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RESEARCH ARTICLE

THE DISPARITIES IN SCIENCE AND TECHNOLOGY INNOVATION POLICIES ACROSS DIFFERENT LEVELS OF GOVERNMENT IN CHINA

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ABSTRACT

Science and technology innovation policies play a pivotal role in fostering economic and social development. The collective policies enacted by governments at different levels constitute a nation's innovation framework, yet comparative analyses of such policies across various levels of government remain limited. This study employs NVivo software to analyze the science and technology innovation policies embedded within government work reports from the central government, Shanxi Province, and Lvliang City from 2018 to 2022. The findings reveal a high degree of similarity between provincial and municipal policy texts, characterized by significant regional coordination. However, the connection between municipal policies and central government policies appears weaker. In terms of attention allocation, the central government places greater emphasis on talent attraction and cultivation, whereas local governments focus more on the functional roles of enterprises, showing noticeable deficiencies in supporting the innovation environment. Therefore, in local science and technology innovation governance, it is crucial to not only enhance regional coordination but also align with the central government's macro-level deployment of various elements. This approach can prevent the neglect of critical factors, facilitate the synergy of innovation elements, and ultimately strengthen innovation capacity.

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INTRODUCTION

China is currently at a critical stage in implementing its innovation-driven development strategy, necessitating the continuous improvement and optimization of science and technology (S&T) innovation policies to maximize their role in fostering an enabling environment and incentivizing innovation. The collective policies issued by governments at various levels constitute the national S&T innovation policy system. Understanding the focal points and disparities in S&T innovation policies across different levels of government is a prerequisite for comprehensively evaluating the effectiveness of these policies (Bozeman, 2000). Therefore, it is essential to systematically review and analyze local S&T innovation policies to provide valuable insights for policy evaluation, optimization, and decision-making, ultimately enhancing the precision and impact of policy formulation.

LITERATURE REVIEW

Science, Technology, and Innovation Policy (STIP) encompasses a set of governmental measures aimed at supporting basic research, fostering innovation, and facilitating the commercialization of inventions. STIP enhances knowledge spillovers, accelerates the emergence of new products and industries, and contributes to regional economic growth (Woolley & MacGregor, 2022), While it often emphasizes economic growth, it can also focus on social inclusivity and environmental sustainability. Beyond its role as a foundation for national economic performance, STIP is also linked to national security and scientific supremacy (Chaminade & Lundvall, 2018). Current discussions on STIP primarily concentrate on the following aspects: fundamental theoretical research on S&T policy(Bach & Matt, 2005);historical analysis and evaluation of S&T innovation policy(Martin, 2012); mechanisms, influencing factors, and evaluations of S & T innovation policy (Kim et al., 2021); comparative studies of S & T innovation policies (Lee, 2015). Overall, existing research has addressed the influencing factors, historical development, mechanisms, evaluations, and disparities of S&T innovation policies. However, most studies focus on national-level governance or differences between national and provincial governments, with limited attention to local government priorities and the disparities among national, provincial, and municipal governments in S&T governance. To address these gaps, this study employs a content analysis method, incorporating a three-tier coding approach from grounded theory.

Based on prior research, an analytical framework is constructed to examine the S&T innovation governance content in government work reports issued by the central government, Shanxi Province, and Lvliang City from January 1, 2018, to December 1, 2022. This analysis explores the internal logic and focal points of local S&T innovation governance, highlighting the disparities in governance priorities across government levels to better capture the directional trends in S&T innovation policy formulation.

RESEARCH METHODOLOGY

Research Approach and Sample Selection: This study employs a text analysis approach to examine the disparities in science and technology (S&T) innovation policies across different levels of government. The methodological process is as follows: first, the text data were analyzed using NVivo 12 to identify word frequencies and extract key terms. Based on these findings, grounded theory's three-tier coding method was applied to summarize policy differences and explore the variations in priorities and attention allocation among different levels of government. Given that local governments began implementing S&T innovation governance policies after 2017, this study selects government work reports from the central government, Shanxi Province, and Lvliang City spanning 2018 to 2022 as the policy texts for analysis. A total of 15 reports were included. These reports comprehensively summarize the measures taken by governments in S&T governance during the preceding year and provide detailed plans for the subsequent year, forming a solid foundation for identifying differences and attention shifts in S&T innovation policies across different levels of government.

