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Mining Investment Risk Assessment for Nations along the Belt and Road Initiative

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Abstract: As the Belt and Road Initiative (BRI) continues to advance, the proportion of China's investment in mineral resources has increased yearly. However, the current research on mineral resources investment risk mainly focuses on specific resources or combinations of minerals. There is still a lack of risk assessment research regarding mineral resources as a whole, which leads to the lack of appropriate methods for decision makers to consider the overall investment risk. This research establishes a six-dimension (6-D) investment evaluation indicator system to comprehensively assess the mineral resources, including political, economic, social, resource potential, environmental risks, and China factors, and 50 countries were studied. Various mineral resources are integrated into the resource potential dimension for quantitative risk assessment calculations. The entropy–fuzzy method determines the indicator's weights and calculates the risk assessment. The results indicate that resource potential is the main determinant of overseas mineral resources investment. The outcomes show that Saudi Arabia, the United Arab Emirates, Pakistan, India, Kazakhstan, Malaysia, Indonesia, and Russia are ideal for China's mineral resources investment. The findings provide a theoretical and methodological basis for the further macroscopic study of mineral resources investment risk between countries.

Keywords: Belt and Road Initiative (BRI); mining resources; investment risk assessment; entropy-fuzzy method

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1. Introduction

On 28 March 2015, China's National Development and Reform Commission (NDRC) established the Belt and Road Initiative (BRI). To promote efficient resource allocation and national cooperation, the BRI establish a cooperative investment network among 64 Eurasian countries. NDRC [1] listed expanding mutual investment and strengthening cooperation in the exploration and development of metal minerals, non-metal minerals, and traditional energy resources as the focus of cooperation and, for the first time, listed the development and utilization of mineral resources in BRI countries as the national strategic goal. As a significant consumer and purchaser of mineral resources, China's external Foreign Direct Investment (FDI) stock in countries along the BRI increased yearly [2,3]. With the advancement of BRI, several studies have focused on risk investment evaluation, such as in mineral resources [4], renewable energy [3], and environmental risk [5]. These studies expand the depth and breadth of the BRI, providing references for policymakers, and moreover, the rich categories and reserves of mineral resources along the BRI provide the possibility and foundation for development and investment. As a national strategy and an initiative to influence the world's mineral supply pattern, overseas mineral resources investment has become the core of China's mineral resources strategy. The BRI provides a platform for developing China's mineral resources, further expanding the space for international cooperation in mineral resources and promoting the whole region's economic development.

To date, studies on risk investment evaluation of mineral resources for BRI are mainly focused on specific categories or combinations of mineral resources, such as oil [6], coal [7], natural gas [8], iron ore [4], copper ore [9], and energy mineral resources [10,11]. Mineral resources are still not considered as a whole to evaluate the investment risk, which may limit decision making. In order to evaluate the potential risks of state investment in a more comprehensive and macro way, it is necessary to treat mineral resources as a whole and evaluate the feasibility of investment behavior at the national level.

2. Literature Review

2.1. The Perspective of Mineral Investment Risk Assessment

Currently, scholars evaluate the investment risk of mineral resources by focusing on a single mineral species or specific combination. For example, Duan et al. [12], Yuan et al. [7], and Zhou et al. [8] evaluate overseas oil, coal-fired, and natural gas investment risk, concluding that the ideal investment target countries are Brazil and Kazakhstan, Singapore and New Zealand, and Uzbekistan, respectively. Later, Duan et al. [10] defined oil, coal, and natural gas as energy minerals, considering them a resource combination for investment risk assessment. In contrast to the conclusions of Duan et al. [12], Yuan et al. [7], and Zhou et al. [8], Duan et al. [10] concluded that the ideal target countries for mineral investment are Saudi Arabia, the United Arab Emirates (UAE), and Pakistan. The main reason for the different conclusions is that, in the comparison of studies, Duan et al. emphasizes that resource combination is more significant than a single resource in formulating a macro mineral investment strategy. Similarly, such divergence of conclusions occurs in both metal and non-metal minerals. Huang et al. [4], Li et al. [13], and Buchholz et al. [14] analyze the overseas investment risk in iron ore, copper, and zinc. Yu et al. [15] takes metal minerals as a whole to conduct the investment risk assessment, and the conclusions conflict with the research of Huang et al., Li et al., and Buchholz et al.. Moreover, the phenomenon of inconsistent conclusions in the target countries of investment among non-metals can be referred to in the studies of Ezechi et al. [16], Du et al. [17], and Fleury et al. [18].

The conflict of the above research conclusions may be accepted in a single mineral investment project assessment; however, inconsistent conclusions may confuse the decision-maker when formulating a general policy on mineral investment between countries [19,20]. Ken's [21] research shows that the essential characteristics of the country's outbound investment policy are stability and sustainability, especially in a national strategic layout like the BRI. Cascio's [22] and Buera et al.'s [23] research shows that formulating different and clear macro guidance policies for specific investment target countries can improve the effectiveness of detailed policies. Specific to mineral investment, most BRI countries have more than one category of mineral resource. Based on this, the overall consideration of mineral resources to clarify the macro investment policy between countries has the potential to assist the detailed mineral investment policy formulation from top to bottom. However, there is still a lack of research on the investment risk assessment of mineral resources as a whole, which leads to the inability of decision-makers to assess mineral investment risks between countries from a macro and relatively comprehensive perspective, and then formulate effective policies.

2.2. Mineral Investment Risk Assessment Indicator System

Risk assessment is significant in the risk management of overseas investment [24]. Root [25] and Kobrin [26] incorporated political risk assessment into the risk assessment system of overseas investment, analyzing the business decisions of multinational corporations. The results show that, compared with qualitative research, the quantified risk index enables the decision-makers to understand the investment risk clearly and directly. Later, the single-dimension quantitative analysis was developed into a three-dimensional (3-D) risk evaluation index to comprehensively elaborate on the investment risk. For example, the International Country Risk Guide (ICRG) has published country risk assessment grades monthly based on the three dimensions: political, economic, and financial risk [3,4].

ICRG indicators are widely used in risk assessment and are generally accepted. Kim and Hwang [27] developed the evaluation system and rated overseas investment risk in 3-D: politics, economy, and society, enriching the 3-D risk assessment approaches. More recently, the 3-D evaluation system has gradually developed into a multi-dimension (more than three dimensions) system, such as the six-dimensions (6-D) risk evaluation index approach. For example, Duan et al. [10], Wu et al. [3], and Huang et al. [4] used the 6-D method to evaluate investment risk and effectively achieved the goal of risk assessment. Compared with the 3-D risk evaluation method, the research of Duan et al., Wu et al., and Huang et al. presents more balanced evaluation results, showing better reliability. Furthermore, Aven and Terje [28] systematically studied the risk assessment and management approach in a multi-dimensional evaluation system, clarifying the reliability and effectiveness of the 6-D evaluation approach. On this basis, this research employs 6-D to evaluate the investment risk of mineral resources.

In the 6-D evaluation system, the political, social, and economic dimensions are essential, which is verified by several research outcomes [10,26,29–33]. To make the risk evaluation system reasonable, three other dimensions are necessary. Scholars include the increased dimensions of environmental factors, resource richness, and national relationships [28,34–36]. For example, Tracy et al. [37] cited several instances in which projects were delayed or canceled due to the lack of advance ecological assessment, causing economic losses to investors and indicating that environmental risk assessment should be included. Moreover, Dou et al. [38] and Sekerin et al. [39] indicated that local mineral resource endowment also determines the investment decision. The research of Duan et al. [10] supports the research of Dou et al.; the risks of the mineral investment in Singapore are specially discussed and modified due to the resource endowment problem. In addition, Huang et al. [4] and Cui et al. [40] add the dimension of Chinese factors as the national relationships to the evaluation system, demonstrating that China, as an investor, plays a central role in the research on investment risks with the BRI countries as the research objects. Therefore, this research introduces three basic dimensions, i.e., politics, society, and economy, together with resource potential, environmental constraints, and China factors to form 6-D to evaluate the investment risk of mineral resources in the BRI.

