Comparative Study on Innovation Strategies and Policies of Major Nordic Countries in the Post-COVID-19 Era: From the Perspective of Building Innovation Highlands (Postprint)

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Date: 2023-08-12T00:00:00+00:00

Abstract

China is currently in an accelerated phase of constructing world-class important innovation hubs, and there is an urgent need to learn from the development experience of globally renowned innovation hubs. The major Nordic countries, represented by Denmark, Finland, Sweden, and Norway, possess relatively rich practical experience in developing an innovation economy. Through implementing innovation strategies and policies, they have strengthened the role of scientific and technological innovation in supporting the economy, nurtured a number of world-renowned technology enterprises and brands, and are veritable innovation hubs. Since the COVID-19 pandemic, Nordic countries have generally deployed or adjusted their innovation strategies and implemented new innovation policies, which merit attention. This article systematically reviews the important innovation strategies and policies of major Nordic countries since the COVID-19 pandemic, and distills new measures and experiences of relevant countries in areas such as financial support for SMEs, tax incentive policies, distinctive innovation strategies, and innovation clustering models. On this basis, from the perspective of innovation hub construction, this study analyzes the common characteristics of the innovation strategies and policies of relevant countries, crystallizes an innovation strategy and policy framework, and proposes implications for China's construction of world-class important innovation hubs.

Full Text

Preamble

ChinaXiv Partner Journal
Policy & Management Research

Citation format: Li X Q, Wang Y C. Comparative study on innovation strategies and policies of major Nordic countries after COVID-19 pandemic—Based on perspective of building innovation highland. Bulletin of Chinese Academy of Sciences, 2023, 38(7): 1012-1022

Comparative Study on Innovation Strategies and Policies of Major Nordic Countries After COVID-19 Pandemic—Based on Perspective of Building Innovation Highland

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Abstract

China is currently accelerating the construction of world-class innovation highlands and urgently needs to draw upon the development experiences of renowned global innovation centers. The major Nordic countries—Denmark, Finland, Sweden, and Norway—possess rich practical experience in developing innovation-driven economies. Through strategic and policy deployments in innovation, they have enhanced the capacity of scientific and technological innovation to support economic growth and cultivated numerous world-renowned technology enterprises and brands, establishing themselves as veritable innovation highlands. Since the COVID-19 pandemic, Nordic countries have generally deployed or adjusted their innovation strategies and implemented new innovation policies, developments that merit close attention. This article reviews the important innovation strategies and policies of major Nordic countries since the pandemic, distilling their new initiatives and experiences in financial support for small and medium-sized enterprises, preferential tax policies, distinctive innovation strategies, and innovation cluster models. From the perspective of building innovation highlands, the study analyzes the common characteristics of these countries' innovation strategies and policies, refines an overarching framework for innovation strategy and policy, and proposes insights for China's efforts to build world-class innovation highlands.

Keywords: innovation highland, Nordic, innovation strategy, innovation policy

1. Overall Innovation Capacity Trends in Major Nordic Countries

The innovation capacity of major Nordic countries ranks among the world's best. According to the World Intellectual Property Organization's *Global Innovation Index 2022* (GII 2022), Sweden, Denmark, and Finland all rank within the top 10 globally . Although their rankings have declined somewhat compared to previous years, they remain "innovation leaders." High-intensity R&D expenditure and investment in scientific and human resources have maintained these countries' innovation competitiveness at a high level. For instance, Denmark, Sweden, and Finland's R&D expenditure as a percentage of GDP approaches or

exceeds 3%, demonstrating substantial investment intensity. In terms of scientific human resources, Denmark, Sweden, and Finland each have more than 14 R&D personnel per thousand employed individuals, compared to approximately 10 in Japan and Germany during the same period. Nordic countries attach great importance to attracting and cultivating talent, viewing talent competitiveness as the foundation of innovation competitiveness, with Denmark and Sweden ranking among the top five in the *2022 Global Talent Competitiveness Index*. According to the European Commission's *European Innovation Scoreboard 2022*, Sweden, Finland, and Denmark are European innovation leaders, occupying the top three positions in innovation performance—far exceeding the EU average.[1] Analysis by the European Investment Bank also identifies Finland and Denmark as leading innovators.[2] These indicators demonstrate that the innovation capacity of major Nordic countries belongs to the top tier.

