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The Evolutionary Study of China's Technology Transfer Policy Structure

-- A Mixed Paradigm Analysis based on Latent Dirichlet Allocation Model

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Abstract

As global competition in science and technology has intensified, the commercialization of scientific and technological achievements has become an important way to promote innovation-driven and high-quality economic development. Using a corpus of 409 policy documents issued by China's central and local governments from 1991 to 2024, this study examines how policies on the commercialization of scientific and technological achievements changed over time through a mixed analytical framework. The Latent Dirichlet Allocation (LDA) topic model is used to analyze policy development from internal and external perspectives. The internal analysis focuses on the thematic structure and content of policy documents, whereas the external analysis looks at their temporal evolution, spatial distribution, and institutional sources. Together, these two dimensions trace the development path and policy logic of China's system in this area. The study further examines the structural features and changes in technology transfer policy instruments, identifies the main weaknesses in the current policy framework, and proposes targeted suggestions for improvement. In this way, the findings clarify how China's technology transfer policies have evolved and provide evidence for strengthening the policy system and improving the efficiency of commercializing scientific and technological achievements.

Keywords

Technology Transfer; LDA Model; Policy Text Analysis; Evolution Trend.

1. Introduction

As global competition in science and technology changes, the ability to commercialize scientific and technological achievements has become more important for sustaining innovation-led and high-quality economic development[1]. At the same time, national innovation capability is often seen as a key sign of comprehensive competitiveness. Technology transfer links scientific research with industrial application. For this reason, it plays a central part in converting innovation into economic value and has gradually become a strategic tool in industrial transformation and sustainable growth.

Many developed economies have established relatively mature technology transfer systems to improve innovation performance. These systems usually rely on close cooperation among universities, research institutions, and enterprises, together with wide policy support. China has also kept adjusting its institutional arrangements in this area. Since the enactment of the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements in 1996, the country has gradually built a multi-level policy system

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covering reform of the science and technology system, delegated authority over research outcomes, and incentives for commercialization. Policy activity increased as well. During this period, both the number of relevant policy measures and their strength grew substantially.

Even with these policy advances, technology transfer is still relatively inefficient overall. Available statistics show that the commercialization rate of scientific and technological achievements in China is still below 30%, which means a large share of research outputs has not yet been converted into productive applications[2]. As a result, many innovations remain in the "laboratory-publication-drawer" cycle instead of generating clear economic or social value. This gap appears to stem from two related problems. The first is the technological uncertainty that accompanies commercialization. The second is the weakness of the current policy framework, including an imbalanced mix of policy instruments, poor coordination among policy tools, and limited synergy across different policy measures.

Against this background, the Third Plenary Session of the 20th Central Committee of the Communist Party of China, convened in July 2024, treated deeper reform of the science and technology system and stronger national support for technology transfer as priority tasks. The Decision of the Central Committee of the Communist Party of China on Further Deepening Reform Comprehensively to Advance Chinese Modernization also called for stronger policy support for technology transfer, including establishing a professional technology manager system, advancing reforms in the ownership and usufruct rights of scientific and technological achievements, and improving government procurement and first-commercial-application support policies. These policy arrangements place technology transfer near the center of China's innovation-driven development strategy during the Fifteenth Five-Year Plan period and make it an important part of advancing Chinese modernization. For that reason, it is a good time to examine how technology transfer policies have developed and how effective they have been.

Most existing studies focus on the institutional environment, the factors that shape technology transfer, and the channels through which it takes place. Relevant literature still depends mainly on qualitative methods, with less attention given to how themes change over time and how policy instruments interact within policy texts. Some gaps remain. These include dynamic modeling of policy evolution, analysis of the spatial-temporal distribution of policy themes, and the interactions among policies issued by governments at different administrative levels.

Qualitative research grounded in interpretivist social science has its own rationale, but it does not offer a unified comparative framework or consistent standards for policy text analysis, which may reduce scientific rigor and objectivity[3]. At the same time, criticism of strict positivism is not new. Jeffrey C. Alexander, a representative post-positivist scholar, argued that giving excessive weight to empirical observation in positivism can hinder scientific progress[4]. More recently, natural language processing and text mining have made data-driven policy analysis more practical. On this basis, scholars have proposed a "mixed-method paradigm" that combines qualitative and quantitative approaches within conventional analytical frameworks[5].

This paper makes a modest but clear contribution to public administration research by addressing the relative lack of mixed-method studies in this field. It uses the LDA topic model to analyze policy texts on technology transfer alongside conventional qualitative policy text analysis. Combining these methods, the study examines the internal structure of policy documents and tracks how they change over time, offering another way to understand these policies.

