Innovation System for Chinese Modernization: Connotations and Strategic Priorities

Chen Jin[1, 2], Wu Feng[*1, 2]

[1] *Tsinghua University School of Economics and Management (Tsinghua SEM), Beijing, China*

[2] *Tsinghua University Research Center for Technological Innovation (RCTI), Beijing, China*

Abstract: *The modern innovation system with Chinese characteristics serves as a critical foundation for achieving China's strategic goal of becoming a global leader in science and technology, promoting high-quality development, and advancing comprehensive modernization. This paper offers a systematic theoretical exploration of the system's connotations and key areas of focus. It begins by tracing the conceptual origins of innovation systems and their development in China, analyzing the evolution of the national innovation system and the theoretical basis for improving its overall effectiveness. Building on this, the authors examine the evolving characteristics of China's innovation system, including the shift from technology introduction and imitation to independent innovation, the emergence of a post-Schumpeterian innovation paradigm, the refinement of localized innovation theories, and a comparative assessment of Chinese and international innovation models. This paper explains the core characteristics of the innovation system with Chinese characteristic. Finally, it identifies five key strategic priorities: Guiding the modern innovation system's efficient operation through the pursuit of new quality productive forces; enhancing resource allocation by deeply integrating scientific, technological, and industrial innovation; fostering a demand- and scenario-driven, digitally empowered innovation ecosystem; improving innovation governance through institutional and policy reforms; and strengthening the transformation mechanism for scientific and technological achievements to maximize innovation value.*

Keywords: *Modern innovation system with Chinese characteristics; Post-Schumpeterian innovation paradigm; Connotation analysis; Strategic focus areas*

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The modern innovation system with Chinese characteristics is a vital pillar for the rejuvenation of the Chinese nation. Additionally, it is an essential platform for promoting global development cooperation and contributing China's unique wisdom to the world. On June 24, 2024, President Xi Jinping, in his speech at Speech at the Nationwide S&T Conference, National Science and Technology Awards Conference, and the Conference of Academicians of the Chinese Academy of Sciences (CAS) and the Chinese Academy of Engineering (CAE), announced the goal of making China a sci-tech powerhouse by 2035 and emphasized that, "We must have the firm determination and tenacious will that

[*] CONTACT: Wu Feng, email: guevafeng@163.com.

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'sharpens the sword for ten years,' seizes the day, and works hard, in order to turn this strategic objective into reality step by step." The construction of a modern innovation system serves as both a strategic cornerstone for achieving scientific and technological self-reliance and strength, and a powerful engine driving industrial innovation and high-quality economic development. The *Report to the 20th National Congress of the Communist Party of China* places scientific and technological innovation at the core of the country's overall development, explicitly proposing to "improve the scientific and technological innovation system". The Third Plenary Session of the 20th CPC Central Committee further proposes "building institutions and mechanisms that support comprehensive innovation" and emphasizes that "education, science and technology, and talent constitute the foundational and strategic supports for Chinese modernization". In light of this, this paper aims to systematically elaborate on the conceptual connotations of the modern innovation system with Chinese characteristics and to identify its key strategic focus areas, thereby enriching China's innovation theory and facilitating deeper integration among scientific, technological, and industrial innovation.

1. Conceptual Origins and Chinese Practice of the Innovation System

1.1 Conceptual Origins of the Innovation System

The concept of the innovation system originated from the national innovation system (NIS), first proposed by British economist Christopher Freeman in 1987. Freeman defined this as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies" (Freeman, 1987; Chen & Li, 2024). Building upon this foundation, scholars have strengthened the analysis of NIS from a systemic perspective. In doing so, they characterize it as a dynamic network that emphasizes the synergy of diverse actors and the efficient allocation of resources (Lundvall, 1992; Chen & Li, 2024). As this concept has evolved, the innovation system has become a broader theoretical framework encompassing multilevel innovation networks at national, regional, and sectoral levels.

The Organization for Economic Co-operation and Development (OECD) defines the National Innovation System (NIS) as a network of public and private entities—including governments, enterprises, universities, research institutions, and intermediary organizations—that influences technological innovation through the division of labor and collaboration. Notably, this emphasizes the system's structure, functions, and interactions among the factors of production (OECD, 1997; Chen & Li, 2024). Moreover, this analytical framework has been widely accepted in academic circles (Chen & Li, 2024; Du & Li, 2024). As a lens for examining the role of innovation in economic growth and national competitiveness, Chinese scholars have conducted in-depth studies of the NIS. In doing so, they emphasize that its core lies in establishing an open and dynamic innovation network through the synergy between government and market forces, thereby promoting the deep integration of science and technology with economic and social development (Chen & Li, 2024; Du & Li, 2024). The system encompasses innovation actors, factors of production, activities, and supporting policies, aiming to enhance overall innovation efficiency through optimized resource allocation. In the Chinese context, the NIS emphasizes the integration of industry, academia, research, and application, as well as the role of the "new whole-nation system", which mobilizes collective efforts to address key technological bottlenecks. As such, they form a uniquely Chinese model for building an innovation system (Chen & Li, 2024; He et al., 2023).

The effectiveness of the NIS, as a key indicator of operational efficiency and value realization, has attracted growing attention in recent years. At its core, effectiveness is driven by the coordinated interaction among innovation actors, institutional mechanisms, and the broader innovation environment, enabling the efficient allocation of innovation resources (Chen & Li, 2024; Meng et al., 2024). Both

international organizations and Chinese scholars have performed in-depth research on mechanisms to enhance system effectiveness. For example, drawing on perspectives on system structure, function, and the interactions among factors of production, the OECD proposed the concept of "innovation ecosystem synergy" as a pathway to improving the effectiveness of innovation systems. Building on this, Chinese scholars have further explored how integrating resources and institutional innovation—within the framework of the "new whole-nation system"—can enhance the overall performance of the NIS (Chen et al., 2024; Chen & Li, 2024). Based on this body of research, this paper proposes "organized innovation" as a novel strategic paradigm for improving the effectiveness of the NIS, providing theoretical support for China's development of an innovation system in the new era.