Data Analysis: Grounded theory initially emphasized theory generation, with Glaser advocating the extraction of theories directly from data. However, as analytical techniques evolved, Strauss and others highlighted the use of data collection and analysis processes for qualitative research within grounded theory (DePoy & Gitlin, 2016). This study adopts a qualitative analysis approach rooted in grounded theory, importing government work reports into NVivo and utilizing its three-tier coding process for analysis.

The coding process comprises three stages:

Open Coding: Involves line-by-line examination of the data to describe and classify elements systematically, preventing data from being forced into pre-existing categories.

Axial Coding: Establishes connections among various categories, reorganizing data in new ways to uncover relationships.

Selective Coding: Systematically identifies categories closely related to the core category to form a cohesive framework (DePoy & Gitlin, 2016)

The study analyzed 15 policy texts issued by the national, provincial, and municipal governments, extracting content, refining categories, and ultimately forming primary categories. These categories were used to assess policy text similarities and differences in attention allocation. The grounded theory three-tier coding approach was implemented as follows:

Step 1: opencoding: Line-by-line examination of the data was conducted to identify key elements related to S&T innovation governance. Relevant elements were categorized and summarized into preliminary categories. Table 1 presents examples of open coding results. By employing this systematic approach, the study seeks to reveal the underlying logic and variations in attention allocation among government levels in S&T innovation governance.

Table 1. Coded Categories and Representative Statement

Category	Representative Statement
Enterprise Support	Strengthen the role of enterprises as the main entities of innovation; encourage leading enterprises to form innovation consortia.
Talent Cultivation	Accelerate the establishment of globally significant talent hubs and innovation centers; improve talent development systems; promote the spirit of scientists; enhance support for young researchers to enable focused and productive work.
Intellectual Property Protection	Strengthen intellectual property protection; improve punitive compensation systems for intellectual property infringement; promote invention, creation, and application.
Industry-Academia-ResearchCollaboration	Support collaborative innovation among research institutes, universities, and enterprises; accelerate the application of innovative outcomes.

Step 2, axialcoding: In the axial coding phase, the initial categories were analyzed to determine their relationships and grouped into broader categories. The analysis resulted in the following groupings:

Subject Policies, includes policies related to enterprise innovation, universities and research institutes, and innovation service institutions. Element Policies, covers policies on S&T investment, talent cultivation, and S&T infrastructure. Relational Policies, Encompasses policies on industry-academia-research collaboration, military-civil fusion, and S&T-education integration. Industry-Specific Innovation Policies, Focuses on innovation policies targeting specific industries. Innovation Environment Policies: Includes policies on market conditions, S&T finance, internationalization, and cultural environment.

Step 3, selective coding: In the selective coding phase, the relationships among the final categories were identified to establish a core category and develop the ultimate model. Based on the coding process, the following methods were employed to achieve deeper insights: Clustering analysis using pearson coefficients. This method was used to measure the similarity of policy texts across different levels of government. Evaluation of policy disparities via coding point analysis. The frequency of coded elements was assessed to quantify differences in policies. Analysis of attention shifts in S&T governance. The use of keyword analysis enabled the identification of changes in attention allocation across government levels over time. This structured approach facilitates the integration of insights from policy texts into a coherent framework for understanding disparities and priorities in S&T innovation governance.

Composition of Analytical Dimensions

The composition and analysis of the dimensions are as follows:

***Element Policies**:* This dimension includes fiscal support, talent cultivation, S&T platforms, S&T infrastructure development, and project support. Literature analysis highlights the pivotal role of various elements such as talent, funding, equipment, infrastructure, and project investment in S&T innovation by different levels of government. Accordingly, this study examines these aspects as part of element policies, categorizing them into fiscal support, talent cultivation, S&T platforms and infrastructure, and project support, which are designated as case nodes.

Subject Support: This dimension encompasses enterprise innovation policies and content related to universities, research institutes, and other innovation service institutions. Literature analysis reveals that governments support innovation entities such as enterprises, universities, and research institutes in the S&T innovation process. This study, therefore, focuses on these three aspects to examine subject support and designates them as case nodes.

