Article

Evaluation and Analysis of Synergy between Energy and Environmental Policies in Coal Resource-Rich Areas

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Abstract: The policy synergy of coal resource-rich areas directly affects the process of regional green transformation and high-quality development. Shanxi, Shaanxi and Inner Mongolia are important coal energy bases, and studying the energy and environmental policies of these three provinces is of great significance to sustainable development. Using social network analysis, the Latent Dirichlet Allocation (LDA) topic model and textual similarity methods, we conducted a synergistic study of policy issuance subjects and policy text contents of Shanxi, Shaanxi and Inner Mongolia from both horizontal and vertical perspectives. The results show that: (1) in the policy subject dimension, Shanxi had the highest degree of synergy, but overall the synergy in all three provinces was insufficient, and the number of multi-subject joint texts was relatively small; (2) in the policy content dimension, the textual similarity and goal consistency between Inner Mongolia and the Central Government were better than that of Shaanxi and Shanxi. Therefore, the region of “Shanxi–Shaanxi–Inner Mongolia” should improve the synergistic ability of policy issuance subjects; it should also pay attention to the linkage and refinement of the policy content, and make flexible innovations based on the compatibility with the Central policy incentives, to better promote the low-carbon and green transformation of coal resource-rich areas.

Keywords: policy synergy; “Shanxi–Shaanxi–Inner Mongolia” region; social network analysis; LDA topic model; textual similarity

1. Introduction

Under the trend of global warming and increasing consumption of traditional energy sources, ecological issues have become acute [1,2]. Human production activities have led to serious climate change and environmental pollution. At the same time, irrational utilization of natural resources has led to resource depletion and ecological imbalance [3]. This is especially true in coal resource-rich areas, where irresponsible mining activities have led to soil destruction, severe air and water pollution, large amounts of waste and dumpsites. Balancing human activities and the environment is a priority that humanity needs to address. Some countries have introduced circular economy principles and sustainable development of energy, aiming to utilize and improve the way natural resources are extracted more efficiently, to reduce the pollution generated, and to recycle waste and increase energy efficiency [4].

China is also actively exploring a new development model to improve resource utilization efficiency, curb its production’s ecological footprint and move towards a circular economy. It is gradually realizing its carbon peak and carbon neutrality (“dual carbon”) goals [5]. In recent years, the Central Government has promulgated the guiding ideology and top-level design of the “1 + N” policy system, which has released clear signals of carbon and pollution reduction to the whole of society as well as to the whole of mankind, and the key to the implementation of the policy is to encourage the cooperation of the
local governments and to realize the coordinated development of the region. The synergy between energy and environmental policies, especially between Central and local policies, is decisive for the effectiveness of policy implementation.

China’s current system is characterized by a decentralized governance structure. In formulating and promulgating public policies, local governments often prioritize maximizing their interests in the local political environment, while relegating the public interest to the back burner, tending to act self-interestedly and flexibly [6,7]. As a result, the level of synergy in public policies such as energy and environment is much lower than expected by the Central Government [8], which is not conducive to coordinated regional development.

As a coal resource-rich area in China, “Shanxi–Shaanxi–Inner Mongolia” is a major coal-producing and coal-transferring area, where irrational mining activities have led to resource depletion and ecological imbalance. There is an urgent need to promote the circular economy principle and policy support and guidance to promote the sustainable development of people and resources. Currently, during the implementation of policies, the policy’s initial intention is often not well reflected in the regional governance, which is specifically reflected in two aspects. First, energy and environmental policies involve more departments, less communication among the formulating subjects, insufficient number of joint documents, and are prone to fragmentation and a lack of synergy; second, due to the complexity of the policy implementation environment and the heterogeneity of the regional resources and economy, “Shanxi–Shaanxi–Inner Mongolia” has a skewed perception of the Central Government’s policy focus, which has made a difference in the effect of the policy’s implementation. Therefore, analyzing and studying the synergy of regional energy and environmental policies and assessing the degree of synergy between Central and local policies and policy subjects can help to alleviate the conflicting and poorly coordinated problems, so that regional energy and environmental policies can better contribute to the realization of the goal of “dual-carbon” [9].

Energy and environmental policies are based on policy texts, and both policy subjects and policy content are important parts of the policy system and are indispensable. Based on the above analysis, this study focuses on answering three questions: first, what is the degree of synergy between the policy subjects in “Shanxi–Shaanxi–Inner Mongolia”? Second, is there consistency between the energy and environmental policy contents issued by “Shanxi–Shaanxi–Inner Mongolia” and the Central Government? Third, what measures should be taken in future policy formulation to better realize energy and environment policy synergy in “Shanxi–Shaanxi–Inner Mongolia”?

This paper takes the energy and environment policy texts promulgated by the Central and “Shanxi–Shaanxi–Inner Mongolia” regions from 2010 to 2023, and introduces social network analysis, the Latent Dirichlet Allocation (LDA) topic model, and textual similarity into the study of policy synergy. From both horizontal and vertical perspectives, we assess the policy subject synergy and the policy content synergy between “Shanxi–Shaanxi–Inner Mongolia” and the Central Government, and analyze the shortcomings and differences in the implementation of energy and environmental policies. To effectively utilize the regional characteristics and resource advantages in future policy formulation, there must be better synergies with the Central policy and policy subjects, better promotion of low-carbon, and a green transformation and development of coal resource-rich areas.

