experts argue that the licensing of SEPs will most likely be very different across industry sectors.[151] The importance of patents in technical standards will only increase.

  These effects are not limited to the payment of royalties for SEPs. Companies that fail to establish their technological solutions as technical standards must redesign their products to comply with other standards. This results in what is widely referred to as 'switching' or 'adaptation' costs.[152] Hence, those that successfully set international technical standards can not only expect royalties from SEPs but also avoid adaptation costs. Given the considerable size of

both royalties and fees, there is a clear correlation with competitiveness.
China has well understood the importance of SEPs and is striving not only to obtain more SEPs, but also to achieve control over SEPs pricing. For this purpose, the PRC's Supreme Court has issued an anti-suit injunction that threatens companies with high penalty payments if SEPs conflicts are not brought to the Chinese courts. The EU and the US have taken a case to the WTO judiciary.
The anti-suit injunction is not the only risk emerging from the close interlinkage between the party-state and its standardization agenda. In fact, the uneven playing field described above, which includes direct and indirect subsidies facilitating the development of technical standards but also enormous state investments in standards education, distorts fair competition over international standardization.
A final example is China's tactic of swamping international SDOs with standard proposals and sending a high number of representatives. This overload increases the chances of Chinese contributions being accepted, not least if it comes with significant Chinese voting power and comprehensive coordination.

The final section explores how the US and the EU can meet these challenges through a coordinated de-risking strategy.

Policy recommendations on transatlantic cooperation

- The transatlantic partners face a dilemma: they need to meet the challenges from China's state-centric approach and adopt a de-risking policy but must avoid dismantling the existing private sector-led standardization system which works to their advantage.
- As a general guideline, a commitment to continued standardization cooperation with China should be coupled with deeper transatlantic coordination, but along the lines of the four risk profiles.

Both transatlantic partners face the same dilemma in responding effectively to China's growing footprint in technical standardization. On the one hand, the US and the EU are striving to respond to the risks outlined above and should integrate technical standard-setting into their de-risking strategies. On the other hand, they should strive to prevent the disintegration of the private sector-led system that has served the interests of both transatlantic partners well. At its extreme, state interference could lead to a partial adoption of Chinese state-centric approaches. For example, for good reason, the US Government withdrew a previous executive order that could have deterred companies from standardization cooperation with sanctioned Chinese actors. If upheld, this would have eroded the relevance of the respective SDOs and could have facilitated the relocation of standardization to other forums or the fragmentation of standards.

Both the EU and the US have recognized this general dilemma and have sought to strike a balance between the different policy needs in their respective standardization strategies. The European Standardization Strategy, published in February 2022, has been criticized by some stakeholders for taking a too state-centric approach. It is not unlikely that the US Strategy, published by the White House in May 2023, will meet similar concerns as its vaguer clauses indicate a similar course to that of the EU. Private sector stakeholders should bear in mind, however, that the EU and the US must de-risk their standardization approaches. Policy changes are essential.

As a general guideline, the author suggests committing to continued standardization cooperation with China as well as deeper transatlantic coordination, but along the lines of the four risk profiles.