At the same time, the paper broadens the use of the LDA model in policy analysis and gives public administration research another method for studying policy texts. The value of this approach is both practical and methodological. Analyzing policy texts through quantitative and qualitative methods together can provide a useful basis for improving public policy.

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This paper collects 409 central and local policy documents on technology transfer issued from 1991 to 2024. Using LDA topic modeling, it sets up a mixed analytical framework that brings together internal dimensions, specifically policy instruments and subject structure, with external dimensions, namely time, space, and issuing institutions. The study examines how China's technology transfer policies have changed over time and how they are governed, then uses these results to identify structural problems in the current policy system. It also aims to offer theoretical and practical support for improving policy instrument portfolios and increasing the efficiency of technology transfer.

2. Literature Review

2.1. Concept Definition and Theoretical Evolution of Technology Transfer

The concept of "technology transfer" was first proposed by American scholar Gilmore in 1969 and defined as "the purposeful and deliberate shift of technical devices, materials, methods or information from the origin of discovery or development to new users". In domestic research, scholars often treat technology transfer together with the commercialization of scientific and technological achievements. Comparing the two, technology transfer seems to refer only to physical relocation, while the commercialization of technology transfer also involves changes in the form of technical knowledge. In this sense, it includes the meaning of technology transfer.

Huo Guoqing (2022) defined the commercialization of scientific and technological achievements as a process of transforming scientific ideas into knowledge, scientific knowledge into technologies, technical knowledge into products, and scientific products into industrialized outputs[6]. This definition treats commercialization as part of the whole technology transfer chain and extends the term to cover more types of technology transfer activities.

2.2. Research on the Development of China's Technology Transfer Policy System

Technology transfer policy has become a major concern for governments that want to strengthen national innovation systems, although their priorities differ from one country to another. In the United States, the Bayh–Dole Act centers on intellectual property ownership in publicly funded university research. This policy has encouraged cooperation between government, universities, and industry, and it changed how these actors interact[7]. More specifically, it set clearer ownership rules and stronger incentives for scientific and technological achievements.

The European Union follows a different path. Horizon 2020 places more weight on transnational collaborative innovation and aims to reduce regional disparities through resource integration, knowledge exchange, and cross-border cooperation among member states.

Previous studies suggest that, for a long time, China's technology transfer policy focused more on supporting scientific research than on helping research results reach commercialization. As a result, many scientific achievements were not transformed effectively and remained at the experimental or laboratory stage instead of being put into productive use. This problem has persisted.

In response, the Chinese government has gradually adjusted its policy direction in recent years. Revisions to the Law on Promoting the Transformation of Scientific and Technological Achievements have strengthened intellectual property protection and expanded the role of market-oriented mechanisms. Together, these changes point to a gradual policy shift, from mainly prioritizing research investment to giving more support to downstream commercialization and industrial application.

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Compared with developed countries, research on China's technology transfer policy system began relatively late, but it has expanded quickly in recent years. Current studies usually identify two main channels of technology transfer. The first is the diffusion of frontier scientific knowledge through academic publications, which provides enterprises with an important knowledge base for technological innovation[8]. The second channel, and the one discussed more often, is collaborative innovation among universities, enterprises, and research institutes. In these joint research and development activities, scientific research connects with industrial demand. This has become a main route for technology commercialization[9–11].

Existing studies provide a useful starting point, but China's technology transfer policy system still has several structural problems. Lin Fangfang and Zhao Hui argued that the current policy framework does not provide a sustainable long-term incentive mechanism, which weakens stakeholders' willingness to participate in technology commercialization[12]. Zhang Luyuan found a similar imbalance in the policy mix. According to this study, existing policy instruments put too much emphasis on environmental and supply-side measures, while demand-side policies receive too little attention[13].

At the university level, the obstacles are still clear. Yang Zhen and Liu Chang pointed out that higher education institutions, although they are the main actors in technology transfer, continue to face institutional barriers in the commercialization process[14]. Kang Yunkun et al. also argued that many scientific and technological achievements produced by Chinese universities are still not being used effectively. This gap matters. It does not match China's strategic goal of reducing technological dependence and achieving breakthroughs in key core technologies[10].

3. Research Design and Methodology

3.1. Research Framework

This study uses Latent Dirichlet Allocation (LDA) topic modeling together with conventional policy text analysis to examine how China's technology transfer policy system developed over time. The analytical framework includes two related dimensions, external characteristics and internal characteristics. External characteristics cover the contextual features of policy documents, including the time of issuance, issuing institutions, and geographic distribution. Internal characteristics refer to the thematic structure of policy texts identified through topic modeling. Considering both dimensions allows the analysis to track the visible features of the documents and how the main policy themes changed over time.

3.1.1. Framework for External Characteristic Analysis

The external characteristic analysis is conducted in three sequential stages.