2. Key Innovation Strategies and Policies in Major Nordic Countries Since COVID-19

2.1 Enhanced Financial Support for Small and Medium-Sized Enterprises

Countries worldwide universally emphasize SME cultivation, and Nordic countries are no exception, particularly showing a strong preference for high-tech startups. Since 2020, Nordic countries have generally increased support for SMEs, especially through direct financial assistance. According to a European Investment Bank survey, "subsidies or other non-repayable financial support" represents the most common form of financial assistance for European enterprises, accounting for 40% of total support—higher than guaranteed credit (18%) and deferred payments (17%). In response to COVID-19, the Danish government introduced guarantee and loan programs for SMEs, increasing government-guaranteed loans from DKK 1.246 billion in 2019 to DKK 2.934 billion in 2020, with a focus on supporting innovation activities. Finland faced economic downward pressure beginning in 2020 and implemented a series of measures to support economic development, increasing government loan guarantees from €611 million in 2019 to €1.1 billion in 2020. Simultaneously, Finland directly supported SME innovation activities through policy instruments such as InnovFin. The Swedish government's direct loans increased from SEK 2.29 billion in 2019 to SEK 3.93 billion in 2020, while private equity funds invested €1.467 billion in Swedish startups and growth-stage companies—an increase of nearly 146% from the previous year.[3] Norway has recently begun drawing on Swedish experience in cultivating SMEs, building a complete innovation ecosystem for startups. A report by British technology consulting and investment firm GP Bullhound notes that Norway's tech ecosystem is gradually maturing, with financing rapidly catching up to Denmark and Finland. These developments indicate that when facing pressures from the pandemic and economic uncertainty, Nordic countries have generally strengthened support for enterprise innovation, betting on high-tech SMEs as the engine of economic recovery.

2.2 Preferential Tax Policies for Innovation

Using tax incentives to encourage enterprise innovation is a common practice worldwide. According to the *International Tax Competitiveness Index 2022* published by the U.S. tax research think tank Tax Foundation, while Nordic countries' overall performance among OECD members is average, Denmark, Finland, and Norway have generally strengthened innovation-oriented tax preferential policies since 2020, including R&D expense super-deductions, tax credits, and fixed asset depreciation . Denmark has increased its R&D super-deduction rate, proposing a gradual increase from 105% in 2021 to 110% by 2026; to address COVID-19, the rate was temporarily raised to 130% for 2020–2022.[6] Finland has the lowest corporate income tax rate among Nordic countries and plans to increase R&D expenditure to 4% of GDP by 2030.[7] To encourage innovation, Finland implemented a new tax incentive in 2021 allowing eligible taxpayers to enjoy separate tax preferences for expenses related to joint research with universities and other research institutions—an initiative that positively promotes industry-university-research collaboration.[8] Although Sweden does not have tax preferences for R&D expenses, the government provides substantial support for enterprise innovation through indirect means, such as exempting employers from 19.59% of social security contributions.

2.3 Innovation Strategies Addressing Socio-Economic Development Needs

In recent years, Nordic innovation strategies have focused on green economic development and addressing socio-economic challenges. Notably, Nordic countries exhibit high levels of digitalization. According to the European Commission's *Digital Economy and Society Index 2022*, Finland ranks first in digitalization, Denmark second, and Sweden fourth. A 2021 survey shows that while 55% of EU SMEs have achieved at least a "basic level" in digital technology application, the figure reaches 86% in Sweden and 82% in Finland. Denmark, Finland, and Sweden rank highest in digital transformation, possessing the EU's most advanced digital economies.[9] Since 2020, the key innovation strategies of major Nordic countries are summarized in .

2.3.1 Finland: Innovation Strategy for Ecosystem Reconstruction Finland's innovation system possesses strong competitiveness in Europe and globally. In recent years, Finland has placed increasing emphasis on innovation, positioning it at the center of economic development. To enhance innovation competitiveness, Finland passed the *National Roadmap for Research, Development and Innovation* in 2020, updated in December 2021. The roadmap proposes a new policy framework to strengthen national innovation competitiveness, setting goals and strategies across 36 initiatives focused on attracting and cultivating research talent, enhancing cooperation between research institutions and enterprises, and improving public services for innovation.[10] Typical measures include enhancing Finland's global innovation ecosystem appeal,

expanding open collaboration, promoting flexible partnerships among diverse innovation actors, and encouraging enterprises to increase R&D investment. Finland is actively adjusting its innovation strategy to reconstruct its innovation ecosystem and create a favorable environment for innovation actors.

