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Guangdong's New R&D Institutes: China's Regional Tool for Innovation and Technology Transfer

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Summary

In pursuit of technological development, China has created new organizations to promote innovation. This brief examines New Research and Development Institutes (NRDIs), which are designed to foster knowledge transfer to industry. NRDIs were pioneered in Guangdong province in the 1990s, and have gained prominence in China's national science, technology, and innovation policies since the 13th Five-Year Plan (2016-2020). NRDIs are defined by their market orientation and extremely flexible organizational form. They work by establishing "innovation platforms" with local governments and private knowledge actors to carry out research and development (R&D), commercialize scientific and technological achievements, incubate local technology industries, and cultivate high-end talent. NRDIs have been instrumental to regional development in Guangdong, and especially Shenzhen, where they have succeeded in attracting talent from outside the region. NRDIs have important policy implications for international competition for talent. Understanding NRDIs is crucial for other countries that want to improve their own inter-regional innovation resources and respond to the challenge of China's drive to attract global talent and knowledge resources.

This brief is part of a special series organized jointly by the University of California Institute on Global Conflict and Cooperation (IGCC) and the Mercator Institute for China Studies (MERICS). This analysis was originally presented at the Conference on the Chinese National Innovation and Techno-Industrial Ecosystems in Berlin, September 5–6, 2023.

Key Findings

- NRDIs are extremely diverse and have few restrictions on how they operate. A few characteristics unite the various NRDIs, including their market-facing orientation and flexibility in responding to market conditions.
- NRDIs originated in Guangdong, beginning with the city of Shenzhen's 1995 initiative to upgrade the city's industrial knowledge base by forming an R&D institute with Beijing's Tsinghua University. Soon, other cities in the Pearl River Delta followed suit, and the provincial government in Guangdong began to implement regulations for the institutes.
- NRDIs consist of partnerships between local governments and relevant knowledge actors, including universities, technology firms, and research institutes. They take various institutional forms, but all operate with some degree of separation from government.
- Guangdong's provincial government has set out regulations detailing the functions NRDIs are expected to perform. These include conducting research and development, commercializing scientific and technological advances, incubating local industry, and cultivating talent.
- NRDIs are tied inextricably to regional development goals. By setting up innovation platforms, local governments are able to influence the actions of the NRDIs in partnership with the relevant knowledge actors. Doing so allows the governments to nudge NRDIs towards their development objectives.
- NRDIs have a number of important policy implications for foreign governments. They provide a model for how to grow industrial knowledge, increase regional innovation, and overcome technological bottlenecks. Their recruitment strategies call for a refinement of the guidelines for international cooperation in the academic sector to ensure a transparent, rules-based competition for talent.

Introduction

China has striven to enhance the scientific and technological knowledge base of its industry. Viewed as a pillar of innovation-driven development, the country has introduced new types of institutions to bridge the gap between research and application. New Research and Development Institutes (NRDIs, 新型研发机构, *xinxing yanfa jigou*) have played a significant role in this regard. NRDIs have featured prominently in China's national science, technology, and innovation (STI) policy ever since the 13th Five-Year Plan period (2016-2020),[7] with more extensive legislation by the Ministry of Science and Technology in 2019.[8]

As in other policy domains, national-level policies on NRDIs have built on local experience. Guangdong province has been a front runner on NRDI development. This brief looks at Guangdong's experience, summarizing and contextualizing three recent papers published on this topic by the author and colleagues.[1,2,3] Today, NRDIs have spread beyond Guangdong to become prominent in many provinces, including Jiangsu, Zhejiang, and Shaanxi.[4]

What is an NRDI?

NRDIs are extremely diverse and have been given great freedom to evolve in various ways. The Chinese government's official definition highlights the market orientation of NRDIs and imposes few limitations on how they operate. To adapt to market conditions, NRDIs are allowed flexibility in how they manage strategic and human resources.

NRDIs can be established under one of three legal-organizational forms: as a private non-profit science and technology organization (科技类民办非企业单位, kejilei minban qiye danwei), a public institution (事业单位, shiye danwei), or as a firm (企业, qiye). In Guangdong province, even the public NRDIs do not operate under the state administrative staffing system (事业编制, shiye bianzhi) and are not guaranteed funding by the state.

