Implications and Significance of Chinese Modernization for Global Open Science Practice

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Abstract

This paper advocates for implementing open science practices through the framework of Chinese-style modernization. The core connotations of Chinese-style modernization encompass adherence to the general laws of modernization, alignment with national realities, embodiment of national characteristics, and the principle that national strength building and national rejuvenation constitute the sole correct path. Open science is defined as an inclusive architecture designed to render scientific knowledge in multiple languages publicly usable, accessible, and reusable for all, to enhance scientific collaboration and information sharing, and to open the processes of scientific knowledge creation, evaluation, and dissemination to social actors beyond the traditional scientific community. The philosophy of Chinese-style modernization aligns seamlessly with open science principles, including grounding in national conditions and actual development needs, respecting diverse national pathways for open science development, acquiring experience through practice, and actively sharing humanity's collective wisdom. The solutions offered by Chinese-style modernization involve grounding in national conditions and actual development needs, engaging in proactive development, gradually addressing practical problems raised by various stakeholders; and respecting each country's open science development path while actively cooperating to resolve practical issues.

Full Text

The Implications and Significance of Chinese Modernization for Global Open Science Practice

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Abstract: This paper argues for advancing open science practice through the lens of Chinese modernization. The core tenets of Chinese modernization include following general modernization principles while adapting to national conditions and maintaining distinctive characteristics, representing the only correct path toward national strength and rejuvenation. Open science is defined as an inclusive framework enabling universal access to, use of, and reuse of scientific knowledge in multiple languages, enhancing scientific collaboration and information sharing while opening the processes of knowledge creation, evaluation, and dissemination to social actors beyond traditional scientific communities. Chinese modernization aligns seamlessly with open science principles—both emphasize grounding initiatives in national contexts and development needs, respecting diverse pathways for open science across countries, accumulating experience through practice, and actively sharing humanity's collective wisdom. The solutions offered by Chinese modernization involve proactive development tailored to national conditions to systematically address practical concerns raised by stakeholders, while respecting each nation's open science trajectory through active cooperation to solve real-world problems.

Keywords: Chinese modernization; open science; open access; institutional repository; open publication funding

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1. The Convergence of Chinese Modernization and Open Science

The core philosophy of Chinese modernization holds that in pursuing modernization, a nation must not only follow universal principles but also integrate its own realities and distinctive features. This concept emphasizes practicality and feasibility, offering a unique perspective that requires consideration of cultural, historical, and institutional factors. While encompassing common characteristics of modernization worldwide, Chinese modernization prioritizes the expression of its own distinctive traits—a proven approach representing the sole correct path toward national strength and rejuvenation [1-2].

In this context, the open science concept emerges as a crucial component aligned with Chinese modernization. Defined as an inclusive architecture integrating various movements and practices, open science aims to enable universal access to, use of, and reuse of scientific knowledge, enhancing collaboration and information sharing. This paradigm transcends traditional scientific boundaries by opening knowledge creation, evaluation, and dissemination to social actors beyond academia. Spanning basic and applied sciences, natural sciences, social sciences, and humanities, open science is built upon key pillars: open scientific knowledge, open science infrastructure, science communication, open participation of societal actors, and open dialogue with other knowledge systems.

Table 1. Definition of Open Science (compiled from [3])

An inclusive architecture integrating various movements and practices that: -

Enables everyone to openly use, access, and reuse scientific knowledge in multiple languages; - Enhances scientific cooperation and information sharing for the benefit of science and society; - Opens the processes of creating, evaluating, and disseminating scientific knowledge to social actors beyond traditional scientific communities.

Main Pillars: - Open scientific knowledge - Open science infrastructure - Science communication and open participation of social actors - Open dialogue with other knowledge systems

Theoretically, both Chinese modernization and open science pursue more comprehensive and profound development. While Chinese modernization emphasizes local characteristics and national realities, open science promotes global knowledge sharing through transdisciplinary and transnational collaboration. These two paradigms complement each other, forming an integrated modernization concept that offers new perspectives and models for China's scientific development and national modernization in the era of globalization.

