Does a "Whole-Nation System" Exist in Japan's Science and Technology Field? A Postprint Case Study of Semiconductor Technology Development

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Abstract

Japan's adoption of the "organic development system," "integrated promotion system," and industry-university-government collaboration mechanisms in the science and technology domain has achieved remarkable results. However, academic circles hold differing views on whether this model constitutes a "whole-nation system." Different scholars' interpretations of the connotation and characteristics of the "whole-nation system" vary, and there is controversy over whether the Japanese government's key tackling practices fall under the "whole-nation system." This article systematically summarizes the connotation and characteristics of the "whole-nation system" in the science and technology field, selects Japan's semiconductor technology tackling as a case study, and demonstrates from an empirical perspective that its practices embody the features of the "whole-nation system." The article also summarizes the industrialization goal orientation of Japan's semiconductor technology tackling "whole-nation system," its "large-enterprise-based R&D system," the "dual functions" of national research institutions in applied research and coordination management, as well as the Japanese government's practices and experiences in technology funding areas and project selection criteria. Finally, it discusses the limitations of the "whole-nation system," proposing that a comprehensive and objective view should be taken of the key success factors behind Japan's "whole-nation system" model, avoiding exaggeration of this model's role in technology R&D, thereby deepening domestic research and understanding of Japan's technology tackling model, with the hope of providing some reference for advancing and perfecting the "whole-nation system" in China's science and technology domain.

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Full Text

Preamble

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Title: Is There a "Nationwide System" in Japan's Science and Technology Field?—A Survey of Semiconductor Technology Development

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Abstract

The Japanese government has achieved remarkable success through mechanisms such as the "organic development system," "integrated implementation system," and "industry-university-government collaboration" in science and technology. However, scholars hold divergent views on whether this model constitutes a "Nationwide System." Different interpretations of the connotation and characteristics of the "Nationwide System" have led to debates over whether Japan's approach to tackling key technological challenges qualifies as such. This article synthesizes the defining features of the "Nationwide System" in science and technology, selects Japan's semiconductor technology development as a case study, and empirically demonstrates that its practices embody the characteristics of a "Nationwide System." The article further summarizes Japan's semiconductor "Nationwide System," including its industry-oriented goals, "large-enterprise-based R&D system," the "dual functions" of national research institutes in applied research and coordination, and the Japanese government's approach to selecting funded projects. Finally, it discusses the limitations of the "Nationwide System," arguing for a comprehensive and objective assessment of the success factors behind Japan's model and cautioning against exaggerating its role in technological development. This analysis aims to deepen understanding of Japan's technology development model and provide references for improving China's "Nationwide System" in science and technology.

Keywords: semiconductor technology, nationwide system, organic development system, integrated implementation system, industry-university-government collaboration

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1. Basic Characteristics of the "Nationwide System"

Based on existing research, scholars generally agree that the "Nationwide System" in science and technology refers to an organizational model and operational mechanism adopted to accomplish specific scientific and technological missions in response to major national strategic needs. This article identifies four key dimensions from the academic discourse: task objectives, participating entities, implementation mechanisms, and resource allocation.

1.1 Strategic and Urgent Task Objectives

The "Nationwide System" in science and technology reflects national strategic goals. It represents a work system and operational mechanism through which the state mobilizes and allocates relevant resources and forces nationwide to achieve specific strategic objectives or tasks. Scholars variously describe these "specific strategic objectives or tasks" as "national goals," "national strategic S&T objectives," "national interests," or "national will." While strategic goals evolve across different periods of national development, they invariably possess clarity and urgency. Through the "Nationwide System," missions are completed within compressed timeframes to rapidly realize national will. This urgency is particularly evident in catch-up efforts in critical strategic domains, such as the "Two Bombs, One Satellite" program, development of cutting-edge technologies, frontier technologies that determine future strategic high ground, "bottleneck" industrial generic technologies, major equipment addressing industrial weaknesses, and major strategic fields concerning national security.

