Research Article

An Algorithm Combining Latent Dirichlet Allocation and Bimodal Network for Evaluating Goal Deviation of Intellectual Property Strategy Execution in China

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China has implemented the intellectual property strategy since 2008 to support innovation-driven development. However, statistical data issued during the “12th Five-Year Plan” (2011–2015) showed that there are certain deviations between the actual and expected intellectual property strategy’s goals. To effectively diagnose the goal deviation, an algorithm combining the latent Dirichlet allocation and bimodal network based on policy text was proposed. In this method, topics in intellectual property text so of China’s provincial regions were extracted through the latent Dirichlet allocation model, and a bimodal network centered at provincial administration district-policy topics was constructed. Subsequently, the characteristics of the goal execution deviation of the IPS in the provincial government were explored based on the centrality of the bimodal network and singular value decomposition. Finally, some diagnosis results and conclusions were demonstrated to provide reasonable methods for evaluation of national strategic planning and promoting policy performance.

1. Introduction

China’s economic development is characteristic of decreasing growth rate, the urgent needs of structural upgrading, and dynamic transformation since 2008. To get rid of resource restrictions, realize the transformation from resource element-driven development to innovation-driven development, and finally improve the economic development quality, the Chinese government issued the Outline of National Intellectual Property Strategy in 2008, which symbolized the application of intellectual property strategy (IPS) in innovation-driven development, to eliminate resource restrictions, transform resource element-driven development to innovation-driven development, and improve the economic development quality. IPS has become the overall strategy that has driven China to the knowledge-based economic development in the coming decades [1]. The central and provincial regions enacted more than 500 policy measures and documents for the smooth implementation of the IPS from 2009 to 2017. Hence, the IPS system under Chinese policies and laws was formed gradually. However, a large gap between the actual and expected goals of Chinese IPS was observed. In 2016, China released the National Intellectual Property Protection and Application Planning during the “13th Five-Year Plan,” which indicated that Chinese intellectual property (IP) during the “12th Five-Year Plan” still faces numerous challenges, such as incoordination between the number and quality of intellectual properties, the small number of core patents, famous brands and high-quality copyrights, poor association with the market, low transformation rate of achievements, and imperfect management mechanism, as well as backward awareness of intellectual property protection, which restrict the improvement of China’s intellectual property protection capability. The successful implementation of China’s national overall strategy relies highly on the execution of provincial regions’ supporting policy measures, which is the main reason for the deviation between the actual and
expected goals of Chinese IPS. Nevertheless, existing studies mainly focus on evaluating the IPS or other public policies’ goal performance [2–7] rather than analyzing the deviation characteristics from the execution stages of provincial regions. Thus, they neither accurately evaluate the specific execution stage of the overall goal deviation of the national IPS nor disclose the causes of deviation. From this perspective, diagnosing the goal execution deviation of Chinese IPS in the provincial region’s implementation stage, accurately positioning relevant weak stages, scientifically adjusting the implementation of the strategic plan, and assuring maximized implementation benefits are practically crucial.

The remainder of this paper is organized as follows. Section 3 introduces the methodologies, which mainly include data source and processing, LDA topic mining model, and bimodal network analysis. Section 4 describes the empirical analysis of the goal execution deviation characteristics of IPS in China’s provincial regions based on policy texts. Section 5 presents the results and discussions. Section 6 draws the conclusions and proposes the future prospects. The framework of this study is shown in Figure 1.