- *De-risking to enhance supply chain security:* Central to strengthening supply chain security by means of standardization policy is the promotion of international standards while avoiding the fragmentation of standard-setting and lock-in effects to Chinese standards. For this purpose, the transatlantic partners should adopt four policy measures:
  - ✓ *Coordinate support for concrete international standards in the TTC:* Transatlantic endorsement of technical standards continues to be a powerful tool boosting the international relevance of technical standards. The recently concluded TTC ministerial meeting in Luleå, Sweden provides an example of best practice. The Joint Statement included an agreement on a common approach to international standards developed by ISO/IEC/SAE to support the megawatt charging system infrastructure for heavy duty vehicles. This is likely to strengthen international standards competition with the "Super-Chaoji" standard, which is currently being jointly developed by China and Japan. The Joint Statement further explores similar cooperation in additive manufacturing, recommending the development of standards with three logos (ISO, CEN, ASTM).
  - ✓ *Introduce voluntary certification schemes to increase the resilience of SDOs:* The governance structure of many SDOs has proved robust, but this does not hold true for all standard-setting organizations. Voluntary certification that includes a stress test along the lines of the criteria set out for international standardization in the TBT Agreement could strengthen the impact of SDOs with robust governance structures. These procedural criteria are transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and a development dimension that implies standard setting must be open to developing states.[153] Stress test certification should also consider the distribution of votes.
  - ✓ *Bind infrastructure investment cooperation consequently to international standards:* States participating in the BRI are increasingly aware that incorporating Chinese technical standards comes with inherent technological dependencies. The EU and the US should therefore try to alleviate any related unease by incorporating and incentivizing the adoption of international standards in all financing vehicles in their infrastructure investment initiatives, not least within the G7 format. Where international standards are not available, the transatlantic partners should develop processes to develop standard solutions with local partners that avoid lock-in effects.
  - ✓ *Uphold conditional standardization cooperation with China:* Preventing the fragmentation of standard-setting requires maintenance of Chinese commitment to existing international standards. The US and the EU should actively encourage Chinese participation as long as this conforms to the rules of established international SDOs. In cases of non-compliance or discrimination against foreign-invested enterprises in domestic standardization in China, the transatlantic partners should coordinate by raising concerns in bilateral meetings with China and bringing them to the WTO/TBT Committee.
- *De-risking to enhance national security:* Meeting risks to national security primarily requires identification of critical standardization efforts by the PRC and matching Chinese engagement with actors with an active interest in and mandate to safeguard the national security of the US and the European Union. Four tools could support such transatlantic activities:
  - ✓ *Transatlantic security review mechanism:* Most technical standards have no impact on national security defined as relevance for military and intelligence capabilities. Identifying and tracking standardization activities across the multitude of international standard-setting organizations – not to mention de facto standardization – with security relevance is an ambitious undertaking. The transatlantic partners should consider setting up a registry of security-relevant standardization projects – possibly

as part of cooperation within the North Atlantic Treaty Organization (NATO) and its existing standardization arm.

- ✓ *Enhancement of public actor engagement:* National security is not the primary concern of the corporate sector. It would be naive to assume that defending national security interests in international SDOs will be successful without an increase in the number of state representatives in these organizations. As technical expertise is required, transatlantic partners should consult and explore best practices for attracting talent to fill these positions, and increase public budgets.
- ✓ *Proactive mapping of upcoming technical leadership vacancies:* Agenda setting is central to defining the scope of standardization, which – as argued above – has security relevance. Mapping upcoming vacancies in technical leadership positions in relevant international SDOs coupled with transatlantic coordination could help to fill more of these leadership positions.[154]
- ✓ *Pushback against Chinese civil-military fusion in international standardization:* China's standardization efforts could suffer from international pushback due to the explicit linkage of the civilian and military purposes of standard setting. This "civil-military fusion" has the potential to damage China's international reputation. Transatlantic partners should raise awareness and concerns, and encourage China to commit to the civilian purposes and common good principles of standardization. If China were to make any such commitments, these would need to be reflected and clearly communicated in its domestic policy.

- *De-risking to enhance normative ambitions:* A core challenge to the protection of fundamental values is that current standardization practices consider economic and technical merit but not fundamental values. Four measures could promote the normative agenda of the transatlantic partners:
  - ✓ *Promote values as benchmarks for international standardization:* Technical standards are inscribed with values that touch on human rights concerns, among other things. The transatlantic partners should aim for fundamental human rights to be acknowledged as a criterion − at least in strategic sectors such as AI. The EU and the US could advocate SDOs and standard-developing industry consortia to adopt a self-commitment to basic human rights. The Internet Research Task Force (IRTF), for example, has already developed human rights guidelines.[155]
  - ✓ *Broaden standardization cooperation to like-minded partners:* The US and the EU should not be the only actors with an active interest in the defense of fundamental rights. Coordination among lawmakers and standardizers from Europe, the United States and like-minded partners such as Japan, South Korea, Australia and New Zealand should be explored and focused on specific and concrete value concerns. While such coordination is necessarily of limited impact, the TTC has proved that it can be instrumental – not least in the context of coordination ahead of leadership elections in the ITU.
  - ✓ *Enhance the participation of civil society and public actors:* Technical standards are mainly developed by large companies. In addition to increasing SME participation in standardization, the EU and the US could provide financial incentives for non-profit civil society actors to get more involved in international standard setting. In the absence of business interests, civil society actors can be freer to address the values dimension of standardization. At the same time, political representatives need to take an increasingly direct and prominent role in standard setting to protect values that are outside of the corporate interests of companies.