Relational Support: This dimension includes support for interactions between entities, such as industry-academia-research collaboration and military-civil fusion. Literature analysis indicates that governments actively promote collaboration among innovation entities and facilitate the transformation and application of innovative outcomes. Accordingly, this study examines relational support through these two aspects and designates them as case nodes.

Industry-Specific Innovation Support: This dimension addresses innovation policies targeting specific industries, such as emerging sectors like new energy vehicles. Literature analysis shows that governments prioritize supporting the development of certain industries in their S&T innovation efforts. This study, therefore, categorizes these as industry-specific innovation support and designates them as case nodes.

Innovation Environment Support: This dimension includes intellectual property (IP) protection and the cultivation of an innovation-friendly cultural atmosphere, which provide external environmental support for innovation activities. Literature analysis highlights that governments contribute to building an S&T innovation environment through institutional supports such as IP protection, the refinement of project and institutional management systems, evaluation and reward systems for scientific research outcomes, granting autonomy in research decision-making, and fostering research integrity. These efforts aim to create a conducive innovation ecosystem and a culture that encourages innovation. This study, therefore, categorizes these aspects as innovation environment support and designates them as case nodes. By organizing these analytical dimensions and associated nodes, the study offers a structured framework for analyzing the policy differences and attention dynamics across different levels of government in S&T innovation governance.

RESULTS

Correlation Analysis of S&T Innovation Policies Across Government Levels: Clustering refers to the grouping of data, and its meaning varies across different analytical contexts (Hennig, Meila, Murtagh, & Rocci, 2015). This study employs clustering analysis to assess the common factors considered by various levels of government in implementing S&T innovation governance. The similarity of policy texts is measured using the Pearson coefficient, where a higher correlation coefficient indicates greater textual similarity. Policy texts were classified into three levels: national, provincial, and municipal. Pearson coefficients were calculated to assess the relationships among these levels, and the results are summarized as follows:

National and Provincial Policies: The Pearson coefficient between provincial and national policy texts approaches 0.8, indicating a high degree of correlation. For instance, in 2021, the Pearson coefficient between the Shanxi Provincial report and the national report was 0.79, while in other years, the coefficient did not exceed 0.8.This suggests that provincial S&T innovation policies exhibit significant regional characteristics, reflecting the unique socio-economic conditions of provinces.

Provincial and Municipal Policies: Provincial and municipal policy texts show strong similarities, with Pearson coefficients consistently exceeding 0.8.For example, in 2020, the Pearson coefficient between lvliang City's government report and Shanxi Province's government report was above 0.85. Similarly, in 2021, the Pearson coefficient between lvliang City's and Shanxi Province's government reports exceeded 0.84.These findings indicate that provincial and municipal policies are highly aligned, reflecting strong regional policy coherence.

Municipal and National Policies: The Pearson coefficients between Lvliang City's S&T innovation reports and the national reports were consistently below 0.7, indicating weaker alignment. Overall, the similarity between national and provincial policy texts is relatively high, while the similarity between provincial and municipal texts is the highest.However, the alignment between municipal and national policy texts is relatively low.The analysis results suggest that regional S&T innovation policies exhibit strong characteristics of synergy and inheritance. Provincial policies serve as a bridge, closely following national policies while simultaneously guiding municipal-level governance. This layered coherence highlights the importance of localized adaptations in implementing national directives.

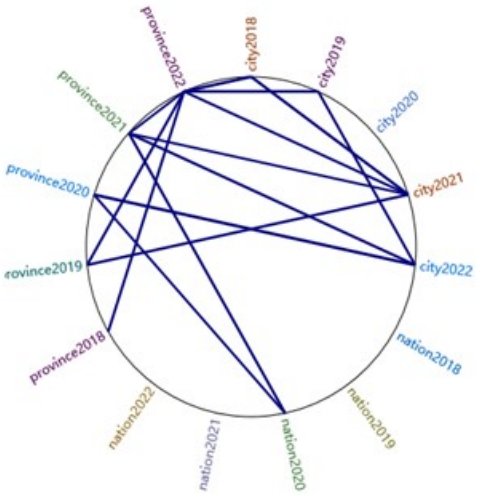

Figure 1. Pearson Index cluster graph of national, provincial and civic innovation policy texts

Analysis of Policy Differences Across Government Levels: After coding the government work report texts in NVivio12,

the frequency of coded nodes was analyzed. The number of coding points reflects the distribution of relevant nodes in the texts. A higher number of coding points for a node indicates that the related information appears more frequently, signaling its emphasis within the S&T innovation governance framework. The analysis of the differences in S&T innovation policies at various government levels revealed the following findings:

Subject Policies: At all three government levels, there is consistent support for enterprise innovation. This indicates that fostering innovation through enterprises is a priority across the national, provincial, and municipal governments.

