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# Chinese Scientific Achievements along the Belt and Road: Pathways for CrossBorder Technology Transfer and Commercialization

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**Abstract**

Drawing on the practical experience of senior technology managers, this paper distinguishes between the concepts of "technology transfer" and "commercialization of scientific and technological achievements" in China and abroad, and links them to the specific technology demands of Belt and Road (B&R) partner countries. It then examines the strategic value of transforming Chinese scientific achievements into productive forces in B&R economies. Using recent cases in photovoltaics, new energy vehicles, agricultural machinery and infrastructure, the paper identifies three key challenges in crossborder commercialization: insufficient technological adaptation, discrepancies in technical standards, and shortages of qualified technology transfer professionals. In response, it proposes an integrated "technology screening–local adaptation–collaborative commercialization" pathway that combines China's domestic industrialization experience with international technology transfer practices. The findings aim to provide practical implications for making better use of Chinese scientific and technological achievements in support of highquality B&R cooperation.

**Keywords**

commercialization of scientific and technological achievements; Belt and Road Initiative; crossborder adaptation; technology managers; transformation pathways

## 1. Introduction

The Belt and Road Initiative (BRI) has entered a stage that places greater emphasis on innovationdriven and highquality cooperation. As China's research and development capacity and patent output continue to grow, how to transform domestic scientific and technological achievements into productive forces in B&R partner countries has become a salient issue for policymakers and practitioners. Existing studies on the BRI have mainly focused on infrastructure investment, trade and finance, while research that combines the analytical lens of technology transfer with the concrete process of commercialization remains relatively limited.

This paper draws on the practical work of technology managers and on policy documents related to the commercialization of scientific and technological achievements in China. It first clarifies the conceptual boundary between "technology transfer" and "commercialization" and compares domestic and international practices. It then discusses the strategic value of crossborder commercialization of Chinese technologies for B&R cooperation, followed by an analysis of current developments and key challenges. Finally, it proposes a set of pathways and institutional arrangements to support crossborder commercialization, with particular emphasis on the role of technology managers as intermediaries between research, enterprises and overseas markets.

## 2. Conceptual Clarification: Technology Transfer and Commercialization

### 2.1 Legal definition and practical implications in China

According to the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (amended in 2015), the commercialization of scientific and technological achievements refers to followup activities such as further testing, development, application and dissemination of such achievements, which lead to the formation of new technologies, new products and new industries [1]. In practice, this process generally covers the stages from laboratory results through pilot testing and engineering verification to largescale industrial application.

For example, research on a new battery material conducted in a university laboratory is only an early outcome. Only when this material passes through process development, pilot testing and product prototyping, and is ultimately applied in the production of batteries for new energy vehicles, can it be regarded as an instance of commercialization in the sense defined by the law.

By contrast, "technology transfer" usually refers to the transfer of technology ownership, implementation rights or knowhow across different entities or regions, such as patent assignments or licenses. It focuses on the movement of knowledge or rights rather than the full industrialization process. Technology transfer and commercialization are closely related but not identical. Technology transfer is often a necessary condition for commercialization, while commercialization is the stage in which transferred technologies generate tangible economic and social value.

### 2.2 International practices and their relevance to the BRI

In many developed economies, technology transfer work has long concentrated on improving the efficiency of technology flows between universities, firms and government, including crossborder transfers. A wellknown example is the Bayh–Dole Act in the United States, which allowed universities to retain patent rights to inventions arising from federally funded research. University technology transfer offices (TTOs), such as the one at Stanford University, have used "patent licensing + international collaboration" models to license semiconductor technologies to firms in Japan and the Republic of Korea. In 2023, crossborder licensing revenues of U.S. universities exceeded USD 12 billion [12].

In Japan, the Japan Science and Technology Agency (JST) has promoted international technology transfer through industry–academia–research collaboration projects and the establishment of local bases in Southeast Asia. In 2023, JST supported more than 1,200 crossborder technology transfer projects in the field of new energy, with a focus on "technology adaptation and local collaboration" [13].

In China, the term "commercialization of scientific and technological achievements" is more closely associated with the process of moving from research results to industrial application. For instance, a RMB 50 million licensing agreement for intelligent transmission technology developed at Chongqing University illustrates how technology maturation and market application can be linked through commercialization arrangements. At the same time, the technology demands of B&R countries combine basic needs with strong requirements for adaptation. Many Southeast Asian economies are interested in mature technologies in fields such as agricultural machinery and photovoltaics, while some Central Asian countries pay more attention to infrastructure equipment and resource processing. This situation calls for approaches that combine the international emphasis on crossborder technology flows with China's comparative advantages in scaling up and industrializing technologies, and that build integrated pathways of "technology export–local adaptation–collaborative commercialization".