2.3. Research on the Quantitative Evaluation Method of Mineral Resources Investment Risk

Using the entropy method to obtain the weights of indicators in each dimension is a proper method [41–43]. Zhou et al. [44] reviewed the quantitative research of the entropy method, expounding the adaptability of the entropy method in calculating the dimension-indicator system. Specifically, Philippatos and Wilson [45] applied entropy to determining portfolio weights and resolved the effectiveness of entropy in determining weights. The entropy weight method is widely used in evaluation systems, such as in national electric power development [46], environment economics [47], and global sustainable development [48].

Various evaluation methods can be used based on the weight determined by the entropy method, including the Analytic Hierarchy Process (AHP), Grey System theory, and fuzzy evaluation. Among them, the AHP is unsuitable for multi-objective problems because of the heavy workload of numerical calculation and the subjectivity of weight allocation [49]. Grey System theory describes correlation degrees that can only reflect the positive correlation of data columns and lacks reflection of the negative correlation [50]. On the contrary, the fuzzy method can solve the problems of fuzziness and difficulty quantifying qualitative evaluation and applying uncertainty problems [51–53]. For example, Zhou et al. [44] systematically reviewed entropy in the fuzzy portfolio selection situation as a measure of risk, verifying the effectiveness of the entropy–fuzzy evaluation approach. Moreover, the entropy–fuzzy evaluation method is currently widely used to evaluate the dimension-indicator risk assessment system, including in Blagojević et al.'s [51] evaluation of the safety of railway traffic; Saraswat et al.'s [54] evaluation of energy alternatives for sustainable development; and Lam et al.'s [55] evaluation of a construction company's performance. The reliability verification in the long term and in multiple fields establishes the significant position of the entropy–fuzzy method in evaluating multi-dimensional and multi-indicator problems. Therefore, this research adopts the entropy–fuzzy method to evaluate the investment risk of mineral resources.

2.4. Aims of Research

This research aims to evaluate the investment risk of mineral resources from 6-D by the entropy and fuzzy methods from a macro and comprehensive perspective. The research gaps are briefly analyzed as follows:

Current studies' perspectives mainly focus on a specific resource category (e.g., iron ore, oil, and natural gas) or combinations of minerals resources (e.g., energy, metals, and non-metals). The restricted perspective may limit the decision-makers' judgments on the overall investment risk, leading to the decline of the effectiveness of the mineral resources investment policy between countries. BRI countries are increasingly important; therefore, putting forward a macro and comprehensive risk assessment approach to evaluate the target countries in terms of investment risk is urgent.

To address the challenges, this research:

1. Proposes a 6-D risk assessment based on political, economic, social, resource potential, environmental constraints, and China factors. Significantly, the dimension of resource potential is considered from the perspective of overall mineral resources, including ore and metals exports, ore and metals imports, proven reserves of natural gas, proven reserves of crude oil, proven reserves of coal, and mineral resource reserves.
2. A fuzzy comprehensive evaluation model based on the entropy method is used to evaluate the overall risk of overseas investment. The obtained results provide guidance and a basis for mineral resources investment decisions.

This paper makes two main contributions. First, from the perspective of resources constraint, this research strengthens the weight of resource potential, improving the 6-D risk evaluation system of mineral resources. Second, from the overall view of mineral resources, it establishes an evaluation system for risk investment, providing a theoretical and methodological basis for decision-makers to consider overseas mineral investment.

3. Materials and Methods

The evaluation procedure is divided into three stages (see Figure 1). Stage (1): the risk of mineral resources investment affects the identification of broad categories of factors. Analyze the situation from the political risk, economic foundation, and investment environment. Consider all aspects that affect the risk, carry out appropriate classification and sorting, and divide the investment risk of mineral resources into major categories. Stage (2): introduce the fuzzy probability method, combined with the entropy and the fuzzy methods, to objectively evaluate the mining investment risks of the countries along the BRI. Stage (3): evaluation of risk.

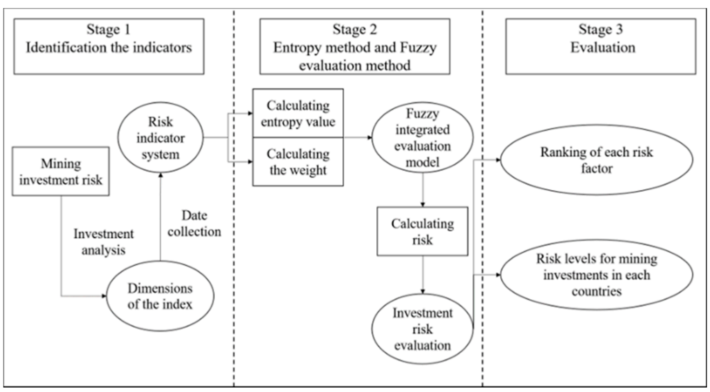

Figure 1. Evaluation procedure.

3.1. Selection of Targeted Countries

Countries along the BRI have different resource endowments; distinct, complementary advantages; and great potential for cooperation. This study selects 50 countries along the BRI as the research objects, including Mongolia in East Asia, 9 countries in Central Asia, 4 countries in South Asia, 8 countries in South Asia, 17 countries in West Asia, 6 countries in the Commonwealth of Independent States (CIS) including Russia, and 14 countries in Central and Eastern Europe. According to the Minerals Yearbook 2018 [56], oil and gas reserves in the region are 1001.5 Bbbl and 4605.59 Tcf, representing 57.90% and 66.25% of the world's total, respectively. According to BP [57], the BRI countries include 6 of the world's 10 most oil-rich countries, which are the important global energy production region. Moreover, the countries along the BRI are rich in metallic mineral resources. According to the 2019 Global Mining Development Report [58], copper reserves are 396 million tons, accounting for about 47.71% of the world's copper reserves, mainly distributed in Myanmar, Russia, and Indonesia. The reserves of iron ore, nickel, tin, and gold are 34.2 billion tons, 300 million tons, 300 million tons, and 12.55 thousand tons, accounting for 40.61%, 37.53%, 41.30%, and 23.24% of the world reserves (see Table 1, data source [56–58]).

Table 1. Basic data of 50 nations along the BRI.