Element Policies: Municipal policies show some deficiencies, especially in terms of fiscal support. Compared to provincial and national levels, municipal-level policies focus less on funding, highlighting a gap in financial investment for innovation.

Relational Policies: Lvliang City places less emphasis on industry-academia-research (IAR) integration than the national and provincial levels. Furthermore, Lvliang's policies do not reflect strong initiatives for military-civil fusion to promote the transformation of technological achievements. This indicates that Lvliang's policies need to be strengthened in these areas.

Innovation Environment Support: Lvliang City mainly focuses on intellectual property (IP) protection, but it does not give adequate attention to aspects such as cultivating an innovative culture, promoting research integrity, and fostering a favorable innovation ecosystem. These areas are not sufficiently prioritized in Lvliang's S&T innovation governance policies.

Industry-Specific Innovation Support: Lvliang City also shows significant shortcomings in supporting industry-specific innovation. Compared to the national and provincial policies, Lvliang's policies are less comprehensive in driving sector-specific innovation, particularly in emerging industries. Over all, the analysis indicates that while all three levels of government prioritize enterprise innovation and overall innovation support, there are notable differences in their focus areas. Municipal-level policies, especially in Lvliang City, show gaps in fiscal support, relational policies, innovation environment support, and industry-specific innovation. These findings suggest that Lvliang's S&T innovation policies need further enhancement, particularly in fostering a broader innovation ecosystem and strengthening collaborative frameworks between academia, industry, and government. Table 2 presents the detailed results of these policy differences across government levels.

Analysis of Attention to S&T Innovation Governance Across Different Government Levels: This section utilizes the keyword extraction method to measure the differences in attention to S&T innovation governance across various levels of government. By conducting a word frequency analysis based on government levels, it becomes apparent that both central and local governments emphasize the development of S&T innovation. All levels focus on fostering innovative "enterprises," attracting and nurturing innovative "talents," and achieving "innovation" in science and technology. However, the emphasis varies across levels. Central government S&T innovation policies primarily highlight the core role of technological innovation**,** positioning it as the central element of the country's development strategy. Shanxi Province's innovation policies place greater emphasis on the centrality of talent**,** focusing on developing and nurturing human resources as a key driver of innovation. In contrast, Lvliang City centers its policy on enterprises**,** considering them as the fundamental engine driving innovation, and prioritizing support for businesses as the main force in advancing technological and economic progress.

This analysis reveals that while the overarching goals remain similar across government levels, the focus of policy attention differs, with the central government prioritizing technological innovation, provincial policies stressing talent development, and municipal policies emphasizing the role of enterprises.

Analysis of Innovation Subject, Element Support, Relational Support, and Innovation Environment Across Different Government Levels: From the perspective of innovation subjects, government work reports at all levels emphasize the central role of "enterprises," "universities," and "research institutions" in innovation. However, there are differences in the specific focus areas.

In terms of enterprise innovation**,** the central government emphasizes system mechanisms that incentivize technological innovation within enterprises. Shanxi Province focuses more on corporate R&D investment and the scaling-up of high-tech enterprises, while Lvliang City prioritizes the increase in the number of high-tech enterprises, with a decreasing emphasis on technological breakthroughs as the focus shifts from the central to local levels. Regarding elemental support**,** which primarily involves talent, technological investment, and related infrastructure, all levels of government exhibit concern for S&T innovation infrastructure and talent. However, the focus on long-term mechanisms for incentivizing S&T innovation talent varies. The central government emphasizes the construction of S&T innovation infrastructure and the initiation of major innovation projects. Shanxi Province, in contrast, places more emphasis on the development of innovation platforms, centers, and engineering projects, while Lvliang City focuses on the construction of laboratories, engineering research centers, and incubators.