1.2 Development Practice of China's Innovation System

Before reform and opening-up in 1978, China's NIS underwent several distinct developmental stages. In the early years following the founding of the People's Republic of China in 1949, the CPC oversaw the rapid establishment of a talent cultivation system, the construction of an industrial base through 156 key projects, and the consolidation of the Chinese Academy of Sciences (CAS). In 1956, the CPC Central Committee issued the call to "march toward science", initiating long-term plans for science and technology development and establishing the "five forces for progress in science and technology". Subsequently, under the planned economy system, China adopted a research and development model focused on pooling national resources to accomplish major scientific and technological tasks, achieving remarkable results in strategic areas such as the "Two Bombs, One Satellite" program (i.e., the development of the atomic bomb, hydrogen bomb, and artificial satellite). This government-led phase laid a crucial foundation for the subsequent evolution of the NIS.

In the early stages of reform and opening-up in 1978, China initiated reforms to its science and technology (S&T) system to dismantle outdated institutional constraints and unleash the innovative potential of scientific personnel. In 1985, the CPC Central Committee issued the *Resolution on the Reform of the Science and Technology Management System*, promoting integration of science and technology with the economy and accelerating the transformation of scientific achievements into a fundamental productive force. Subsequently, a series of policies aimed at strengthening S&T innovation was rolled out, including the establishment of the National Natural Science Foundation of China (NSFC), providing crucial funding for basic research. In the 1990s, as the socialist market economy gradually took shape, China deepened its S&T system reforms by launching major national initiatives, such as the "863 Program" and the "Torch Program", to boost high-tech industries and cultivate innovative enterprises. In 1995, the CPC Central Committee and the State Council issued the *Resolution on Accelerating Scientific and Technological Progress*, which for the first time introduced the national strategy of "invigorating the nation through science and education", emphasizing the central role of science, technology, and education in driving economic and social development. In 2005, the State Council released the *National Medium- and Long-Term Program for Science and Technology Development (2006–2020)*. For the first time, this defined the NIS from a policy perspective as "a government-led social system that gives full play to the fundamental role of the market in resource allocation, while promoting close collaboration and effective interaction among various S&T innovation actors". Thus, advancing and refining this NIS was established as a core goal of continued S&T system reform.

China's blueprint for developing its national innovation system has evolved progressively through the 18th, 19th, and 20th CPC National Congresses, each adding new layers of priority. The 18th CPC National Congress in 2012 introduced the innovation-driven development strategy, recognizing S&T as the strategic foundation for national strength. Notably, it called for placing innovation at the center

of development and for an enterprise-led, market-driven innovation system that integrated industry, academia, and research. Thus, reforming the S&T management system was seen as key to unlocking innovation. The 19th CPC National Congress in 2017 went further, calling for accelerating the construction of an innovation-oriented nation. Moreover, it emphasized strengthening basic research, enhancing the national innovation system, and expanding strategic S&T capacity. It also reaffirmed the enterprise-led, market-driven, and deeply integrated innovation model, while promoting an innovation-friendly culture and stronger intellectual property protection and use. The 20th CPC National Congress in 2022 underscored that S&T are the primary productive force, that talent is the foremost resource, and that innovation is the core driving force. It called for strengthening the NIS by refining the "new whole-nation system", focusing on serving strategic needs, advancing self-reliance in science and technology, improving talent development, and fostering a fertile environment that encourages and embraces innovation. The Third Plenary Session of the 20th CPC Central Committee, held in 2024, further emphasized the need to build a robust innovation-supporting framework through integrated reform of education, S&T, and talent systems. Key measures include reinforcing national strategic S&T capacity, enhancing program management, positioning enterprises at the heart of innovation, improving central funding mechanisms, and deepening the institutional reform of the mechanism for transforming scientific and technological achievements.

2. Evolving Connotation of China's Innovation System

2.1 Shifting the Innovation Path: From Import and Imitation to Indigenous Creation

Amid intensifying global competition, China's scientific and technological innovation is undergoing a critical transition from being a significant scientific power to becoming a worldwide science and technology leader. Since the launch of reform and opening-up in 1978, the nation has pursued a strategy of "introduction, digestion, absorption, and re-innovation", and then progressed to integrated innovation. These approaches laid a solid technological foundation, propelled industrial upgrading, and significantly narrowed the gap with global leaders. However, the current international landscape has intensified challenges in achieving technological progress through imitation and catch-up strategies, particularly in critical core technologies where China faces severe "bottleneck" constraints. Simultaneously, a new wave of technological revolution and industrial transformation is accelerating, intensifying global competition for leadership in frontier technologies. Against this backdrop, China's innovation path has undergone a significant transformation—shifting decisively toward independent innovation. Landmark achievements such as the successful launch of *Mozi*, the world's first quantum science satellite, and the fully self-developed CR400 Fuxing Hao high-speed trains exemplify breakthroughs in original innovation. These advances not only signal progress in cutting-edge fields but also provide strong support for industrial upgrading and sustained economic growth (Chen & Li, 2024; Liu et al., 2019; Pei, 2024).

Original innovation, characterized by fundamental breakthroughs in science, technology, and engineering, is the most essential and intellectually intensive form of innovation. It serves as the wellspring of scientific and technological progress. Typically emerging from significant advances in basic research, original innovation can open up entirely new disciplines, research frontiers, or technological pathways. Additionally, it lays the foundation for subsequent technological development and industrial transformation and plays a critical, strategic role within a nation's independent innovation system (Chen et al., 2023; Chen & Li, 2024). Recently, China has achieved notable breakthroughs in original innovation, particularly in quantum communication and high-temperature superconductivity. These breakthroughs have

significantly advanced scientific theory and granted China an early advantage in the development of related industries, thereby enhancing its position in global science and technology competition. However, substantial challenges remain. These include relatively insufficient investment in basic research, an imperfect research evaluation system, and suboptimal talent cultivation and incentive mechanisms.