Region	Country	Population (Million)	GDP (Billion Dollars)	Ores and Metals Exports (%of Merchandise Exports)	Ores and Metals Imports (%of Merchandise Imports)	Crude Oil Proved Reserves (Billion Barrels)	Proved Reserves of Natural Gas (Trillion Cubic Feet)	Coal Reserves (Million Tons)	Reserves of Metallic and Non-Metallic Mineral Resources (Thousand Tons)
East Asia	Mongolia	3.17	13.35	42.89	0.26	0	0	2520	2,040,006.09
Central Asia	Kazakhstan	18.28	204.0	11.55	3.43	35	30	25605	3,606,001
	Brunei	0.43	13.49	0.00035	1.08334	9.5	1.1	0.00	0.00
	Indonesia	267.66	1146.85	6.69	3.54	97.5	3.2	37,000	2,052,902.5
	Malaysia	31.53	382.13	4.3	5.27	84.5	3	1700	110,280
	Myanmar	53.71	84.49	5.52	0.77	41.3	0.05	258	95,410
	Philippines	106.65	340.30	5.01	2.27	3.48	0.14	0	82,290
	Singapore	5.64	333.10	0.88	1.11	0	0	0	0
	Thailand	69.43	442.26	1.61	4.37	6.6	0.3	1063	54,552
	Vietnam	95.54	187.69	0.9	4.43	22.8	4.4	3360	3,854,706
South Asia	Bangladesh	161.36	194.15	0	0	5.7	0.03	250	0
	India	1352.62	2822.17	3.3	6.03	45.5	4.5	101,363	4,484,800
	Pakistan	212.22	254.22	2.12	4	12.9	0.25	3064	0
	Sri Lanka	21.67	85.51	0	0	0	0	0.00	0.00
West Asia	Bahrain	1.57	33.71	22.8	5.75	6.4	0.12	0.00	0.00
	Cyprus	1.19	27.41	4.24	0.61	0	0	0.00	0.00
	Egypt	98.42	286.15	4.56	5	75.5	3.3	52	1,348,000
	Greece	10.73	252.72	8.67	3.96	0.04	0.01	2876	280,000
	Iran	81.80	504.99	0	0	1127.7	155.6	90	2,861,400.393
	Iraq	38.43	210.53	0	0	125.6	147.2	0	0
	Israel	8.88	308.67	1.13	1.38	14.6	0.01	0	67,000
	Jordan	9.96	32.52	7.72	1.79	0.21	0	0	1,000,000
	Kuwait	4.14	137.00	0.17	3.38	59.9	101.5	0	0
	Lebanon	6.85	42.56	11.57	1.68	0	0	0	0
	Oman	4.83	74.22	5.42	6.36	23.5	5.4	122	0
	Qatar	2.78	175.97	0.11	5.08	872.1	25.2	0	0

Table 1. *Cont.*

Region	Country	Population (Million)	GDP (Billion Dollars)	Ores and Metals Exports (%of Merchandise Exports)	Ores and Metals Imports (%of Merchandise Imports)	Crude Oil Proved Reserves (Billion Barrels)	Proved Reserves of Natural Gas (Trillion Cubic Feet)	Coal Reserves (Million Tons)	Reserves of Metallic and Non-Metallic Mineral Resources (Thousand Tons)
	Saudi Arabia	33.70	701.62	1.18	3.41	208.1	297.7	0	1,475,000
	Syria	16.91	0.00	0	0	9.5	2.5	0	1,800,000
	Turkey	82.32	1240.47	4.32	8.2	0.22	0.27	11,526	469,200.7
	UAE	9.63	398.02	6.55	2.91	209.7	97.8	0.00	0.00
	Yemen	28.50	18.04	0	0	9.4	3	0.00	0.00
Russia and CIS	Armenia	2.95	13.01	36.88	2.01	0	0	0.00	0.15
	Azerbaijan	9.94	57.66	0.92	0.9	75.2	7	0.00	170.00
	Belarus	9.48	62.46	0	0	0.1	0.2	0.00	0.00
	Moldova	2.71	9.55	0	0	0	0	0.00	0.00
	Russia	144.48	1739.13	5.54	1.83	1375	106.2	160,364	28,580,381.3
	Ukraine	44.62	131.29	8.31	2.48	38.5	0.4	34,375	140,000
Central and Eastern Europe	Albania	2.87	14.55	2.03	0.39	0.03	0.17	0	0
	Bulgaria	7.03	60.91	14.08	9.577	0.2	0.02	2366	0
	Croatia	4.09	65.02	3.89	2.71	0.88	0.07	0	0
	Czech Republic	10.63	247.93	1.36	2.96	0.14	0.02	2657	0
	Estonia	1.32	26.37	2.32	1.59	0	0	0	0
	Hungary	9.78	162.63	1.45	2.77	0.29	0.03	2876	0
	Latvia	1.93	31.25	2.13	1.36	0	0	0	0
	Lithuania	2.80	49.41	1.87	1.99	0	0.01	0	0
	Poland	37.97	633.91	3.04	3.47	2.2	0.16	26,479	29,713
	Romania	19.47	225.62	2.18	2.48	3.6	0.6	291	0
	Serbia	6.98	48.08	0	0	1.7	0.08	7514	0
	Slovakia	5.45	112.06	2.06	2.92	0.5	0.01	0	120,000
	Slovenia	2.07	55.34	4	5.38	0	0	0	0
Total		3167.10	14,694.55	NA	NA	4605.59	1001.55	427,771	54,551,813.13
World		7591.93	82,892.75	NA	NA	6951.8	1729.7	1,054,782	164,007,502.3
%		41.72%	17.73%	NA	NA	66.25%	57.90%	40.56%	33.26%

3.2. Indicators and Its Specifications

Establishing a reasonable evaluation indicator system is the essence and foundation of evaluation. The risk assessment report of energy resources investment under the BRI strategy [59] establishes an evaluation standard system that includes 6-D: economic foundation, social risk, political risk, Chinese factor, energy factor, and environmental risk. To analyze the mining investment risk of the countries along the BRI, this research designs the indicator according to the mineral resources' characteristics and makes it more specific. In addition, the indicators of each dimension are redesigned based on the research [10,59], and each dimension contains 6 indicators, totaling 36. The specific indicators and data sources of mining investment risk assessment are shown in Table 2. This research refers to the ICRG classification criteria and determines the evaluation indicators criteria according to each country's risk numerical distribution (see Appendix A).

Table 2. Indicator system and data source.

Dimension	Indicators	Data Source
Political risk	Control of Corruption	Worldwide Governance Indicators
	Government Effectiveness	Worldwide Governance Indicators
	Political Stability	Worldwide Governance Indicators
	Regulatory Quality	Worldwide Governance Indicators
	Rule of Law	Worldwide Governance Indicators
	Voice and Accountability	Worldwide Governance Indicators
Economic risk	GDP per capita	The International Country Risk Guide
	Real GDP growth	The International Country Risk Guide
	Annual inflation rate	The International Country Risk Guide
	Budget balance as a percentage of GDP	The International Country Risk Guide
	Foreign debt as a percentage of GDP	The International Country Risk Guide
	Exchange rate stability	The International Country Risk Guide
Social risk	Investment freedom	Index of Economic Freedom
	Business Freedom	Index of Economic Freedom
	Labor Freedom	Index of Economic Freedom
	Unemployment	World Development Indicators
	The business extent of the disclosure index	Worldwide Governance Indicators
	Literacy rate	World Development Indicators
Resource potential	Ores and metals exports	World Development Indicators
	Ores and metals imports	World Development Indicators
	Proved reserves of natural gas (trillion cubic feet)	Global Mining Development Report
	Crude oil proved reserves(billion barrels)	Global Mining Development Report
	Proven coal reserves (million metric tons)	Global Mining Development Report
	Mineral resources reserves (thousand metric tons)	Global Mining Development Report
Environmental constraint	EPI	Environmental Performance Index
	Air Quality	Environmental Performance Index
	Forest area (% of land area)	World Development Indicators
	Climate and Energy	Environmental Performance Index
	Air Pollution	Environmental Performance Index
	Water and Sanitation	Environmental Performance Index
Chinese factor	BIT	Ministry of Commerce of China
	Outward FDI stock	Statistical Bulletin of China's Outward Foreign Direct Investment
	Value of total import from china	UN Comtrade Database
	Value of total export from china	UN Comtrade Database
	Value of contracted projects	International Statistical Yearbook
	China's investment in non-performing assets	UN Comtrade Database

1. Political risk investigates the quality and efficiency of resource country government in dealing with national problems and maintaining political stability and legal construction. Lower political risk reduces the possibility of overseas investment being damaged.
2. The economic foundation measures the long-term stability of a country's investment environment. A country with an excellent economic foundation has a relatively low risk of overseas investment inflow and relatively high profitability and safety of Chinese enterprises' overseas investment returns.
3. Social risk reflects the risk factors caused by the social situation of mining investment target countries: the more stable the country's social level, the more favorable the investment.
4. Resource potential is an important indicator for measuring investment feasibility in resource countries. Countries with abundant resources and excellent resource potential have exceptionally high investment value, which is the basis for obtaining overseas mining investment.
5. Environmental risk measures a country's attention to environmental protection awareness, actions, and policies. As for mining investment, every link of mining develop-

ment is affected by environmental governance and control by governments of various countries.