1.2 Diverse and Large-Scale Participation

The "Nationwide System" involves diverse and substantial participation from multiple entities. To achieve goals of collective value, it creates a collaborative pattern involving government, market, society, and individuals. Its fundamental characteristic is mobilizing actors with different social divisions of labor and distinct natures to accomplish tasks that no single type of actor could complete alone. This broad participation manifests in two aspects: first, diversity of participant types, including government, enterprises, universities, research institutes, social organizations, and individuals, maximizing the mobilization of enthusiasm and creativity across all sectors; second, scale of participation, as achieving specific strategic goals requires massive resource mobilization that exceeds the capacity of conventional approaches, necessitating the assembly of large-scale forces to overcome fragmentation and limited mobilization.

1.3 Organizational and Systematic Implementation Mechanisms

Effective operation of the "Nationwide System" requires establishing a highly organized and coordinated division of labor and collaboration system. This organizational coordination operates at two levels: first, vertical overall planning mechanisms. China's socialist system with Chinese characteristics possesses the supreme advantage of the Communist Party of China's leadership and the core strength of concentrating resources to accomplish major tasks, representing the fundamental institutional guarantee for China's development and progress. The "Nationwide System" emphasizes "scientific overall planning," where the Party conducts unified planning, allocates and integrates resources, and coordinates all work, fully demonstrating its role in exercising overall leadership and coordinating all parties. Second, horizontal division of labor mechanisms. The government plays a strategic guiding role, relying on positive interactions among government, market, and society to conduct nationwide division of labor and collaboration to achieve ultimate goals. Simultaneously, the relationship between government and other actors, especially market entities, must be viewed dynamically, which may constitute an important difference between traditional and new types of "Nationwide Systems."

1.4 Concentrated and Diverse Resource Allocation

The "Nationwide System" exhibits "whole-nation" characteristics in resource allocation. It addresses the limitations of dispersed resources by consolidating multi-party forces to provide super-scale funding and other resources for specific goals and dedicated tasks. National major projects typically serve as the primary platform for constructing the "Nationwide System," mobilizing and allocating diverse and large-scale advantageous resources nationwide through these platforms to form a pattern of open cooperation and collaborative 攻关. Notably, resource input is not merely about fiscal or financial scale; it emphasizes diversity, encompassing human and talent resources, knowledge resources such as basic theories and technical processes, and diverse resource elements including scientific instruments, large-scale equipment, research data, and technical intelligence.

In summary, based on analysis of existing literature, this article defines the "Nationwide System" in science and technology as: a scientific and technological mission 攻关 model based on strategic decisions made by the highest authorities regarding S&T development, under the guidance of supreme national will, with joint participation and complementary coordination among diverse entities including government, market, and society, employing scientific organizational management and division of labor mechanisms, relying on national major projects, and mobilizing diverse innovation elements. This system exhibits strategic and urgent task objectives; diverse and large-scale participation; organizational and systematic implementation mechanisms; and concentrated and diverse resource allocation.

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2. Examination of Japan's Semiconductor Technology Development Model

2.1 Terminology Origins of Japan's "Nationwide System" for Technology Development

According to official historical records in Japan's science and technology field, the Japanese terms "organic development system" (有機的開発体制) and "integrated implementation system" (整合的に進め得る体制) describe a scientific research and development system where, under national macro-strategy and fiscal funding, diverse entities including government, academia, and industry broadly participate. These concepts share high similarity with China's "Nationwide System" in both etymology and connotation, providing reasonable support for studying Japan's "Nationwide System."

The "organic development system" refers to Japan's approach during its technology catch-up phase: to shorten the technological gap with leading countries, it focused on pioneering large-scale industrial technologies critical to the national economy that required substantial R&D investment and long development cycles, entailing significant failure risks that private enterprises could not independently undertake. The state funded these efforts, with national research institutes, industry, and academia cooperating closely to conduct planned, efficient R&D activities. The "integrated implementation system" focuses on S&T system reform: recognizing Japan's deficiencies in research autonomy and creativity, and the departmental parochialism among ministries and agencies that affected the comprehensiveness and effectiveness of R&D implementation, this system aimed to clarify responsibilities between government and private sectors and define the functional positioning of universities and national research institutes to establish an "integrated implementation system" that promotes industry-university-government collaboration and enhances private-sector R&D vitality.