Disruptive innovation focuses on creating transformative impacts on existing markets and industrial landscapes through novel technologies, products, or business models, offering late entrants opportunities to surpass established leaders (Chen & Li, 2024; Qu et al., 2023). In the current digital economy, the role of disruptive innovation has become increasingly prominent. Emerging technologies—such as the internet, artificial intelligence, and big data—are continually giving rise to new industries and business models, including the sharing economy and intelligent manufacturing, that are profoundly reshaping how people work and live. Furthermore, disruptive innovation can break away from existing technological trajectories, alter the course of economic development, and foster the emergence of new quality productive forces. China has demonstrated strong capabilities in some regions of disruptive innovation—for example, mobile payments and short-video platforms have achieved global leadership. However, to better compete on the international stage, it remains essential for China further to strengthen the integration of technological R&D with market applications and enhance its ability to identify, cultivate, and scale disruptive technologies.

2.2 Rise of the Post-Schumpeterian Innovation Paradigm

The post-Schumpeterian innovation paradigm has emerged in response to the knowledge era and the digital age. Characterized by diversified actors, open governance, societal objectives, and a networked ecosystem, this paradigm aligns closely with the development path of China's modern innovation system. It highlights the pivotal role of non-traditional innovators—such as ordinary users and makers—which echoes China's recent "mass entrepreneurship and mass innovation" initiative. The diversification of innovation actors ensures that innovation outcomes are more attuned to societal needs. Additionally, the paradigm promotes an inclusive vision of technological innovation, emphasizing that innovation should advance economic growth, social welfare, and sustainable development—an idea deeply aligned with China's people-centered development philosophy. Furthermore, China's new whole-nation system, through policy coordination and resource integration, provides institutional support for implementing this paradigm, fostering collaborative innovation and the emergence of a networked innovation ecosystem (Chen & Li, 2024).

From the perspective of innovation actors, the post-Schumpeterian innovation paradigm emphasizes the pivotal role of non-producers—such as ordinary people and makers—in the innovation process, recognizing their irreplaceable contributions to technological R&D and the diffusion of innovation (Chen & Li, 2024; Chen & Li, 2022). This paradigm significantly broadens the definition of innovation actors within China's national innovation system, expanding it beyond traditional enterprises and research institutions to include end users, maker communities, and innovation networks. Notably, by bringing innovation activities closer to societal needs, it promotes more inclusive knowledge sharing and collaborative innovation. Thus, integrating non-producers into the national innovation framework has markedly improved the efficiency of innovation resource utilization.

From the perspective of innovation goals, the post-Schumpeterian innovation paradigm shifts the focus from a purely economic orientation toward broader social value and the public interest, highlighting the public nature and societal functions of technological innovation. It views innovation as a driver of economic growth and as a crucial tool for addressing social challenges, promoting equity, and enhancing public well-being. This paradigm calls for China's NIS to incorporate social needs, ecological

sustainability, and human welfare into its innovation agenda. Through targeted policy guidance and strategic resource allocation, it aims to ensure that innovation activities are more responsive to societal realities and public demands, thereby fostering a deeper integration of technological progress and social development.

From the perspective of innovation governance, the post-Schumpeterian innovation paradigm marks a shift from closed, single-entity management to multi-actor collaborative governance. Traditional models dominated by either government or enterprises alone struggle to meet the complex and diverse demands of contemporary innovation. In contrast, the post-Schumpeterian innovation paradigm advocates creating open platforms that reconcile diverse interests and facilitate the efficient flow of innovation resources among stakeholders. This model of governance requires innovation systems to emphasize multi-actor coordination in policy design—by establishing shared rules, promoting knowledge exchange, and incentivizing collaborative innovation. In this way, open governance becomes a key mechanism for fostering a robust innovation ecosystem.

From the perspective of the innovation ecosystem, the post-Schumpeterian innovation paradigm emphasizes its networked, dynamic nature, calling for a shift from a linear, single-track model to a complex, interconnected system. Collaboration among innovation actors is no longer unidirectional or static; it now takes place within an open, evolving network driven by the dynamic flow of knowledge and the sharing of resources. In building its innovation system for the new era, China is actively cultivating an open and interactive innovation ecosystem through regional collaborative innovation, cross-industry knowledge integration, and global partnerships. This transformation not only enhances the efficiency of resource allocation but also provides crucial support for strengthening China's strategic position in international science and technology competition (Chen & Li, 2024; Chen & Li, 2022).

In summary, the post-Schumpeterian innovation paradigm integrates forward-looking demand-pull with effective problem-solving across the innovation process, positioning the broader populace as the ultimate users. This approach adeptly addresses the issues of innovation generation and diffusion, providing a coherent framework for the entire process.

2.3 Evolution of Indigenous Innovation Theories

In October 2015, the Fifth Plenary Session of the 18th CPC Central Committee underscored the need to uphold a people-centered development philosophy, prioritizing the enhancement of public well-being and comprehensive human development as the core objectives of progress. On November 23, 2015, during the 28th collective study session of the Political Bureau of the 18th CPC Central Committee, President Xi Jinping emphasized that this philosophy reflects the foundational stance of Marxist political economy. This approach demands that S&T innovation draw on the needs and insights of the people, honor their pioneering spirit, harness public participation to advance innovation, convert S&T achievements into tangible benefits for society, and evaluate innovation's impact through practical outcomes. Recently, drawing on China's innovation practices and focusing on its ultimate societal value, scholars have developed distinctive indigenous innovation theories, forging a pathway for S&T innovation to "originate from the masses and serve the masses."