1) Policy documents are systematically classified according to their year of issuance, issuing authority, and geographic region.

2) The analysis then compares several dimensions, including publication period, regional distribution, document category, and issuing institution, to identify where policy development and implementation differ.

3) Based on these analytical results, the temporal evolution and overall development trajectory of China's technology transfer policies are summarized.

3.1.2. Framework for Internal Characteristic Analysis

The internal characteristic analysis consists of four main steps.

1) Policy documents were gathered from the PKULAW Database by searching for "technology transfer", after which the results were screened using predefined selection criteria to establish the final research dataset.

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2) Python is used to build and train the Latent Dirichlet Allocation (LDA) topic model, and the parameters are adjusted during testing to improve topic extraction performance.

3) The screened policy texts are imported into the trained LDA model to identify the latent thematic structure embedded in the policy corpus.

4) The resulting topic distributions are analyzed to reveal the evolutionary patterns and changing priorities of China's technology transfer policies over time.

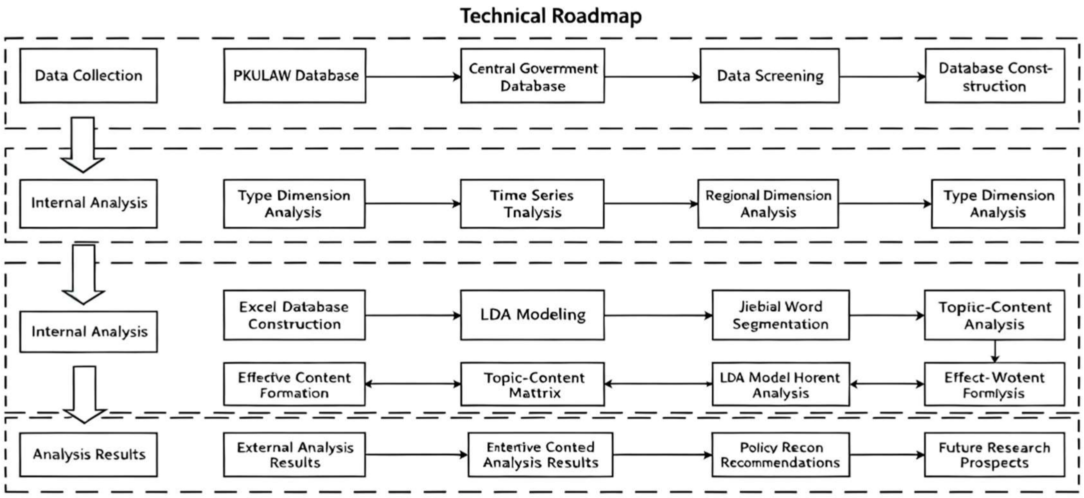

Figure 1. Technical Roadmap of This Research

3.2. Data Sources

The empirical dataset includes central government and provincial-level policy documents issued between 1978 and 2024. Most policy texts came from the PKULAW Policy Database, with additional materials from the State Council Document Library to widen coverage. The search used "technology transfer" as the keyword, and the retrieved documents were then screened using predefined inclusion criteria.

The selected documents include several types of policy instruments, such as laws, regulations, notices, announcements, administrative measures, opinions, guidelines, provisions, decisions, implementation plans, and specialized policy measures. The initial search returned 1,489 documents. Not all of them were usable. After invalid records were removed, including routine notices and administrative circulars that did not contain substantive policy provisions, the final sample included 409 policy documents for subsequent text mining and model-based analysis, as shown in Table 1.

Table 1. Classification and Quantity of Policy Documents

Document Type	Quantity	Document Type	Quantity
Circular Notice	276	Decision	8
Regulation	55	Announcement	3
Official Opinion	26	National Law	2
Administrative Measure	19	Special Measure	2
Guidance Manual	8	Official Reply	1
Administrative Provision	8	Implementation Guide	1

The selected policy documents differ clearly in both legal and administrative form. Circular notices account for the largest share of the sample, with 276 documents. Regulations are the second-largest category, with 55 documents, followed by administrative measures with 19.

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Other types, including replies, announcements, guidelines, and specialized measures, appear far less often.

This distribution relates to the policy roles these documents serve at different stages of development. Laws and Regulations establish the basic institutional framework. Their legal authority is comparatively strong, and they are usually tied to longer-term planning. At the same time, stricter drafting and revision procedures make frequent adjustment more difficult. Circular Notices and Official Opinions are used to issue policy quickly and assign tasks, which lets them respond more easily to changing practical demands. Guidance Manuals and Provisions set operating standards for specific industrial and technological activities, while Decisions and Opinions provide broader strategic direction for major reform agendas.