BOX 1

Policy definition of New Research and Development Institutes (NRDIs)

Against the background of China's current 14th Five-Year Plan (2021-2025), the National Development and Reform Commission (NDRC) offered the following explanation of the NRDI concept:[9]

> "New R&D Institutes focus on the demand for technological innovation and primarily engage in scientific research, technological innovation, and research and development (R&D) services. They are independent legal entities with diverse ownership structures, modern management systems, market-oriented operating mechanisms, and flexible employment regimes. New R&D Institutes can be legally registered as private non-profit science and technology organizations, public institutions or firms."

NRDIs are typically established jointly by local governments at district, city and/or provincial level and a relevant knowledge actor deemed capable of advancing the region's STI system. Such knowledge actors can come from the academic or business sector, and from inside or outside the region. They include universities, public and non-public research institutes, entrepreneurial teams, and technology firms.

As of June 2023, 277 research institutions were recognized as NRDIs by Guangdong's provincial authorities.[10] Three types of NRDIs stand out:[1]

University Satellite Institutes: These institutes, co-established by local government and a university partner, constitute the most important group of NRDIs in Guangdong. University NRDIs are separate legal entities that are generally established outside the university campuses. A notable feature of NRDI development in Guangdong is the relevance of non-local universities as co-initiators of NRDIs.[2] Guangzhou universities have set up NRDIs in many other cities in the province, and universities from outside the province have contributed considerably to NRDI development—notably those from Beijing, Hong Kong, Wuhan, and the Yangtze River Delta.

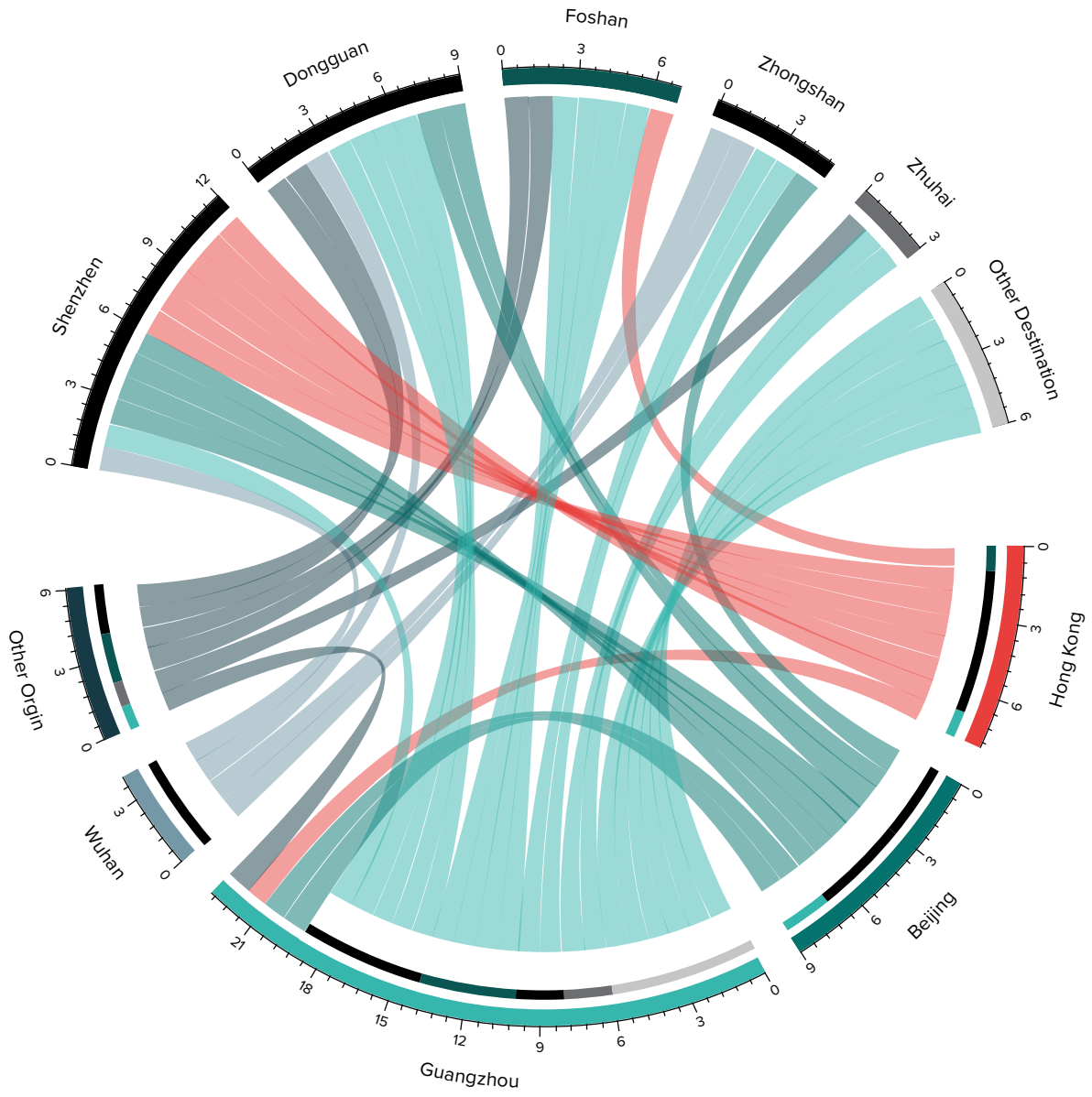
Corporate Open R&D Centers: Many NRDIs in Guangdong have been established within local technology firms such as Midea or TCL. These centers function like corporate R&D subsidy programs. The local government supports the firms' R&D with public resources in order to develop technologies targeted by government policies and open up the R&D process to outside innovation actors. By giving these centers the NRDI title, officials intend to increase the attractiveness of local firms to highly qualified researchers from academia.