First, people-centered innovation: an approach that puts people's needs at its core and aims to enhance their overall well-being. It regards the public as the primary agents and the ultimate beneficiaries of innovation. As such, it emphasized that innovation should serve not only economic growth but also social progress and the holistic development of individuals. Rooted in the Marxist principle of a people-centered stance, this concept advocates for "innovation for the people, by the people, and shared with the people". Through mechanisms of multi-actor collaboration, it seeks to mobilize the innovative potential of the entire population and transform innovation outcomes into social value. This approach also

integrates traditional Chinese cultural values, such as the holistic worldview embodied in the concept of the "unity of man and nature", emphasizing cultural continuity and ecological balance. Through such integration, the innovation paradigm shifts from one narrowly focused on economic metrics to one that prioritizes social welfare and sustainable development. As a concrete manifestation and further development of the post-Schumpeterian innovation paradigm within China's socialist system, it extends the role of innovation to encompass broader societal objectives. On one hand, it highlights the diversity and inclusivity of innovation actors, contributing to the more efficient and socially embedded allocation of innovation resources. On the other hand, it emphasizes the universal sharing of innovation benefits, promoting equitable access and distribution. Moreover, it drives a transition from a "production-driven" to a "society-driven" innovation system—guided by the multifaceted needs of the people—and integrates economic, technological, cultural, and ecological dimensions in a coordinated manner. This people-centered innovation framework provides crucial support for advancing China's strategic goals of becoming a science and technology leader and achieving shared prosperity (Chen & Li, 2024).

Second, meaningful innovation. Meaningful innovation is an emerging paradigm in the new era that places "meaning" at the core of corporate innovation. It emphasizes the strategic recombination of innovation elements to fully articulate both the intrinsic value of innovation outcomes—such as meeting user needs and fostering emotional resonance—and their extrinsic value, such as advancing social welfare, supporting national strategic goals, and promoting sustainable human development. Conceptually, meaningful innovation treats meaning as a central variable, balancing short-term instrumental benefits with long-term strategic value. The goal is to foster innovation practices that carry economic, social, strategic, and future-oriented significance (Qu et al., 2020). Notably, this paradigm goes beyond traditional technology- and market-driven models by reintegrating humanistic and philosophical considerations into innovation, encouraging enterprises to break free from short-term profit constraints and focus on medium- and long-term returns and broader societal benefits. Furthermore, it promotes groundbreaking innovation practices that drive social progress and human development (Chen et al., 2019). By introducing the dimension of "meaning", meaningful innovation reshapes both the theoretical framework and practical trajectory of China's innovation system. Significantly, it expands the scope of innovation beyond purely technological or market-driven approaches to encompass broader social needs and national strategies—providing theoretical support for the strategic upgrading of China's innovation system (Qu et al., 2021). Therefore, encouraging firms to integrate social value and national priorities into their innovation activities enhances their capacity to respond to external demands, facilitating China's transition from imitative to leading innovation. Furthermore, by emphasizing the dynamic processes of "meaning discovery" and "meaning transformation", it guides enterprises in building cognitive and decision-making frameworks grounded in meaning management. This approach aligns efficiency-driven logic with meaning-oriented goals, enabling more efficient allocation of innovation resources and enhancing synergy and sustainability within China's innovation ecosystem. In the face of intensifying global competition and accelerating technological change, meaningful innovation lays a foundation for China to develop a more inclusive, forward-looking, and systemic innovation model.

2.4 Characteristics of Innovation Systems: An International Comparison

Innovation systems in other countries are predominantly market-driven, with government policies primarily aimed at incentivizing R&D investment and facilitating technology transfer. Their innovation goals tend to focus on economic growth and enhancing national competitiveness. These systems often operate within relatively closed ecosystems and governance structures, where stakeholder collaboration

is fragmented. Mainly rooted in the Schumpeterian paradigm, innovation activities in these contexts are typically driven by technological breakthroughs, with limited emphasis on social welfare or ecological sustainability. In contrast, China's innovation system emphasizes the synergy between an *enabling government* and an *efficient market*, building a new whole-nation innovation system that positions enterprises at its core. Additionally, it promotes a shift from technology importation and imitation to independent innovation, strengthening strategic scientific and technological capabilities through the integration of industry, academia, research, and application. Notably, this model highlights both original and disruptive innovation while balancing economic development with social value and ecological sustainability. Moreover, China places a strong focus on collaborative, multi-actor governance and an open, adaptive innovation ecosystem. By leveraging regional coordination and international cooperation, it improves the efficiency of innovation resource allocation. Over time, this has contributed to the emergence of a people-centered value orientation and a distinctive culture of innovation. A comparative overview of China's national innovation system and those of other countries is presented in the table below.