6. The China factor measures the relationship between a country and China's trade and investment cooperation. If a country has a more friendly relationship with China, China's investment risk in local areas will be lower, and the return on investment will increase.

3.3. Entropy Method

The entropy method is based on Shannon entropy [60]. Shannon entropy is a concept based on probability theory to measure the uncertainty of information. In information theory, Shannon's entropy determines the objective weight based on the variability of indicators. If the information entropy of a certain indicator is smaller, it indicates that the degree of variation of the indicator value is greater. On this basis, more information provided means a more significant role in the comprehensive evaluation, resulting in greater weight. Therefore, the tool of information entropy can be used to calculate the weight of each indicator to provide a basis for evaluating multiple indicators. Several problems make the entropy method widely used:

- Evaluating the risk assessment [61];
- Safety Evaluation [62];
- Environmental conflict analysis [50].

The entropy-weight method is developed according to the following definition.

Definition 1. *Assume that there are m countries for evaluation, and each has p evaluation dimensions and has n_k indicators under each dimension ($p = 1, 2, \cdots, 6$). The indicator system X consists of p dimensions; that is, $X = [X_1, X_2, \cdots X_P]$, represents six risk dimensions. X_k is composed of n_k indicators,$X_k = \left[X_1^k, X_2^k, \cdots, X_{n_k}^k\right]$, which forms a decision matrix $x_k = \begin{bmatrix} x_{11}^k & \cdots & x_{1n_k}^k \\ \vdots & \ddots & \vdots \\ x_{m1}^k & \cdots & x_{mnk}^k \end{bmatrix}$, where $x_{mn_k}^k$ represents the value of the n_kth indicator for the kth dimension of the mth country.*

The steps can be described below:

Step 1: Standardization of indicators.

Standardizing the matrix eliminates the difficulties caused by dimensional differences between indicators.

$$y_{ij} = \frac{x_{ij}^k - \min\limits_j x_{ij}^k}{\max\limits_j x_{ij}^k - \min\limits_j x_{ij}^k} \qquad j \in [1, 2, \cdots n_k], x_j^k \in I_1 \tag{1}$$

$$y_{ij} = \frac{\max\limits_j x_{ij}^k - x_{ij}^k}{\max\limits_j x_{ij}^k - \min\limits_j x_{ij}^k} \qquad j \in [1, 2, \cdots n_k], x_j^k \in I_2 \tag{2}$$

where $y_{mn_k}^k$ represents the standardized numeric value of the n_kth indicator of the kth dimension for the m th country. I_1 is the benefit indicator. I_2 is the cost indicator.

Step 2: Quantification of indicator similarity.

$$z_{ij}^k = \frac{y_{ij}^k}{\sum_{i=1}^m y_{ij}^k} \tag{3}$$

where z_{ij}^k repesents the indicator value proportion for the ith country.

Step 3: Calculating entropy value.

$$e_j^k = -c\sum_{i=1}^{m} z_{ij}^k \ln z_{ij}^k \tag{4}$$

where c is a constant, letting $c = (\ln(m))^{-1}$.

Therefore, the indicators system for the kth dimension X_k, has an entropy vector $e_k = [e_1^k, e_2^k, \cdots, e_{n_k}^k]$.

Step 4: Calculating weight.

g_j^k represents the contribution divergence of each alternative regarding criterion j.

$$g_j^k = 1 - e_j^k \tag{5}$$

The variable d_i^k represents the weight of the jth indicator in X_j^k.

$$d_{ij}^k = \frac{g_j^k}{\sum_{i=1}^{m} g_j^k}, k = 1, 2, \cdots, p, j = 1, 2, \cdots, n_k \tag{6}$$

The weight matrix consisting of each indicator under the kth dimension indicator system is $D_J^K = [d_1^k, d_2^k, \cdots, d_{n_k}^k]$, $w^k = \sum_{j=1}^{n_k} d_j^k$; therefore, each dimension's weight is $W = [w^1, w^2 \cdots, w^p]$.

The weighted sum of p dimensions is equal to 1, $\sum_{k=1}^{p} w^k = 1$.

3.4. Fuzzy Method

The degree of national risk is generally a relative concept, and there is no clear limit to classic fuzzy sets. It is reasonable to use the fuzzy set to describe the continuous change of the evaluation indicator [52]. Meanwhile, the fuzzy theory is applied in various fields:

- The engineering field [63];
- The management and business field [64];
- The science and technology field [65].

According to the fuzzy theory, the question of membership degree is transformed from qualitative evaluation to quantitative evaluation, and risk indicators of various dimensions are divided into different levels. Then the membership degree of each indicator is calculated at a specific level. With reference to ICRG's classification standards, this paper divides each indicator into five levels: highest risk, higher risk, medium risk, lower risk, and lowest risk.

All indicators selected in this paper belong to interval indicators, and their membership functions are as follows:

$$r_{ij,l}^k(x) = \begin{cases} 1 - \dfrac{\max\left\{c_{i,l} - x, x - c_{j,(l+1)}\right\}}{\max\left\{c_{j,l} - \min\limits_i x, \max\limits_i x - c_{j,(l+1)}\right\}} & x \notin \left[c_{j,l}, c_{j,(l+1)}\right] \\ 1 & x \in \left[c_{j,l}, c_{j,(l+1)}\right] \end{cases} \tag{7}$$

where $i = 1, 2, \cdots, m; j = 1, 2, \cdots, n_k; k = 1, 2, \cdots, p; l = 0, 1, 2, 3, 4$. Here, $r_{ij,l}^k(x)$ represents the degree of membership for x_{ij}^k in the lth dimension. The ith country in the fuzzy relation matrix for the kth dimension is R_i^k.

$$R_i^k = \begin{bmatrix} r_{i1,0}^k & \cdots & r_{i1,4}^k \\ \vdots & \ddots & \vdots \\ r_{in_k,0}^k & \cdots & r_{in_k,4}^k \end{bmatrix} \tag{8}$$

Therefore, the risk assessment set of the ith country in the kth dimension is:

$$B = D^k \times R_i^k = \left[a_1^k, a_2^k, \cdots a_{n_k}^k\right] \times \begin{bmatrix} r_{i1,0}^k & \cdots & r_{i1,4}^k \\ \vdots & \ddots & \vdots \\ r_{in_k,0}^k & \cdots & r_{in_k,4}^k \end{bmatrix} = \left[b_{i,0}^k, b_{i,1}^k, \cdots b_{i,4}^k\right] \tag{9}$$

where $b_{i,0}^k$ means the risk assessment result of the ith country in the kth dimension is 0, the lowest risk; and $b_{i,4}^k$ means the risk assessment result of the ith country in the kth dimension is 4, the highest risk. The result that will get the risk evaluation matrix of the ith country in the pth in the evaluation indicator system is:

$$C_i = \begin{bmatrix} B_i^1 \\ B_i^2 \\ \vdots \\ B_i^p \end{bmatrix} = \begin{bmatrix} b_{i,0}^1, & b_{i,1}^1, & \cdots & b_{i,4}^1 \\ b_{i,0}^2, & b_{i,1}^2, & \cdots & b_{i,4}^2 \\ \cdots & \cdots & \cdots & \cdots \\ b_{i,0}^p, & b_{i,1}^p, & \cdots & b_{i,4}^p \end{bmatrix} \tag{10}$$