Photo: Asian Development Bank, CC BY-NC-ND 2.0

Technology Commercialization Platforms: This type of NRDI aims to commercialize specific scientific and technological achievements in targeted sectors. The approach has gained some notoriety because of its association with China's international talent recruitment programs, offering promising (returnee) entrepreneurs from the United States and elsewhere a platform to monetize the knowledge brought with them. However, the prime example for this type of NRDI is BGI Shenzhen, which was established as a non-profit NRDI by an entrepreneurial team from outside the province—not from outside the country. These types of NRDIs are increasingly being established near major science facilities to be close to sites where new technological achievements are made. Examples include the National Supercomputer Center in Guangzhou, with its access to Tianhe-2, one of the fastest supercomputers in the world, and the Spallation Neutron Source Science Center in Dongguan, which is connected to a large scientific infrastructure for the study of materials.

FIGURE 1

University Satellite Institutes: Connections Between Home and Host Regions



Source: Conlé et al., [2], License: Creative Commons CC BY

Explanation: Host regions of the university NRDIs (n=46) at the top half of the chord diagram, home regions of their parent universities are located at the bottom half of the chord diagram. Guangzhou is both, the most important home region (e.g. of Sun Yat-sen University, Guangdong University of Technology) and a host region for university NRDIs from Beijing, Hong Kong and Zhejiang (indicated by the different arc end lengths). The arcs connect home and host regions; the breadth of the arc is proportional to the number of NRDIs connecting particular regions. "Other Origin" means further home regions of parent universities (e.g. in the Yangtze River Delta); "Other Destination" means further university NRDI host regions apart from the Pearl River Delta cities mentioned in the diagram.

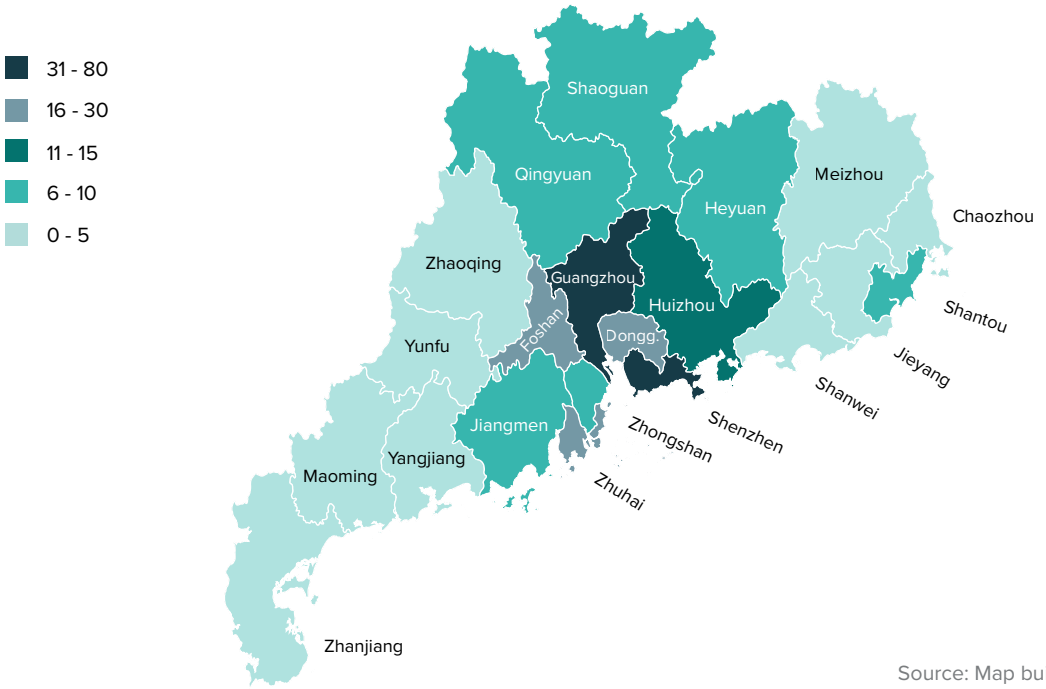
By 2023, Guangdong's 21 prefecture-level cities have all established at least one NRDI,[10] although the majority remain concentrated within a few Pearl River Delta cities. That region profited tremendously from the rapid development of labor-intensive manufacturing in the 1980s and 1990s, based on foreign direct investment and the migration of low-skilled workers from other parts of China.