Table 1: Comparison of Innovation Systems Between China and Other Countries

Comparison dimension	China's distinctive innovation system	Innovation systems from other countries (based on major OECD economies)
Innovation entities	Prioritizes enterprises as leading actors, promotes integration of industry, academia, research, and application, with participation from users and makers; features diverse innovation actors	Center on enterprises, universities, and research institutes, with a clear division of roles among actors; limited participation from ordinary users and non-producers
Innovation goals	Balances economic growth, social well-being, ecological sustainability, and national strategic needs, with a strong focus on social value	Primarily focus on economic growth and national competitiveness, with limited attention to social issues and ecological sustainability
Innovation paths	Shifts from "introduction, digestion, absorption, and re-innovation" to independent originality, focusing on original and disruptive innovation to address bottlenecks in critical technologies	Primarily incremental innovation, relying on technological accumulation and market mechanisms, with a focus on optimization and improvement
Innovation governance	Stresses government-market coordination through the new whole-nation system, aligning diverse actors to promote resource flow and benefit sharing	Market-led, with government incentivizing innovation through policy; governance is decentralized with weak coordination mechanisms
Innovation ecosystem	Builds an open, dynamic, and networked ecosystem that promotes regional coordination and global cooperation with high resource-allocation efficiency	The innovation ecosystem is relatively closed, with limited collaboration between entities, relying more on market mechanisms, and displaying a static or linear model
Innovation paradigm	Leans toward the post-Schumpeterian innovation paradigm, with diversified innovation entities that focus on social goals and collaborative network ecosystems	The innovation model, based on the Schumpeterian paradigm, emphasizes corporate competition and technological breakthroughs. It is oriented toward economic benefits and follows a relatively closed, unidirectional approach
Policy support	The government promotes the deep integration of technology with the economy and society through policy guidance, resource integration, and institutional innovation, strengthening the role of enterprises as innovation entities	Policies mainly incentivize R&D investment and technology transfer, focusing on economic growth, with less emphasis on social and cultural innovation environments
International cooperation	Enhances international collaboration through open innovation, focuses on independent innovation of key technologies, and promotes connectivity of global innovation resources	Rely on multinational companies and tech alliances to enable international technology flow, with more market-oriented and economically-driven collaboration

3. Core Manifestations of the Modern Innovation System with Chinese Characteristics

Modernization typically refers to the developmental trajectory of a society, nation, or organization, encompassing technological progress, economic restructuring, social evolution, and lifestyle transformations (Xie, 2018). It is a dynamic historical process that extends beyond material and technological advancements to include a profound shift in human civilization, centering on the modernization of people. Chinese modernization highlights that this process involves technological catch-up and a redefinition of civilizational progress. The modern innovation system with Chinese characteristics can be analyzed through three dimensions: the S&T innovation system, the industrial innovation system, and the management innovation system. Its modern essence manifests in three key aspects: the paradigm restructuring of knowledge production, the dynamic equilibrium of the innovation ecosystem, and the integrated symbiosis of science and humanities. The paradigm restructuring of knowledge production serves as the theoretical foundation, the dynamic equilibrium of the innovation ecosystem ensures operational efficacy, and the integrated symbiosis of science and humanities defines its value orientation. Amid intensifying global S&T competition, rapid industrial transformation, and growing social demands, the modern innovation system with Chinese characteristics must leverage the "new whole-nation system" to foster an open, dynamic, and inclusive innovation ecosystem. As such, this requires coordinated resource allocation, collaboration among diverse actors, and enhanced institutional design, providing robust S&T support and theoretical grounding for advancing Chinese modernization (Figure 1).

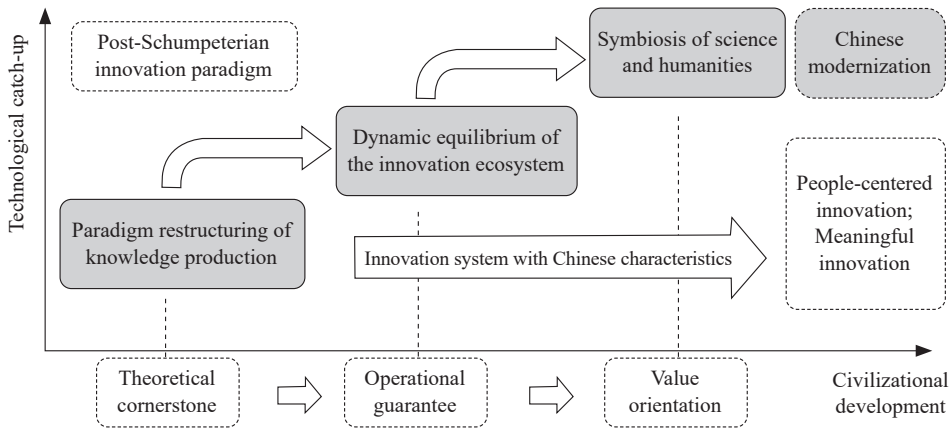

Figure 1: Core Components of China's Modernization Innovation System

The core components of the modern innovation system with Chinese characteristics are defined through a synthesis of theoretical inquiry and the practical evolution of China's innovation landscape, as follows:

Theoretical Foundations: This framework draws upon the post-Schumpeterian innovation paradigm, innovation ecosystem theory, and systems science. The post-Schumpeterian innovation paradigm emphasizes the diversification of knowledge production, the networked nature of innovation ecosystems, and the socialization of innovation goals—offering a theoretical foundation for both the "restructuring of knowledge production paradigms" and the "dynamic balance of innovation ecosystems" (Chen & Li, 2022). The innovation ecosystem theory advocates for building a dynamically balanced system through

multi-actor collaboration and the efficient flow of resources, resulting in an open, networked innovation system (Lundvall, 1992; Chen et al., 2024). At the same time, the "people-centered" tenet of Chinese modernization underscores the deep integration of science and the humanities, making the "integrated symbiosis of science and humanities" a critical component (Xie, 2018).

Practical Foundations: This division is aligned with *Report to the 20th CPC National Congress*, which emphasized that "science and technology are the primary productive forces, talent is the primary resource, and innovation is the primary driving force"—clearly identifying the core mission of the innovation system. In addition, the *National Medium- and Long-Term Program for Science and Technology Development (2006-2020)* identified "comprehensively advancing the establishment of a national innovation system with Chinese characteristics" as a key task in reforming the science and technology management system for the present and years to come, and specified the priorities for developing such a system in five aspects. *The Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035* outlines a series of arrangements for further reforming the science and technology management system, improving the national science and technology governance system, and optimizing the management and operational mechanisms of national science and technology programs. Thus, these strategic policy documents provide a strong practical foundation for identifying the core components of the modern innovation system with Chinese characteristics.