The following equation represents the results of a comprehensive evaluation of the ith country:

$$V_i = W \times C_i = \left[w^1, w^2, \cdots, w^p\right] \times \begin{bmatrix} B_i^1 \\ B_i^2 \\ \vdots \\ B_i^P \end{bmatrix}$$

$$= \left[w^1, w^2, \cdots, w^p\right] \times \begin{bmatrix} b_{i,0}^1, & b_{i,1}^1, & \cdots & b_{i,4}^1 \\ b_{i,0}^2, & b_{i,1}^2, & \cdots & b_{i,4}^2 \\ \cdots & \cdots & \cdots & \cdots \\ b_{i,0}^p, & b_{i,1}^p, & \cdots & b_{i,4}^p \end{bmatrix} = \left[v_{i,0}, v_{i,1}, \cdots, v_{i,4}\right] \tag{11}$$

where $v_{i,0}$ represents that the risk assessment result of the ith country in the kth dimension is 0, the lowest risk; and $v_{i,4}$ represents that the risk assessment result of the ith country in the kth dimension is 4, the highest risk. The final risk evaluation grade of country i is the maximum grade in the V_i.

4. Result and Discussion

4.1. Comparison of Dimensions and Indicators

Table 3 shows the weights of mining investment risk evaluation under 3-D. The weights of political risk, economic risk, and social risk are 0.358, 0.354, and 0.288, respectively; the weight of political risk accounts for the highest proportion. Among the indicators under 3-D, the highest weights are GDP per capita, the business extent of disclosure index, and political stability, with weights of 0.146, 0.093, and 0.088, respectively. Among them, GDP per capita and the business extent of the disclosure index belong to the dimension of economic risk and social risk. Figure 2 visualizes the weights of the dimensions and indicators (3-D).

Table 3. Evaluation criteria system for mining investment risk under 3-D.

Dimension	Weight of Dimensions	Indicators	Weight of Indicators
Political risk	0.358	Control of Corruption:	0.076
		Government Effectiveness	0.038
		Political Stability	0.088
		Regulatory Quality	0.054
		Rule of Law	0.050
		Voice and Accountability	0.053

Table 3. *Cont.*

Dimension	Weight of Dimensions	Indicators	Weight of Indicators
Economic risk	0.354	GDP per capita	0.146
		Real GDP growth	0.023
		Annual inflation rate	0.028
		Budget balance as a percentage of GDP	0.049
		Foreign debt as a percentage of GDP	0.079
		Exchange rate stability	0.029
Social risk	0.288	investment freedom	0.067
		Business Freedom	0.016
		Labor Freedom	0.022
		Unemployment	0.058
		Business extent of disclosure index	0.093
		Literacy rate	0.032

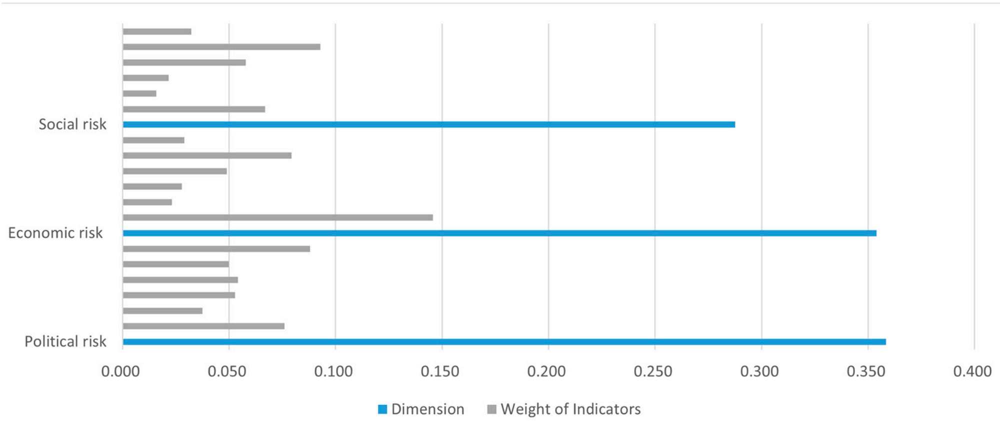

Figure 2. Determined criteria weight (3-D).

Table 4 shows the weights of mining investment risk evaluation under 6-D. The weights of political risk, economic risk, social risk, resource potential, environmental constraint, and the China factor are 0.035, 0.034, 0.028, 0.481, 0.046, and 0.376, respectively; the weight of resource potential is the largest, followed by the China factor and environmental constraint. Among the indicators of the 6-D, China's investment in non-performing assets has the highest weight of 0.167, mineral resources reserves has a weight of 0.111, and proven coal reserves has a weight of 0.107. The indicators with the highest weights belong to two dimensions: the resource potential and the China factor. Figure 3 visualizes the weight of the dimensions (6-D).

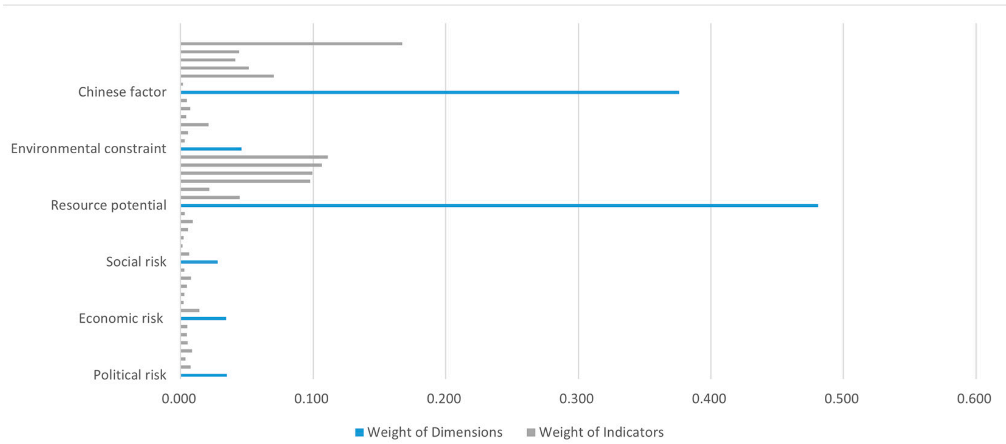

Figure 3. Determined criteria weight (6-D).

Table 4. Evaluation criteria system for mining investment risk under the 6-D.

