A Study of Country Economic Risks in Countries Along the Belt and Road: A Classification Method Based on DEA Sort

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Abstract. Today, with the development of international trade and prosperity, the implementation of the Belt and Road strategy has brought a large number of international trades, international lending and cross-border investment business. In the process of business decision-making, the investigation of national economic risks is indispensable. To solve this problem, this paper adopts the idea of DEA Sort, selects relevant economic indicators, combines the input-oriented CCR multiplier model and cluster analysis to classify the national economic risks of sample countries, and finally obtains three classifications and the economic risks of most countries were found to be high. It is expected to provide reference for relevant cross-border business in the countries along the Belt and Road and relevant enterprises.

1. Introduction

In order to promote the orderly and free flow of economic factors, the efficient allocation of resources and the deep integration of the market, and promote the economic policy coordination among the countries along the line, China has put forward a strategic concept of co-building the Silk Road Economic Belt and Marine Silk Road in the 21st Century (hereinafter referred to as the Belt and Road). The implementation of this strategy enables countries along the route to carry out greater, higher and deeper regional cooperation, and carry out a large number of international trades, international lending and cross-border investment business.

In the decision-making process of international trade, international lending and cross-border investment business, in addition to the domestic credit risk rating of domestic trades, loans and investment business, it is necessary to focus on the assessment and assessment of the country risk of the country where the customer is located[1]. However, the development of countries along the Belt and Road is different. Domestic banks and enterprises inevitably face the country's national risks when conducting relevant cross-border business, of which the economic risks are most obvious and direct. Therefore, it is of practical significance to evaluate and classify the country's economic risks in the countries along the Belt and Road.

In the analysis of country economic risks, multiple evaluation indicators are often involved, so the country economic risk assessment is essentially a multi-standard risk classification problem. The DEA itself is a linear programming technique that evaluates problems based on multiple indicators. Therefore, this paper will use the DEA method to analyze the economic risks of countries along the Belt and Road.
2. Related concepts

2.1. Country economic risks

The scope of country risks is complex, including political, economic, social, cultural, international relations, natural environment and emergencies. Country risks refers to the unexpected change in the economic, political or social policy or environmental factors of a country or a bank when the bank or enterprise conducts cross-border business, so that the bank or enterprise cannot recover the relevant credit or investment funds as scheduled and in full. According to existing research by scholars, combined with the actual situation of the Belt and Road, country risks can be divided into economic risks, political risks, social risks, and legal risks[2].

The economy is the most obvious factor influencing country risk, and it has a long-term sustainable impact on country risks. Economic risks mainly refer to the loss of corporate profits that may result from fluctuations in economic activities and price levels, and thus it is difficult to repay debt.

2.2. Brief introduction of DEA

DEA (Data envelopment analysis) is a nonparametric efficiency analysis method that uses a mathematical programming model to identify dominant decision units. When using the DEA method for efficiency evaluation, the two basic models are the CCR multiplier model and CCR envelopment model. The CCR multiplier model specifically combines input factors and output factors linearly, and reflects the relative efficiency by the ratio. The value range of the efficiency value is (0,1], and the efficiency equal to 1 indicates that the input is efficient, also known as efficiency. The edge, the rest of the efficiency value is not equal to 1, the closer to 1, the higher the efficiency it will be[3].

3. Information on country selection and country economic risk assessment along the Belt and Road

3.1. Country selection along the Belt and Road

When determining the research object, this paper selects 30 countries as the research object based on the comprehensive consideration of the important nodes and data availability of the countries along the Belt and Road.

| No | Country         | No | Country         | No | Country     |
|----|----------------|----|----------------|----|-------------|
| 1  | Afghanistan    | 11 | Indonesia      | 21 | Montenegro  |
| 2  | Albania        | 12 | Jordan         | 22 | Nepal       |
| 3  | Armenia        | 13 | Kazakhstan     | 23 | Pakistan    |
| 4  | Bangladesh     | 14 | Kyrgyzstan     | 24 | Philippines |
| 5  | Belarus        | 15 | Laos           | 25 | Romania     |
| 6  | Bhutan         | 16 | Lebanon        | 26 | Serbia      |
| 7  | Bosnia and Herzegovina | 17 | Macedonia | 27 | Sri Lanka   |
| 8  | Burma          | 18 | Maldives       | 28 | The Arab Republic of Egypt |
| 9  | Cambodia       | 19 | Moldova        | 29 | Turkey      |
| 10 | India          | 20 | Mongolia       | 30 | Ukraine     |