Table 2. Statistics of Coding Number

Policy	Subject Policies	Element Policies	Relational Policies	Innovation Environment Support	Industry-Specific Innovation Support
Subject	Coding umber	Coding number	Coding number	Coding number	Coding number
Nation	9	25	6	24	8
Shan xi Province	7	25	6	9	4
Lvliang City	7	15	2	2	2

On talent policies**,** the central government emphasizes talent development, incentives, and international talent recruitment, while Shanxi Province primarily focuses on talent

introduction, incentives, and management. Lvliang City emphasizes talent cultivation and introduction but lacks sufficient emphasis on talent incentives.

Regarding relational support**,** which involves the interaction and cooperation among innovation subjects, all levels of government emphasize cooperation and innovation among subjects. However, from the central to the local level, the emphasis on the linkages between innovation subjects weakens, likely due to the lack of local innovation subjects and their capacities. The central government focuses on the integration of industry, academia, and research, as well as the integration of large, medium, and small enterprises. Shanxi Province emphasizes the transformation of scientific and technological achievements and the integration of industry-academia-research. Lvliang City highlights diverse cooperation and the transformation of results, but its emphasis on specific relational subjects is not as strong.

In terms of innovation environment support, all levels of government emphasize the protection of intellectual property. The central government primarily focuses on the research autonomy of innovation subjects such as universities and research institutes, as well as institutional guarantees for related systems such as project funding. Shanxi Province emphasizes the establishment of systems for project approval, achievement evaluation, and the transformation of results. Lvliang City, however, lags in terms of building a comprehensive innovation environment.

CONCLUSIONS AND IMPLICATIONS

Respect Regional Differences in Innovation Governance, Support Interaction, and Innovation Systems: Currently, China's national, provincial, and local innovation governance exhibits a development pattern where the central government leads, while regional characteristics are prominently featured. One significant role of innovation policy is to support the formation of a technological innovation network. Therefore, innovation policies must take into account the long-term relationships between various innovation entities (such as industry, academia, and research), which is crucial for innovation success. Governments must not only ensure adequate scientific investment and promote strategic technologies, but also transcend their focus on technological suppliers to foster cooperation among different innovation subjects (Chaminade & Lundvall, 2018). Particularly in terms of innovation subjects, local governments emphasize enterprise-led regional development, increasing financial support for enterprise-driven technological innovation. Furthermore, in relational policies, local governments emphasize the importance of industry-academia-research integration to facilitate the transformation of scientific and technological achievements and strengthen technical innovation cooperation between local enterprises and national and provincial key universities and laboratories. Therefore, besides increasing talent attraction and cultivating more innovation subjects, local governments should focus on leveraging regional development advantages, creating a favorable environment for technological innovation, enhancing the autonomy of research subjects, and implementing management systems for projects, talent, and funding to foster cooperation among innovation subjects and improve innovation performance.

Focus on Government Attention Trends, Define Development Vision, and Guide Technological Innovation Work: The attention paid to technological innovation policies is a key manifestation of the governance priorities in innovation. Innovation policies not only facilitate the establishment of related infrastructure, support the creation of macro-level rules, and provide funding for specific technologies but also articulate development visions and guide innovation efforts based on those visions (Weber & Rohracher, 2012). Understanding the changing trends in policy attention helps local governments align their innovation governance goals and guide innovation efforts effectively. The analysis indicates that, while regional policies show significant alignment within the province, there are attention differences between central and local governments. For example, local policies tend to lag behind central policies in terms of formulation. According to the clustering analysis results, the 2020 and 2021 Shanxi provincial government reports exhibit high similarity with the central government's 2020 report, and the 2022 Lvliang city report shows a high similarity with the 2020 Shanxi provincial report, indicating a delay in local innovation policies. Additionally, in terms of development vision, local policies appear more conservative compared to central policies. The central government's work reports emphasize broad reform and social innovation, while local reports focus more on "construction" and "development," with less emphasis on "reform," suggesting that local governments show a weaker commitment to reform. Therefore, local innovation policies, while aligning with provincial policies and highlighting regional characteristics and needs, should also pay attention to the evolving trends in central government innovation governance. Local governments should maintain coordination with national innovation policies in a timely manner and utilize innovation policies to incentivize innovation entities.

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