The rest of the paper is organized as follows. Section 2 lays out a brief literature review of energy and environmental policies and policy synergies. Section 3 presents the data sources, the research framework, and the steps. Section 4 presents the results of the subject and content assessments and analyzes them. Section 5 concludes and provides policy recommendations.

2. Literature Review

2.1. Energy and Environmental Policies

Poor human mining activities and greed for natural resources have led to resource depletion and pollution. Society needs to change production and consumption patterns
within an ecological context [10]. The circular economy is a principle that promotes national, organizational and societal sustainability, focusing on reducing resource consumption, greenhouse gases and waste, and is one of the directions of green economy [11]. Florinda et al. [12] investigated the relationship between energy and circular economy using methods such as Pearson’s correlation and principal component analysis, and found a strong correlation; Viktor et al. [3] found that circular economy provides direction for mineral resource conservation and sustainable development policies; Camelia et al. [13] described the development of Romania, a prominent energy country, to propose policy planning for a sustainable development path. Therefore, incorporating mining sustainability and circular economy principles into energy and environmental policies is essential for the long-term prosperity and development of coal-rich regions.

Currently, most energy and environmental policies research focuses on the impacts on the economy, environment, social welfare, etc. Lin et al. [14] described the impacts of energy saving and emission reduction fiscal policies on emission reduction and economic growth; Zakeri et al. [15] assessed the impact of carbon tax and carbon emissions trading policies on economic growth in Australia and found a non-linear relationship; Yang et al. [16] confirmed that energy policy implementation has a positive effect on urban air quality, the atmospheric environment and the health of the population; Zhu et al. [17] investigated the straw burning ban policy’s impact on greenhouse gas emissions and synergistic emission reduction effects; Hildingsson [18] observed synergies and conflicts between low-carbon policies and environmental goals; Guo et al. [19] showed that lower energy prices favor real GDP growth and improves social welfare; Lou [20] found that carbon tax rate increases, marginal CO$_2$ emission intensity decreases, and the level of social welfare can be increased by adjusting the use of carbon tax.

In addition, some scholars have also focused on evaluating the effectiveness of policy implementation. Wang et al. [21] assessed the effects of implementing different wind power industrial policies and their combinations on corporate innovation; Jin et al. [22] quantitatively evaluated the development and implementation effects of provincial “dual-carbon” policies; Zhang et al. [23] compared the emission reduction effects of a single carbon tax policy and a combined carbon tax-clean energy policy, and showed that the implementation of the combined policy can improve the policy’s cost-effectiveness and emission reduction performance; Landa et al. [24] found a “double dividend” when simulating research on energy tax and environmental tax, which could reduce greenhouse gas emissions and improved the efficiency of the tax system and social welfare; but Magdalena et al. [25] found that the “double dividend” did not exist in the short term.

2.2. Policy Synergy

Policy synergy refers to the use of different policy measures among government departments, and their collaboration and coordination to generate maximum policy coherence to promote the realization of policy objectives [26]. Effective policy synergy can promote policy performance, while the lack of policy synergy can lead to public policy failure [27]. In terms of policy content synergy measurement, the research is more diverse. Hughes et al. [28] used the eight principles of good governance proposed by the United Nations Economic and Social Commission for Asia and the Pacific to determine the assessment criteria, and assessed the policy synergy according to the stakeholders’ scores for each criterion; Fu et al. [29] used the quantitative analysis of the policy content to analyze China’s carbon emission reduction policy in two dimensions, according to the way of categorization of the policy tools; Peng et al. [30] used the expert scoring method for quantitative scoring and developed a policy quantification manual that has been referenced and studied by many scholars; Jiang et al. [31] selected some benchmark policies from two types of policy clusters, and assessed the synergy of the two types of policies by comparative analogy; Zhou et al. [9] constructed a multidimensional framework to study the level of regional science and technology innovation policy synergy based on the perspective of regional heterogeneity; Yoon et al. [32] measured policy coherence by research and development
(R&D) activity coherence based on the patent citation network; Vinokurov et al. [33] constructed a general equilibrium model to conduct a simulation analysis and seek the optimal coordination of three monetary policies.

In terms of policy subject synergy, mostly through social network analysis, the cross-sectoral joint issuance, inter-sectoral cooperation relationship, synergy and evolution rules are studied. Zhang et al. [34] combined the PDM methodology to draw policy maps, exploring cross-government departmental policy undertakings and policy synergy issues; Shrestha et al. [35] identified the four key sectors of climate policy and used the hierarchical analysis method to rank them; Sun et al. [36] counted the subjects’ issuance form, synergistic network structure, and individual subject’s network influence to measure the synergistic effect of policy subjects; Zhang et al. [37] studied and analyzed the synergism and evolution of policy-related departments through the joint policy issuance situation and the number of joint departments; Han et al. [38] used the data on the cooperative issuing relationship of each policy subject in normative policy texts, to elaborate the behavioral logic of the collaborative governance of multiple policy subjects; Pei et al. [39] counted the composition of policy subjects, the degree of cooperation, and the attributes of the network nodes at each stage, and explored the evolutionary rules of the roles of different subjects and the characteristics of the evolution of the collaborative network.