Table 2. Main Pillars of Open Science (compiled from [4])

Four Main Pillars

1. **Open Scientific Knowledge**
2. **Open Science Infrastructure**
   - (1) Scientific publications
   - (2) Open research data
   - (3) Open-source software and source code
   - (4) Open educational resources
   - (5) Open hardware
   - (6) Physical facilities
   - (7) Virtual facilities
3. **Science Communication and Open Participation of Social Actors**
   - (8) Scientific volunteering
   - (9) Public and participatory science
   - (10) Crowdfunding
   - (11) Crowdsourcing
4. **Open Dialogue with Other Knowledge Systems**
   - (12) Indigenous peoples
   - (13) Marginalized scholars
   - (14) Local communities

Although *Excerpts from Xi Jinping's Discourses on Chinese Modernization* does not directly address open science, and UNESCO's Open Science Recommendation series does not mention Chinese modernization, careful study of the former reveals conceptual insights valuable for advancing open science. These insights provide important guiding principles for our work under current domestic and international circumstances.

In studying Chinese modernization, we must cultivate high-level logical think-

ing and grasp its sophisticated analytical framework. Simultaneously, advancing open science requires balancing tradition with innovation, continuously exploring new approaches. Particularly crucial is setting clear ultimate goals, determining how to confront difficulties, and ensuring rational target selection. This process demands listening to one's inner voice to choose meaningful objectives rather than following others blindly. Such principles embody the core tenets of Chinese modernization while aligning with global open science practice.

In practice, we should use Chinese modernization as our guide, promoting open science through continuous learning and overcoming obstacles. When encountering various difficulties, we must maintain a learning mindset, strive to solve problems, and share experiences when appropriate. This reflects both the practical requirements of Chinese modernization and the embodiment of global open science practice.

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2. Five Characteristics of Chinese Modernization

First, Chinese modernization involves a massive population scale. The sheer size fundamentally shapes the nature and difficulty of modernization tasks. Decision-making must prioritize population considerations alongside significant urban-rural and regional development disparities. This necessitates a development philosophy of historical patience and sustained progress—advancing steadily and incrementally without blindly pursuing overly ambitious goals or rigidly adhering to tradition, but rather finding balance through long-term historical development.

The South-South cooperation concept in global open science practice echoes contemporary ideas of broad participation. Unlike earlier e-science initiatives focused on elite institutions and universities, the 2023 vision of open science emphasizes whole-society engagement, reflecting both the breadth and global nature of research. This evolution demonstrates that technological development should serve not only advanced nations but also the broader interests of global society, embodying inclusivity and public good. The gradual, expansive approach better serves societal needs compared to previous models concentrated in a few institutions.

Second, Chinese modernization aims for common prosperity for all people. This represents a crucial modernization objective. The flaw of Western modernization lies in its capital-centric approach, maximizing capital interests rather than serving the majority, resulting in severe wealth gaps and polarization. This problem manifests in some developing countries as the "middle-income trap"—prolonged stagnation or even regression—largely due to failure in addressing social issues like polarization and class solidification.

The evolution of the Open Science Recommendation reflects growing recognition of common interests and diversity in research. Compared to the 2017

version, the 2021 *Recommendation on Open Science* places greater emphasis on "bibliodiversity," meaning that scientific development and open dissemination must not constrain the voice and research topics of non-English speakers or scientifically disadvantaged regions. This underscores the need in global scientific cooperation to attend to diverse research contexts and cultures to ensure scientific equity and inclusion. Additionally, the issue of transnational corporations aligning with regional elites highlights the importance of addressing local needs in open science practice to avoid neglecting unique regional contexts and development requirements. This resonates with the common prosperity principle, demonstrating that technological development must prioritize global shared prosperity and prevent widening disparities.

Third, Chinese modernization emphasizes coordination between material and spiritual civilization. Balancing these dimensions represents a crucial modernization challenge. Chinese modernization demands not only abundant material wealth but also rich spiritual wealth, achieved through cultural and ideological confidence and self-improvement. This requires a "two-handed approach" where both material and spiritual civilizations develop in harmony, ensuring the people maintain a united ideological foundation, a pioneering spirit, and healthy values.

As previously discussed, the first two pillars of open science focus on material infrastructure funded by substantial public investment, while the latter two address more challenging aspects of global open science practice. A fundamental attribute of science is its openness—a spiritual force supporting good scientific practice. However, scientific progress depends on project funding, representing an input-output system requiring material support. Therefore, examining whether open science receives both material and spiritual support is essential. Scientific practice must emphasize material foundations like open knowledge and infrastructure while also valuing spiritual dimensions including science communication, open participation of societal actors, and dialogue with other knowledge systems. This comprehensive approach helps build a more holistic and sustainable scientific development system.