## 3. Strategic Value and Practical Significance for the BRI

### 3.1 Contributions to economic development

Crossborder commercialization of Chinese scientific and technological achievements has become an important channel for promoting regional economic development within the BRI framework. In 2024, the value of China's technology contracts with B&R countries reached RMB 89 billion, with photovoltaics, agricultural machinery and infrastructure equipment accounting for more than 60% [5–7]. In the Middle East, cooperation has concentrated on new energy. Chinese enterprises have launched integrated "photovoltaic + hydrogen" projects in Saudi Arabia, adapting domestic concentrated solar power technologies to highirradiation environments and adjusting equipment to comply with Saudi SASO standards. One such project is expected to start operation in 2025 and supply green hydrogen to the European market [6].

In Africa, cooperation has focused more on agricultural technology. A Chinese agricultural machinery company established a "technology adaptation center" in Tanzania and upgraded domestic combine harvesters into lighter models suitable for small plots, while also developing a local maintenance network. As a result, equipment failure rates fell from 40% to 12% and more than 5,000 farming households benefited in 2024 [5].

New energy vehicle (NEV) cooperation provides another relevant example. A Chinese battery producer built a hightemperatureadapted battery plant in Thailand with a production capacity of 5 GWh in 2024, contributing to a 45% increase in local NEV output [7]. In Ethiopia, customized small electric vehicles with higher chassis were developed for rural logistics; more than 2,000 units were sold in 2023, helping to ease transportation constraints in remote areas [7].

Domestically, commercialization has also become an important driver of economic growth. According to the China Annual Report on the Transformation of Scientific and Technological Achievements (2024), a onepercentagepoint increase in the commercialization rate of scientific achievements can raise GDP growth by 0.25 percentage points. In 2024, the total value of technology contracts nationwide exceeded RMB 4.8 trillion, illustrating the central role of commercialization in innovationled development [9].

### 3.2 A key linkage within the innovation ecosystem

Commercialization of scientific and technological achievements links the "research side" and the "application side" of the innovation ecosystem. Universities and research institutes produce new knowledge, enterprises are responsible for industrial application, and the commercialization process coordinates these actors by matching research outputs with concrete application scenarios and structuring the division of labor among them. In this sense, commercialization is a critical link in university–industry–government collaboration, consistent with the triple helix model [2].

In the context of the BRI, crossborder commercialization connects China's domestic innovation system to the industrial upgrading needs of partner countries, and thereby contributes to more diversified and longerterm forms of cooperation. Compared with traditional projectbased collaboration, commercializationoriented cooperation often requires deeper local participation, continuous service provision and more sophisticated institutional arrangements.

## 4. Current Developments and Major Challenges

### 4.1 Policy foundations and institutional progress

In recent years, China has significantly improved its policy framework and platform infrastructure for commercialization, which has also provided an institutional basis for crossborder transformation. In 2024, the State Council issued the Guiding Opinions on Improving the Evaluation Mechanism for Scientific and Technological Achievements [3]. The document calls for an evaluation system guided by innovation quality, contribution and performance, and encourages a shift from articleoriented to applicationoriented assessment. This has led more researchers to consider the practical value of their work and to seek cooperation with enterprises when planning projects. According to the 2024 National Technology Market Statistical Bulletin, the total value of technology contracts nationwide exceeded RMB 4.8 trillion in 2024, reaching a historical peak and indicating a high level of activity in the technology market [9].

At the regional level, marketoriented platforms have expanded their functions to support crossborder collaboration. The "open call for champions" mechanism in Chongqing has been extended to B&R projects, including cooperation with Indonesia on the localization of palm oil processing equipment [8]. The Shenzhen Hightech Zone, in collaboration with Singapore, has set up a "crossborder proofofconcept center" to support the adaptation of twelve electronic technologies to Southeast Asian markets [8]. The G60 Science and Technology Innovation Corridor in the Yangtze River Delta has developed partnerships with Central and Eastern European countries; in 2023, crossborder biomedical technology transfers through this corridor reached RMB 28 billion, representing 47% of the corridor's crossborder technology transfer volume [9].

### 4.2 Core challenges and bottlenecks

Despite these advances, crossborder commercialization of Chinese technologies along the BRI still faces several structural constraints.

First, insufficient crossborder adaptation remains a prominent issue. Existing pilot testing and demonstration systems are largely designed for domestic conditions, whereas many B&R countries require additional investment in adaptation. In fields such as new energy and agricultural machinery, extra adaptation costs frequently account for 30%–50% of the total project budget. In Africa, agricultural machinery must be adjusted for smallplot farming and lowmechanization environments; in the Middle East, photovoltaic equipment has to be adapted for high temperatures and sandstorms [10].