In summary, the analysis of policy synergy mostly separates the policy subject synergy and policy content (policy targets, policy measures) synergy, which is not conducive to systematically grasping the current status of policy synergy [40]. From the perspective of the research object, the research focuses on technology and innovation policies, and there are fewer studies on the synergy of energy and environmental policies in coal resource-rich areas such as “Shanxi–Shaanxi–Inner Mongolia”. In addition, policy synergy studies tend to use qualitative analysis and policy quantification methods based on expert scoring methods, which are somewhat subjective and uncertain. Compared with existing studies, this paper has three main contributions: (1) Constructing a synergistic analytical framework of policy subject-policy content, incorporating policy themes into policy content analysis, and summarizing the hotspots and key issues of energy and environmental policies. (2) Taking the coal resource-rich areas of “Shanxi–Shaanxi–Inner Mongolia” as the research objects and visualizing the characteristics and differences in the regional policy system. (3) Adopting the research methods of social network analysis, the LDA topic model and textual similarity measure, which avoids the problems of subjectivity and uncertainty to an extent and provides a more objective reference basis for the formulation and implementation of energy and environmental policies.

3. Materials and Methods

3.1. Data Sources

In the context of “dual-carbon”, the basic goal of energy and environmental policies is to improve energy use efficiency, reduce environmental pollution, and to realize circular economy and sustainable development. To this end, the government has put forward binding targets for emission reduction and the adjustment of the energy structure [41]. This paper selected the Central Government and “Shanxi–Shaanxi–Inner Mongolia” as the research object, focusing on policy texts on optimizing energy structure, energy conservation and emission reduction, and pollution and carbon reduction.

To ensure the reliability and accuracy of the results of the subsequent analysis, the selected policy texts were collected from publicly published data sources, in combination with the Peking University Law Treasure Database and official government websites. To respond to the central government’s goal of reducing emissions and optimizing the energy structure, we searched the keywords “energy”, “coal”, “energy saving”, “emission reduction”, “pollution”, “low carbon”, “green”, “environmental protection”, and “sustainable”. Policy texts with a clear issue number were collected from January 2010 to June 2023; policy types were opinions, notices, laws, and other documents that fully expressed national concerns. By eliminating insubstantial and invalid documents, in the end, 261 policy texts were
screened as material (111 in the central government, 53 in Shaanxi Province, 52 in Shanxi Province, and 45 in Inner Mongolia), as shown in Table 1. The policy types were mainly divided by the signifier in the title, and policy-type distribution as shown in Table 2 (The policy types are Opinions, Programs, Notices, and Planning, which are high in number).

Table 1. Energy and environmental policies (partial).

<table>
<thead>
<tr>
<th>Area</th>
<th>Issue Time</th>
<th>Issue Subject</th>
<th>Policy Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>6 April 2023</td>
<td>National Energy Administration</td>
<td>Guidance on energy work in 2023</td>
</tr>
<tr>
<td>Shanxi</td>
<td>10 March 2023</td>
<td>provincial government</td>
<td>Outline of the Plan for the Construction of Beautiful Shanxi (2023–2035)</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>26 February 2023</td>
<td>General Office of the Provincial Government</td>
<td>Autonomous Regions New Pollutants Governance Work Program</td>
</tr>
<tr>
<td>Central</td>
<td>16 January 2023</td>
<td>National Government Offices Administration</td>
<td>Work Arrangements for Energy Resource Conservation and Ecological Environmental Protection in Public Organizations in 2023</td>
</tr>
<tr>
<td>Shanxi</td>
<td>5 January 2023</td>
<td>provincial government</td>
<td>Shanxi Province Carbon Peak Implementation Program</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>31 December 2022</td>
<td>provincial government</td>
<td>The “14th Five-Year Plan” Energy Conservation and Emission Reduction Comprehensive Work Implementation Program of Shaanxi Province</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>9 September 2022</td>
<td>Provincial Development and Reform Commission, Provincial Department of Ecology and Environment</td>
<td>Energy Conservation and Carbon Reduction Implementation Program for High Energy Consumption Industries in Key Areas of Shaanxi Province</td>
</tr>
</tbody>
</table>

Table 2. Policy-type distribution.

<table>
<thead>
<tr>
<th>Area</th>
<th>Laws</th>
<th>Regulations</th>
<th>Measures</th>
<th>Opinions</th>
<th>Programs</th>
<th>Guidelines</th>
<th>Decisions</th>
<th>Notices</th>
<th>Planning</th>
</tr>
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<td>2</td>
<td>2</td>
<td>33</td>
<td>18</td>
<td>2</td>
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<td>22</td>
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<td>12</td>
<td>26</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
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<td>1</td>
<td>9</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>15</td>
</tr>
</tbody>
</table>

3.2. Basic Research Framework

The synergy between different policy subjects can reflect the inheritance and development of policy intention, and have a strong explanatory effect on the policy–synergy relationship [42]; policy content synergy can reflect the actual effect of the realization of the policy text, which largely influences the quality of energy and environment polices’ synergy. This paper constructs the analytical framework of “policy subject—policy content”. The policy subject dimension mainly analyzes the synergy of different subjects at the same level in the region from a horizontal perspective, while the policy content dimension mainly analyzes the degree of synergy and response between Central and local policies from a vertical perspective. The basic framework is shown in Figure 1.
3.2.1. Research Steps in the Policy Subject Dimension

Policy subjects are individuals and groups involved in the formulation, implementation, evaluation and monitoring of public policies. It is the core element of the policy system. This study adopted the social network analysis method to analyze the evolution and degree of policy subjects’ synergy.

Social network analysis is a method to quantitatively analyze the network structure and its properties. Social network is a collection of multiple related subjects, which can fully reflect the relationship between each node, and can be visualized through network mapping [43]. It has positive reference significance for analyzing the policy subject’s importance and collaborative governance behavior, so it is favored by many scholars [38].