The government of Shenzhen—home to China's oldest and largest Special Economic Zone—undertook early measures to upgrade the city's knowledge base. A decisive move came in 1995 when the Shenzhen government joined forces with Tsinghua University in Beijing—widely considered China's best science and technology university—to found an applied R&D institute. The resulting Research Institute of Tsinghua University in Shenzhen (RITS), which went into operation in 1999, is widely considered the first NRDI in China.

Soon, further university satellite institutes were established in Shenzhen, particularly with university partners from Beijing and Hong Kong, and became a major force in the initial development phase. Between 2005 and 2009, the Guangdong provincial government provided fresh impetus to the NRDI program by linking up with national-level institutions to secure their support for establishing NRDIs, including the Ministry of Education, the Ministry of Science and Technology, and the Chinese Academy of Sciences (CAS). Following these agreements, several national universities under the Ministry of Education and CAS research institutes came to the region, establishing NRDIs in Shenzhen but also in several other Pearl River Delta cities, particularly Dongguan and Foshan. After 2010, Shenzhen's government led in broadening the NRDI concept by extending cooperation with private sector actors such as technology firms and entrepreneurial teams, including those from outside the city. Starting in 2015, the Guangdong government formally introduced a provincial-level NRDI policy with relevant regulations spelling out support measures and evaluation criteria.[5,6]

FIGURE 2

Regional Distribution of NRDIs (2023)



Source: Map built with paintmaps.com

FIGURE 3

Phases in Guangdong's NRDI Development

The provincial capital Guangzhou, despite being a latecomer, boasts the highest number of established NRDIs. Among those are several of Guangzhou's former public research institutes that had already been transformed into supposedly market-oriented firms before the turn of the century, so the adoption of the NRDI model is a less dramatic step for them.

In contrast, the cities of Dongguan, Foshan, Zhuhai, and Huizhou, which have also established many NRDIs, share with Shenzhen the city's original circumstances. These cities are "knowledge-peripheral" in that their innovative capabilities are still relatively weak, although they are not marginal economically. The clustering of NRDIs in those cities may increase their attractiveness for highly skilled workers and help the cities diversify into higher-value industries.

The Functions and Objectives of NRDIs

The Guangdong provincial government's NRDI regulation lays out four functions for the institutes to perform:[11]

1. Carry out research and development: NRDIs conduct R&D on frontier technologies in the province's key development areas, common technologies for strategic emerging industries, and core technologies for local pillar industries to overcome technological bottlenecks impeding their development. They are also intended to provide support for the innovation-driven development of the province and for the nation writ large.

2. Transform scientific and technological achievements into useful products: NRDIs are to proactively implement national and provincial policies on the transformation of scientific and technological achievements, establishing institutional mechanisms for accelerating the commercialization of technology and improving the provision of relevant services to meet regional industrial demand.

3. Incubate the local technology industry: NRDIs combine innovation resources from diverse parties to nurture science and technology-based enterprises, and provide support for the development of the local technology economy.

4. Assemble and cultivate high-end talent: NRDIs seek to attract high-end talent, including leading scientists and entrepreneurs, in priority sectors to settle in Guangdong and promote local economic development.