3.1 Paradigm Restructuring of Knowledge Production

The construction of a modern innovation system with Chinese characteristics must be grounded in a fundamental restructuring of the knowledge production paradigm. This transformation entails a shift from a traditional, linear, and closed model to an open, dynamic, and networked approach that emphasizes multi-actor collaboration, deep interaction among innovators, and the efficient circulation of knowledge resources (Chen & Li, 2022). The emergence of the post-Schumpeterian innovation paradigm offers strong theoretical support for this shift by advocating the active participation of non-traditional producers—such as users and makers—which expands the boundaries of innovation actors. This approach liberates knowledge creation from the monopoly of professional institutions, making socialized collaboration a key feature of contemporary knowledge production. It calls for knowledge activities to align more closely with societal needs, leveraging synergy among diverse actors to fully unleash the creative and transformative power of knowledge.

The modernization of China's innovation system should also incorporate the strengths of the "new whole-nation system" to optimize the organizational model of knowledge production. This system addresses critical "chokepoint" issues by concentrating superior resources, enhancing original innovation in basic research, and strategically advancing the development of frontier technologies. Such a systematic approach to knowledge production promotes deep accumulation and breakthroughs in key areas (Chen et al., 2023). It also mobilizes the innovative potential of diverse actors—governments, enterprises, universities, research institutes, and end users—fostering efficient collaboration across the entire knowledge chain, from generation and dissemination to application. Through this process, knowledge production extends beyond traditional technological R&D to become a multidimensional endeavor that integrates technological, institutional, and cultural innovation. This provides a solid theoretical and practical foundation for building a modern innovation system.

3.2 Dynamic Equilibrium of the Innovation Ecosystem

The modern innovation system with Chinese characteristics should place the pursuit of dynamic

equilibrium within its innovation ecosystem at the core of its development strategy. This entails cultivating an open, collaborative, and adaptive environment that actively supports and sustains innovation. Notably, dynamic equilibrium serves as both the foundation for the system's efficient operation and a vital mechanism for responding to global technological competition, industrial transformation, and shifting societal demands. Drawing on the post-Schumpeterian innovation paradigm, the innovation ecosystem is characterized by its networked, dynamic nature—necessitating a shift from static, linear models of collaboration to dynamic, interactive partnerships among innovation actors. The circulation of knowledge drives this transformation, the sharing of resources, and collaborative innovation, ultimately shaping an open and interconnected ecosystem. At its core, such an ecosystem fosters a flexible and organic environment for innovation through the active engagement and interaction of diverse stakeholders. It enables the system to self-regulate, adapt, and evolve continuously in response to complex and changing internal and external conditions.

The modern innovation system with Chinese characteristics also bolsters the dynamic equilibrium of the innovation ecosystem through the collaborative framework of the "new whole-nation system". By uniting strategic scientific and technological forces, national innovation platforms, and user enterprises, it creates a cohesive network spanning the entire innovation chain. This structure also facilitates efficient macro-level resource allocation while unlocking the innovative potential of diverse actors at the micro level (Chen & Wu, 2024). The government's meta-governance role is equally vital, leveraging policy guidance, resource distribution, and risk management to ensure the ecosystem's resilience against internal and external disruptions (Wu et al., 2024). Therefore, this dynamically balanced ecosystem not only enhances innovation efficiency and effectiveness but also provides robust systemic support for high-quality development and high-standard security (Chen et al., 2025).

3.3 Integrated and Synergistic Development of Science, Technology, and the Humanities

The construction of the Chinese-style modernization innovation system should prioritize the deep integration of science and technology with humanistic values as a critical direction. Importantly, innovation should not be confined to the technological and economic domains, but should also embody social value, cultural meaning, and ecological responsibility. Modernization represents technological advancement and a profound transformation of human civilization. Scientific and technological innovation, therefore, must align with the broader goals of societal development (Xie, 2018). In this context, the innovation system must transcend traditional instrumental rationality and forge strong connections between innovation, human well-being, ecological sustainability, and cultural inheritance. This will promote a more advanced and synergistic integration of science and technology with the humanities.

The people-centered development philosophy serves as a fundamental value underpinning the modern innovation system with Chinese characteristics. President Xi Jinping has emphasized that this philosophy embodies the core stance of Marxist political economy, calling for scientific and technological innovation to respond to the needs of the people, draw upon their insights, and respect their pioneering spirit—ultimately transforming innovation outcomes into tangible improvements in public well-being (Chen & Li, 2024). In fields such as healthcare, public safety, and green energy, technological innovation should prioritize enhancing quality of life and meeting public needs. The significance of innovation lies not only in technological breakthroughs and economic returns but also in its ability to address social issues, promote equity, and improve public welfare. This people-centered innovation paradigm expands the value dimension of science and technology, infusing the modern innovation

system with profound cultural connotations.

The seamless integration of science and technology with the humanities highlights the ongoing emergence of ecological benefits. The innovation system in China plays a vital role in promoting green development and establishing an ecological civilization. Through the research and application of green technologies, it aims to chart a sustainable development path that balances economic growth with ecological preservation (Chen et al., 2024). By promoting new energy sources, optimizing energy storage technologies, and advancing environmentally friendly innovations, this system also contributes to achieving China's "dual carbon" goals—namely, reaching peak carbon emissions before 2030 and achieving carbon neutrality by 2060. Additionally, it also offers Chinese insights for global environmental protection. In this process, innovation transcends technological advancement alone, becoming deeply intertwined with social values, cultural heritage, and ecological responsibility—demonstrating the unique synergy between science and technology, and the humanities, each enriching and reinforcing the other in meaningful ways.

4. Priorities in Building a Modernized Innovation System with Chinese Characteristics

Building a modern innovation system with Chinese characteristics is a crucial lever for achieving the strategic goal of becoming a global leader in science and technology, as well as a central pathway to promoting high-quality development and comprehensive modernization. In the context of intensifying global technological competition, accelerating industrial transformation, and increasingly diverse societal demands, this system requires systematic theoretical inquiry, deep practical application, and continuous adaptation. To enhance the overall effectiveness of China's innovation system, focus must be directed toward key areas such as strategic goal-setting, resource allocation, operational mechanisms, and value realization. This approach ensures efficient coordination and dynamic equilibrium throughout the entire innovation process—from conception to implementation.