3.3. Data Processing

3.3.1. External Characteristic Analysis

This paper draws on policy system theory, which treats policy as an interconnected system shaped by stakeholders, regulated objects, implementation processes, and the external environment. In this framework, external attributes such as temporal distribution, institutional distribution, and regional distribution can be used to assess the policy system in a more objective way. The study compiles metadata from 409 policy documents, including issuing institution, document type, release time, and geographic jurisdiction, and examines them across the time, space, and institution dimensions to trace how technology transfer policies have changed.

3.3.2. Internal Characteristic Analysis via LDA Topic Model

Latent Dirichlet Allocation (LDA) is an unsupervised Bayesian statistical learning algorithm often used in text mining. In Python, the text was preprocessed with Jieba word segmentation to remove stop words and other meaningless terms that might lower analytical accuracy. The two hyperparameters of the Dirichlet distribution were then adjusted through repeated trials. α (document-topic sparsity parameter) was set to 0.1 and β (topic-word sparsity parameter) was set to 0.01, as this combination produced the best fit for the policy text corpus.

Choosing the right number of topics affects LDA performance directly. If the decision is based only on perplexity, the result may be biased because this measure has known limitations[15,16]. For this reason, this study considers both perplexity values and topic coherence scores when selecting the topic number.

As shown in Figures 2 and 3, the perplexity curve becomes relatively stable when the number of topics is set to four, which appears to offer a reasonable balance between model complexity and overfitting. The coherence score is also highest at this setting. That matters here. It indicates that the extracted topics are most semantically consistent when the model includes four topics. Based on these results, four representative policy themes are used in the following analysis.

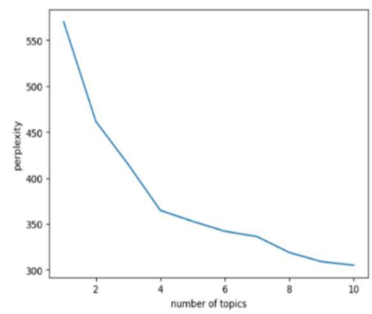

Figure 2. Perplexity Curve with Different Topic Quantities

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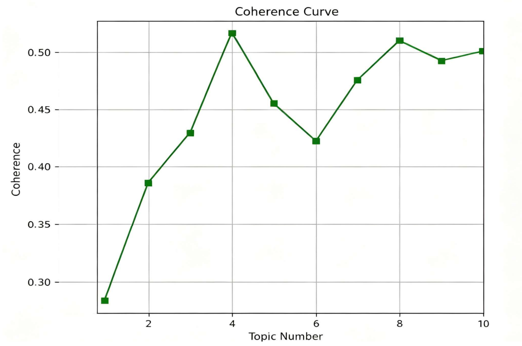

Figure 3. Topic Coherence Index Curve with Different Topic Quantities

4. Analysis Results

4.1. External Characteristic Analysis Results

4.1.1. Temporal Heterogeneity Analysis

Following the stage division standard proposed by Li Shenghui (2021), this study groups the 1991–2024 policy sample into three phases: Legalization Development Stage (1991–2005), Targeted Strengthening Stage (2006–2013), and Systematic Improvement Stage (2014–2024). Figure 4 presents the annual distribution of policy releases.

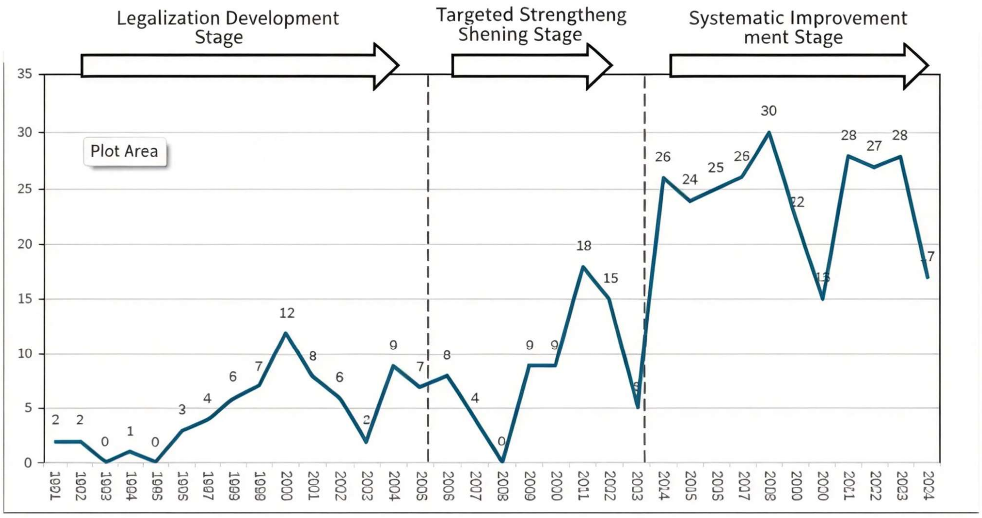

Figure 4. Annual Issuing Quantity Trend of China's Technology Transfer Policies across Three Stages