1. Synergistic evolution of policy subjects

Horizontal policy-subject relationships are quantified by the number of joint local government departments, which refers specifically to two or more policy-issuing departments. Joint issuance, as a more specific type of policy form in government activities, is an important source of data for studying departmental cooperation [43]. In the analysis of synergistic evolution, the number of policy issuances, the number of jointly issued policies, the number of joint departments, and the frequency of jointness were counted for each year from 2010 to June 2023, respectively, and the collaborative evolution diagram of policy actors, concerning the structural ratio of policy issuances and multisectoral joint issuances, was drawn and analyzed.

2. Degree of synergy among policy subjects

The degree of the synergy of policy subjects was analyzed by using the indicators of “synergy breadth” and “synergy strength” [38]. The synergy breadth indicates the number of joint subjects, and the higher number shows the stronger inter-departmental coordination and the more diversified network structure; to avoid the influence of different breadths on the strength, the ratio of the joint issuance number to the breadth is used to indicate the synergy strength, which reflects the strength of the subject’s cooperative relationship and the degree of functional completeness.

To compare the roles of policy subjects in the network diagram, this paper selected the average value of synergy breadth and strength as the origin coordinates, and used the specific values of breadth and strength as the numbering of the abscissa and ordinate to construct the “breadth (X)-strength (Y)” two-dimensional matrix. Policy subjects
at high breadth–high strength (H–H) are the core subjects, high breadth–low strength (H–L) are the important structural subjects, low breadth–high strength (L–H) are the important functional subjects, and low breadth–low strength (L–L) are considered to be the peripheral subjects [44].

3.2.2. Research Steps in the Policy Content Dimension

The policy content dimension analysis mainly assessed the degree of synergy and responsiveness between the Central-local policy texts from a vertical perspective, including policy topic extraction and text similarity measurement.

1. Text topic extraction method

    LDA is a generative probabilistic model in a corpus that quantifies a large amount of unstructured textual data in a collection of documents into comparative data. Since the LDA model was proposed, many scholars have extended and applied research using it. Bi [45] compared the results of topics extracted using the LDA model and word frequency statistics methods, showing that the word correlation using the LDA model is stronger; Qiu [46] indicated that the topics extracted using the LDA topic model are more representative, and the results can be visualized via LDAvis. Lin [47] used the LDA model for text mining to obtain popular topics and their evolutionary trends.

    The above studies show that the LDA model can extract popular research topics more accurately and is more distinguishable and exact than the results extracted using traditional methods such as word frequency clustering statistics. Therefore, it is a more widely used topic model.

    The LDA model topic extraction processes were (all of the following were performed under the Python program):

    1. After collecting the policy texts, a package called Jieba was used to perform word segmentation on the data;
    2. In eliminating stop words, the clustering effect of integrating a multiple stop word list is significantly improved compared with that of a single stop words list. Therefore, we combined “Chinese stop word list”, “Baidu stop word list”, and “Harbin Institute of Technology stop word list” and eliminated the words that cannot represent the text features to form a canonical corpus for the theme modeling;
    3. The theme consistency score was calculated to determine the optimal theme number K and called pyLDAvis to visualize the results to observe the clustering reasonableness.

    We used the LDA algorithm in the Gensim library, and set the theme number as $K \in [0, 10]$, $a = 50/K$, $b = 0.01$, minimum_probability = 0.01, passes = 10, and output 20 keywords under the optimal themes. Each topic was numbered and named separately to form a topic set of policy texts.

2. Text similarity calculation method

    In Natural Language Processing, text similarity calculation is a common task. Text similarity is evaluated by calculating the distance or similarity score. It contains many algorithms; for example, cosine similarity measures the angle between two vectors, which is commonly used in vector space modeling; TF-IDF is a statistical method that indicates the words’ importance in the document, which can represent the text as vectors, and then calculate the cosine similarity; Word2Vec can obtain the semantic relationship between words, which can be represented as a vector’s model. In this paper, combining the above three algorithms improved the accuracy of the text similarity calculation.

    The specific calculation steps were (all of the following were performed under the Python program):

    1. The inverse document frequency of each word was calculated in the vector using the TF-IDF model;
    2. The Word2Vec word embedding model in Python was utilized to train the canonical original corpus. Here the skip-gram model, which works better for low-frequency words, was used to obtain the spatial word vector model;
③ After word vectorization for each document, the cosine similarity calculation was conducted, and the average value was utilized to represent the similarity value of the Central-Shaanxi, the Central-Shanxi, and the Central-Inner Mongolia policy texts. The cosine similarity expression is given by

$$\text{Cos}(\theta) = \frac{\mathbf{u} \times \mathbf{v}}{|\mathbf{u}| \times |\mathbf{v}|} = \frac{\sum_{i=1}^{n} u_i \times v_i}{\sqrt{\sum_{i=1}^{n} (u_i)^2} \times \sqrt{\sum_{i=1}^{n} (v_i)^2}}$$

(1)

where $\theta$ is the angle between vector $\mathbf{u}$ and vector $\mathbf{v}$. $\text{Cos}(\theta)$ is the cosine similarity score between $\mathbf{u}$ and $\mathbf{v}$. Its score is between 0 and 1, and usually the closer it is to 1 is indicative that the two texts are more similar.

