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ARTICLE

INNOVATION OF SCIENCE AND TECHNOLOGY AND RECONSTRUCTION OF LOCAL ECONOMIC: A STUDY ON THE TRANSFORMATION OF RESOURCE-BASED COMMUNITIES FROM AN ANTHROPOLOGICAL PERSPECTIVE

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ARTICLE DETAILS

ABSTRACT

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From an anthropological perspective, this article discusses, how science, technology, and innovation contribute to the reconfiguration of resource-based communities at the economic, social, and cultural levels. With the publication of the 14th Five-year Plan, it has once again made clear that China will firmly implement the concept of innovation, coordination, green, open, sharing, marking the end of China's resource-based areas of high consumption, high pollution of the traditional economic development model has come to an end. At present, it has gradually become a consensus to drive economic development and transformation with scientific and technological innovation. However, there are still many cities and regions with a resource-based economy in China, which face quite a lot of practical obstacles in the process of transformation and cannot grasp the direction of transformation. Therefore, it is of great practical value and practical significance to profoundly analyze the integration mechanism and path between scientific and technological innovation and resource-based economy and put forward practical suggestions to promote economic transformation.

KEYWORDS

Anthropologic, Resource-based Economy, Scientific and Technological Innovation, Transformation Development Path

1. INTRODUCTION

Since the establishment of the People's Republic of China, a resource-based economy has drastically transformed the nation's economic landscape and elevated the standard of living. Abundant natural resources initially served as a crucial engine for the economic progress in resource-rich regions. However, since the 1970s, the advancement of traditional resource-dependent economies has faced significant obstacles and stagnation. The predominant reason for this stagnation lies in the economic development model reliant on the extraction of natural resources, particularly minerals. This model led to a singular industrial structure, severe environmental degradation, and intensified social conflicts within resource-dependent areas. In the context of the deteriorating quality of socio-economic development in these regions, and as the new economic normal and supply-side structural reforms advance, China has timely proposed new developmental concepts focusing on high-quality economic growth. There is an ongoing exploration of a civilization development model that integrates productive advancement, affluent living, and ecological well-being, termed the "Three-Life Integration". Technological innovation emerges as the key driving force and intrinsic motivation for fostering economic quality and harmonious development of economy and ecology. The

"14th Five-Year Plan" introduced by the Central Committee explicitly highlights the necessity of optimizing economic structures and significantly enhancing innovation capabilities. Leveraging innovation for regional transformation and upgrading, especially in resource-dependent economies, stands as the primary strategic direction for the transformation of such economies in China's new norm. Consequently, investigating how resource-based economic areas can escape the "resource trap" through technological innovation and analyzing the pathways by which innovation can facilitate the transition of resource-dependent economies holds substantial significance.

2. RESEARCH ON THE DEVELOPMENT OF TECHNOLOGICAL INNOVATION**2.1 Connotation of Technological Innovation**

Technological innovation holds new connotations in the contemporary era. Broadly, it encompasses not only the innovation of scientific technology but also new production methods and management modes, constantly developing new products and services in the process. At the end of the 20th century, Schumpeter [1] first summarized the concept of innovation, demonstrating its fundamental role in economic

growth through extensive empirical analysis, marking the birth of innovation theory. This sparked a wave of innovation within the academic community. Researchers began to explore various facets of technological innovation, including its concept, implications, processes, elements, significance, impact, and performance, yielding fruitful results. As technology evolved, the era of technological revolution emerged, providing new avenues for economic and social development. Humanity recognized technological innovation as a catalyst for economic and social progress, prompting deeper explorations of innovation. Schools of thought like the Institutional Innovation School and National Innovation System School contributed to the advancement of innovation theory amid scholars' persistent deliberation, debate, and validation. Today, technological innovation primarily comprises three types: knowledge innovation, technology innovation, and management innovation driven by modern science and technology [2].