The annual volume of policy issuance and the themes emphasized changed clearly across different developmental stages, as the government's view of technology transfer developed over time and its policy goals were adjusted. During the Legalization Development Stage (1991–2005), fewer than ten policy documents were issued each year, which indicates that government involvement in technology transfer was still at an exploratory stage. At that point, policy work focused mainly on establishing basic institutional arrangements. Key legislative measures, including the Law on Promoting the Transformation of Scientific and Technological Achievements, provided the initial legal basis for later policy development.

During the Targeted Strengthening Stage, policy output continued to increase as international competition in technology intensified. In this period, policy attention gradually moved beyond

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establishing basic institutions and turned more toward the application and commercialization of scientific and technological achievements. Support also shifted away from focusing mainly on individual actors and toward collaborative innovation involving multiple stakeholders.

The role of policy changed as well. Government-led intervention became less central, while market-oriented mechanisms assumed a larger part in guiding innovation.

The Systematic Improvement Stage had a more developed policy framework, with more attention to incentive structures, cross-organizational collaborative innovation networks, and financial risk-sharing mechanisms. During this period, multiple government departments issued many more joint policies. This appears to indicate an attempt to coordinate resources across administrative boundaries, strengthen interdepartmental collaboration, and improve policy coordination overall.

4.1.2. Spatial Heterogeneity Analysis

Where technology transfer policies are concentrated is closely tied to regional differences in economic development, and policy intensity generally weakens from the eastern region to the central and western regions. Major urban agglomerations usually have more policy activity because their economies are stronger, demand for technological innovation is higher, and scientific and technological resources are more concentrated[17]. The pattern is clear.

In regions with stronger economies, local firms and institutions are usually better able to absorb and use new technologies. That tends to increase both policy demand and institutional support for technology transfer. In less-developed areas, the situation is different. Market demand is more limited, industrial capacity is weaker, and enterprises often have less incentive to adopt new technologies. As a result, local governments are less willing to formulate and implement related policies.

Regional differences in innovation resource endowments also help explain why the number and intensity of technology transfer policies vary across places.

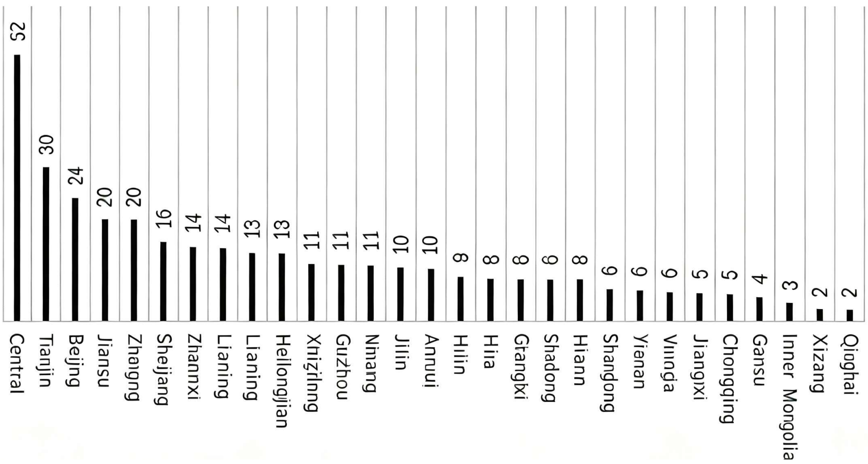

Figure 5. Quantity of Technology Transfer Policies by Jurisdiction

Technology transfer policies are not evenly distributed across regions. They show a clear pattern, moving from the eastern core to inland peripheral areas. At the national level, central government authorities issued the largest number of policy documents (52 items), suggesting that technology transfer was treated as an important part of national innovation development. At the provincial level, policy activity is stronger in the east. Tianjin (30 documents), Beijing (24), Jiangsu (20), Zhejiang (16), and Shanghai (11) stand out as the most active regions.

Several conditions help explain this pattern. In these areas, universities, research institutions, and high-tech enterprises are concentrated, which gives them a stronger institutional and

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industrial base for technology transfer. Many eastern regions were also chosen early as pilot areas for national reform and institutional experimentation. That made a difference. Together, these conditions seem to have supported the faster development of related policy systems.

Compared with the eastern provinces, policy development in the central region is less balanced. Anhui (13 documents), Henan (11), and Hunan (10) issued more relevant policies, while Jiangxi (6) and Hubei (8) issued fewer. This difference may be linked to regional economic conditions, the degree of coordination among industrial, innovation, and value chains, and the level of local innovation capacity[18].