4. Results and Discussion

4.1. Analysis of Synergy of Policy Subjects

4.1.1. Analysis of the Synergistic Evolution of Policy Subjects

The 150 policies issued by Shaanxi, Shanxi and Inner Mongolia from 2010 to June 2023 were viewed as a unified whole. The policy-issuing subjects’ synergy and cooperation were measured by counting the number of policies issued, the number of jointly issued policies, the number of joint departments, and the frequency of jointness, as shown in Figure 2.

![Figure 2. Synergistic evolution of subjects from 2010 to June 2023.](image)

In Figure 2, the number of policies increases, and more and more local departments focus on energy structure optimization and environmental protection. During this period, the Provincial People’s Government (PPG) and the General Office of the Provincial Government (GOPG) issued 94 policies, accounting for 63.1% of the total. The PPG, as the highest level of local administration, has the role of carrying the top and the bottom, and is the pointing card for other administrative agencies; the GOPG is an important hub for the PPG to exercise internal and external functions, and is tasked with assisting in drafting and reviewing policies for issuance.

The number of jointly issued policies, the number of joint departments and the frequency of jointness all show fluctuating upward trends. This indicates an increasing capacity for cooperation between policy subjects, a progressively closer relationship, and a gradual increase in the number of joint issuances. In 2010–2015, the cooperation between government departments was low, and the joint documents were concentrated in the GOPG and the Provincial Development and Reform Commission (PDRC), indicating that...
inter-subjective collaboration only involved a few fixed governmental organs. In 2016, the frequency of jointness suddenly increased, marked by the PPG and other 11 departments jointly issuing the Notice on the Implementation Rules for Promoting the Work of Structural Reform on the Supply Side of Coal, with more departments involved, and the interdepartmental collaboration was constantly exploring and bonding. In 2020, the number of jointly issued policies showed a significant upward trend, with a marked increase in the number of joint departments and the frequency of jointness. This indicates that strengthening cooperative relationships is a prerequisite for synergistic regional governance and that cooperative behavior among policy subjects has become a major trend.

According to the independence of issuance, it can be categorized into independent issuance subjects and joint issuance subjects, while multi-sectoral joint issuance is a direct manifestation of subject synergy. In Table 3, there are 121 documents issued by a single department, accounting for 81.2%, and 28 documents issued by two or more departments, accounting for 18.8%. The overall structure reflects that the energy and environmental policy-making in the “Shanxi–Shaanxi–Inner Mongolia” region has the basic characteristic of issuing documents individually, supplemented by multi-departmental collaborative joint documents.

### Table 3. Proportion of structure of issuance.

<table>
<thead>
<tr>
<th></th>
<th>No. of Independent Issuances (Proportion/%)</th>
<th>No. of Joint Issuances (Proportion/%)</th>
<th>Total Number of Issuances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shaanxi</td>
<td>45 (84.9)</td>
<td>8 (15.1)</td>
<td>53</td>
</tr>
<tr>
<td>Shanxi</td>
<td>36 (69.2)</td>
<td>16 (30.8)</td>
<td>52</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>40 (88.9)</td>
<td>5 (11.1)</td>
<td>45</td>
</tr>
<tr>
<td>Total number of issuances</td>
<td>121 (80.7)</td>
<td>29 (19.3)</td>
<td>150</td>
</tr>
</tbody>
</table>

In Figure 3, the number of joint issuances in Shanxi is relatively high, with two to three subjects jointly issuing 10 documents, accounting for 62.5%. Not only can multi-sectoral coordination and mutual constraints be realized, but also the phenomena of mutually exclusive objectives and cross-management caused by the participation of too many departments can be avoided. The subject synergy of Shaanxi and Inner Mongolia is obviously weaker than that of Shanxi, with the number of joint issuances being 8 and 6, respectively, accounting for only a small portion of the total, and with four departments dominating the joint policy process.

![Figure 3. Multi-sectoral joint statistics.](image-url)
4.1.2. Analysis of the Degree of Synergy among Policy Subjects

To further explore the roles of each subject, this paper measured and analyzed the degree of synergy by using the indicators of “synergy breadth” and “synergy strength” as shown in Table 4.

Table 4. Breadth and strength of policy subjects’ synergy (partial).

<table>
<thead>
<tr>
<th>Shaanxi</th>
<th>Shanxi</th>
<th>Inner Mongolia</th>
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<tr>
<td><strong>Joint Issuance</strong></td>
<td><strong>Joint Subject</strong></td>
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<td>Number</td>
<td></td>
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<tr>
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<td><strong>Number</strong></td>
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<td>7</td>
<td>0.29</td>
<td>0.42</td>
</tr>
<tr>
<td>6</td>
<td>0.33</td>
<td>0.25</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

* Provincial People’s Congress (PPC), Provincial People’s Government (PPG), General Office of the Provincial Government (GOPG), Provincial Development and Reform Commission (PDRC), Provincial Department of Industry and Information Technology (PDIT), Provincial Department of Finance (PDF).

1. Two-dimensional matrix analysis of Shaanxi policy subjects

The maximum value of synergy breadth in Shaanxi is 17, with a mean of 5.69; the maximum value of synergy strength is 1, with a mean of 0.3. Its policies involve 19 departments, and only 16% of the policy subjects’ synergy breadth-strength is above the overall average. In Figure 4, the PDRC and the Provincial Department of Ecology and Environment (PDE) are in the H–H quadrant, with outstanding breadth and strength, and are the core nodes in this network. Among the eight policies jointly issued, all of them have the participation of the PDRC, which has generated links with 89% of the policy subjects, and has undertaken the role of planning and coordination in the network structure. The PDE has participated in joint issuance with 10 departments and has good continuity. It is in an indispensable position.