Dimension	Weight of Dimensions	Indicators	Weight of Indicators
Political risk	0.035	Control of Corruption:	0.007
		Government Effectiveness	0.004
		Political Stability	0.009
		Regulatory Quality	0.005
		Rule of Law	0.005
		Voice and Accountability	0.005
Economic risk	0.034	GDP per capita	0.014
		Real GDP growth	0.002
		Annual inflation rate	0.003
		Budget balance as a percentage of GDP	0.005
		Foreign debt as a percentage of GDP	0.008
		Exchange rate stability	0.003
Social risk	0.028	investment freedom	0.007
		Business Freedom	0.002
		Labor Freedom	0.002
		Unemployment	0.006
		Business extent of disclosure index	0.009
		Literacy rate	0.003
Resource potential	0.481	Ores and metals exports	0.045
		Ores and metals imports	0.022
		Proved reserves of natural gas (trillion cubic feet)	0.098
		Crude oil proved reserves (billion barrels)	0.099
		Proven coal reserves (million metric tons)	0.107
		Mineral resources reserves (thousand metric tons)	0.111
Environmental constraint	0.046	EPI	0.003
		Air Quality	0.006
		Forest area (% of land area)	0.021
		Climate and Energy	0.004
		Air Pollution	0.007
		Water and Sanitation	0.005
Chinese factor	0.376	BIT	0.002
		Outward FDI stock	0.070
		Value of total import from China	0.052
		Value of total export from China	0.041
		Value of contracted projects	0.044
		China's investment in non-performing assets	0.167

Table 5 shows the weight distributions of indicators after expanding from 3-D to 6-D. For comparison, Figures 4 and 5 show the visual distribution of indicators in 3-D and 6-D dimensions, respectively. The weight distributions falling into each interval are balanced and refined by expanding the evaluation dimension. This research quotes Duan et al. [10] and Yuan et al. [7] for comparison of whether the balanced weight index positively impacts the risk assessment system. Duan et al. [10] and Yuan et al. [7] expanded the 3-D indicators system proposed by Kim and Hwang [27] to n-dimension (n > 3), as shown in Table 5. In the Duan et al. [10] and Yuan et al. [7] research, the results indicators weight distribution that was less than 0.005, 0.005 to 0.01, 0.01 to 0.05, and 0.05 to 0.1 and greater than 0.1 accounted for 2.8%, 8.3%, 75%, 13.9%, and 0%, respectively; and 7.7%, 12.8%, 64.1%, 12.8% and 2.6%, respectively. Compared with the 3-D evaluation system, the n-dimension risk evaluation approach shows that the weights of the evaluation indicators are evenly distributed between 0.005 and 0.1, instead of distributions accounting for 0%, 0%, 50%, 44.4%, and 5.6% in the 3-D evaluation system. Duan et al. [10] and Yuan et al. [7] concluded that the refinement and dispersion indicators in n-dimension approaches positively impacted the research's reliability, consistent with the method of setting 6-D and 36 indicators for the assignment calculation in this research.

Table 5. Distribution of weights.

Weight of Indicators	6-D	Approach I (3-D Approach)	Approach II (Specific Resource)	Approach III (Combination)
0.005≤	41.7%	0%	2.8%	7.7%
0.005–0.01	22.2%	0%	8.3%	12.8%
0.01–0.05	16.7%	50%	75%	64.1%
0.05–0.1	11.1%	44.4%	13.9%	12.8%
0.1≥	8.3%	5.6%	0%	2.6%

Approaches: Approach II (Specific resource): Data from [7]; Approach III (Combination): Data from [10].

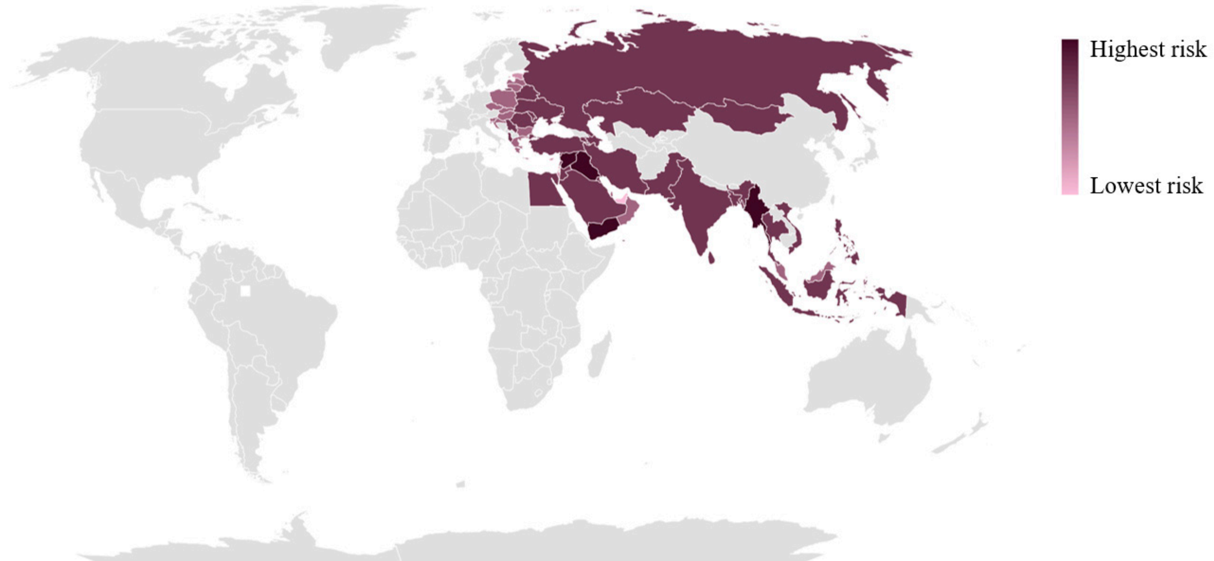

Figure 4. The results of the national investment risk evaluation based on 3-D evaluation.

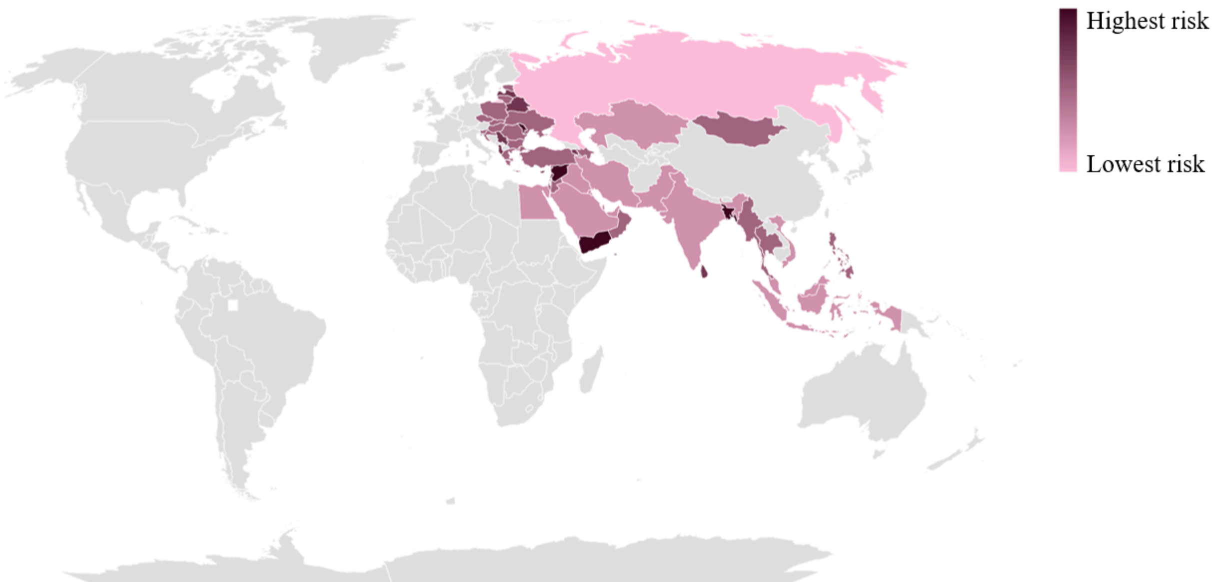

Figure 5. The results of the national investment risk evaluation based on 6-D evaluation.

Based on the distributions of the weights, the numerical analysis of the BRI countries is carried out by the fuzzy evaluation method. Figure 5 shows the results of the investment risk evaluation of the BRI mineral resources under the 6-D indicators system. The results show that, among the 50 countries along BRI, the numbers of countries with the lowest risk, low risk, medium risk, high risk, and highest risk are 1, 13, 24, 8, and 4, respectively.