In recent years, driven by three types of innovation-based technological advancement, China's resource-based economy has shifted from extensive growth with high input and low yield to a more intensive model [3]. Knowledge innovation, via the knowledge spillover effect, has enhanced both the quality and quantity of economic growth, bolstering the competitiveness of resource-based industries [4]. The knowledge spillover-induced technological innovation is a leading factor in transforming the economic growth model. Concentrating scientific and technological efforts to tackle technical challenges, establishing a positive cycle of technological innovation, and continuously adjusting the industrial structure are essential for fostering new industrial clusters and promoting rapid economic development under a technological innovation paradigm [5]. Meanwhile, management innovation under modern technology's guidance is the prerequisite for integrating technology with resource-based economic transformation [6]. Generally, optimizing and configuring various production factors are driven by management innovation.

2.2 Subjects of Technological Innovation

The technological innovation system comprises diverse subjects, including government, research institutions, universities, and enterprises, which compete, collaborate, and integrate in an open system with multiple elements, such as research talent, funding, and an innovative environment [7]. Universities and research institutions play key roles by nurturing innovative talent, conducting foundational research, and providing technical support. They serve as crucial actors in the innovation system. In contrast, enterprises, as major market participants, utilize extensive R&D funds to enhance core competitive capabilities and thus become primary executors of technological innovation activities. The collaboration between universities, research institutions, and enterprises forms an integrated ecosystem for innovation. Universities and research institutions supply theoretical guidance for enterprise technological management innovation, while enterprises provide a platform for theory realization. Beyond this cycle, governments and local departments provide policy support, establish frameworks, and ensure oversight. As leaders in innovation direction, they offer auxiliary support, formulate development plans, undertake innovation projects, and introduce institutional innovations, thus invigorating the innovation system. Strengthening the integration of technological innovation with the transformation of resource-based economies to foster the transformation process and its effectiveness remains a critical topic in China's development efforts [8].

In traditional resource-based economies, resource industries held monopolies locally, faced little competitive pressure, and lacked development drive. These industries should transform through technological innovation. In alignment with national plans for transforming resource-based economies, traditional enterprises now establish advanced R&D centers with government policy guidance and support. They increase technological investments and attract innovation talent, channeling various technological innovation elements into enterprises. With the assistance of universities, research institutes, and government, resource enterprises engage in innovation. Large and medium enterprises lead critical technological breakthroughs, enhancing innovation capabilities and production efficiency. This drives the commercialization and industrialization of technological achievements, making them vital innovation subjects in resource-rich regions.

3. EVOLUTION AND TRANSFORMATION OF RESOURCE-BASED ECONOMIES

A resource-based economy primarily relies on local natural resources, with development anchored in minerals like iron, aluminum, copper, and coal, as well as energy resources such as oil and natural gas. This economic framework focuses on the development and utilization of resources, driven by energy extraction, with the resource industry as its foundational sector. Resource processing, trade, and related activities serve as the main drivers of economic growth [8]. The hallmark of a resource-based economy lies in its concentration on resource products, supported by dense clusters of resource-intensive industries [9]. By examining the evolution of such economies, one can discern the unique features at each developmental stage. During periods of decline, transitioning to alternative development strategies becomes crucial for both resource industries and cities.

3.1 Evolution of Resource-Based Economies

The other term for "resource-based economy" is "resource-dependent economy." It often faces the "resource curse" during rapid development. This is mainly due to a singular industrial structure leading to a path dependency on traditional modes, slowing economic growth. Additionally, extensive natural resource extraction results in severe ecological damage, making development unsustainable and volatile.

Many scholars assert that resource-based economy evolves through stages of building, maturity, decline, and regeneration [10]. For instance, resource-rich regions in China's central and western areas experienced a period of rapid development due to economic advantages from resources [11]. During this time, resource industries absorbed sufficient labor and economic resources, transitioning from a building to maturity phase. However, since the 21st century, many resource-based industries in China face insufficient resource reserves, labor saturation, and declining productivity, quickly entering a decline phase. The cities and regions that thrived on resource industries now face economic stagnation and the "resource trap." In this context, transforming the resource-based economy is a correct choice under external environmental pressure and internal societal demands. Internationally, as a major global player, China committed to global emission reduction targets at the 2011 Durban Climate Conference and aimed to start achieving these post-2020. At the Paris Climate Conference four years later, China formally presented its Intended Nationally Determined Contribution (INDC) targets. Domestically, the consensus among economists is to transform the coal-dominated high-pollution energy structure and comprehensively promote the transition of the resource-based economy. The 2017 Government Work Report emphasized that "winning the battle against air pollution should be the top priority," urging nationwide controls on coal consumption and significantly increasing the use of clean energy like solar and wind. China's urgent environmental needs and commitment stimulate the dynamic transformation of the resource-based economy.