![Figure 4. Two-dimensional matrix of Shaanxi policy subjects.](image)

The GOPG has the highest synergy strength in the L–H quadrant and is an important functional subject, with limited cooperative subjects due to its sectoral attributes. The Provincial Department of Housing and Urban-Rural Development (PDHU), the Provincial...
Department of Commerce (PDC) and another six departments are in the H–L quadrant, with higher-than-average breadth but insufficient strength, and are important structural subjects. The synergy of these departments is mainly reflected in the fact that there are more subjects generating contacts, while the continuity of cooperation is poor, and the number of synergistic documents has not been increased concurrently. The breadth and strength of PPC are 0. As the highest local authority, they are in a meta-policy position, and are in a leading and being led relationship with other departments, which is consistent with the directional policy proposed by Han [38].

2. Two-dimensional matrix analysis of Shanxi policy subjects

Shanxi has a synergy breadth maximum of 20 and a mean of 9.78; and a synergy strength maximum of 0.58 and a mean of 0.21. It contains 27 policy subjects, and the policy subjects are significantly more diversified than in Shaanxi. In Figure 5, 22% of the policy subjects with synergistic breadth–strength are above the overall average, contain six core subjects, and have a wide communication object and frequent cooperation. Among them, the number of joint departments of the PDRC and the PDE is 19 and 17, respectively, and the joint issuance occurs 11 and 7 times, respectively, which are the policy subjects with strong local synergistic capacity, high specialization in synergistic issuance, and strong continuity of cooperation.

![Figure 5. Two-dimensional matrix of Shanxi policy subjects.](image)

The Provincial Bureau of Statistics (PBS) and the Provincial Department of Water Resources (PDWR) are in the L–H quadrant, with fewer joint government departments, but focus on a strong resource transfer relationship with the connected subjects to produce a stable linkage effect. There are 45% of the policy subjects in the L–L quadrant, and the synergy breadth and strength are lower than the average value, indicating that subject diversification does not form a good fit with the synergy breadth–strength relationship.

The Provincial Department of Science and Technology (PDST), the Provincial Department of Agriculture and Rural (PDAR) and the Provincial Energy Bureau (PEB) are in the H–L quadrant, characterized by high breadth and low intensity, and belong to the important structural subjects. Their subject synergy is mainly reflected in the establishment of a wide range of cooperative relationships, and the volume of joint issues and the functionality of the subject still needs to be improved. Consistent with Sun [36], the lack of functionality implies that most subjects, except for the core subjects, are only overly concerned with the consistency of collaborative issuing behaviors.
3. Two-dimensional matrix analysis of policy subject in Inner Mongolia

The maximum value of synergy breadth in Inner Mongolia is 6, and has a mean of 2.36; the maximum value of synergy strength is 0.67, and has a mean of 0.3. It involves 11 policy subjects in total, which is a relatively small number of policy subjects compared to Shaanxi and Shanxi provinces, and the structure of the subject network is relatively closed and simple. In Figure 6, 55% of the policy subjects are core subjects in the H–H quadrant, with higher-than-average synergy breadth and strength. It shows that although Inner Mongolia has not formed widely diversified policy subjects, most of the subjects maintain a high density of cooperation with each other. The breadth and strength of the PDRC is relatively prominent, with the PDRC appearing in all four joint issuances, and maintaining a frequent and high continuity of cooperation with other subjects. It fully reflects that it emphasizes not only the establishment of synergistic structural relationships, but also the strength of cooperative relationships and the degree of information exchange with existing joint subjects, paying attention to the completeness of the subject’s functions.

![Figure 6. Two-dimensional matrix of policy subjects in Inner Mongolia.](image)

The Provincial Energy Bureau (PEB) is in the L–H quadrant, with a lower-than-average breadth and a higher-than-average strength, and is an important functional subject. It prefers to issue documents in the scope of its own management, which is a full reflection of its departmental functional orientation. The number of departments in the H–L quadrant is 0, indicating that there is no situation in which the policy subjects have many cooperative subjects but rather have poor information exchange. It reflects that the information exchange and collaborative division of labor is better, and all policy subjects are fully involved in the information construction work.

4.2. Analysis of Synergy in Policy Content
4.2.1. Extracting Topic Words Based on LDA Modeling

Policy topic richness (i.e., the optimal number of topics) is related to comprehensiveness and is the basis for policy synergy [48]. Through the theme consistency test, the optimal number of topics for the Central, Shaanxi, Shanxi and Inner Mongolia areas are initially determined to be 5, 5, 8 and 6, respectively. To observe the relationship between topics from the clustering effect and draw the LDAvis image, the distance between the bubbles indicates the degree of association between the topics, and the overlapping part of the bubbles indicates that there are cross-featured words in the two topics [49].

As shown in Figure 7, the distance between the Central topics is clear; the five policy topics are oriented and independent, indicating that the topic identification is better and there is a certain degree of difference between the topics. The topics of Shaanxi and Inner Mongolia partially overlap, and the overlap of Shanxi Topic 1, Topic 3, Topic 6, and Topic 7
is high and less clear. Therefore, this paper integrates Shanxi T1, T3, T6, and T7 into one topic term, and finally determines that the optimal number of topics for the Center, Shaanxi, Shanxi, and Inner Mongolia are 5, 5, 5, and 6, respectively.