Fourth, Chinese modernization pursues harmonious coexistence between humanity and nature. This represents a vital modernization dimension. Since modern times, Western countries have typically pursued modernization through rampant resource exploitation and ecological destruction, creating vast material wealth while causing severe environmental pollution and resource depletion. Given China's severe per capita resource constraints, accelerated development inevitably faces greater energy and environmental limitations, precluding simple replication of the Western path.

A robust research ecosystem cannot rely on continuous external support, though scientific activities do involve purchasing and exchanging instruments, materials, data, and literature, as well as sharing resulting papers, data, and devices. However, excessive dependence on external cooperation—particularly seeking quick, short-term collaborations—may inflict destructive damage on long-term

ecological systems. This reflects the need to carefully balance short-term gains against long-term ecosystem health in research cooperation. While external collaboration can accelerate research, we must guard against regional development imbalances and uncontrollable cost increases to ensure sustainability. Such balanced thinking contributes to building a healthier, more resilient research ecosystem.

Fifth, Chinese modernization follows a path of peaceful development. This approach upholds independence and self-reliance, depending on the people's diligent work and innovation while combining internal dynamism with peaceful utilization of external resources. Chinese modernization does not oppress other nations or plunder their resources, but instead strives to provide support and assistance to developing countries within its capacity. It consistently champions peace, development, cooperation, and mutual benefit, pursuing win-win opening strategies that create new opportunities for the world through China's own development.

In this context, Belt and Road countries and 75% of the world's population urgently need to develop their own scientific and technological capabilities to solve local problems and establish mutual assistance mechanisms. Although a "center-periphery" supply system still exists and will remain important for some time, changing global circumstances have led open science to advocate against exploitative development and discriminatory standards that restrict, exclude, or create barriers. During this transformation, we must recognize open science's importance in promoting more just and equitable international cooperation through scientific collaboration and knowledge sharing. Such efforts will contribute to global mutual benefit and advance Chinese modernization along the path of peaceful development toward new heights.

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3. Six Relationships Navigated by Chinese Modernization

First, the relationship between top-level design and practical exploration. This relationship proves crucial in scientific and technological development. Article 95 of the *Law of the People's Republic of China on Science and Technology Progress* identifies promoting open science as a national S&T development goal, making China the first country to enshrine "open science" in law. However, the path to realizing open science remains fraught with difficulties and obstacles. We must continuously explore and experiment in our respective positions, actively summarizing and sharing experiences. More importantly, we should not fear failure but learn from mistakes while promoting successful cases. This accumulation and sharing of experience will foster more flexible, adaptive practices, providing innovative and feasible pathways for scientific development.

Second, the relationship between strategy and tactics. This relationship is vital in scientific research. The *Policy Statement of the Chinese Academy of Sciences on Open Access to Publications from Publicly Funded Research Projects*

outlines an open access strategy with two tactics: institutional repository development and open publication funding. These constitute the "two legs" of the strategy and the "two axes" of tactics. Repositories enable alliances with other institutions to ensure continuous document supply and temporary alternatives, while open publication funding provides negotiation leverage. However, for various reasons, this strategy has been fragmented and stigmatized, preventing it from playing its full leadership role in East Asia and beyond. Urgently restoring its proper function is essential to ensure sustainable open access development and promote scientific sharing and cooperation.

Third, the relationship between upholding fundamentals and innovation. The *Measures for the Management and Open Sharing of Scientific Data of the Chinese Academy of Sciences (Trial)* establishes data contributors as research contributors, breaking from the traditional focus solely on paper authors. By identifying data as assets, it enables deposition, management, sharing, and organization of scientific data for both innovation and integrity. This initiative upholds fundamental principles—maintaining compliance and proper conduct within traditional academic systems—while introducing innovation through open data sharing and management, expanding research approaches. Building upon this, we should further develop digital infrastructure serving more countries and regions to promote global scientific cooperation and innovation.