2.3.2 Denmark: Innovation Strategy Serving Green Economic Development Denmark has achieved a high level of green economic development, with its innovation strategy integrated into climate, energy, and environmental policies. In 2021–2022, the Danish government released three versions of *Denmark Can Do More* to promote socio-economic development, implementing reforms in key areas critical to Denmark's future. In 2021, Denmark introduced the *Danish Recovery and Resilience Plan*, comprising approximately DKK 11.6 billion in initiatives to fund previously agreed green deals (such as improving energy efficiency, reducing CO_2 emissions, and promoting digital transformation) and encourage enterprises to increase R&D investment within the overall green R&D framework.[11] Overall, Denmark's innovation strategy and policies are scenario-based, built upon green economic frameworks.

2.3.3 Norway: Innovation Strategy Focused on Energy Economy Transition Norway is an innovation powerhouse that has consistently regarded innovation as a key factor in maintaining national competitiveness. According to the *2022 European Innovation Scoreboard*, Norway's innovation performance reaches 122.3% of the EU average. In recent years, Norway has made green strategy a critical component of economic transformation. In 2021, Norway introduced the *National Strategy for a Green, Circular Economy* (Nasjonal strategi for ein grøn, sirkulær økonomi) to strengthen its green circular economy competitiveness through a series of measures. From an innovation perspective, Innovation Norway (Innovasjon Norge) plays a crucial role in Norway's innovation system. Established under special legislation, Innovation Norway is a key policy instrument supporting enterprise innovation and high-tech industry development, aiming to cultivate high-value enterprises addressing socio-economic development needs and support Norway in building a more efficient innovation system. In 2021, Innovation Norway provided NOK 10.1 billion in support to the business sector and serves as a growth partner for SMEs, offering financing and consulting services based on enterprises' innovation needs and bridging enterprises with investors and research institutions. 95% of surveyed enterprises consider Innovation Norway's support decisive for implementing innovation projects.[12]

2.3.4 Sweden: Innovation Strategy for Developing Key Emerging Industries Sweden is an innovative nation that has introduced national strategies in climate, environment, energy, life sciences, and digitalization. Since 2020, Sweden has released the *Sweden's Recovery Plan*, *Swedish Circular Economy Strategy*, and *Strategy for Sweden's Global Development Cooperation in Environment, Climate and Biodiversity 2022–2026*. Vinnova (Sweden's Innova-

tion Agency) is a key implementing body, with investments reaching SEK 3.7 billion in 2021—a 20% increase from 2020—supporting 3,716 projects.[13] At the national level, the most influential innovation strategy is the "Strategic Innovation Programs" jointly promoted by Vinnova, the Swedish Energy Agency, and the Swedish Research Council for Sustainable Development (Formas). These programs aim to create conditions for addressing challenges, achieving sustainable development, and enhancing international competitiveness through collaboration in strategic areas, primarily supporting 17 innovation fields including "Smart Transport Sweden," medical health technology, intelligent electronic systems, and "Manufacturing 2030."[14] In 2022, Vinnova is updating and planning to implement "Strategic Innovation Programs 2.0" (Nästa generations strategiska innovationsprogram).[15] Sweden's innovation strategy clearly focuses on cultivating emerging industries in key sectors.