3.2. Country economic risk assessment indicator

The relevant indicators of national economic risks are the basis for a comprehensive assessment of the economic risks of countries. Refer to the country risk indicator system proposed by Hu and Wang[4], to construct the following indicators as evaluation criteria for evaluating the economic risks of countries along the Belt and Road. The purpose of CCR multiplier model is to maximize the output
index and minimize the input index. Therefore, the indicators is divided into the following input and output indicators.

| Indicators                      |
|--------------------------------|
| Output                        |
| GDP Growth Rate               |
| Export of goods and services  |
| Per capita GDP                |
| Input                         |
| Current account balance       |
| Total foreign debt            |

- **GDP growth rate (annual percentage):** GDP growth rate is the core indicator of economic fundamentals. The stronger a country’s GDP growth, the better its economic development prospects, the less likely it will default. Therefore, this index is chosen as the output indicator.

- **Export of goods and services:** Includes all transactions between residents of a country and other countries of the world, including changes in ownership of general goods from residents to non-residents, goods sent for processing or repair, non-monetary gold and services. The more exports of goods and services, the more foreign exchange the country earns, the richer the country is, and the smaller the economic risk, so this index is chosen as the export indicator.

- **Per capita GDP:** Per capita GDP is a measure of a country’s economic development, which directly reflects the degree of prosperity of a country. The higher a country’s per capita GDP is, the richer it will be and the less economic risks it will face. Therefore, this index is chosen as the output indicator.

- **Current account balance:** The current account balance is the sum of net exports of goods and services, net income and net current transfers. Current account balances are the original source of repayment of loans by debtor countries. The more current account balances are, the stronger the foreign exchange earning capacity of the debtor countries, the stronger the external solvency capacity and the smaller the economic risk. However, since the data found are all negative, according to the actual situation, combined with the non-negative index of the CCR multiplier model, the absolute value of the national data is used as the calculation data of each country. Therefore, the smaller the value, the smaller the economic risk, so it is selected as the input indicator.

- **Total foreign debt:** refers to debts repaid in the form of foreign currency, goods or services that are in arrears to nonresidents. The smaller the total foreign debt of a country, the smaller the debt burden and the less likely it is that a debt default will occur, so this paper choose it as the input indicator.

### 3.3. Country economic risks assessment method

Based on the DEA Sort idea, this paper will classify and analyze the economic efficiency scores of countries along the Belt and Road based on country economic risks related indicators. DEA Sort is an extension of DEA that aims to classify items into ordered classes[5]. This paper mainly uses the DEA multiplier model (CCR model) to calculate the classification requirements, and finally performs the class assignment according to K-means cluster analysis. The main methods are as follows:

**Step1. Calculation of the item efficiency scores.** For each item evaluated (this article is specific to each country), the efficiency score is calculated according to the following linear equation formula[3].

$$\max p_o = \sum_{r=1}^{s} \mu_r y_{ro}$$

s.t. $$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0, \quad j = 1, ..., n$$
$$\sum_{i=1}^{m} v_i x_{io} = 1$$
\[ \mu_r, v_i \geq 0, ..., n \]

Among them, \( j \) denotes the country which number is \( j \), \( y_{ro} \) denotes the output index \( r \) of the country which number is \( o \), \( x_{ij} \) denotes the input index \( i \) of the country which number is \( j \), \( p_o \) denotes the economic efficiency score of the country which number is \( o \), and \( \mu_r, v_i \) denote the output and input multipliers respectively.

Step2. Definition of classes. Sort according to the obtained efficiency score. Cluster analysis is the process of breaking a collection of physical or abstract objects into similar object classes. The K-means clustering method, also known as rapid clustering, is a widely used classical clustering algorithm. The data is regarded as a point on the K-dimensional space, and the Euclidean distance is used as an indicator to measure the degree of "degree of affinity" of the individual. Fast, simple algorithm, and efficient processing of large data sets[6]. K-means clustering is a stepwise clustering analysis of large sample data of user-specified categories. The so-called stepwise clustering analysis is to first classify the objects to be aggregated, and then gradually adjust to obtain the final K categories and cluster center.

Step3. Sorting into classes. Assign items to different classes based on final cluster centers.