Next, to facilitate the presentation and discussion of the results, this research divided the 50 countries along the BRI into three parts: (1) Southeast Asia and Central Asia, (2) West Asia, and (3) Russia and CIS countries and Central and Eastern Europe.

4.2. Comparison of Numerical Trends

Table 6 shows risk evaluation results in Southeast Asia and Central Asia along the BRI. The proposed approach in this research is compared with three existing evaluation approaches, including Approach I (i.e., risk assessment evaluated by the 3-D approach), Approach II (i.e., an n-dimension evaluation approach towards a specific resource category), and Approach III (i.e., an n-dimension evaluation approach towards the combination of resources). Compared with the calculation results of the proposed approach, the risk assessment results of Approach I, II, and III for the 14 countries are consistent in 1, 2, and 9 countries, respectively. The most prominent feature of the comparative results is that, compared with the proposed approach, the differences between the evaluation results of Approach I and II are significantly higher than that of Approach III. Such an evaluation trend is also reflected in Tables 7 and 8. Table 7 shows that, among the 17 countries in Western Asia, the evaluation results of Approach I and II are consistent with those of the proposed approach in 5 and 3 countries, respectively, while the results of Approach III are consistent with those of 11 countries. Table 8 shows the risk assessment results for 19 countries. Among them, 5 and 2 results of Approach I and II are consistent with the proposed approach, respectively, while 9 results of Approach III are consistent with the proposed approach.

Table 6. Comparison of risk assessment results in Central Asia and Southeast Asia.

Country	6-D Approach	Approach I (3-D Approach)	Approach II (Specific Resource)	Approach III (Combination)
Mongolia	Medium risk	↑	↓	↑
Kazakhstan	Lower risk	↑	↑	→
Brunei	Medium risk	↓	NA	→
Indonesia	Lower risk	↑	↑	→
Malaysia	Lower risk	↑	→	→
Myanmar	Medium risk	↑	NA	→
Philippines	Medium risk	↑	→	→
Singapore	Medium risk	↓	↓	↓
Thailand	Medium risk	↑	↓	→
Vietnam	Lower risk	↑	↑	↑
Bangladesh	Highest risk	↓	↓	↓
India	Lower risk	↑	↑	→
Pakistan	Lower risk	↑	↑	→
Sri Lanka	Higher risk	→	NA	↑

Approaches: Approach II (Specific resource): Data from [7]; Approach III (Combination): Data from [10]. "↑", "→", and "↓" mean the results of risk assessment "rised", "unchanged", and "decreased", respectively. "NA" means the relevant data is unavailable.

Table 7. Comparison of risk assessment results in West Asia.

Country	6-D Approach	Approach I (3-D Approach)	Approach II (Specific Resource)	Approach III (Combination)
Bahrain	Medium risk	↑	↑	↑
Cyprus	Highest risk	↓	NA	↑
Egypt	Lower risk	↑	↑	↑
Greece	Medium risk	→	NA	→
Iran	Lower risk	↑	→	→

Table 7. *Cont.*

Country	6-D Approach	Approach I (3-D Approach)	Approach II (Specific Resource)	Approach III (Combination)
Iraq	Lower risk	↑	↑	→
Israel	Medium risk	↓	↑	→
Jordan	Medium risk	↑	↑	↑
Kuwait	Lower risk	↑	↑	→
Lebanon	Higher risk	→	↑	↑
Oman	Medium risk	→	↑	→
Qatar	Lower risk	↑	↑	→
Saudi Arabia	Lower risk	↑	↑	→
Syria	Highest risk	→	→	→
Turkey	Medium risk	↑	→	→
UAE	Lower risk	↑	↑	→
Yemen	Highest risk	→	NA	↓

Approaches: Approach II (Specific resource): Data from [8] Approach III (Combination): Data from [10]. "↑", "→", and "↓" mean the results of risk assessment "rised", "unchanged", and "decreased", respectively. "NA" means the relevant data is unavailable.

Table 8. Comparison of risk assessment results in Central and Eastern Europe and Russia and CIS.

Country	6-D Approach	Approach I (3-D Approach)	Approach II (Specific Resource)	Approach III (Combination)
Armenia	Higher risk	↓	NA	↑
Azerbaijan	Medium risk	↑	↑	→
Belarus	Higher risk	↑	↑	→
Moldova	Highest risk	↓	NA	→
Russia	Lowest risk	↑	→	→
Ukraine	Medium risk	↑	↑	↑
Albania	Higher risk	→	↑	↓
Bulgaria	Medium risk	↑	↑	→
Croatia	Medium risk	→	↑	↑
Czech Republic	Medium risk	↑	↓	↑
Estonia	Medium risk	↓	NA	↑
Hungary	Medium risk	→	↑	↑
Latvia	Higher risk	↓	NA	↑
Lithuania	Medium risk	↓	NA	↑
Poland	Medium risk	→	→	→
Romania	Medium risk	↑	↑	→
Serbia	Higher risk	→	NA	→
Slovakia	Medium risk	↓	↑	→
Slovenia	Medium risk	↓	NA	↑

Approaches: Approach II (Specific resource): Data from [8] Approach III (Combination): Data from [10]. "↑", "→", and "↓" mean the results of risk assessment "rised", "unchanged", and "decreased", respectively. "NA" means the relevant data is unavailable.

Tables 6–8 show that the 3-D evaluation method and the evaluation method for a specific resource category have lower stability than the n-dimension evaluation methods for multi-categories. This research result is consistent with Duan et al. [10], Wu et al. [43], and Lam et al. [55]: multi-dimensional and multi-categories risk assessment results will be relatively more stable. The research object of this paper is the risk analysis of China's investment decision in BRI countries, which serves the assessment of macro risks. Multi-dimensional evaluation methods and risk evaluation results for multiple mineral varieties meet the internal demands of macro policies for stability and reliability [22,23].

4.3. Comparison of Risk Grades

Table 6 shows two remarkable changes. First, the risk assessment of Kazakhstan, Indonesia, and India has been changed in Approach I and II; however, the results of Approach III are consistent with the calculation results of the proposed approach. The main reasons for the differences are the indicators distribution system and the definition of risk assessment objects. For Approach I (i.e., the 3-D approach), the weights of mineral resource potential are ignored, therefore, the investment risk assessment of these three countries has not been adjusted according to their resource potential. Similarly, Approach II focuses on a specific resource category (i.e., coal), overlooking macro-policy considerations regarding the countries' resources. On the contrary, Approach III considers expanding the evaluation dimensions from Approach I, while expanding the considering resources types from Approach II. Compared with Approach I and II, Approach III is balanced in consideration indicators, which is more consistent with the research results calculated by the proposed approach. Similar phenomena are shown in Table 7 in Kuwait, Qatar, Saudi Arabia, and the UAE; as well as in Azerbaijan, Belarus, and Bulgaria in Table 8. The above calculation results are basically consistent with the results in Section 4.2. The increase in the dimension of risk assessment and the number of varieties makes the results more stable and consistent with the approach proposed in this paper. Such results strengthen decision making for risk assessment (mentioned in Section 4.2), addressing the need for the stability of macro policy making across countries [19,20]. Figure 6 shows the detailed investment risk: Saudi Arabia, the United Arab Emirates, Pakistan, India, Kazakhstan, Malaysia, Indonesia, and Russia are ideal for China's mineral resources investment.