The 20 feature words with the highest probability were extracted from each topic, and the feature words were labeled and named to form the topic set of energy and environment policies, as shown in Table 5. It can be seen that there is no obvious relationship between the number of optimal topics and the number of policy texts. The Central Government and the “Shanxi–Shaanxi–Inner Mongolia” areas should not only pursue the “quantity” of policies, but also pay more attention to the “quality” of policies, to improve the richness of policy topics and realize the comprehensive coverage of energy and environmental issues.

Table 5. The Central and “Shanxi–Shaanxi–Inner Mongolia” policy topics.

<table>
<thead>
<tr>
<th>The Central</th>
<th>Shaanxi</th>
<th>Shanxi</th>
<th>Inner Mongolia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Name</td>
<td>Number</td>
<td>Name</td>
</tr>
<tr>
<td>CT1</td>
<td>Energy utilization and environmental governance</td>
<td>ST1</td>
<td>Industrial demonstration</td>
</tr>
<tr>
<td>CT2</td>
<td>Technical research and development</td>
<td>ST2</td>
<td>Regional pollution monitoring and prevention</td>
</tr>
<tr>
<td>CT3</td>
<td>Construction of new energy generation facilities</td>
<td>ST3</td>
<td>Government regulatory subjects</td>
</tr>
<tr>
<td>CT4</td>
<td>New energy storage</td>
<td>ST4</td>
<td>Energy conservation and emission reduction</td>
</tr>
<tr>
<td>CT5</td>
<td>Government regulatory subjects</td>
<td>ST5</td>
<td>Environmental governance</td>
</tr>
</tbody>
</table>

Although the number of topics in the Central is not the largest, the feature words under each topic are richer and cover a more comprehensive domain, which is consistent with the results obtained by Zhou [9], and also proves the accuracy of topic extraction. Feature words include “carbon peak”, “carbon neutrality”, “environmental protection”, “energy-saving technologies”, “infrastructure construction”, “pollution control”, “digitalization”, etc., closely following the background of the “dual carbon” era, involving industry, agriculture, new energy, construction, transportation, automobiles, and other fields. Emphasis should be placed on the construction of digital intelligence, infrastructure, new energy generation facilities, with an increase of investment in product development and technology research. Furthermore, there should be an effort to build a joint supervision and management system among public institutions, including the People’s Government, the Ministry of Ecology and Environment, the Ministry of Industry and Information Technology and other government departments. In addition, there should be plans to optimize energy structure and environmental management, to build a clean and low-carbon energy system and a beautiful and livable ecological environment.
Figure 7. LDAvis visualization interaction image. (a) The Central Government; (b) the Shaanxi Province; (c) the Shanxi Province; (d) the Inner Mongolia.
The energy and environmental policies of Shanxi, Shaanxi and Inner Mongolia are distinctive, and all implement and respond to Central Government policies to some extent. And a common topic word, “governmental regulatory subjects”, has emerged, demonstrating that the construction of a core governance and regulatory system based on the leadership of the Party Central Committee and the coordinated responsibility of governmental departments has become the consensus of the three regions.

Shaanxi covers construction, transportation, courier services, automobiles and many other industries, with more emphasis on the use of industrial and project demonstrations to achieve regional governance. However, less attention has been paid to energy utilization, new energy construction and technological innovation. Shanxi involves agriculture, construction, climate, culture, new energy and other fields, focusing on standardization issues such as licensing and emission rights in regulating the development of the industry, and improving the efficiency of energy use and the employment of environment governance in infrastructure construction, institutional systems, pollution monitoring, intelligent construction, and other means. Inner Mongolia focuses on technological innovation, emphasizes the development of new energy storage equipment, and is concerned with dual control of energy consumption and energy efficiency management. However, Inner Mongolia’s policy involves a relatively singular industry, mostly focused on the construction sector.

4.2.2. Policy Textual Similarity Analysis

This paper calculates the textual similarity between the three provinces of “Shanxi–Shaanxi–Inner Mongolia” and the Central policy. As shown in Table 6, the similarity value ranges from 0.75 to 0.85, indicating that the three provinces are in line with the Central Government’s policies and have a high degree of consistency. Among them, Central-Inner Mongolia has the highest textual similarity and the strongest synergy level; Central-Shanxi has the second highest textual similarity; and Central-Shaanxi has a lower textual similarity. In policy practice, there are mainly two types of policy combinations: “policy packaging” and “policy patching”. The former is to apply or replace the original policy as a whole; the latter is to make corresponding modifications and innovations under the overall goal consistency [50].

<table>
<thead>
<tr>
<th>Textual Similarity</th>
<th>Central—Shaanxi</th>
<th>Central—Shanxi</th>
<th>Central—Inner Mongolia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central—Shaanxi</td>
<td>0.7765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central—Shanxi</td>
<td>0.7909</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central—Inner Mongolia</td>
<td>0.8048</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Through the Central and “Shanxi–Shaanxi–Inner Mongolia” energy and environmental policy fields, objectives, and measures comparison, it was found that Inner Mongolia-involved industry is relatively singular, but it focuses on synergy with the Central energy and environmental policy. They all include the objectives of improving energy utilization efficiency, building new energy generation infrastructure, accelerating technological research and innovation, and developing new energy storage equipment. Moreover, Inner Mongolia tends to apply or replace the Central policy as a whole in the form of “policy packaging”, which lacks flexibility.