2.4 Reconstruction of Innovation Clusters: From Science Parks to Science Cities

From the innovation histories of Nordic and other developed countries, innovation clusters represented by science parks have played an irreplaceable role. In recent years, the distribution, form, and function of innovation clusters have been quietly changing. New urban-form innovation clusters represented by science cities and innovation districts are gradually becoming the future innovation highlands of the Nordic region, leading the direction of innovation-driven economic development. Currently, major Nordic countries are actively deploying science cities and promoting the upgrading of science parks to better enhance their attractiveness to world-class scientists and technology enterprises. For example, Technopolis Group, established in Oulu, Finland in 1982, has upgraded and optimized its existing science parks in recent years, actively exploring new service models. It now operates multiple campuses across six European cities, serving 1,500 companies and becoming a cross-regional innovation space and specialized service provider.[16] Sweden's Kista Science City hosts over a thousand enterprises and more than 20,000 tech talents, representing a transformation from an ICT industrial park to a modern science city. Originally an ICT industry cluster formed by enterprise agglomeration, Kista adapted to new innovation needs of tech enterprises by renovating and optimizing facilities, improving functions, and building schools, gradually evolving into a modern science city.[17] Copenhagen Science City in Denmark focuses on location and research resource advantages, having evolved through three stages from science park to high-tech zone to science city, now becoming a globally influential innovation highland in life sciences.[18] Norway's Oslo Science City, the country's first innovation district currently under construction, aims to develop a vibrant new urban area in Norway's knowledge-intensive region, integrating the existing Oslo Science Park and University of Oslo to build a green, smart, livable, and attractive science city.[19] Representative new innovation clusters in major Nordic countries are shown in .

3. Framework of Nordic Innovation Strategies and Policies from the Perspective of Building Innovation Highlands

Nordic countries regard innovation as the lifeline of sustainable development and timely adjust their innovation strategies according to various environmental changes to maintain their competitiveness in the global innovation landscape. By reviewing the new changes in Nordic innovation strategies and policies since 2020 and analyzing them from the perspective of building innovation highlands, we can distill an overall framework (Figure 1 [Figure 1: see original paper]). As illustrated, Nordic innovation strategies and policies can be divided into four main components:

3.1 Focused Innovation Policy Supply

The UN 2030 Agenda for Sustainable Development and the practical needs of national economic development form the important foundation for innovation strategies. Since the COVID-19 pandemic, Nordic innovation strategies have demonstrated both continuity and new adjustments, with national economic recovery plans influencing innovation strategy formulation. Under these strategies, policy priorities mainly manifest in two aspects: enterprise R&D support policies represented by R&D incentives, and talent policies focused on cultivating and attracting highly skilled personnel and leading researchers.

3.2 Multi-Department and Multi-Agency Collaborative Support

Innovation strategies influence the specific measures of government departments, financial institutions, innovation funds, and intermediary service organizations. Government innovation departments support enterprises through complementary policies, implementation guidelines, consulting services, and expert assistance. Banks, venture capital, and innovation funds provide investment and financing services. Intermediary service organizations and associations serve as bridges, offering specialized services for technology transfer and commercialization.

3.3 "Education + Digitalization + Green" Advantageous Foundation

Nordic countries emphasize basic education and vocational training, with rich scientific and educational resources. Their high-level research universities and research institutions actively cooperate with enterprises, providing intellectual support for R&D. Simultaneously, digitalization and greening represent important foundations and development directions for Nordic innovation strategies. Based on extremely high digitalization levels, Nordic countries have extended their service chains for SMEs and promoted technological and product innovation through "digital +" models. The green economy creates new application scenarios, providing richer market space for Nordic products.

3.4 Innovation Centers with Science Cities as Carriers

Major Nordic countries are using science cities as carriers to build innovative, human-centered, comfortable, green, and smart urban innovation ecosystems, reshaping innovation systems based on urban environments. Science cities adapt to new trends in research paradigms, centering on the needs of scientists and makers, building comfortable urban functions and favorable research environments, and promoting innovation in research organization forms and models to create international scientific communities conducive to knowledge production, sharing, exchange, and integration. They are becoming new centers of scientific and technological innovation.

4. Potential Impacts of Nordic Innovation Strategies and Policies

Through comparative analysis of the new round of Nordic innovation strategies and policies, combined with economic and technological factors, we can identify potential impacts of relevant measures and strategic deployments (Table 5).

4.1 Further Enhancement of High-Tech Enterprise Innovation Competitiveness

Through optimizing the innovation ecosystem, broadening financing channels for SMEs, and strengthening preferential tax policies for innovation activities, Nordic countries are comprehensively guiding innovation resources toward SMEs. These measures send strong support signals to high-tech enterprises, boost market confidence, help expand the scale of high-tech startups, and enhance enterprise innovation competitiveness and resource utilization efficiency. These efforts may nurture more new globally renowned enterprises in the future.