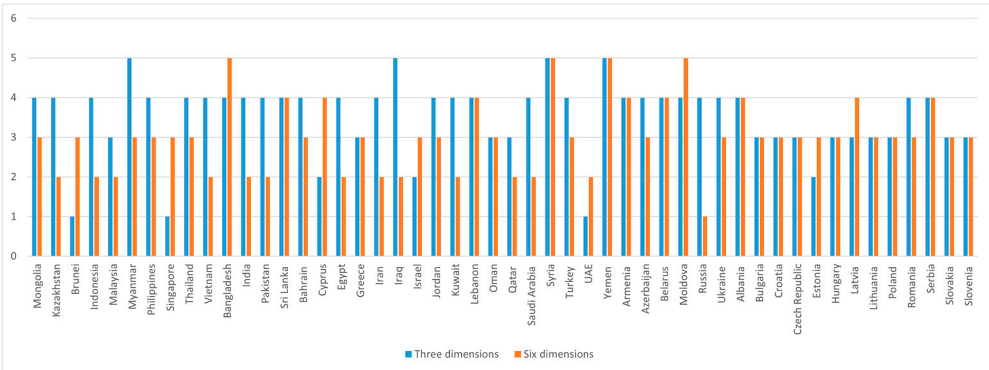

Figure 6. The investment risk results of the integrated evaluation of mineral resources.

The second remarkable change is that, compared with the proposed approach, the risk assessment results, such as in Singapore, Vietnam, Bangladesh, Bahrain, Egypt, Jordan, and Ukraine in all of Approach I, II, and III, are changed. The main reason is the differences in consideration of the resource variety. According to the entropy method, there is a significant positive correlation between the richness of resource categories and the weight of resource potential; see Equations (4)–(6). For example, the performance of Singapore in nearly all dimensions shows the characteristics of low investment risk, but the resource potential of Singapore is insufficient. According to the calculations of Approach I, II, and III (original calculated results), the risks of Singapore are all the lowest, however, the result of the proposed approach is medium risk. Such risk assessment results (i.e., medium risk) are consistent with the modified results of the authors' intervention in Approach II [7] and III [10]. The risk assessment results of Vietnam, Bangladesh, Bahrain, Egypt, Jordan, and Ukraine are similar to that of Singapore [7,10,13]. The rebalancing of the weights of resource potential directly reflects the risk assessment results instead of human intervention in the calculation results.

Strengthening the weights of resource potential is a tentative improvement of the current 6-D assessment method. Such improvement is based on the risk assessment calculation method of the entropy–fuzzy method. In previous studies on mineral resources, some countries with low mineral reserves may be low risk investments due to the low risk of other factors [10,13]. Based on practical considerations, mining investment risks in low mineral reserves countries are significantly high [28,66]. Therefore, scholars may conduct separate discussions on the results and artificially interfere in the presentation of the results [8,10]. Human interference has weakened the quantitative analysis significance of the entropy–fuzzy method to a certain extent. Therefore, in this paper, the characteristics of the entropy method are used to strengthen the weight of resource potential and then calculate the risk assessment results. The above results show that the enhanced resource potential weight, to a certain extent, can show the results which should be presented after the manual intervention, achieving the expected purpose of improving the existing 6-D assessment method.

5. Conclusions

The Belt and Road Initiative, which involves Asia, Africa, and Europe, has brought new opportunities and development for China's mining investment, and meanwhile, the potential risks of investment cannot be ignored. In the face of new opportunities and challenges, formulating a macro and comprehensive risk assessment method for decision-makers becomes urgent and necessary.

In summary, this paper proposes an evaluation system for risk analysis of overseas mineral investment, which regards mineral resources as a whole for comprehensive and macro investment risk analysis. This paper identifies 6 dimensions and 36 indicators influencing the overseas mineral investment risk, adopting the entropy–fuzzy method to score and determine the risk degree of the countries along BRI. The research shows that the richness of resource potential is the most influential factor, significantly affecting China's investment risk assessment of target countries. The high weight of resource potential shows the characteristics of the mineral investment relationship and confirms the fundamental position of resource richness in investment evaluations. On this basis, Saudi Arabia, the United Arab Emirates, Pakistan, India, Kazakhstan, Malaysia, Indonesia, and Russia are ideal for China's mineral resources investment. Moreover, the enhanced resource potential weight improves the existing investment evaluation methods of mineral resources: the reduced manual intervention strengthens the significance of quantitative analysis methods.

However, there are still some limitations in this research. First, risk assessment indicators do not incorporate major public crises, such as the COVID-19 pandemic. Major public crises may affect investment risk on a global scale, which needs to be considered in the following work. Furthermore, the data collection and acquisitions are still based on several annual statistical reports, which cannot provide real-time feedback on mineral investment risks caused by changes in investment conditions. In the following work, it is necessary to establish a data collection system to collect real-time investment risk-related data from multiple channels, enhancing the ability to provide the latest decision support for decision-makers.

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Appendix A

Table A1. Risk grade classification for each indicator.

Dimension	Indicators	Lowest Risk	Lower Risk	Medium Risk	Higher Risk	Highest Risk
Political risk	Control of Corruption	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
	Government Effectiveness	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
	Political Stability	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
	Regulatory Quality	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
	Rule of Law	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
	Voice and Accountability	≥2.5	2.5–1.5	1.5–0.5	0.5–0.5	≤−2.5
Economic risk	GDP per capita	≥4.0	4.0–3.5	3.5–3	3.0–2.5	≤2.5
	Real GDP growth	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
	Annual inflation rate	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
	Budget balance as a percentage of GDP	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
	Foreign debt as a percentage of GDP	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
	Exchange rate stability	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
Social risk	investment freedom	≥80	80–70	70–60	60–50	≤50
	Business Freedom	≥80	80–70	70–60	60–50	≤50
	Labor Freedom	≥80	80–70	70–60	60–50	≤50
	Unemployment	≥80	80–70	70–60	60–50	≤50
	Business extent of disclosure index	≥8.0	8.0–7.0	7.0–6.0	6.0–5.0	≤5
	Literacy rate	≥95	95–90	90–80	80–70	≤70
Resource potential	Ores and metals exports	≥5	5.0–3.0	3.0–1.5	1.5–0.0	≤0
	Ores and metals imports	≥5	5.0–3.0	3.0–1.5	1.5–0.0	≤0
	Proved reserves of natural gas	≥1000	1000–100	100–10.0	10.0–0.1	≤0.1
	Crude oil proved reserves	≥100	100–10.0	10.0–1.0	1.0–0.1	≤0.1
	Proven coal reserves	$\geq 10^4$	10^4–10^3	10^3–100	100–10	≤10
	Mineral resources reserves	$\geq 10^7$	10^7–10^6	10^6–10^5	10^5–10^4	$\leq 10^4$
Environmental constraint	EPI	≥80	80–70	70–60	60–50	≤50
	Air Quality	≥80	80–70	70–60	60–50	≤50
	Forest area (% of land area)	≥80	80–70	70–60	60–50	≤50
	Climate and Energy	≥80	80–70	70–60	60–50	≤50
	Air Pollution	≥80	80–70	70–60	60–50	≤50
	Water and Sanitation	≥80	80–70	70–60	60–50	≤50
Chinese factor	BIT	≥9	10.0–4.0	4.0–2.0	2.0–1.0	≤0
	Outward FDI stock	≥50	50.0–10.0	10.0–1.0	1.0–0.1	≤0.1
	Value of total import from China	≥100	100–10	10.0–1.0	1.0–0.1	≤0.1
	Value of total export from China	≥100	100–10	10.0–1.0	1.0–0.1	≤0.1
	Value of contracted projects	$\geq 5 \times 10^5$	5×10^5–10^5	10^5–10^4	10^4–10^3	≤1000
	China's investment in non-performing assets	$\geq 10^5$	10^5–10^4	10^4–10^3	10^3–100	≤100

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