2. State of the Art

Studies on the diagnosis and evaluation of IPS under the traditional paradigm can be divided into two types. First, a diagnosis or evaluation model was constructed on the basis of the goal-driven evaluation paradigm by using the open structural file information of public departments to evaluate the implementation effect of the IPS. Song et al. established a set of evaluation index systems and methods to measure the IP creation, IP application, IP protection, and IP management based on collected data in the statistical report of intellectual properties in China’s scientific research institutions [2]. Additionally, statistical data related to patents were acquired to construct the patent application network model [3] and a “three stages-two dimensions” model [4]. These models were used to evaluate the patent value or quality and to diagnose the implementation effect of the IPS indirectly. Alternatively, the capability of patent industrialization was evaluated and the commercial effect of the IPS was diagnosed by using the collected transaction information in the technological market through the fuzzy multi-attribute comprehensive evaluation method [5] and the equation of patent standardized measurement [8]. Second, an econometric model was constructed on the basis of the theoretical hypothesis-driven diagnosis paradigm to test the present theoretical hypothesis by using data samples collected from field investigation or by summarizing statistical data of the document. Most of the associated studies focused on the influences of IPS or IP policies on product output [9–12] and innovation level [13, 14] or on enterprises’ technological innovation [15, 16] and production efficiency [17–19]. However, the traditional evaluation models, which are based on the structural information of single-file data and driven by goals and theoretical hypothesis, can only diagnose the implementation results of IPS. National strategies or public policies cover multiple stages, such as the formation, execution, evaluation, feedback, and correction of public policies [20]. The traditional goal- and theoretical hypothesis-driven evaluation models based on structural information have a weak information basis. Therefore, the final evaluation results cannot involve the diagnosis of most policy execution stages or others.

Different from the traditional evaluation modes, the data-driven evaluation for policy effectiveness has become a new paradigm and been practiced in education policy [21, 22], energy policy [23–25], safety management [26, 27], building [28, 29], public medical policy [30–32], and so on. However, the aforementioned studies only achieve the local perfection of public policies on specific occasions with limited structured information; they have not discussed execution-stage evaluation problems that involve public policy processes. With the continuous development of the Internet in recent years, the public-derived big data based on the Internet unstructured text information may exert reconstructive influences on the national decision-making process [33]. The public policy evaluation driven by unstructured text information has started. However, existing associated studies only theoretically discuss the feasibility of such public policy evaluation and conduct a qualitative analysis of the influences of Internet unstructured text information on policy formulation and legislation changes [34] as well as the optimization of public policies [33]. Internet unstructured text information has not been applied in the field of public policy evaluation. Relevant studies remain in the theoretical exploration stage and associated empirical analysis must be extended urgently.

The goal of strategic planning is an important component of the national strategy and public policy [35]. The gap between the overall execution and expected goals has been expanding since China implemented the IPS in 2008. However, studies on the goal deviation of IPS, let alone goal execution deviation, are limited. Organizational behavioral science concerned “goal deviation” early. This field described goal deviation as follows: the organization deviates from the original preset goal and shifts to other goals in the actual process due to the influences of different factors [36]. Subsequently, connotations of goal deviation were further extracted. Representative scholars Resh and Marvel indicated that goal deviation occurs when the organization focuses on the replacement of output indexes, which are difficult to measure and have great relevance [37]. Liu et al. argued that goal deviation is an organizational phenomenon that pays further attention to the easy-to-measure explicit goal or uses the mean as the goal rather than the preset goal [38].

The study on the goal execution deviation of IPS can only be screened indirectly from previous investigations. For example, Wang and Hsieh [5] and Tamura [8] evaluated the application of IP and its commercial performance. The goal execution deviation is gained indirectly on the basis of a simple comparison between the evaluation results and the expected goal of IPS, but the characteristic of goal execution deviation remains difficult to obtain. As the goal of IPS is realized by specific policies and measures of the provincial region, the research scale on the goal execution deviation of
IP policies, which are important components of public policies, has been formed, thus laying the foundation for the goal execution deviation diagnosis. However, the goal execution deviation diagnosis of public policies sets different measurable variables, including the incompletion degree of the goal and the fuzzy degree of results [39–42]. Subsequently, the degree of goal execution deviation is determined through empirical analysis based on a questionnaire survey or statistical data. Research perspectives remain limited in the implementation outcome of public policies due to the structured information, and the specific execution has not been discussed yet.