Japanese scholars further interpret the "integrated implementation system" as a national large-scale R&D project implementation system that, under national strategic guidance, comprehensively reforms the S&T system, enhances private-sector R&D vitality, promotes organic cooperation among industry-university-government entities, and focuses on advancing cutting-edge technology R&D. In essence, both "organic development system" and "integrated implementation system" demonstrate high consistency with the "Nationwide System" discussed in Chinese academia regarding strategic task objectives, diverse participation, organizational coordination, and concentrated resource allocation.

Additionally, "industry-university-government collaboration" (産学官連携) represents an interactive relationship among three types of actors—industry, academia, and government—and serves as the core organizational mechanism for implementing the "organic development system" and "integrated implementation system." Here, "government" generally refers to administrative agencies providing fiscal support. During specific historical periods, based on administrative affiliation with the government, national research institutes also partially performed "government" functions. For example, the early Agency of Industrial Science and Technology under MITI could assist the government in coordination and management. "Academia" represents universities and national (public) research institutions, while "industry" primarily refers to various entities in the industrial sector.

2.2 Examination of Japan's Semiconductor Technology "Nationwide System"

Building upon pre-war and post-war industrialization, Japan formed a complete semiconductor industry chain comprising semiconductor manufacturing, equipment, and materials. Between 1966 and 1989, to address market opening shocks and the risk of American enterprises encroaching on domestic markets, Japanese government ministries led by MITI (now METI) deployed nearly 10 R&D projects focused on improving the self-sufficiency rate of Japanese-made computers and conquering semiconductor core technologies, with total national investment exceeding 300 billion yen. Using these R&D projects as platforms, and under the coordination of the Japanese government and national research institutes, computer manufacturers served as primary implementers, mobilizing upstream equipment manufacturers, material suppliers, software design companies, and other enterprises to conduct effective cooperation with universities and research institutions, collectively creating Japan's semiconductor technology rise in the 1980s. This article examines the specific practices of Japan's semiconductor technology development, identifies its main characteristics, and evaluates whether its implementation model constitutes a "Nationwide System."

2.2.1 Urgent Tasks and Clear Goals: Rapidly Achieving Computer Industry Catch-up After World War II, Japan introduced foreign advanced technologies, implemented improvement-based innovation, and adopted supportive policies including tariff barriers, export restrictions, and government procurement. These measures reduced Japan's computer industry import dependency from 69% in 1961 to 37% in 1965, further dropping to 21% by 1968, with domestic computer usage surpassing foreign models by 1969. As Japan's national strength grew and foreign interest in its market intensified, Japan-U.S. trade friction erupted frequently. Under multiple pressures, the Japanese cabinet reluctantly introduced a series of trade liberalization policies. Facing potential market encroachment by American IBM and other computer manufacturers, how to enhance the international competitiveness of domestic computer industries within a limited timeframe became an urgent concern across Japanese society.

Focusing on semiconductor components and using semiconductor core technology as a breakthrough to build competitive advantages in the computer industry became Japan's chosen path for catch-up. Since integrated circuits (IC) and large-scale integrated circuits (LSI) represented key components determining computer performance, achieving computer industry catch-up within a limited time required prioritizing competitiveness in semiconductor device-related technologies. The 1976 MITI "Very Large Scale Integration (VLSI) Technology R&D Project" exemplified this approach, focusing on semiconductor technology R&D to leverage competitive advantages in the computer industry. This demonstrates that in response to impending international competition, Japan's strategic adjustments reflected timely and gradual focus, using technology to promote and protect industries, and building "asymmetric advantages" through technology to achieve catch-up.