Second, there are discrepancies in technical standards and serious shortages of qualified personnel. Chinese photovoltaic products usually comply with GB/T standards, while Middle Eastern countries tend to adopt SASO standards and many African countries use SON standards. Parameter inconsistencies can lead to compatibility problems. In addition, Chinese exports have often prioritized equipment over services. For example, a photovoltaic project in Egypt experienced a failure rate of 25% because of insufficient local operation and maintenance capacity [6]. On the personnel side, China has fewer than 50,000 certified technology managers, but only about 1,000 have combined expertise in technology assessment, crossborder negotiation and local languages, which is insufficient to support largescale crossborder commercialization [15].

Third, cultural and policy barriers complicate project implementation. In one instance of rice cultivation technology transfer to Kenya, limited understanding of local customs related to tribal land allocation led to disruptions in the project. In another case, a photovoltaic project in the United Arab Emirates was delayed by six months due to differences in environmental approval procedures [5]. In some Southeast Asian countries, patent infringement rates exceed 30%, which affects enterprises' willingness to export key technologies [5].

## 5. Pathways and Innovative Strategies for CrossBorder Commercialization

### 5.1 Endtoend optimization: from technology screening to industrial deployment

#### 5.1.1 Demandoriented screening for B&R markets

An important starting point is to design a technology screening system tailored to B&R markets that combines the international emphasis on demandorientation with China's attention to technology maturity. A practical screening framework can be based on three dimensions:

(1) technology readiness level (TRL 6–8, suitable for conditions in B&R countries);

(2) intensity of local demand (for example, small agricultural machinery in Southeast Asia or infrastructure equipment in Central Asia); and

(3) compatibility with international and local standards (such as between GB/T and IEC/ISO or national standards).

The Ningqiang Technology Transfer Center at Shaanxi University of Science and Technology has piloted this approach in selecting technologies for B&R markets. In commercializing gastrodia elata deepprocessing technology, the center gave priority to equipment solutions suitable for hot and humid climates in Southeast Asia. In 2024, it signed a cooperation agreement with an enterprise in Laos, enabling local processing capacity to triple.

#### 5.1.2 Dualbase model: "domestic pilot testing + local adaptation"

Drawing on JST's experience with overseas bases, China can develop a dualbase system consisting of domestic "B&Roriented adaptation pilot bases" and overseas "local adaptation bases". For example, a domestic university may upgrade its optical fiber sensing pilot platform to include hightemperature simulation facilities for Southeast Asia, while a partner institution in Thailand focuses on adapting and testing batteries under tropical conditions. If supported by government funds, such bases can substantially reduce adaptation cycles and costs. In practice, with 40% of initial investment coming from government guidance funds and additional support from the Silk Road Fund, several adaptation bases have been established in countries such as Viet Nam and Pakistan, and adaptation cycles have reportedly been shortened by about half compared with traditional models [13].

#### 5.1.3 Diversified commercialization models and local embeddedness

At the commercialization stage, diversified models such as "licensing plus joint development" and "equity investment with stock options" can help balance shortterm revenues with longterm value. For instance, Chongqing Vocational University of Engineering and Technology licensed its robot technology and then jointly built a production line with an enterprise; Chongqing University of Posts and Telecommunications converted a chip technology into RMB 17.8 million in equity, with researchers holding 60% of the shares [14].

For crossborder projects, deeper local embeddedness is particularly important. POWERCHINA, for example, achieved a 75% local content rate in a hydropower project in Bangladesh by working closely with local subcontractors and suppliers [10]. In Morocco, Chinese enterprises set up a photovoltaic training academy together with local universities, training more than 200 operation and maintenance technicians and reducing the response time to maintenance requests to four hours. In Tanzania, a "machinery leasing plus technical guidance" model was introduced, and the average yield per mu (approximately 0.067 ha) in pilot areas increased by 30% [5].

### 5.2 Institutional innovations: addressing incentives and risk sharing

Reform of property rights for employee inventions is a key entry point. Chongqing University has implemented a model that allocates a relatively large share of rights in employee inventions to research teams. In 2024, the number of commercialization projects increased by 60%, suggesting that clearer incentives can stimulate researchers' participation in commercialization [14]. Similar arrangements can also support crossborder commercialization.

Risksharing mechanisms are equally important. New insurance products jointly developed by China Export & Credit Insurance Corporation and insurance institutions in B&R countries—such as "comprehensive technology commercialization insurance"—cover political, commercial and technical risks, with compensation ratios of up to 60%. In a wind power project in Pakistan, policy changes delayed equipment imports; the insurance compensated losses of RMB 20 million, allowing the project to proceed [11]. In parallel, international commercial dispute resolution mechanisms related to the BRI can be used to mediate disputes concerning technology commercialization and intellectual property. In 2023, these mechanisms reportedly handled 15 such cases [11].