Overall, previous studies on goal execution deviation diagnoses of IPS and relevant policies are mainly based on the traditional goal- and theoretical hypothesis-driven paradigm. Diagnosis results only display the achievement of the overall goal but neglect the specific execution of policies. Moreover, the information source is limited in the second-handed data of government statistical report, and heterogeneous information lacks analysis based on policy texts, which hinder decision-makers from identifying multiple causes of goal execution deviation of IPS. For this reason, considering the advantages of the LDA model for accurately extracting text topics, the LDA model was introduced to
mine topics in the IP policy text of provincial regions. Then,
since the bimodal network can analyze the relationship
between two kinds of heterogeneous things, a bimodal
network centered at topics and provinces in IP policy text
was constructed. Through this network, the goal execution
deviation of provincial regions was diagnosed in accordance
with the structural characteristics of the bimodal network.

3. Methodology

3.1. Data Source and Preprocessing. In this study, the text
files of policies, plans, and strategic plans related to IP from
2008 to 2017 were downloaded through artificial interpre-
tation from IP websites of selected 30 provincial regions and
of the Department of Science and Technology in China. A
total of 449 effective policy texts were selected after the
release of the Outline of National Intellectual Property
Strategy in 2017 with considerations to the regionality and
integrity of policy texts, which covered more than 220,000
Chinese characters.

The 449 original policy texts were transformed into the
common CSV format, marked with provinces. IP policy
texts also have specific writing norms. By combining the
word-formation rules of the noun phrase and formal
standards of policy texts, subject terms in policy texts were
extracted in accordance with part-of-speech tagging and
the extraction rule of noun phrases. This approach includes
constructing a new stop words library (which is applicable to
IP policy texts based on the stop words library of Harbin
Institute of Technology) and adding empty words (which are
inapplicable for extracting notional subject terms from the
stop words library), such as "middle-level," "11th Five-Year
Plan," and "copies." In addition, subject terms were
extracted through the Jieba Chinese word segmentation.
During the extraction, the dictionary named dict.txt in Jieba
was used and a noun dictionary on IP policy analysis was
constructed. For example, some professional terms in the IP
policy text were added to the new dictionary, such as "IP
creation," "IP use or application," "IP protection," "patent,"
and "trademark." Subject terms in policy texts were selected
through Jieba word segmentation in Python, thus trans-
forming an IP policy text into the eigenvectors comprising
several subject terms about IP. These eigenvectors were used
in the subsequent topic model analysis.

3.2. LDA Model. LDA is a statistical topic model constructed
by Blei [43] for extracting potential topics. The basic
principle of LDA is to calculate the conditional distribution
of potential variables under the given observation variables
in accordance with a joint probability distribution. The
recognition method of potential document contents, which
is based on the Bayes probability of words, topics, and
documents, is typical unsupervised learning.

In the LDA model, documents were viewed as the mixed
probability distribution of potential subjects, and topics were
viewed as the probability of several words. Therefore, po-
tential topics and documents were regarded as the proba-
ability distributions of vocabulary and potential topics,
respectively, which is beneficial for projecting the document
into the topic layer on a large scale. Figure 2 shows the
process.

In Figure 1, \( \theta \) and \( Z \) are implicit variables, and \( W \) de-
notes the observable vocabulary variable. A document set
\( D = \{d_1, d_2, \ldots, d_m\} \) covers \( m \) documents and each docu-
ment \( d \) contains \( n \) words. The document word set is
\( d = \{w_1, w_2, \ldots, w_n\} \). As assumed, \( D \) is extracted into \( T \)
topics and \( T_k \) represents the \( k \)-th potential topic. The specific
process is introduced as follows [43]:

1. The Dirichlet distribution with a \( \beta \) parameter is
calculated for \( T \)-dimensional vector \( Z \),
\( Z \sim \text{Dirichlet}(\beta) \).

2. The Dirichlet distribution with a \( \alpha \) parameter is
derived for \( T \)-dimensional vector \( \theta \),
\( Z \sim \text{Dirichlet}(\alpha) \).