2.2.2 Diverse and Broad Participation with Enterprises as the R&D Mainstay To focus on semiconductor technology development, Japanese ministries including MITI and the Ministry of Posts and Telecommunications deployed multiple R&D projects starting in 1966. These projects exhibited two major characteristics: first, diverse entities including national research institutes, universities, and enterprises participated and collaborated closely. Semiconductor manufacturing processes are complex and require high R&D investment, necessitating multidisciplinary knowledge in electronics, chemistry, and mechanics, as well as support from optical, vacuum, and high-frequency technologies, objectively requiring joint 攻关 among different entities. For example, the successful market launch of stepper lithography equipment benefited from theoretical advances by MITI's Agency of Industrial Science and Technology (Electrotechnical Laboratory) in "electron beam patterning equipment" and joint trials with enterprises.

Second, Japan implemented a "large-enterprise-based" R&D system. Semiconductor technology has clear market-driven orientation, aiming to improve terminal product performance and win market recognition. Consequently, R&D projects were led by Japan's six major computer manufacturers (Hitachi, Fujitsu, Toshiba, NEC, OKI, and Mitsubishi Electric), tightly integrating R&D outcomes with industrialization goals. This model, where leading large enterprises dominate technology R&D, is summarized by Japanese scholars as the "large-enterprise-based R&D system." In terms of funding allocation, government funds focused on supporting enterprises. For instance, MITI's "Super

High-Performance Electronic Computer Project" (1966–1972) invested a total of 10 billion yen over five years, with 1.5 billion yen allocated to the Electrotechnical Laboratory and the remaining 8.5 billion yen distributed to three enterprises: Hitachi, NEC, and Japan Software.

2.2.3 Emphasis on Organizational Coordination: National Research Institutes' "Dual Functions" In implementing joint R&D activities, Japan's national research institutes performed two distinct functions. First, at the R&D implementation level, they conducted basic and applied research as important actors driving technology industrialization. As "vanguards" of applied research, Japanese national research institutes maintained long-standing close cooperation with enterprises. As Japanese scholars describe, enterprise technical staff frequently visited national research institutes such as the Ministry of Posts and Telecommunications' Electrical Communications Laboratories, while institute researchers providing technical guidance and advice to enterprise personnel was a common occurrence.

Second, at the organizational management level, they assisted the government in project coordination and management. National research institutes possess three major advantages—technical expertise, neutral position, and government affiliation—enabling them to play positive roles in coordinating competitive conflicts among enterprises, leveraging technical strengths, and reducing government project management costs.

These "dual functions" were prominently demonstrated in the 1976 VLSI Technology R&D Project. The project's "Joint Research Laboratory" was headed by Yasuo Tarui from the Electrotechnical Laboratory of the Agency of Industrial Science and Technology. The laboratory concentrated 20+ researchers from each of five competing computer manufacturers (Hitachi, Fujitsu, Toshiba, NEC, and Mitsubishi Electric) for four years of collaborative research. Representative achievements included successful development of electron beam patterning equipment and stepper lithography, with national research institutes playing crucial roles in fundamental theoretical breakthroughs.

Moreover, in joint R&D, different manufacturers' competitive relationships hindered open cooperation. Under the leadership of Laboratory Director Yasuo Tarui, leveraging his neutral position as a national research institute scientist, the research themes were ultimately defined as "basic and common" technologies strongly demanded by all manufacturers after multiple rounds of discussion. "Basic" refers to technologies required by all companies beyond their existing specialized technologies, while "common" refers to technologies whose applications could meet shared development needs across companies. The R&D ultimately focused on two major themes: "microfabrication equipment development" and "silicon wafers." The former enabled R&D cooperation among manufacturers, while the latter facilitated cooperation between manufacturers and upstream semiconductor equipment enterprises. This success stemmed from the national research institutes' inherent advantages in technical expertise and mission orientation.