The western provinces issued fewer policies overall. Xizang (2 documents) and Qinghai (2) show this clearly. In these provinces, a weaker economic base, a smaller number of high-tech enterprises, and limited innovation resources seem to reduce both the motivation and the capacity of local governments to develop technology transfer policies. Local governance therefore tends to focus more on basic economic and social development than on technology commercialization and transfer.

Some coastal open provinces, including Guangdong (5 documents) and Fujian (6), issued fewer policy documents, but their policy systems seem relatively more varied and more mature. A possible reason is that these provinces entered the reform and opening-up process earlier, which helped them form stronger technology transfer connections among universities, research institutions, and enterprises. With this earlier foundation, they may rely more on existing institutional arrangements and market mechanisms, which means they do not need to introduce new policy measures as frequently.

4.1.3. Institutional Heterogeneity Analysis

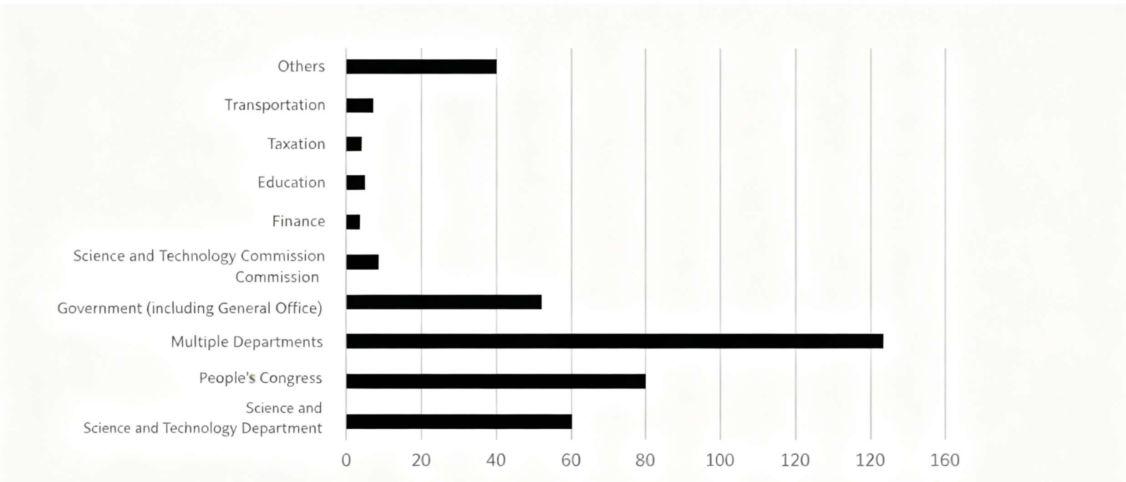

Figure 6. Issuing Quantity of Technology Transfer Policies by Administrative Institution

Technology transfer policies are issued by a range of administrative actors, which matches the multi-level, cross-sector governance structure of technology transfer. Multi-department joint documents form the largest category, with 143 items. Next are documents issued by People’s Congresses (80 items), science and technology departments (60 items), and local governments (52 items). Individual functional departments, including finance, education, and taxation authorities, issued fewer policy documents.

This gap in policy output appears to follow the different institutional responsibilities and functional roles these bodies hold within the technology transfer governance system. It also suggests that cross-department coordination has become a noticeable feature of policy formulation in this field.

People's Congresses hold legislative authority and establish the basic legal framework and broad strategic policies, with the highest level of legal validity. Science & Technology

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Departments and local governments handle administrative implementation and practical guidance.

The high number of joint policy releases suggests that technology transfer is not managed by a single department. Instead, it relies on coordination across departments and the integration of different resources, because fragmented policy implementation can reduce its effectiveness. Single functional departments, by contrast, usually issue more targeted operational policies for specific parts of technology transfer, such as fiscal subsidies, talent cultivation, and tax incentives.

4.2. Internal Characteristic Analysis Results

LDA modeling identifies four main policy themes: Theme 1: Incentive Mechanisms for Technology Transfer; Theme 2: Collaborative Innovation Systems; Theme 3: Technology Finance Risk-Sharing Mechanisms; and Theme 4: Industrialized Practice of Technology Transfer. Taken together, these themes show a shift in policy attention, from support for basic research to industrial application, from governance by a single actor to collaboration across multiple stakeholders, and from government-led fiscal support to more market-based resource allocation. The high-frequency vocabulary in each thematic cluster is shown in Table 2.