3. With respect to vocabulary \( w \) in the document: the
multinominal distribution with a \( \theta \) parameter is
generated for topic \( z \), and \( P(w|z, \beta) \) is obtained for the
vocabulary in accordance with the \( \beta \) parameter:

\[
P(w|z, \beta) = \int p(\theta|w) \left( \prod_{i=1}^{T} \sum_{k=1}^{T} P(z_k|\theta)P(w_i|z_k, \beta) \right) d\theta,
\]

where \( \theta \) and \( Z \) are implicit variables and \( W \) denotes the
observation variable. The LDA model calculates the poste-
rior and conditional distributions of implicit variables under
the given observable document.

3.3. Bimodal Network. A bimodal network is formed by two
types of heterogeneous nodes through certain connections.
The dataset in the bimodal network is the entity that rep-
resents different types by rows and columns and is mainly
utilized to describe the “binary” structural relationship
between a group of actors and the active events. In this study,
a bimodal network that uses provincial and policy topics as
the heterogeneous nodes was constructed by extracting
relevant topics from all IP policy texts of provincial gov-
ernment departments through LDA. Subsequently, the goal
execution deviation of the national IPS of provincial regions
was reflected by the structural characteristics of the bimodal
network.

In the bimodal network, the two types of heterogeneous
nodes are actors and events [44]. In this study, actors and
events represent the provinces and policy topics of IP, re-
spectively. The characteristic indexes of the bimodal network
are as follows.

3.3.1. The Characteristics of the Bimodal Network Based on
Centrality. The node centrality of the bimodal network is a
quantitative analysis of individual power, which explores the
positional characteristics of all nodes in the network from
the perspective of microscopic nodes [45]. This model
mainly includes degree, closeness, and betweenness centralities.

(1) Degree Centrality. Degree centrality refers to the degree of connections between the actor and other actors in the network. The actor with more connections has a stronger influence than that with fewer connections [45]. The degree centrality of provincial nodes is the number of topics concerned by the provincial nodes, whereas the degree centrality of topic nodes refers to the number of involved provinces. If \( g \) provinces form the actor set \( n = (n_1, n_2, \ldots, n_g) \) and \( h \) topics form the event set \( z = (z_1, z_2, \ldots, z_h) \), then the degree centralities of province \( i \) and topic \( k \) can be expressed as

\[
C_D^{NZ} (n_i) = \sum_{i=1}^{g+h} x_{ik}, \quad (i = 1, 2, \ldots, g; \quad k = 1, 2, \ldots, h),
\]

\[
C_D^{NZ} (z_k) = \sum_{i=1}^{g+h} x_{ik}, \quad (i = 1, 2, \ldots, g; \quad k = 1, 2, \ldots, h),
\]

where \( NZ \) is the bimodal network comprising \( g \) provinces and \( h \) topics. \( x_{ik}^{NZ} \) denotes the affiliation relationship data of the bimodal network of \( g \times h \) bipartite matrix \( X^{NZ} \).

(2) Closeness Centrality. Closeness centrality is applied to represent the time for information diffusing from one node to another [44]. Different from closeness centrality in the single-mode network, the closeness centrality of actors in the bimodal network is proportional to the sum of the distance between one node and other nodes in the network and between the node and all event nodes. The closeness centrality of events is similar. The calculation formulas for the closeness centralities of actors and events are as follows:

\[
C_C^{NZ} (n_i) = \left[ 1 + \frac{\sum_{j=1}^{g+h} \min_{i} k d(k, j)}{g + h - 1} \right]^{-1}, \quad (k = 1, 2, \ldots, h),
\]

\[
C_C^{NZ} (m_k) = \left[ 1 + \frac{\sum_{i=1}^{g+h} \min_{j} j d(i, j)}{g + h - 1} \right]^{-1}, \quad (i = 1, 2, \ldots, g).
\]

In equation (3), connections exist between event point \( k \) and actor \( i \). In equation (4), actor \( j \) and event node \( k \) are connected. \( d(k, j) \) indicates the distance between event node \( k \) and node \( j \) in the bimodal network. Here, \( j \) can be used to represent the event or actor node.