Fourth, the relationship between efficiency and fairness. This relationship is paramount in research. Young scientists from developing countries frequently point out that journal publication fees and database access costs continue rising despite the 20-year history of the Berlin Declaration on Open Access. Why do these paywalls persist and even grow higher? Will open science become a new hope or merely another "access barrier" in 20 years? The Confederation of Open Access Repositories (COAR) has long worked to address this issue, while China's Institutional Repository Promotion Working Group and China arXiv Service Working Group have also devoted considerable effort. We must consider how to pursue efficiency while ensuring equitable distribution of research opportunities, potentially involving reforms to academic publishing, optimizing research funding, and strengthening international cooperation. Such efforts could build a more efficient and fair research ecosystem, promoting global scientific sharing and progress.

Fifth, the relationship between vitality and order. This relationship proves particularly important in open-source technology. Open science, especially regarding open-source software and hardware, involves both industry and loosely organized hacker communities. Maintaining continuous code development and contribution while complying with social ethics and promoting beneficial technological progress tests a region's cyber governance capacity and open science culture. Recently, the OpenAtom Foundation has offered hope in addressing this challenge. In open-source ecosystems, maintaining innovative vitality and ensuring order are not contradictory. Rather, transparent, partici-

patory governance mechanisms can help communities balance openness with social norms, providing a model for active social participation and co-construction that demonstrates harmonious coexistence between technology and society.

Sixth, the relationship between self-reliance and opening up. This relationship is crucial in research. Among growing numbers of graduate students and young scientists, strategic scientists and research staff must provide sound guidance and support. Equally vital is the healthy guidance from librarians, information specialists, and scientific journals, particularly regarding research integrity. Publishing in foreign or domestic journals represents a scholar's choice; currently, we must both support international journals in implementing open access and help domestic journals become "internationally renowned" in other countries—a formidable task. To address this, the Excellence Action Plan for China STM Journals has revitalized domestic publications by improving their quality and influence, creating more opportunities for disseminating Chinese research globally. Self-reliance and opening up are not contradictory. By fostering independent innovation while attracting global resources, China can provide more development opportunities for local research forces. In an era of globalization, scientists must achieve win-win outcomes through open cooperation, better integrating Chinese research into the international scientific community and contributing Chinese wisdom to global technological development.

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4. Chinese Modernization Supporting Global Open Science Practice

While global open science practice has achieved remarkable accomplishments, it faces practical difficulties affecting scientific research, data sharing, software development, educational resources, hardware openness, physical facilities, virtual facilities, scientific volunteering, public participation, crowdfunding, crowdsourcing, indigenous peoples, marginalized scholars, and local communities. These challenges include:

Table 3. Difficulties in Global Open Science Practice

Scientific Publications - Lack of mechanisms to control group purchasing prices while maintaining comprehensive local infrastructure

Open Research Data - Massive data volumes but difficulty locating needed datasets

Open-Source Software and Source Code - Growing number of developers but difficulty attracting international talent

Open Educational Resources - Widespread availability of massive online courses and materials but limited international exchange impact

Scientific Volunteering - Increasing science enthusiasts but no established mechanism for recognizing contributions

Public and Participatory Science - Science popularization activities receive high priority but hands-on participation remains limited

Crowdfunding and Crowdsourcing - Concepts are leading but practical implementation in S&T fields remains limited

Marginalized Scholars - Active competition to enter core regions conflicts with attempts to influence resource allocation

Indigenous Peoples and Local Communities - "Open science" brings more opportunities but may also close doors

Overall Challenges - Rising demand but limited resources that cannot be abused - Tension between free services and sustainable operations - National support continues but public awareness of open science remains low

Chinese modernization offers viable solutions to these global challenges:

Table 4. Solutions from Chinese Modernization

Based on National Conditions - Through proactive development, gradually solve practical problems raised by stakeholders, considering China's national context and actual development needs

Respecting National Development - On the open science path, respect differences in national development, actively cooperate, and solve practical issues like system interoperability and metadata standards

Promoting Cultural Development - Strive for the great rejuvenation of the Chinese nation, share experiences, and conduct open science practice using Chinese modernization approaches to contribute to global science

These solutions emphasize cooperation, respect for differences, nation-based development, and Chinese modernization approaches, providing positive references and demonstrations for global open science practice.

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Note: Figure translations are in progress. See original paper for figures.