3.2 Transformation of Resource-Based Economies

Transformation represents an innovative process. Resource-dependent economies manifest and exacerbate issues from prolonged reliance on resources, single-industry focus, deteriorating trade conditions, economic imbalance, stunted growth, and severe environmental degradation, creating a low-yield, growth-stagnant loop, hindering sustainable development [12]. Thus, only by transitioning can constraints be broken and evolution achieved. Most cities needing economic transformation rely heavily on resources, necessitating timely strategy adjustments, shifts in economic operations, and development path changes to escape resource dependency. Considering ways to integrate technological innovation with resource economies to find new growth points is crucial. This aids in breaking single-path economic growth, fostering diversified industrial structures, and pushing the development of traditional and emerging industries and tertiary sectors, ensuring long-term prosperity for resource-based regions and cities [13]. Globally and domestically, successful resource economy transformations exist, such as Germany's Ruhr, France's Lorraine, China's Fuxin in Liaoning, and Zaozhuang in Shandong.

The transformation of resource-based economies involves not only restructuring the economic framework but also undertaking comprehensive adjustments and optimizations of operational

mechanisms and allocation of production factors through institutional and technological innovations [14]. During this transitional phase, it is crucial to recognize the systemic and long-term nature of the project, carefully guiding resource-based economies from a period of decline into regeneration, ultimately overcoming traditional development model drawbacks and fostering new growth drivers. Within this process, the interplay of “old industries” and “new dynamics,” “self-development” and “function transformation,” and “transition costs” and “benefits” intertwines. Technological innovation serves as the driving force for converting old and new relationships, marking it as a pivotal factor in the transformation journey of resource-based economies [15].

4. TRANSFORMATION AND DEVELOPMENT PATH OF RESOURCE-BASED ECONOMIES DRIVEN BY TECHNOLOGICAL INNOVATION

Promoting mechanisms for resource-based economic transformation should primarily focus on the integration and improvement of traditional resource industries, development of new energy and materials, and extension of the resource industry chain to build a diversified industrial system. It should be supplemented by enterprise management innovation and government innovation management mechanisms, paired with optimized allocation of production factors such as capital, to ultimately form a positive cycle that achieves harmonized and unified sustainable development of economic, ecological, and social benefits (see Figure 1).

Technological innovation, driven by knowledge creation and leveraging knowledge spillover effects, fosters interactions among talent, research and development, and the transformation of outcomes. This interplay provides intellectual support for the transition of resource-based economies. On this foundation, continuously advancing old technologies leads to technological innovation, significantly propelling the digitization, mechanization, and modernization of the resource industries. On one hand, technological innovation accelerates the transformation and upgrading of traditional resource industries. It enhances resource development planning and management, improves the efficient and intensive use of resources, promotes energy conservation and consumption reduction, and ensures the security of the nation’s vital energy and mineral resources. On the other hand, developing a green and circular resource economy becomes paramount. This approach

strengthens environmental standards within resource-based economic development, emphasizes ecological protection principles, and phases out enterprises unable to meet environmental, energy-saving, and emission-reduction compliance requirements. Consequently, the share of traditional resource-based industries in the overall economy diminishes. This reduction facilitates the transformation of traditional resource-based sectors into more innovative models, cultivating a diversified industrial system that thrives alongside high-end manufacturing, modern services, and green and new energy industries. Moreover, extending the industrial chain through technological innovation proves imperative in the transition process of traditional resource-based economies. By leveraging advanced technologies and increasing investment in research and development, industries can extend their value chain, enhance the added value of resource products, and develop substitute industries and differentiated products. This approach promotes diversification and sustainable development, ensuring a robust and resilient economic landscape.