2.2.4 Japanese Government Establishes Technology Selection Criteria to Enhance Industrial R&D Levels MITI-led industrial promotion measures served as the "escort fleet" for Japan's semiconductor technology development. In 1961, MITI explicitly proposed government funding guidelines: to enhance international competitiveness, Japan must build a government-industry coordinated R&D promotion system that stimulates private-sector R&D enthusiasm and selects key technology projects for national funding. Specifically, selection criteria included: (1) urgency—the technology is critically important and urgently needed for industrial structure improvement and international competitiveness enhancement; (2) pioneering and ripple effects—the technology significantly contributes to industrial technology advancement with substantial technological spillover effects; (3) large-scale funding or long R&D cycles—the technology requires massive funding or long-term R&D, involves high failure risks, and cannot be undertaken by industry alone; (4) clear R&D objectives—the technology's goals are predictable and definable, with technically feasible approaches; (5) necessity for multi-actor participation—the technology's development requires consolidating resources and forces from national research institutes, industry, and academia.

In project design and evaluation standards, the Japanese government emphasized the ripple or driving effects of R&D outcomes on industry and technology. For example, the "Super High-Performance Electronic Computer" project explicitly aimed to develop globally representative large-scale commercial computers and establish world-leading advantages. Upon completion, the project yielded numerous fundamental technologies including LSI, design automation systems, and automatic testing systems, which received high evaluations not only for performance, stability, and reliability but also for their immeasurable ripple effects across many other technology fields—precisely the R&D outcomes most valued in Japan's joint R&D project deployment.

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3. Conclusions and Implications

Based on the above analysis of the "Nationwide System" connotations and examination of Japan's semiconductor technology development, Japan's approach demonstrates basic "Nationwide System" characteristics: under clear strategic guidance to enhance domestic computer product performance and address impending international competition, Japan mobilized broad participation from national research institutes, enterprises, and universities, built inter-actor coordination mechanisms, and secured sustained government investment, ultimately winning international competitive advantages with some key technologies maintaining leading global positions to this day. This further confirms that the "Nationwide System" is a task-oriented system related to the need to accomplish major missions, without inherent connection to ideology, political system, or economic system. From the perspective of international S&T development history, the "Nationwide System" management framework also widely exists in major S&T projects in developed countries.

Beyond these general characteristics, Japan's "Nationwide System" exhibits distinctive features in its specific implementation, offering several insights:

(1) Government-Market Relations: Japan's semiconductor "Nationwide System" positions enterprises as the R&D mainstay with clear industrialization goals, essentially implementing industrial technology policy. Semiconductor technology is strongly market-driven. Under clear industrialization objectives, terminal enterprises demonstrate strong enthusiasm and initiative. The prominent role of enterprises as R&D actors, termed the "large-enterprise-based R&D system" by Japanese scholars, aligns highly with the requirement from China's Central Committee for Comprehensively Deepening Reform's 27th meeting in September 2022 to "promote better integration of effective markets and capable governments, strengthen enterprises' principal position in technological innovation, accelerate transformation of government S&T management functions, foster a favorable innovation ecosystem, and stimulate innovation vitality." This orientation naturally determines that this 攻关 model is not for implementing pure science or basic research emphasizing free exploration, but for implementing industrial technology policy that uses technology to drive industrial development, stays close to market demand, and aims for technology productization and industrialization as final goals, with high enterprise enthusiasm and autonomy. This approach of integrating technology policy into industrial policy, particularly industrial structural policy, gradually formed Japan's distinctive "industrial technology policy," becoming an important policy instrument for the government to promote integration of S&T with industry and economy.

(2) Organizational Management: Japan's national research institutes play important organizational and management roles, rooted in their long-standing close cooperation with industry. As described above, the relationship between Japan's national research institutes and industry was established during wartime S&T mobilization. The Ministry of Posts and Telecommunications' Electrical Communications Laboratory modeled itself after Bell Labs, establishing an R&D system directly connected with industry, and jointly developed the Type 4 telephone with Japanese communications equipment manufacturers (NEC, Hitachi, Fujitsu, OKI, etc.) shortly after WWII. The laboratory also signed Joint R&D Agreements with these enterprises, established the "Electronic Switching Research Association," held regular technical exchange meetings, and jointly developed variable-parameter component computers. As national public R&D institutions, their openness to industry is evident, forming the important prerequisite and foundation for their organizational effectiveness and management authority. Regarding organizational management of the "New Nationwide System," China's Central Committee for Comprehensively Deepening Reform proposed "accelerating transformation of government S&T management functions." Japan's project implementation experience shows that given government administrative departments' limited technical expertise, relying on national research institutes with close government ties to undertake specific coordination, project selection, and evaluation functions represents an effective organizational management model.