4.2 Enhanced Competitiveness in Key Emerging Industries

The new round of Nordic innovation strategies focuses on climate, life sciences, and digitalization, combined with extensive green and smart application scenarios, creating greater space for industrial development. The selection of relevant industries fully leverages national innovation resource endowments, particularly based on solid digital infrastructure. Emerging industries with "smart + green" attributes are poised for development opportunities, injecting new momentum into Nordic countries from new tracks and potentially making them leaders in a new round of "green manufacturing."

4.3 Comprehensive Enhancement of Talent Competitiveness

Nordic countries' strategies and policies for scientific and technological talent will enhance their global talent attractiveness while improving the competitiveness of domestic scientific talent, thereby increasing the total stock of scientific

and human resources. Particularly in digital economy and life sciences, the deployment of new R&D centers will gather more high-level research talent, creating a mutually reinforcing situation among talent competitiveness, innovation competitiveness, and economic competitiveness.

4.4 Birth of Emerging Innovation Highlands

Urban-form innovation clusters are emerging across Nordic countries, gradually becoming the main arena for Nordic innovation economies through iterative upgrades of existing science parks. The development of science cities may change the geographic distribution of high-tech enterprises and scientific talent in relevant countries, adjust existing innovation networks, and form more competitive innovation ecosystems. In the future, the development of science cities will strengthen Nordic innovation competitiveness and may produce emerging globally competitive innovation highlands.

5. Implications for China's Construction of World-Class Innovation Highlands

5.1 Strengthen Top-Level Design for Innovation Highland Construction

Conduct strategic research on building world-class innovation highlands, systematically review policy measures of typical innovation highlands, and develop implementation roadmaps. Deepen reforms in the "delegation, regulation, and service" areas of scientific and technological innovation, establish institutional mechanisms to promote innovation highland construction, and unblock channels for cross-regional circulation of innovation elements. Innovate policy supply, shift from selective industrial policies to functional industrial policies, and provide a favorable foundation for high-quality cultivation of high-tech enterprises, technology-based SMEs, and "gazelle" enterprises.

5.2 Accelerate Construction of World-Class Science Cities

Future global competition for innovation highlands will manifest as competition among science cities, which will become important gathering places for future industries and national strategic scientific and technological forces. Recommendations include: develop top-level design guidelines for building world-class science cities based on key core technology breakthroughs and the "dual circulation" development paradigm; coordinate the deployment of international science and technology innovation centers and science city construction to form a national "unified chessboard" approach; promote integrated development of high-level research universities and new R&D institutions with science cities; optimize urban functions and supporting services to attract world-class scientific and technological innovation talent; layout major scientific and technological infrastructure; conduct tracking studies on science city construction; and en-

courage national high-end think tanks to conduct third-party assessments of science city innovation capacity.

5.3 Improve the Cultivation System for Leading Technology Enterprises

Formulate cultivation plans for leading technology enterprises to create a growth echelon of technology firms. Strengthen the innovation leadership role of backbone enterprises, further reinforce enterprises' principal position in innovation, and enable "chain master" enterprises to become main allocators of innovation resources through mechanisms like "unveiling the list and taking the lead." Accelerate the construction of high-level enterprise innovation consortia and promote the formulation of specific implementation guidelines across regions. Provide support for joint technology tackling by technology enterprises and new R&D institutions. Precisely implement R&D expense super-deduction policies for key emerging industry sectors, research and formulate more powerful tax preferential policies, and further encourage enterprises to increase R&D investment. Innovate science and technology financial policy tools, encourage various financial institutions to provide financing services for technology enterprises, and strengthen direct support for startup technology firms. Explore supporting policies for financial institutions to conduct credit and investment in technology investment scenarios. Utilize new policy tools such as the enterprise innovation scoring system to identify more high-quality enterprises, reduce information asymmetry, and guide innovation resources toward "hard technology" enterprises.

5.4 Strengthen the Construction of Future Technology Transfer Systems

Give full play to the role of national societies and new research institutions in international scientific and technological cooperation, and deepen science diplomacy. Further promote the construction of international technology transfer institutions, increase efforts to facilitate future technology transfer in line with high-quality economic development needs, and serve the "dual carbon" strategy. Build a green technology transfer system, support green technology business incubators and green park construction, and promote green technology transfer from Nordic countries. Establish mechanisms for technology cooperation through entrepreneurship competitions, third-party market cooperation, flexible talent attraction, and corporate joint laboratories to serve technology transfer and transformation.

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