(3) Betweenness Centrality. Betweenness centrality represents the positional importance of nodes in the network. In the bimodal network, connections between every two actor nodes must run through all event nodes concerning them [45]. Therefore, the event nodes are in the shortest route between actors. Similarly, actor nodes are in the shortest route between event nodes. For this reason, calculating the betweenness centrality of event nodes in the bimodal network must consider all actor nodes concerning the event node. The calculation formulas of the betweenness centrality of actor and event nodes are as follows:

\[
C_B^{NZ} (n_i) = \frac{1}{2} \sum_{m, m' \in n_i} \frac{1}{N_{kl}}, \quad (i = 1, 2, \ldots, g; \quad k = 1, 2, \ldots, h),
\]

\[
C_B^{NZ} (m_k) = \frac{1}{2} \sum_{n, n' \in m_k} \frac{1}{N_{ij}}, \quad (i = 1, 2, \ldots, g; \quad k = 1, 2, \ldots, h).
\]

In equation (7), actors \( n_i \) and \( n_j \) concern a total of \( x_{ij}^{NZ} \) events. For any pair of actors \( (n_i, n_j) \) in \( m_k \), the betweenness centrality contribution of \( m_k \) is \( 1/x_{ij}^{NZ} \) units. \( X^{N} \) and \( X^{M} \) represent the data matrixes of single nodes of actors and events, respectively.

3.3.2. The Characteristics of the Bimodal Network Based on Singular Value Decomposition (SVD). Singular value analysis is used to reduce the dimension of the bimodal network. The hierarchical classification of the network structure is conducted, and the classification factors hidden in the bimodal network are recognized. The network characteristics are close to the overall structure of the bimodal network by analyzing the hidden classification factors. The calculation principle of the SVD method is as follows [44].

An \( n \times m \) information matrix of the bimodal network \( X \) \((n \geq m)\) is available. Matrices \( U, D, \) and \( V \) are simultaneously obtained through SVD. \( X = U \times D \times V' \), where \( V' \) is the transposed matrix of \( V \) and \( D \) denotes the \( r \times r \) diagonal matrix and has \( r \) singular values. Matrices \( U \) and \( V \) are \( n \times r \) and \( m \times r \) matrices, which cover the \( r \) eigenvector of matrix \( XX' \). The corresponding eigenvalues are arranged in descending order. A real matrix \( A \) with an order of \( r \) can be decomposed as follows:

\[
A = U \begin{bmatrix} a_1 & & & \end{bmatrix} V'.
\]

Equation (8) is defined as the SVD of matrix \( A \). In equation (8), matrices \( U \) and \( V' \) are orthogonal matrices and
4. Empirical Results and Discussions

4.1. Topic Extraction Based on LDA. LDA modeling is performed through Gibbs sampling. Topics are analyzed by using Gensim source packages based on the Python software. Moreover, 4–20 topics and 1000 iterations are set, thereby obtaining the document-topic and word-topic probability matrices according to formula (1). Topic clustering data under different numbers of topics are compared repeatedly. Finally, nine topics are selected in accordance with the nine task goals in Outline of National Intellectual Property Strategy. Table 1 lists the 10 major characteristic words of each topic.

Table 1 shows that nine subjects are selected on the basis of the LDA topic model, namely, IP culture, IP intermediary services, IP transformation and applications, IP legal system, IP administration management, IP overseas cooperation, IP talents, IP law enforcement, and IP creation. These topics are the key strategic goals proposed in the Outline of National Intellectual Property Strategy. The provincial topics are classified in accordance with previous marks of provinces, thereby further exploring the frequency distributions of each provincial policy text in the nine topics. Then, the number of topics involved in all policy texts of each province is calculated, which provides a data basis for the subsequent construction of the bimodal network matrix and explores contents hidden in the province-topic information matrix.

4.2. Goal Execution Deviation Diagnosis of IPS Based on the Bimodal Network. The bimodal data are visualized automatically by using Ucinet 6.0 software on the basis of the data matrix of the constructed bimodal network. Figure 2 presents the results.