4.1 Driving the Efficient Operation of the Innovation System through the Development of New Quality Productive Forces

The construction of a modern innovation system with Chinese characteristics should prioritize the development of new quality productive forces as the core guiding principle, as it serves both as the theoretical foundation and the practical pathway for ensuring the system's effective operation. As a core engine of the modern economic system, new quality productive forces represent a fundamental transformation, like productivity, from traditional material-driven models to those powered by knowledge, technology, and innovation. This transformation calls for qualitative breakthroughs in integrating factors, allocating resources, and fostering functional synergy within the innovation system. On a theoretical level, it is essential to redefine the connotation and extension of productivity itself, moving beyond a narrow focus on material production to incorporate knowledge, data, technology, and ecological elements as key components. These elements must be recognized as central drivers of economic development and social progress. On the practical level, greater emphasis should be placed on the dynamic interaction and structural optimization of innovation factors. By enhancing the fluidity and alignment of scientific and technological resources, the internal efficiency of the innovation system can be significantly improved. In advancing new quality productive forces, priority should be given to the deep integration of technology and industry, transforming cutting-edge scientific achievements into productive capacities that generate both market value and social benefits. At the same time, the

development of new infrastructure—encompassing digital elements such as data, computing power, and algorithms—should serve as a key enabler, unleashing the agglomeration and multiplier effects of innovation factors to maximize systemic impact.

Moreover, the development of new quality productive forces should adopt a System of Systems (SoS) approach (Chen et al., 2023), prioritizing interconnectedness and synergy within the modern innovation system. This approach entails fostering deep collaboration among diverse innovation entities—enterprises, universities, and research institutions—forming a dynamic consortium that maximizes the strengths of industry-academia-research-application integration. Simultaneously, by refining innovation policies and institutional frameworks, the government's role in steering resource allocation, establishing regulations, and managing risks should be enhanced. Notably, this should be paired with market-driven mechanisms for resource circulation, creating a complementary partnership between government and market forces to drive collaborative innovation. From a management standpoint, advancing new quality productive forces goes beyond technological progress and resource integration; it is also a process of cultural evolution and value redefinition. By nurturing an innovation-centric value system and fostering a societal culture that values knowledge and creativity, a robust cultural foundation and institutional support can be established. This ensures the efficient and sustainable operation of the modern innovation system with Chinese characteristics.

4.2 Focusing on the Deep Integration of Scientific and Technological Innovation with Industrial Innovation to Optimize Resource Allocation

While advancing new quality productive forces, the modern innovation system with Chinese characteristics should also center on the deep integration of scientific and technological innovation with industrial innovation to optimize the allocation and efficient use of innovation resources. Scientific and technological innovation is the outward expression of the knowledge system, whereas industrial innovation is the pathway through which scientific achievements are transformed into economic value. The integration of these two dimensions is a key driver of a robust, adaptive modern innovation system. Scientific and technological innovation provides industrial innovation with cutting-edge technologies, a reservoir of knowledge, and theoretical support, serving as its primary driving force. In contrast, industrial innovation offers application scenarios, market feedback, and the impetus for sustainable advancement, acting as a practical extension of scientific innovation. Therefore, constructing a modern innovation system with Chinese characteristics requires achieving a dynamic balance and structural optimization of resource allocation at the intersection of these two innovation domains.

In practice, a demand-driven approach should be adopted to strengthen the role of scientific and technological innovation in supporting industrial upgrading. When building the innovation system, it is essential to identify the critical links where science and technology intersect with the industrial and value chains. This includes strategically advancing basic research and frontier technologies to address "bottleneck" issues in key areas, thereby providing strategic support for industrial development. Equally important is improving the efficiency of technology transfer and commercialization. A unified, streamlined mechanism must be established to facilitate the translation of scientific achievements into practical applications, effectively bridging the "last mile" from the laboratory to industrial deployment. This ensures that scientific and technological innovation can fully empower industrial progress. Conversely, industrial innovation should also provide dynamic feedback to scientific research. Market demand should guide R&D, driving greater precision and applicability in technological development. Furthermore, it is vital to build a regionally coordinated innovation ecosystem that leverages local resource endowments and industrial strengths. Such a system can foster a dual-engine innovation

model—driven by both scientific advancement and industrial innovation—thereby enhancing regional synergy and development impact.

From a resource-allocation perspective, the deep integration of scientific and technological innovation with industrial innovation relies on the collaborative participation and resource-sharing of multiple stakeholders. Enterprises should act as the principal drivers of innovation, taking the lead in technology development, the commercialization of research outcomes, and market deployment. Universities and research institutions should focus on basic research and frontier exploration, providing the theoretical insight and technological foundation needed to fuel industrial innovation. Meanwhile, the government should play a guiding and enabling role—shaping a supportive innovation ecosystem through policy direction, resource coordination, and institutional design—thereby ensuring effective synergy between scientific, technological, and industrial development.

4.3 Fostering a Digitally Empowered Innovation Ecosystem Driven by Demand and Usage Scenarios

The development of a modern innovation system with Chinese characteristics should be propelled by demand and real-world scenarios, with a focus on nurturing an innovation ecosystem defined by digital empowerment. Amid the rapid rise of the digital economy, the innovation paradigm is shifting from a technology-centric approach to one driven by practical use cases. The pervasive adoption of digital technologies offers fresh opportunities and actionable models for building this ecosystem (Yin et al., 2024). A scenario-driven innovation approach prioritizes application needs as its foundation, dismantling barriers between technology and its practical use by creating diverse innovation contexts. This facilitates the swift transformation and widespread deployment of technological value. To achieve this, the modern innovation system with Chinese characteristics must align closely with societal and market demands, cultivating an open, dynamic, and interconnected innovation ecosystem powered by the digital economy.