Technological innovation propels the transformation of resource-based economies through management innovation, encompassing both enterprise-led and government-led management approaches. From the perspective of internal management innovation within enterprises, the maturation and extensive application of the Internet of Things and industrial internet technologies enhance management precision. Consequently, every stage of product lifecycle—from resource extraction, production line manufacturing, logistics transportation, to sales service—undergoes precise monitoring. This transformation offers substantial opportunities for efficiency improvement in traditional resource-based enterprises, moving away from inefficient management models. By refining enterprise management innovation models, these entities achieve competitive advantages characterized by “technological innovation,” thus accelerating the transformation process. From the viewpoint of government-led management innovation, adjustments in trade policies, industry development policy directions, resource allocation management, and financial support policies are crucial in regulating the development of traditional resource-based industries alongside other sectors in line with new era requirements. Historically, the prosperity of singular industries in resource-rich regions resulted in increased production factor costs, negatively impacting the ecosystem of non-resource sectors and absorbing necessary production elements

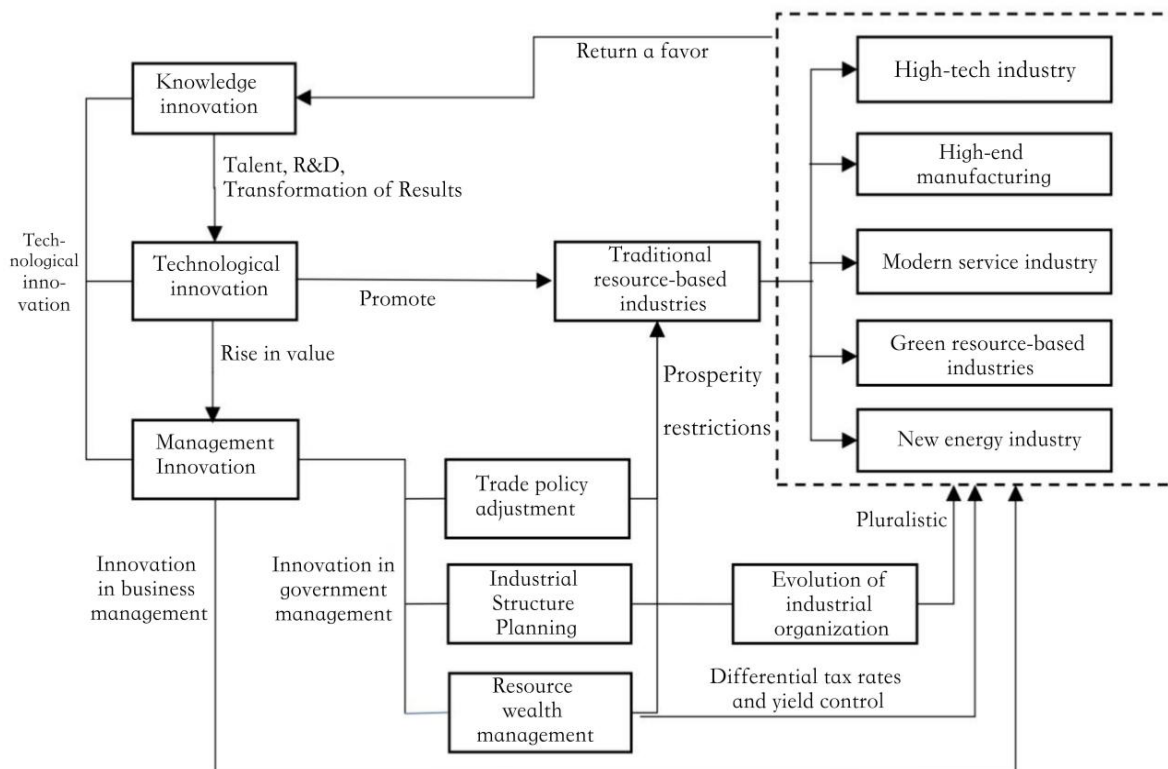


Figure 1: Transmission Mechanism of Science and Technology Innovation to Promote the Transformation of Resource-based Economies