### 4. Empirical analysis

This paper intends to use the DEA method to calculate the economic efficiency scores of 30 countries along the Belt and Road. The data comes from the International Monetary Fund's Balance of Payments Statistical Yearbook, the International Financial Statistics (IMF), World Bank National Accounts Data, and the OECD National Accounts Data File, most of which are 2018 data, some temporarily unavailable data will be replaced by 2017 data.

According to the proposed method, the economic efficiency scores of each country are calculated. The calculation results are shown in Table 3. Referring to the characteristics of the CCR multiplier model, the higher the economic efficiency score is, the less the economic risks of the country will face.

#### Table 3. Efficiency score for each country

| No | Country             | Score | No | Country             | Score | No | Country             | Score |
|----|---------------------|-------|----|---------------------|-------|----|---------------------|-------|
| 1  | Afghanistan         | 0.2792| 11 | Indonesia           | 0.4915| 21 | Montenegro          | 0.7975|
| 2  | Albania             | 0.5393| 12 | Jordan              | 0.4076| 22 | Nepal               | 0.7171|
| 3  | Armenia             | 0.5752| 13 | Kazakhstan          | 1.0000| 23 | Pakistan            | 0.2630|
| 4  | Bangladesh          | 0.7048| 14 | Kyrgyzstan          | 0.5526| 24 | Philippines         | 0.9731|
| 5  | Belarus             | 1.0000| 15 | Laos                | 0.5473| 25 | Romania             | 0.7681|
| 6  | Bhutan              | 0.8009| 16 | Lebanon             | 0.1971| 26 | Serbia              | 0.6390|
| 7  | Bosnia and Herzegovina | 0.5040 | 17 | Macedonia           | 1.0000| 27 | Sri Lanka           | 0.3434|
| 8  | Burma               | 0.2515| 18 | Maldives            | 1.0000| 28 | The Arab Republic of Egypt | 0.4626|
| 9  | Cambodia            | 0.9737| 19 | Moldova             | 0.5366| 29 | Turkey              | 0.4449|
| 10 | India               | 0.8693| 20 | Mongolia            | 0.4014| 30 | Ukraine             | 0.4662|

Then according to the result of efficiency score calculation, K-means clustering analysis is carried out by SPSS and classification is obtained. Then we can see 3 final cluster centers. The results are shown in Table 4.

#### Table 4. Final cluster centers

|          | 1         | 2         | 3         |
|----------|-----------|-----------|-----------|
| score    | 0.918253  | 0.306166  | 0.552398  |

The classification results are combined with the efficiency score to classify these countries. The final classification results are shown in the following Table 5.
Table 5. Classification result

| Country                      |
|------------------------------|
| **Low-risk**                 |
| Belarus, Kazakhstan, Macedonia, Maldives, Cambodia, Philippines, India, Bhutan, Montenegro, Romania |
| **Medium-risk**              |
| Nepal, Bangladesh, Serbia, Armenia, Kyrgyzstan, Laos, Albania, Moldova, Bosnia and Herzegovina, Indonesia, Ukraine, The Arab Republic of Egypt, Turkey |
| **High-risk**                |
| Jordan, Mongolia, Sri Lanka, Afghanistan, Pakistan, Burma, Lebanon |

The results showed that among the 30 sample countries, the five countries with the highest risk were Lebanon, Burma, Pakistan, Afghanistan, Sri Lanka, and the five countries with the lowest risk were Belarus, Kazakhstan, Macedonia, Maldives, Cambodia.

5. Conclusion

The strategy of the Belt and Road has become one of China’s most important national strategies and will profoundly affect the world’s political and economic landscape. Country-specific risk analysis for countries along the Belt and Road has important implications for cross-border operations in various countries. Since country risks involve a wide range of issues, this paper only considers the economic risks in country risks, and does not carry out further analysis on other risks such as social risks, so it has certain limitations.

Based on the previous achievements, this paper proposes to use the DEA method to quantitatively study the economic risks of countries along the Belt and Road from the perspective of economic risks, and draws the following conclusions: Overall, medium-risk and high-risk countries account for about two-thirds of the 30 sample countries along the Belt and Road. The country’s economic risks are generally high in the sample countries. The low-risk countries include only ten countries including Belarus, Kazakhstan, Macedonia. Looking ahead, as the strategy of the Belt and Road advances, the corresponding companies in the construction of the Belt and Road should understand the economic risk level of the countries along the route in order to make favorable decisions.

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