A digitally empowered innovation ecosystem hinges on data as its foundational element, unlocking the potential for scenario-driven innovation through robust data collection, analysis, and application. This requires enhancing data fluidity and interoperability among diverse stakeholders by establishing data-sharing platforms and advanced digital infrastructure that deliver precise demand insights and support decision-making for innovation activities. Simultaneously, digital technologies should serve as catalysts for diversifying innovation scenarios. Scenarios that leverage the Internet of Things, artificial intelligence, and big data can be designed to seamlessly integrate technology with societal needs. These applications are especially relevant in domains such as smart cities, intelligent manufacturing, and healthcare. Moreover, emphasis should be placed on understanding the dynamic mechanisms of scenario innovation. By fostering open innovation platforms and cross-stakeholder collaboration networks, rapid iteration and scalable expansion of innovation scenarios can be achieved, ensuring a steady stream of momentum for the continuous enhancement of the modern innovation system with Chinese characteristics.

In a scenario-driven innovation ecosystem, the government's role is particularly crucial. Through strategic policy guidance and targeted resource allocation, the government should promote the widespread application of digital technologies in the public sector, while establishing institutional frameworks that support the cultivation and expansion of innovation scenarios. At the same time, it is essential to foster an open, fair, and inclusive innovation environment by strengthening intellectual property protection and refining market competition rules, thereby stimulating the innovation drive and vitality of diverse stakeholders. By building an innovation ecosystem driven by demand and real-world scenarios, this approach not only enhances the efficiency and effectiveness of innovation

activities but also promotes the deep integration of scientific and technological progress with broader social development. In doing so, it provides strong technical support and an enabling environment for innovation to advance Chinese modernization.

4.4 Leveraging Institutional and Mechanism Innovation to Strengthen Innovation Governance Capacity

Development of a Chinese-style modern innovation system should rely on institutional and mechanism innovation to enhance innovation governance capacity and provide more scientific and efficient organizational support for innovation activities. Such innovation in institutions and mechanisms is both a critical foundation and a linchpin for building this system. The essence of this innovation lies in addressing challenges such as inefficient resource allocation, poor coordination among stakeholders, and inconsistent policy implementation inherent to traditional innovation frameworks. By refining institutional designs and governance structures, such efforts aim to establish an enabling environment that enhances the effectiveness and agility of innovation endeavors.

From a governance perspective, an innovation governance system should be built on a new whole-nation system that promotes synergy between government and market forces. The government should act as an "enabling force" by improving policy design, optimizing resource allocation, and strengthening oversight of implementation to provide strong institutional support for innovation. At the same time, the market should play a leading role by empowering enterprises to drive market-oriented development and technology commercialization, thereby achieving an organic integration of an "efficient market" and an "enabling government". Furthermore, emphasis should be placed on collaborative governance involving multiple stakeholders. This includes establishing cross-departmental and cross-industry coordination mechanisms to enhance the overall connectivity and coherence of the innovation ecosystem.

Efforts should aim to innovate governance mechanisms that improve comprehensive management and dynamic regulation throughout the entire innovation process. This includes refining the management of S&T projects to ensure the precise allocation and efficient use of innovation resources. Additionally, it is essential to optimize research evaluation systems to strengthen support for basic research and frontier exploration. Furthermore, enhancing risk prevention and control mechanisms will help increase the adaptability and resilience of the innovation system in the face of uncertainty. Additionally, continuous improvement and adaptive adjustment of innovation policies should be emphasized, with a strong focus on establishing robust evaluation and feedback mechanisms to ensure their scientific soundness and practical effectiveness.

4.5 Optimizing Sci-tech Commercialization Mechanism to Unlock Innovation Value

The commercialization of scientific and technological achievements is a crucial link in the construction of a modern innovation system. At its core, it involves establishing an efficient mechanism that enables the transition of technologies from laboratory research to market and societal application, thereby fully realizing the value of innovation. In developing a modern innovation system with Chinese characteristics, a key focus should be the optimization of the mechanism for transforming scientific and technological achievements. This entails addressing the "last mile" challenge in technology transfer and enhancing the capacity of scientific and technological innovation to support economic and social development.

From a theoretical standpoint, the transformation of scientific and technological achievements lies in the construction and extension of the knowledge value chain. Optimizing this transformation

mechanism requires a dual focus on both the supply and demand sides. On the supply side, it is essential to enhance the market adaptability of technological outputs by aligning R&D objectives more closely with market demands, thereby promoting the practical orientation and application of scientific research. On the demand side, efforts should focus on strengthening enterprises' capacity to absorb and apply new technologies by improving mechanisms for technology acquisition and advancing talent development systems. This will reinforce their leading role and their capacity for innovation in the transformation process. Furthermore, it is recommended to establish sci-tech commercialization platforms that act as collaborative "innovation commons" for a wide range of stakeholders. Such platforms can break down information barriers between the supply and demand sides, facilitating more efficient integration of technology, capital, and market forces.

At the policy level, efforts should focus on improving incentive mechanisms to promote the institutionalization and standardization of the transformation of scientific and technological achievements. This includes enhancing the intellectual property protection system to provide a solid legal foundation for the application and commercialization of such accomplishments. Additionally, a market-oriented profit-sharing mechanism should be established to motivate innovation stakeholders to participate in technology transfer actively. Developing a robust S&T financial service system to foster patient capital and ensure sufficient funding for transformation activities. By optimizing the mechanisms for technology transfer, we can enhance the economic and social returns of innovation and provide a continuous driving force for the sustainable development of a modern innovation system with Chinese characteristics.

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