through high welfare tied to a sole resource. This issue, including talent allocation, policy support, and wealth distribution, hampered economic diversification and hindered the transformation of traditional resource-rich areas. Through regulatory frameworks such as resource product price controls and mining restrictions, governments guide market factor flows and ensure rationalization of factor pricing. Scientific and efficient government economic management, driven by technological innovation, includes adopting differentiated tax rates and production control for traditional and eccentric resource industries. From a market demand creation perspective, policies encourage green urban development solutions like electric buses and taxis, optimizing the energy consumption structure. By steering financial services towards the real economy, government initiatives achieve diversified industrial development and foster the growth of strategic emerging industries, ultimately reducing dependency on resource-based sectors.

Technological innovation propels the transformation of resource-based economies, aligning with inherent societal needs. Historically, under rapid industrialization, residents in resource-driven economic regions in our nation have suffered extensively from emissions, wastewater, and air pollution. Addressing environmental contamination has long been fraught with challenges. However, in recent years, advancements in science and technology, such as CO₂-enhanced oil and gas recovery and storage techniques, have advanced the transition of several traditional resource industries towards more environmentally friendly practices. Moreover, technological innovation plays a pivotal role in developing new energy sectors. For instance, foundational research flourishes in coal-based polymer materials, carbon materials, and functional materials across fields like optoelectronics, photocatalysis, and energy storage. Scientists exploit by-products from coal production to create efficient techniques for developing materials such as lithium, gallium, and coal-derived amber. Additionally, regions rich in natural resources typically possess a robust industrial base, providing a higher starting point for the emergence of high-end manufacturing industries. The deep integration of technological innovation with resource-based economic transformation will accelerate the prosperous development of emerging industries in equipment manufacturing, new materials, and energy saving and environmental protection. This synergy will hasten the achievement of harmonious development across ecological, economic, and societal domains as part of the economic transition.

5. POLICIES AND RECOMMENDATIONS

The transformation of resource-based economies necessitates focusing on technological innovation to drive industry transformation. At the core of this economic transition lies the transformation of industries. It fundamentally involves promoting environmentally friendly practices in traditional resource extraction, establishing new energy sectors, advancing modern service industries, and scaling up emerging manufacturing. These strategies shift the dependency of resource-based regions from a single-resource-centric industrial cluster. Achievement of transformation direction and degree heavily relies on the technological innovation capacity within these regions. Innovations driven by science and technology—spanning knowledge and technology domains—alongside management innovations led by enterprises and government, propel the transition and evolution of traditional industries in resource-dependent areas. These innovations contribute to the optimization and upgrading of conventional industries, foster the emergence of new industries, and induce significant structural changes in the industrial landscape. Ultimately, this process enables the comprehensive transformation of industries in resource-based regions.

First, it is necessary to give full play to the role of resource-based enterprises as the main body of scientific and technological innovation in the process of resource-based economic transformation. The successful experience of some developed countries in the transformation of resource-based economy shows that we must give full play to the main performance of enterprises in scientific and technological innovation, and enterprises become the main body of scientific and technological innovation is the most important thing to improve the capacity of technological innovation. In the process of resource-based economic transformation, we must resolutely clarify the status of enterprises as the main body of scientific and technological innovation, and make full use of the corresponding government policies to promote the continuous improvement of technological innovation capacity of the relevant enterprises, which should also make full use of the

policy concessions, reduce the operating costs of enterprises and increase the investment in scientific and technological innovation. In the enterprise-led establishment of high-level research centers to establish a sound and reasonable incentive mechanism for scientific and technological innovation, not only to ensure the retention of core technology professionals, but also to stimulate technological innovation in the vitality of the enterprise. At the same time, it is necessary to open up the channels through which talents, R&D technologies, and the transformation of achievements in the knowledge and innovation system can enter enterprises, so as to provide a solid foundation for enterprises to give full play to their role as the main body of innovation.