NRDIs perform these functions by establishing "innovation platforms" (创新平台, *chuangxin pingtai*) with local governments.[3] These platforms allow NRDIs preferential access to complementary government resources, while permitting local governments to influence the NRDI's priority setting and its anchoring within the regional innovation ecosystem.

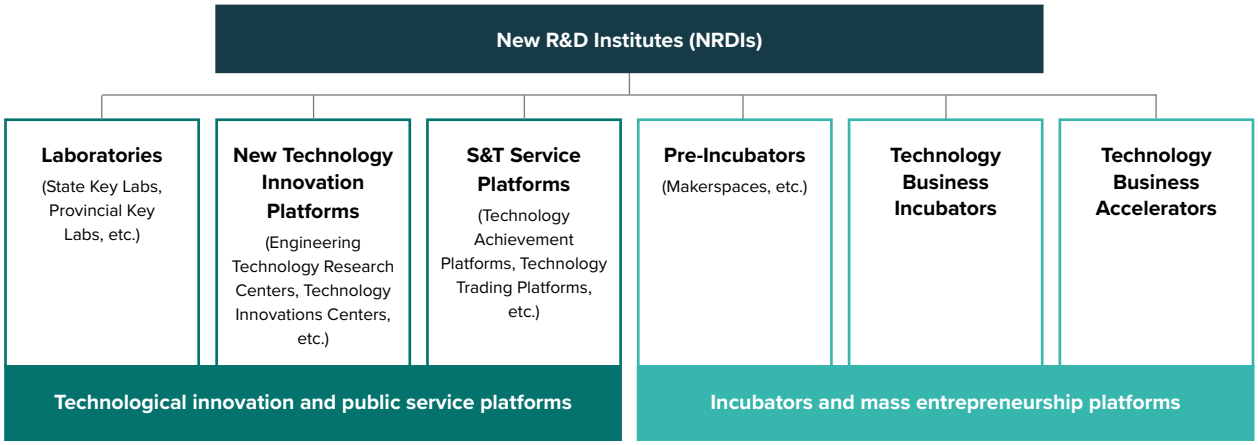
In Guangdong, the term "innovation platform" refers to two broad classes of entities. The first, technological innovation and public service platforms, include government-funded laboratories, engineering research centers, and technology service platforms. In the case of Guangdong's NRDIs, these platforms are largely financed at the local (provincial or city) level, although a few university NRDIs have established branches of their parent university's national-level State Key Laboratories. NRDIs primarily have engineering technology research centers, which are strongly focused on applied R&D. They typically also have public service platforms that support the NRDI's provision of R&D, technology consulting, and technology transfer services to local firms.

The second concerns incubators and platforms for "mass entrepreneurship," typically makerspaces, which were created as part of a 2016 national campaign to comprehensively support entrepreneurship and innovation and are aimed at scientific and engineering professionals, university graduates, and the general public. These platforms are intended to form an "incubation chain" that begins with the support of entrepreneurial teams in makerspaces (as pre-incubators) and extends through start-up firms in incubators to early-growth firms in accelerators.

NRDI managers combine these functions and platforms into specific operational models that allow them to grow their institutes and profit from them directly or indirectly—through investments in start-up firms, for instance. Such operational models can reach a remarkable degree of hybridization, as they combine private with state assets, profit with non-profit activities, closed with open boundaries, private with collective goods, and services with industry.[3]

FIGURE 4

NRDIs and Innovation Platforms



NRDIs and Regional Development

The establishment of NRDIs is tightly connected to the regional development goals laid out in the government plans and strategies.[3,5] Local governments typically translate central government guidelines into concrete techno-industrial policy by defining and redefining the boundaries of local industries as well as determining which sectors to advance and which ones to consolidate. For more than 20 years, the general direction of Guangdong's techno-industrial policy was to restructure and upgrade traditional industries, promote the equipment manufacturing sectors, and move into strategic emerging industries. Development priorities are identified based on the government's intimate knowledge of local industrial structures, opportunities to access external knowledge, and technological demand from local firms and government, supported by expert reports that map "industry chains" (the relevant upstream, midstream, and downstream sectors) and "technology chains" (the sequential connections among technologies within the process of providing an industrial good).