Figure 3 intuitively displays the province-topic binary affiliation relationship. On the basis of the size of the topic center point, IP transformation and applications, IP administration management, IP overseas cooperation, and IP legal system are topics with the highest concern frequency of the provincial region, whereas IP culture and IP intermediary services are topics of less concern. This finding indicates the general emphasis of the provincial region to implement IPS.

Furthermore, the bimodal network forms the single-property concurrence network from the perspectives of topics and provinces to explore the single-property concurrence connotations (Figure 3).

The single-property concurrence network of topics in Figure 4(a) reflects two or more topics simultaneously concerned by provincial IP policy. On the basis of the thick connections of different topics, IP administration management, IP legal system, IP overseas cooperation, and IP creation are highly concerned by provincial regions in IPS implementation. The single-property concurrence network of topics in Figure 4(b) reflects the number of topics concerned by more than two provinces. Similarly, numerous topics are simultaneously concerned by Shanghai, Beijing, Tianjin, and Shandong, but only a few topics are concerned by Hebei, Guizhou, and Ningxia.

The characteristics of nodes are further generated by using Ucinet 6.0. In Table 2, great hierarchical differences are observed among 30 provinces in terms of degree and closeness centralities. Beijing, Tianjin, Shanghai, Chongqing, Sichuan, Gansu, Qinghai, Hunan, and Guangdong rank the top positions in view of the degree centrality of provincial nodes. Hence, these provinces are concerned with extensive and comprehensive scopes of IP policy topics. The content scope and execution speed of supporting policies in these provinces are inferior to those of other provinces. With respect to closeness centrality, Beijing, Tianjin, Shanghai, Chongqing, and Sichuan occupy the first layer of the network, indicating their quick responses to the topics in national IP policies. This result implies that these provinces can formulate supporting policies in accordance with local situations immediately after the release of the national IPS. Nevertheless, all selected provinces show relatively similar betweenness centrality, indicating the unsubstantial performance as the bridge for information diffusion and transportation. This finding conforms to the actual situation of the bimodal network of policies. Data sources of the policy network of different provinces are mainly contributed by the number of concerns of topic information. The characteristics do not highlight the social affiliation. Hence, using provincial nodes as the bridge in the single-mode network is difficult.

In addition, the microstructural characteristics of topic nodes in Table 3 reflect that the three types of microscopic characteristics show a consistent variation trend. IP transformation and applications, IP legal system, IP administration management, and IP overseas cooperation show the highest degree centrality. This result shows that provincial region’s supporting policies provide the highest concerns on the five topics. Topics ranking the top of closeness centrality also belong to the five topics, which confirms that these topics are easy to mention and emphasize through local supporting policies. This finding is closely related to the subsequent successive release of details and directed optimal adjustment of the central government. Similarly, the five topics have the highest betweenness centrality, indicating the prominent universal effect among IP transformation and applications, IP legal system, IP administration management, and IP overseas cooperation. The five topics also serve as the “bridge” in the topic node network. When one or several provincial supporting policies concern these topics, it can be easily “followed” by other provinces. The “followers” may pay great attention to the related supporting policy contents of other provinces to a large extent when they formulate supporting policies. On the contrary, microstructural data of talents, IP law enforcement, IP creation, IP
culture, and IP intermediary services are relatively small, especially the microstructural data of culture and intermediary services. The degree, closeness, and betweenness centralities of IP culture and IP intermediary services are lower than those of the seven remaining topics, which reflects less attention by provincial regions on these two topics. Moreover, the optimization efficiency and performance quantification of the two topics are considerably poorer than those of superior IP transformation and applications. This finding explains the weak positions of IP
cultural and IP intermediary services in the supporting policies of provincial regions for IPS.

The overall features of the province-topic bimodal network are further explored through the SVD, which is used for the hierarchical classification of topics and provinces. The interpretation capability of the first three factors accounted for 76.5%, which is calculated by using Ucinet 6.0, indicating that these factors can interpret the macroscopic relation characteristics between provinces and topics. In addition, the SVD data of topic nodes are obtained, through which the topic factors are calculated as shown in Table 4.