Table 2. Top 10 High-Frequency Words of Four Policy Themes

No.	Theme Name	Top High-Frequency Vocabulary
1	Incentive Mechanisms for Technology Transfer	Duty-related achievements, scientific researchers, science and technology, regulations, equity, contribution, capital contribution via technology, agreements, high-tech industries, administrative authorities
2	Collaborative Innovation Systems	Universities, research bases, innovation platforms, institutional reform, science and technology bureaus, research centers, talents, research institutes, technology trading, special research funds
3	Technology Finance Risk-Sharing Mechanisms	Special funds, science and technology bureaus, loans, risk compensation, risk prevention, commercial banks, expert evaluation, management agencies, project review, equity financing
4	Industrialized Practice of Technology Transfer (Agriculture-Oriented)	Agriculture, manufacturing, equipment, production facilities, rural development, agricultural products, deep processing, biotechnology, new crop varieties, livestock breeding

4.2.1. Theme 1: Incentive Mechanisms for Technology Transfer

Incentive frameworks play an important role in improving transfer efficiency. These include incentives linked to duty-related scientific outputs, researcher equity incentives, technology capital contribution, and policy support for high-tech enterprises. Over time, policy development shifted from basic honorary and financial rewards to market-based equity incentives, and then toward more standardized legal protection of researchers' rights and interests.

Enacted in July 1993, the Science and Technology Progress Law of the People's Republic of China established the national science and technology reward system to recognize outstanding research contributors[19]. During the Legalization Development Stage, this framework was reinforced by the Regulations on National Science and Technology Awards (1999), which gave attention to both material and spiritual rewards for researchers.

In the Targeted Strengthening Stage, technology transfer policies gradually added more market-oriented mechanisms, such as equity-based transfer arrangements and technology capitalization. In this period, policy measures placed greater emphasis on the commercialization capacity of high-tech enterprises, mainly through tax incentives and fiscal subsidies. Later, with the revision of the Law on Promoting the Transformation of Scientific and

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Technological Achievements, China entered the Systematic Improvement Stage and built a more complete institutional framework. The reforms clarified the ownership, decision-making authority, and benefit-sharing mechanisms for scientific and technological achievements, and they also improved the regulation of technology trading markets and the legal protection of researchers' rights and interests[20].

4.2.2. Theme 2: Collaborative Innovation Systems

Collaborative innovation mechanisms provide an institutional basis for improving technology transfer because they make cooperation easier among universities, research institutions, enterprises, innovation platforms, and talent development systems. The policy focus also changed over time. Early on, it centered on institutional reform within research organizations and the establishment of basic university-industry-research cooperation. It then expanded to cross-regional innovation networks, and later to the integrated development of shared innovation platforms and talent support mechanisms.

At the early stage of policy development, government efforts centered on reforming public research institutions and encouraging early collaboration in research and development. Later, the Guiding Opinions on Establishing Industrial Technology Innovation Strategic Alliances issued in 2008 promoted broader cross-regional cooperation, resource sharing, and joint technological innovation among different actors. As policy entered the Systematic Improvement Stage, attention shifted more clearly to building high-level innovation platforms, improving mechanisms for talent cultivation and mobility, and coordinating the roles of enterprises, universities, research institutions, and government agencies.

These changes gradually formed a more integrated collaborative innovation system with multiple participants. They also strengthened the coordination capacity of technology transfer systems.

4.2.3. Theme 3: Technology Finance Risk-Sharing Mechanisms

Originating in 1993, technology finance refers to an institutional framework that combines financial instruments, policy support, and related service systems to support technological research and development, technology transfer, and the commercialization of high-tech industries. It relies on the coordinated participation of multiple actors, including governments, enterprises, financial markets, and intermediary organizations[21]. Through risk-sharing mechanisms, technology finance aims to ease funding constraints and improve the efficiency of commercialization across different stages of innovation and policy development.

During the Legalization Development Stage, technology finance policies depended mainly on government fiscal investment and dedicated research funding programs, and market-based financial resources only had a small role. A shift began with the issuance of the Guiding Opinions on Integrating Science, Technology and Finance in 2011. This document introduced more diversified financing mechanisms and opened market-oriented channels such as venture capital and intellectual property pledge financing, which expanded the sources of innovation funding.

In the Systematic Improvement Stage, technology finance policies pushed this trend further through the fuller development of risk compensation and risk-sharing mechanisms. Here, the allocation of risk became clearer across governments, financial institutions, and enterprises. The framework was more mature. Coordination also improved, which helped support technology transfer and commercialization.

4.2.4. Theme 4: Industrialized Practice of Technology Transfer

Industrialization is the last stage of technology transfer. At this stage, enterprises absorb scientific research outputs, apply them in production, and convert them into market value[6]. In this area, agricultural technology transfer has drawn particular policy attention, especially

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under the framework of rural revitalization strategies. These policies span several fields, including agricultural machinery innovation, biotechnology applications, new crop breeding technologies, and agricultural product processing.