While Guangdong province is widely known for its pivotal role in the country's reform and opening up since the late 1970s, and for the explosive growth of its export-oriented manufacturing, provincial leaders early saw the potential limitations of this traditional growth model. The province's skilled labor and entrepreneurial skills were initially limited in Shenzhen and other Pearl River cities. Within Guangdong, only the provincial capital Guangzhou had an established knowledge infrastructure. Shenzhen's meteoric rise—eventually permitting it to eclipse Guangzhou as the province's science center and providing a model for other cities in the region to emulate—cannot be understood without understanding the role of NRDIs.

Spearheaded by Shenzhen, Guangdong's (initially) knowledge-peripheral regions have reached out to non-local knowledge actors to improve on the region's insufficient endogenous innovation dynamics and promote upgrading and diversification. NRDIs play an important role in this regard by introducing and anchoring relevant knowledge within the region. They do so by facilitating the development of technology transfer ecosystems which link knowledge supply and demand.

NRDIs provide two distinct benefits for skilled researchers which enhance the attractiveness to knowledge actors of (formerly) peripheral regions. First, they provide a physical platform to which highly skilled talents and innovation teams can attach, offering the reputation of an academic institution (enhanced by the parent university's reputation) and the prestige of academic positions, in addition to providing entrepreneurial opportunities.

Second, they provide a policy platform that bundles the preferential policies associated with the innovation platforms, channeling resources including R&D project funding, subsidies for regional actors' purchase of the institute's products and services, government-backed talent recruitment programs, and public startup finance.

One aim of establishing NRDIs is to meet the technological needs within given regional industrial structures. Several NRDIs, for instance, focus on robotics and precision engineering technology, targeting both local equipment manufacturers and users. NRDIs unlock local demand by providing technology consulting to firms in need of manufacturing automation solutions, conducting adaptive R&D to provide such solutions, supporting the technological upgrading of existing equipment manufacturers, establishing specialized markets for automation solutions, and fostering start-up companies that can carry out any of the former activities on a for-profit basis. The most successful NRDIs integrate all of these activities into one consistent business model.

Another aim is to meet the local government's demand for promoting particular emerging industries. In Guangdong's advanced regions, many NRDIs focus on the development and commercialization of knowledge brought in from outside, often by exploiting the region's ready supply of component manufacturers.

Policy Implications

Guangdong's NRDIs provide a model for emulation and demonstrate the challenges inherent to such technology transfer systems. Modernizing regional industrial structures is difficult to realize without a transplantation of external knowledge. Guangdong's NRDIs count on considerable local government support. The province's NRDIs share a focus on markets and open innovation, raising local attractiveness for non-local knowledge providers, and facilitating the regional anchoring of knowledge through entrepreneurialism and outreach to local actors.

There are three important policy implications to consider in this regard. First, Guangdong's NRDIs strengthen the case for applied R&D institutes as an important tool of regional innovation policy. They also reinforce arguments brought forward in the recent literature in favor of accessing external knowledge to overcome technological bottlenecks and stimulate local innovation dynamics, benefiting both the region and the external knowledge provider. In this respect, Guangdong's experience with NRDIs could be valuable for improving "smart specialization strategies" in knowledge-peripheral regions in the United States and Europe.

On the other hand, the NRDIs' dependence on non-local knowledge and talent poaching is a contentious issue. Financially strong cities, Shenzhen in particular, incur the wrath of other Chinese cities for poaching their highly skilled researchers. Concerns about brain drain and technology leakage have also raised concerns within the United States and Europe. In fact, for the United States and Europe, NRDIs in Guangdong's peripheral regions are connected to violations of disclosure requirements and tax evasion related to China's part-time international talent programs. These problems highlight the need to refine the academic sector's internal reporting systems and international cooperation guidelines.

Finally, the biggest fears in this regard are related to the transfer of advanced technology to China's military. The prime example is Kuang-Chi, a military-civil fusion enterprise founded on a technology commercialization platform initiated by returnees from Duke and Oxford. Although an exceptional case among NRDIs, a few NRDIs, typically without foreign staff, are involved in military R&D. The overwhelming majority of NRDIs cooperate with Chinese domestic talent, but it is necessary to raise awareness among researchers in the United States and Europe about potential risks to ensure responsible scientific cooperation.

Conclusion

New Research and Development Institutes are a novel tool for China's provincial cities to enhance their industrial knowledge base, attract talent, and transition to higher value industries in their pursuit of development goals. In their ability to embrace hybrid innovation models and adapt to market conditions, they offer lessons to other knowledge-peripheral regions in the developed and developing worlds alike. However, policymakers outside of China must also be aware of the challenges associated with the poaching of talent and technologies by these institutes.

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