Table 3 shows that characteristic factor 1 is a public factor, which indicates that the topic of characteristic factor 1 is used as the public and universal major content in provincial knowledge property policies. Data in Table 4 reflect that IP overseas cooperation and IP transformation and applications are public and universal topics highly concerned by local provinces in formulating the supporting IP policies. For factors 2 and 3, topics with high values in different factors are clustered into one type. In factor 2, IP culture, IP intermediary services, IP law enforcement, and IP creation are important topics and can be classified into the IP development environment. IP transformation and

Table 2: Characteristics of provincial nodes.

| Province | Degree centrality | Closeness centrality | Betweenness centrality |
|----------|-------------------|----------------------|------------------------|
| Beijing  | 0.231             | 1.716                | 0.001                  |
| Tianjin  | 0.231             | 1.716                | 0.001                  |
| Hebei    | 0.179             | 1.62                 | 0.001                  |
| Shanxi   | 0.154             | 1.575                | 0.001                  |
| Nei Mongol | 0.154             | 1.575                | 0.001                  |
| Heilongjiang | 0.179            | 1.62                 | 0.001                  |
| Jinlin   | 0.205             | 1.667                | 0.001                  |
| Liaoning | 0.205             | 1.667                | 0.001                  |
| Shanghai | 0.231             | 1.716                | 0.001                  |
| Jiangsu  | 0.231             | 1.716                | 0.001                  |
| Sichuan  | 0.231             | 1.716                | 0.001                  |
| Yunnan   | 0.205             | 1.667                | 0.001                  |
| Shaanxi  | 0.179             | 1.62                 | 0.001                  |
| Gansu    | 0.231             | 1.716                | 0.001                  |
| Qinghai  | 0.231             | 1.716                | 0.001                  |
| Ningxia  | 0.128             | 1.533                | 0.001                  |
| Xinjiang | 0.179             | 1.62                 | 0.001                  |
| Hainan   | 0.103             | 1.494                | 0.001                  |
| Guizhou  | 0.128             | 1.533                | 0.001                  |
| Zhejiang | 0.205             | 1.667                | 0.001                  |
| Anhui    | 0.205             | 1.667                | 0.001                  |
| Fujian   | 0.205             | 1.667                | 0.001                  |
| Jiangxi  | 0.205             | 1.667                | 0.001                  |
| Shandong | 0.154             | 1.575                | 0.001                  |
| Henan    | 0.205             | 1.667                | 0.001                  |
| Hubei    | 0.205             | 1.667                | 0.001                  |
| Hunan    | 0.231             | 1.716                | 0.001                  |
| Guangdong| 0.231             | 1.716                | 0.001                  |
| Guangxi  | 0.205             | 1.667                | 0.001                  |

Table 3: Characteristics of topic nodes.

| Topic                              | Degree centrality | Closeness centrality | Betweenness centrality |
|------------------------------------|-------------------|----------------------|------------------------|
| IP culture                        | 0.462             | 1.643                | 0.009                  |
| IP intermediary services          | 0.513             | 1.742                | 0.009                  |
| IP transformation and applications| 0.744             | 2.396                | 0.024                  |
| IP legal system                   | 0.718             | 2.3                  | 0.022                  |
| IP administration management      | 0.744             | 2.396                | 0.024                  |
| IP overseas cooperation           | 0.769             | 2.5                  | 0.027                  |
| IP talents                        | 0.615             | 1.983                | 0.015                  |
| IP law enforcement                | 0.615             | 1.983                | 0.015                  |
| IP creation                       | 0.692             | 2.212                | 0.02                   |
5. Conclusions and Management Implications

5.1. Conclusions. In this study, topics in IP policy texts of the provincial region were extracted by using the LDA model, and the goal execution deviation of the IPS of the provincial region was diagnosed by the bimodal network. The following conclusions can be drawn.

First, in the process of implementing national intellectual property strategic goals, provincial regions have paid much attention to topics such as IP transformation and applications, IP legal system, IP administration management, IP overseas cooperation, and IP talents are five topics belonging to factor 3 and are classified as the IP operation system.