(3) Foundation in Basic Research: Japan's semiconductor technology success through the "Nationwide System" model stemmed from long-term accumulation in basic research; the role of the "Nationwide System" should be evaluated objectively. While the "Nationwide System" model undoubtedly played an important role in Japan's semiconductor technology development and has received high praise both domestically and internationally, it is crucial to recognize that Japan's semiconductor rise was not solely due to the concentrated mobilization of the "Nationwide System" over a few short years. Japanese S&T historians emphasize that even before WWII, numerous research organizations and personnel were engaged in semiconductor research in Japan. After 1948, Japan's Ministry of Education and MITI deployed numerous semiconductor research projects, funding universities for scientific experiments and enterprises for industrial trials. By the mid-1950s, Japanese universities and national research institutes were already prototyping parametrons and transistor computers as vacuum tube substitutes. Statistics show that between 1948 and 1956, Japan deployed 38 experimental research projects with total funding exceeding 60 million yen. These projects were exploratory in nature and belonged to individual research rather than the joint research "Nationwide System" model, yet they laid a solid foundation for Japan's semiconductor technology to achieve industrialization under the "Nationwide System" model. Therefore, we must not overstate the Japanese "Nationwide System" or any "Nationwide System" model as the sole solution for technological breakthroughs. Behind Japan's semiconductor technology success lies decades of sustained accumulation that ultimately achieved breakthrough success through the "Nationwide System" model.

In summary, Japan's sustained international position in semiconductor technology results from coordinated cooperation and orderly advancement among government, enterprises, national research institutes, and universities. The role of this Japanese "Nationwide System" is undeniable. This approach represents an effective method for developing and catch-up countries to compete with developed nations and reach the same starting line. In terms of implementation effects, by pooling national funding and corporate R&D investment, and through close cooperation between national research institutes, universities, and enterprises, it significantly enhanced corporate R&D capabilities and productivity, laying the foundation for Japan's semiconductor technology prosperity. This "Nationwide System" model helps achieve the three-stage leap of technology from "principle to prototype—prototype to product—product to scaled market." In contrast, while China currently emphasizes the importance of the "Nationwide System," it still faces the problem of "nationwide in name but not in reality," highlighting the importance of matching the "Nationwide System" with scientific and effective management methods. Japan's semiconductor technology 攻关 practices offer valuable references for addressing existing problems in China.

References

1. Zhong H B. The new national system for science and technology: Model of resources and relations in the socialist market economy. *Socialism Studies*, 2021, (5): 111-117. (in Chinese)
2. Fan C L. Historical evolution and future development trend of the national system of science and technology. *Governance*, 2020, (42): 23-28. (in Chinese)
3. Lu F, He P Y. The new-type system of nationwide mobilization and breakthroughs: Historical experiences of accomplishing major tasks by special agencies and the lessons. *Journal of Management World*, 2021, 37(7): 1-18. (in Chinese)
4. Lei X M. Research on the new state system of science and technology innovation under the conditions of socialist market economy. *Economist*, 2021, (12): 14-21. (in Chinese)
5. Xie F S, Pan Y M. A proper understanding of the national system. *Marxism & Reality*, 2020, (5): 156-166. (in Chinese)
6. Wang S G, Wang D L. The whole-nation system and its transformation of scientific and technological progress: The enlightenment of new China's industry history. *Review of Economic Research*, 2018, (26): 3-13. (in Chinese)
7. Cao X Y, Zhang K, Liu A R. Thoughts and suggestions on building a new national system and forming a joint technical research mechanism. *Scitech in China*, 2020, (10): 34-37. (in Chinese)
8. Xie Y Z, Hu A G. Background, basic features and application fields of the new whole-nation system. *Journal of Shenzhen University (Humanities & Social Sciences)*, 2021, 38(4): 18-26. (in Chinese)
9. He H S. Connotation, advantages and significance: On the three dimensions of the new national system. *People's Tribune*, 2019, (32): 56-59. (in Chinese)
10. Du B G. Correctly handling several relations in the national system of new science and technology. *Governance*, 2020, (42): 29-31. (in Chinese)
11. Cao R Z, Dong G C. New national system: Concept, connotation and realization mechanism. *Scientific Socialism*, 2021, (4): 83-90. (in Chinese)
12. Li Z, Su N. A study on the new national system for science and technology innovation under the condition of socialist market economy. *Forum on Science and Technology in China*, 2014, (2): 5-10. (in Chinese)