- ✓ *Build standardization alliances for sustainability:* While the transatlantic partners and China may have divergent views on a number of values inscribed in technical standards, they share concern on the protection of the environment, including combating climate change. As part of an agenda that combines cooperative and competitive elements with the PRC, the US and the EU should actively explore the cooperation potential in standardization for sustainability.
  Dialogues with the PRC should explore the potential for common interests in technical standard cooperation in specific sectors, with a focus on concrete deliverables. One ongoing example is EU-China collaboration on green investment taxonomy standard setting.

- *De-risking to enhance competitiveness:* European and US competitiveness suffers from an unlevel playing field in standard-setting vis-à-vis China. Four sets of policy measures could help to defend transatlantic interests:
  - ✓ *Increasing financial support for strategic standardization:* In light of the substantial financial support provided for pre-standardization research and standardization activities in China, the transatlantic partners need to face the reality that they have to spend more on standard-setting. As resources are scarce, five criteria should be applied for targeting financial support for standardization work: preventing lock-in effects, cross-industrial relevance of standards, national security relevance, ethical implications and regulatory relevance.[156] In addition, standardization education needs to become a priority. In China, thousands of engineering students graduate every year from programs that either exclusively train them in technical standardization or include modules exposing them to standard setting. Transatlantic programs promoting and funding the establishment of academic standardization education is needed.
  - ✓ *Coordination of regulation and standardization:* The close interlinkage of standards and regulation can provide enormous force. When referenced in legally binding documents, technical standards remain voluntary but, as they support legislation, have additional relevance to market actors. The EU is making systematic use of this mechanism. When coordinating strategic technology policies, the transatlantic partners should actively explore where international standards developed by ISO and the IEC can support the common agenda and agree to reference the same standards in legally binding documents, effectively outperforming alternative standards.
  - ✓ *Defense of international best practices for pricing of SEPs:* As China strives to gain control over the pricing of SEPs, the transatlantic partners should continue to closely coordinate their efforts in the WTO. As this takes time, both sides should refrain from adopting similar tactics and instead explore defensive measures such as providing legal grounds for courts to issue countermeasures (anti-anti-suit injunctions).
  - ✓ *Insist on reciprocity and explore sanctions targeting Chinese discrimination:* An approach to technical standards that promotes technical quality should not discriminate against actors due to their origin. The transatlantic partners should insist that China fulfil the promises it has made in its Foreign Investment Law and its Standardization Outline, and grant all interested stakeholders—including FIEs—fair access to all TCs, SCs and WGs. China should guarantee equal rights to all entities participating in standard-developing committees, ensuring transparency regarding membership requirements, fees and information disclosure, while encouraging inclusive standard setting across standard-developing associations. Inclusivity should also be increased for association standards. Such calls for reciprocity should be coupled with insistence on compliance with WTO requirements. Despite progress, China still falls short of its reporting duties on technical standards to the WTO's TBT Committee. The EU and the

US should not only continue to raise this with China, but also develop a simple sanctions mechanism for dealing with violations of reporting duties and include this in their WTO reform proposals.

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china-battles-west-for-control-of-vital-technology-standards-11612722698, accessed 17 February 2021. Many standard contributions are made by a group of firms, including actors from several countries. This means that the relevance of companies' standard contributions needs to be weighted. One method of doing this is to only consider first authors because contributing companies are normally listed in the order of their importance to a given standard proposal. An alternative method for calculating standardization contributions is to attribute each contributing company an equal share of a standard contribution (all combined receive one share). For example, if a standard contribution is submitted by four firms, each company is credited with 0.25 standard contributions. While China's share of 5G standard contributions varies depending on specific calculations, the IPlytics database demonstrates that the PRC is ranked first by all calculations. In terms of accepted standard contributions, however, China falls slightly behind contributions from EU companies. Tim Pohlmann et al. (2020): Studie zur Untersuchung und Analyse der Patentsituation bei der Stanardisierung von 5G. Berlin: IPlytics.

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