Shanxi’s text is characterized by a gradual increase in clean and renewable energy policies in the last three years, and has promulgated the Shanxi Photovoltaic Industry Chain Implementation Program, the Shanxi Wind Power Equipment Industry Chain Implementation Program, and the Notice on Promoting the Three-year Action Plan for Distributed Renewable Energy Development (2023–2025), which vigorously promotes the development of clean and green energy. It has also issued the Measures for the Administration of Sewage Rights Trading, the Shanxi Province’s “14th Five-Year Plan” for the Development of Urban Domestic Sewage Treatment and Resource Utilization and other documents, indicating that
Shanxi Province is moving closer to the Central Government’s policy objectives by fully integrating the region’s natural resource advantages and regional development.

Shaanxi’s policies emphasize the prevention and control of regional pollution and the protection of the ecological environment, with documents on environmental governance, the improvement of air quality, the control of greenhouse gases, and the response to climate change accounting for 52.8% of Shaanxi’s total policies. When formulating policies, Shaanxi Province prefers to implement Central policies in the form of “policy patching”, taking into account regional advantages and different characteristics in a more flexible way to improve the pertinence and precision of policies, while the overall goal is the same. Therefore, the textual similarity is relatively low.

5. Conclusions and Policy Recommendations

Analyzing the synergy between energy and environmental policies in resource-rich regions can help alleviate the problems of contradictions and poor coordination, so that the policies can better help the realization of regional green transformation and high-quality development goals, which is of great significance to the sustainable development of energy resources. Based on the quantitative mining analysis of policy texts, this paper constructs a “policy subject-policy content” analytical framework to analyze the synergy of energy and environmental policies in the “Shanxi–Shaanxi–Inner Mongolia” region from 2010 to 2023, and the conclusions are as follows:

(1) Influenced by its development history, the policy system of the “Shanxi–Shaanxi–Inner Mongolia” region is in a stage of continuous exploration. In the early days, the policy subjects were relatively homogenous, with fewer joint documents issued; as time progressed, the number of jointly issued policies, the number of joint departments and the frequency of jointness all showed a fluctuating upward trend. However, policies are still mainly formulated and issued by individual departments, showing the characteristics of policy fragmentation and multi-disciplinarity; joint behavior involves only a small number of fixed government departments, and lacks non-government institutions such as business and scientific research institutes.

(2) Through the analysis of the synergy degree, it can be seen that the departments that play a Central role (H–H) are very limited, but the policy subjects in the H–L, L–H, and L–L quadrants also reflect a problem of insufficient participation. Among them, Inner Mongolia maintains a high cooperation density with the connected subjects, but the subject network structure is relatively simple. Shanxi contains a wide policy subject, but subject diversification has not been well aligned with synergy strength. Shaanxi government departments focus on structural synergies of broadness, plurality and stability, but pay insufficient attention to functionality.

(3) The complexity of the policy implementation environment and the heterogeneity of regional resources and economies means that the energy and environmental policy themes in the “Shanxi–Shaanxi–Inner Mongolia” regions have their own characteristics, but all of them have implemented the policies promulgated by the Central Government to a certain extent. Shaanxi focuses on the ecological environment and pollutant management; Shanxi focuses on energy and environmental monitoring through the setting of emission rights and licenses; and Inner Mongolia tends to focus on energy utilization and energy efficiency management.

(4) The similarity of the policy texts of the three provinces is at a high level, but it is still insufficient compared to the comprehensiveness of the Central policy, and there are still some limitations in the areas covered. In addition, flexible innovation while ensuring no conflict with the Central policy can more effectively realize the policy objectives and promote regional high-quality development.

Based on the above conclusions, this paper draws the following policy recommendations:

(1) Building a policy network with the participation of multiple subjects and enhancing the synergistic capacity of each policy subject. While the policy-issuing subject is an important responsible actor, the government should avoid assuming a single gover-
nance and management role. The “Shanxi–Shaanxi–Inner Mongolia” regions need to increase the proportion of core subjects, and also need to invite the participation of enterprises, research institutes and other non-governmental organizations. They must also actively mobilize the endogenous momentum from multi-level synergies and cultivate the motivation of the subjects to participate in the structural integrity of the synergistic network. In addition, policymakers should not only pay attention to the behavioral consistency of the synergistic relationship, but also to the completeness of the functional aspects. They should increase the proportion of joint issuance by multiple subjects, maintain efficient connectivity paths with the connected subjects, increase the intensity of cooperation, and enhance the capacity of synergistic governance.

(2) With a focus now on the convergence and refinement of policy content and the formation of a Central-local energy and environmental policy synergy system, the local government should do a good job in the articulation and refinement of the policy content to effectively guarantee the implementation of the policy. However, they are not to copy the Central policy, but should combine the regional characteristics, fully consider the actual situation and development goals of the region, and make flexible innovations based on compatibility with the Central document incentives. With the global emphasis on pollutant management and environmental issues, the “Shanxi–Shaanxi–Inner Mongolia” regions, which are highly dependent on coal, should transform its energy development path as soon as possible, and incorporate the energy and environmental sustainability and circular economy principles into its future energy and environmental policies. It should strengthen the exploration of policies in key areas such as construction, transportation and industry, increase renewable energy development and utilization, emphasize the policy progression of science and technology, and enhance pollutant management and ecological and environmental protection.

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