The second is to rely on technological innovation to establish, nurture, and support emerging economic industries and lessen dependency on singular industries typical of traditional resource-based economies, which will create a “multi-legged” approach. The increase in basic research efforts, technical shortcomings and breakthroughs in key core technologies have built a solid foundation for the transformation and development of resource-based economy. Resource-based enterprises have continuously adjusted their output and shifted to high-end manufacturing products and new energy products with high input and high output and low environmental pollution. We have formulated the road of “encouraging the introduction of technology, mainly imitating and learning, supplemented by independent research and development, and gradually embarked on the road of mainly independent research and development”, and made full use of the scientific and technological innovation resources outside the region, such as introducing advanced technology through technology transfer agreements and the use of foreign capital, introducing talents and research institutes from outside the region, and jointly organizing research and development institutes with those in other regions or abroad. In promoting the development of successive alternative industries and new industries, resource-type regions should actively introduce and cultivate venture capital institutions, guarantee the input of R&D funds, overcome the difficulty of insufficient funds for R&D of successive alternative industries and new industries at the beginning of the period, accelerate the pace of industrialization of technological innovation achievements, and promote the rapid and large-scale development of successive alternative industries and new industries.

Thirdly, government’s pivotal role in enhancing the technological innovation capabilities of resource-based regions shall be given full play. Currently, transforming a resource-based economy still necessitates government oversight and directional guidance. Through strategic trade policy adjustments, traditional industries must avoid the unsustainable path of low-cost, high-revenue operations. Moreover, macroeconomic control over industrial structure planning is crucial to optimize the economic system’s industrial layout. A differentiated tax rate policy can ensure the initial growth of emerging sectors. The government possesses an irreplaceable role in advancing the technological innovation ability of resource-heavy areas. Agencies need to refine policy provisions, integrating tech innovation methodologies into an appropriate regulatory framework to mitigate systemic risk and prevent overly rigid structures from stifling innovation. Regular updates and releases of mid-to-long-term innovation plans can provide prolonged guidance for industrial and enterprise technological development. Concurrently, various industry departments must formulate corresponding innovation application pathways to further the transformation of resource-dependent economies.

Fourthly, an environment conducive to the protection and enhancement of research and development funding absorption and conversion shall be established. Generally, research investments often encounter lengthy cycles, low return rates, and high risks. This creates a tendency for market funds to flow into higher-yield, shorter-cycle, low-risk sectors. Therefore, society and enterprises must advocate for a culture keen on innovation. Research institutions need to secure R&D investments with bolstered institutional support and enhanced welfare for scientists to attract top-tier professionals from developed regions. Furthermore, financial entities should be encouraged to provide bespoke support to research bodies, thereby reducing loan thresholds and offering favorable interest rates and services. On the flip side, research institutions themselves should elevate their scientific standards and actively pursue academic and technological exchanges with universities or bodies from more developed regions. Instituting internal mechanisms for performance-based attrition will purify the research environment.

Finally, it is necessary to aggressively attract both domestic and international high-caliber talent and adopt cutting-edge technologies. Despite increased efforts by governments to amplify talent recruitment, retaining researchers remains a challenge across resource-based areas. Therefore, governments and universities should proactively open research roles to distinguished domestic and international figures, avoiding severe protectionist mindsets regarding talent. Reasonable assessments of the overall abilities of leading professionals are essential, warranting corresponding welfare measures. Support in terms of salary, housing, purchase subsidies, spouse employment, and children's education should be prioritized. Crucially, the most paramount element involves reinforcing the execution of high-level talent welfare policies, ensuring robust human resource support for innovation pursuits.

For China to achieve sustainable development, transforming the resource-based economy is imperative. By leveraging resource advantages and bridging the pathways between technological innovation and economic transformation, China is poised to realize the goals set out in the 14th Five-Year Plan pertaining to green transitions and ecological security. Thus, confidently advancing upon the path to ecological civilization development is both feasible and vital.

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