On the basis of the classification of factors 2 and 3, SVD data of nodes in provinces were investigated to classify the policy topics issued by each province accurately (Table 5).

Table 4: SVD data of topic nodes.

| Topic                        | Factor 1 | Factor 2 | Factor 3 |
|------------------------------|----------|----------|----------|
| IP culture                   | 0.052    | 0.153    | -0.14    |
| IP intermediary services     | 0.077    | 0.189    | -0.181   |
| IP transformation and apps   | 0.473    | -0.305   | 0.27     |
| IP legal system              | 0.302    | 0.354    | 0.443    |
| IP administration management| 0.393    | -0.575   | -0.52    |
| IP overseas cooperation      | 0.644    | 0.074    | 0.152    |
| IP talents                   | 0.102    | 0.085    | 0.206    |
| IP law enforcement           | 0.129    | 0.092    | 0.072    |
| IP creation                  | 0.283    | 0.609    | -0.58    |

Second, when it comes to establishing the supporting policies, Beijing, Tianjin, Shanghai, Chongqing, Sichuan, Gansu, Qinghai, Hunan, and Guangdong provinces played the role as forerunners, while other provinces played the role as followers. It is also indicated that the topics that these forerunner governments have concerned about are more timely and comprehensive.

Third, the topics of IP transformation and applications, IP administration, IP overseas cooperation, IP creation, and IP legal system played the roles as “bridge” in the network. When the supporting policies of one or several provinces have paid attention to the above five topics, it is more likely to cause other provinces to focus on these five topics as well when establishing supporting policies. In contrast, the topics of IP talents, IP law enforcement, IP creation, IP culture, and IP intermediary services are at the edge of the network.

5.2. Management Implications. Based on the above findings, we offered the following management implications to correct provincial regions’ IP strategy execution deviation.

First, when provincial regions implement the IP strategic goals, it is better to refer to the nine major goals in the Outline of National Intellectual Property Strategy. Provincial regions should make effort to balance the nine goals of IP culture, IP intermediary services, IP transformation and applications, IP legal system, IP administration, IP overseas cooperation, IP talents, and IP law enforcement in order to avoid execution deviation.

Second, provincial regions should learn rationally rather than blindly accepting and following other provinces. It is suggested that provincial regions can propose the corresponding policies by taking into consideration their regional and developmental phase characteristics.

Third, provincial regions should cooperate more often when implementing policies. They should learn from each other’s experience and consider their own logical path of implementing the nine strategic goals. Therefore, the IP strategy execution deviation or omission can be prevented as much as possible. It is not only about improving the patent quality but also about commercial efficiency. Provincial regions should not only strengthen the legal system and law enforcement but also improve the environment and culture for IP creation and operation.

The major contributions of this paper are discussed as follows.

First, the combination of LDA topic mining and bimodal network can offset the shortcomings of traditional models that cannot diagnose unstructured policy texts. This condition can reflect the goal deviation among different execution stages of the national strategic planning.

Second, the relation network of heterogeneous nodes, which cannot be constructed in the single-mode network,
can be realized on the basis of the LDA topic mining and bimodal network model. This relation network can reflect the roles of provincial administration regions and policy topics in the network, diagnose the accuracy of goal execution deviations, and accurately recognize key topics.

Third, “concurrence” and “marginality” of single-property nodes of policy topics can be measured accurately on the basis of the LDA topic mining and bimodal network model. The goal execution deviation is diagnosed objectively and comprehensively during the implementation of the
strategic plan by the provincial region. A simple and reliable method is offered.

The goal execution deviation for the Chinese national IPS is diagnosed by policy text information, and meaningful results are obtained. This study can further extend the research contents in the following aspects: (1) Popular topics of IP policies are analyzed by combining heterogeneous information on network media, forums, social software, and instant music video, which provides a further extensive basis for the goal execution deviation diagnosis. (2) The occurrence mechanism of deviation is comprehensively analyzed, which is beneficial for constructing the deviation correction mechanism.

Data Availability

All the data used to support the findings of this study are included within the article.

Conflicts of Interest

There are no conflicts of interest.

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