### 5.3 Talent support: building a competency framework for technology managers

Technology managers are an important human resource for crossborder commercialization. Their work connects R&D organizations, enterprises and capital, and directly affects the efficiency and quality of commercialization processes.

#### 5.3.1 Integrated training for crossborder competencies

Building on the National Technology Transfer Talent Base in Chongqing, a training system has been developed that integrates three core knowledge domains with crossborder competencies. The curriculum allocates approximately 40% to technology fundamentals, 30% to business operations and 30% to law and taxation, and adds modules on B&R technical standards (about 20%, including IEC standard interpretation), crossborder negotiation (about 15%) and local cultural adaptation (about 10%). In 2024, more than 800 technology managers completed this training, with a certification pass rate of 75% [4,15].

The Action Plan for Enhancing the Capabilities of Technology Managers (2024–2026) issued by the Ministry of Science and Technology sets a target of training 30,000 crossborder technology transfer professionals within three years, and calls for the establishment of training centers in countries such as Indonesia and Malaysia [4].

#### 5.3.2 Marketoriented remuneration and risksharing

A threetier pricing mechanism for technology manager services—comprising valuation, platform listing and competitive bidding—can improve price transparency and align remuneration with project performance. When combined with crossborder technology transformation insurance products, this can support more rational allocation of risks and benefits among technology managers, research organizations and enterprises [11].

#### 5.3.3 Crossborder recognition and mobility of qualifications

To facilitate crossborder work, China has begun cooperating with ASEAN and Central Asian partners on mutual recognition of technology manager qualifications. By 2024, more than 500 Chinese technology managers had obtained recognition in Southeast Asian countries, and "technology manager workstations" had been established in Indonesia and Kazakhstan. These workstations provide localized technology assessment and matchmaking services and, in 2024, helped facilitate 89 crossborder commercialization projects, reducing the average matching cycle to 45 days [4,15]. At the same time, efforts are under way to link the career development of technology managers with positions such as "industry professor" in universities and "chief technology officer" in enterprises.

## 6. Conclusions and Implications

This paper has explored pathways for the crossborder commercialization of Chinese scientific and technological achievements along the BRI from the perspective of technology managers. Conceptually, it distinguishes between technology transfer—which emphasizes the movement of knowledge and rights across entities and borders—and commercialization, which focuses on turning research outcomes into industrial applications. Combining these two perspectives, the paper argues for a "technology export–local adaptation–collaborative commercialization" model that can better match the mixed pattern of basic and adaptive technology demands in many B&R countries.

Evidence from cases in Saudi Arabia, Tanzania, Thailand, Ethiopia and other B&R countries suggests that mechanisms for local embedding—such as adaptation centers, joint training facilities and localized service networks—can improve the effectiveness and sustainability of crossborder commercialization. At the same time, persistent challenges in technological adaptation, standards alignment, the availability of qualified technology managers, and cultural and policy environments constrain the further expansion of such cooperation.

The analysis points to several policy and managerial implications. First, it is important to coordinate policies on technology transfer and commercialization, so as to reduce institutional fragmentation and provide a coherent regulatory environment for crossborder projects. Second, dualbase systems that combine domestic adaptation pilot sites with overseas local adaptation bases can shorten commercialization cycles and reduce adaptation costs. Third, strengthening the training, certification and crossborder recognition of technology managers can help bridge domestic industrialization experience with international service capabilities, and thereby support more stable and higherquality cooperation under the BRI.

Future research could examine crossborder commercialization models in different regions and sectors in more detail, evaluate the longterm effects of institutional reforms on technology flows, and conduct microlevel studies of the roles and career trajectories of technology managers involved in B&R projects.

## Notes

1. The B&R cases cited in this paper (such as the Saudi "photovoltaic + hydrogen" project and the adaptation of agricultural machinery in Tanzania) are drawn from publicly available reports, including the White Paper on BRI Science and Technology Cooperation 2024 and sectoral reports issued by the China Photovoltaic Industry Association and the China Association of Automobile Manufacturers.
2. The technology readiness levels (TRLs) used in this paper follow the Guideline for Technology Readiness Level Evaluation (GB/T 229002022), in which TRL 6–8 refer to phases of engineering verification, local adaptation and batch application that are particularly relevant for B&R commercialization projects.
3. Data on crossborder adaptation costs and pilot testing cycles come from a sample survey of ten key crossborder technology transfer institutions in China, covering 15 B&R countries in Southeast Asia, Central Asia, the Middle East and Africa and focusing on new energy, agricultural

machinery and infrastructure equipment.

4. The competency framework for crossborder technology managers is based on the Competency Requirements for Technology Managers (GB/T 418312022) and the requirements for BRIrelated science and technology cooperation set by the Ministry of Science and Technology, with additional indicators for crossborder standards alignment and localized service design.

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