In the Legalization Development Stage, policy initiatives focused mainly on basic agricultural technology research and development and on building grassroots technology extension systems to improve production efficiency in cultivation and breeding. In the Targeted Strengthening Stage, policy priorities gradually shifted toward agricultural industrialization and digital agriculture, aiming to connect agricultural technology more directly with industrial development and to extend value chains. The focus changed.

During the Systematic Improvement Stage, the Rural Revitalization Strategic Plan (2018–2022) placed agricultural technology innovation within wider rural development goals, with more attention to green agricultural practices, intelligent agricultural equipment, and the commercialization of agricultural biotechnology. This stage suggests a move toward a more market-oriented allocation of innovation resources, together with greater reliance on endogenous mechanisms for the diffusion and application of agricultural technology.

5. Conclusion and Policy Recommendations

5.1. Research Conclusion

China's technology transfer policy system has passed through three successive stages. Over that period, policy output continued to rise, coordination across regions became closer, and the focus gradually shifted from support for scientific research toward industrial commercialization. Looking across these changes, three developments stand out. Governance moved away from a single-actor model and toward greater cooperation among multiple stakeholders. Resource allocation also shifted, with less direct government administrative control and a stronger role for market mechanisms. Financing changed as well, expanding beyond direct fiscal support into more diversified systems that include risk-sharing arrangements.

Despite these significant advances, several structural constraints remain embedded in the current policy framework.

1) Structural Imbalance in Policy Instrument Portfolios

The current policy system still depends mainly on administrative documents. Circular notices account for the largest share of policy outputs (276 items), while formal legal backing is still limited, with only two national-level laws. The gap is clear.

Many of these measures are fragmented and short-term, so institutions have less continuity and long-term policy stability is harder to sustain. At present, policy arrangements do not yet cover the whole technology transfer value chain, and support remains uneven. Upstream research activities receive strong investment, but downstream commercialization and industrial application still get too little support.

2) Persistent Regional Disparities in Policy Development

Across regions, technology transfer policies differ quite clearly, and both the strength of these policies and the ability to carry them out generally decline from the eastern provinces to the western ones. In the western provinces, technology transfer is constrained by weaker policy support, a less developed industrial base, and a lower ability to absorb and apply technological achievements. These structural differences have gradually widened the gap in technology transfer efficiency between the more developed coastal regions and the inland areas.

3) Limitations of Existing Research Evaluation Mechanisms

Current academic evaluation systems still place greater weight on traditional indicators such as research project acquisition, academic publications, and patent outputs, while

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commercialization outcomes account for less than 30% of the evaluation criteria. This imbalance appears to weaken researchers' motivation to participate in technology transfer, because the uncertain returns from commercialization increase the perceived risk of converting scientific achievements into practical applications.

4) Insufficient Cross-Departmental Coordination Mechanisms

Cross-departmental policy collaboration has increased, as shown by the large number of jointly issued policy documents (143 items). Even so, the arrangements needed for effective coordination are still underdeveloped. Duties remain unclear across science and technology, finance, and education authorities, which appears to contribute to fragmented policy implementation. There is also no integrated coordination platform. This leaves information asymmetries in place and increases transaction costs for universities and enterprises seeking to commercialize technological achievements.

5.2. Policy Recommendations

1) Optimize Combinations of Policy Instruments

Fiscal investment should increase for pilot-scale testing platforms and technology transfer agencies, and dedicated industrialization funds should support joint projects between universities and enterprises. On the demand side, governments can widen policy tools through priority procurement of domestic innovative products, first-set insurance funds, and tax deductions for corporate patent purchases. Policy design needs to connect the whole process from R&D and pilot testing to commercialization and market application, so that "market demand feedback – technological iteration – industrial upgrading" works as a continuous cycle.

2) Establish Cross-Departmental Coordination Mechanisms

Regular joint conferences and cross-ministerial information-sharing platforms should be set up for science, finance, and education authorities to clarify divided responsibilities. Central legislative and administrative bodies should strengthen top-level institutional design through laws and regulations, while functional departments prepare detailed operational guidelines for implementation. Policy evaluation should also become a routine part of the process, with scope for adjustment as conditions change, so that policies remain better aligned with actual needs and are carried out more efficiently.

3) Construct Demand-Driven Policy System

In the short term, the government should require public procurement to give priority to domestic innovative technologies, introduce first-set equipment risk insurance, and add tax deductions for enterprise patent acquisition.

Over the medium term, industrial technology demand databases should be developed to guide research project design with actual market and production needs. At the same time, researcher assessment systems need to be revised so they give more weight to industrialization outcomes.

Over the long term, full-chain integrated policy portfolios should be piloted to address the long-standing imbalance between supply-side and demand-side policy instruments.

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