13. Zhong S H. On whole-nation system for science and technology. *Studies in Science of Science*, 2009, 27(12): 1785-1792. (in Chinese)

14. Bai C L. Accelerate the improvement of scientific and technological innovation system and mechanism. *China Awards for Science and Technology*, 2020, (2): 6-7. (in Chinese)

15. Tooru K. Large-scale technology development in Japan. *The Japan Society of Mechanical Engineers*, 1973, 76: 1232-1237. (in Japanese)

16. Ad Hoc Administrative Investigation Committee. *Third Report on Administrative Reform (Basic Report)*. Tokyo: Ad Hoc Administrative Investigation Committee, 1982. (in Japanese)

17. Yukio U. *Science and Technology Policy Studies*. Tokyo: Rodo Shunpo Sha, 1989. (in Japanese)

18. Feng Z K. The development and innovation of Japan's semiconductor industry: Some inspiration relating to the development of China's chip technology. *Japanese Studies*, 2018, (6): 1-29. (in Chinese)

19. Yoshikazu T. Development of the Computer Industry and Industrial Policy in Japan. *Annals of the Society for Industrial Studies, Japan*, 1987, (3): 27-36. (in Japanese)

20. Kunio M. Making process of Japanese mainframe computer industrial policy: Mid 1960s-1970s. *Journal of International Relations and Comparative Culture*, 2008, 6(2): 371-390. (in Japanese)

21. Hiroshi A. The role of national and public research institutes in the early Japanese computer development. *Yokohama Keiei Kenkyu*, 2000, 21(1): 131-147. (in Japanese)

22. Yasuo T. *50 Years of Japanese Semiconductors: Testimonies of 537 People Who Created an Era*. Tokyo: Sangyo Taimuzusha, 2000. (in Japanese)

23. Industrial Structure Council. *Report on the Exploration of Core Technologies for Future Technological Development, the Role of the Government in Technology Development, the Direction of Industrial Policy for Promoting Corporate Technology*. Tokyo: Industrial Structure Council, 1963. (in Japanese)

24. Research and Development Office of the Industrial Technology Institute. *20 Years of Large-Scale Projects: Laying the Foundation for Japan's Industrial Technology*. Tokyo: Research Institute of International Trade and Industry and Industry, 1987. (in Japanese)

25. Chen J, Yang Z, Zhu Z Q. The theoretical logic, implementation mode and application scenario of the new type of national system. *Reform*, 2021, (5): 1-17. (in Chinese)

26. Heavy Industries Bureau of the Ministry of International Trade and Industry (MITI). *Japanese Electronics Industry*. Tokyo: The Nikkan Kogyo Shimbun LTD., 1957. (in Japanese)

27. Hiroshi A. Development of semiconductor technology in Japan and its background: From the perspective of joint research activities. *The Socio-Economic History Society*, 2009, 74(6): 49-71. (in Japanese)

28. Bao Y G. Analysis of principles of development of key technologies. *Bulletin of Chinese Academy of Sciences*, 2022, 37(5): 636-641. (in Chinese)

Table 1

Statistics on government R&D projects related to semiconductor technology (1960s—1990s)

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