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EVALUATION OF THE BUSINESS ENVIRONMENT OF PARTICIPATING COUNTRIES OF THE BELT AND ROAD INITIATIVE

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Abstract. As an important indicator for measuring the quality of business environment of different countries, ease of doing business (EDB) issued by the World Bank (WB) provides an important reference for investors in making decisions on transnational investment. The calculation method for EDB issued by the WB is improved using a technique for order preference by similarity to an ideal solution (TOPSIS) method based on Mahalanobis distance. Based on various indicator data in 2019, business environments in 121 countries participating in "the Belt and Road Initiative (BRI)" were empirically analysed and compared through such models. The result showed that TOPSIS method based on Mahalanobis distance can more fully utilise information and take the effect of negative ideal points into account. Therefore, compared with ranking method by the WB, TOPSIS method based on Mahalanobis distance is more applicable for ranking BRI countries. The ranking results indicated significant geographical characteristics. The EDB rankings obtained through the WB overestimate the business environments of countries in Central and Eastern Europe while underestimate those in Southeast Asia, Africa, etc.

Keywords: the Belt and Road initiative, TOPSIS, Mahalanobis distance, business environment.

JEL Classification: C63, F13, F41.

Introduction

"The Belt and Road Initiative" (BRI), as a major strategic measure for expanding opening-up, was proposed by the Chinese Government in 2013. It aims to facilitate orderly and free flow of economic factors, efficient allocation of resources and deep integration of markets; drive coordination of economic policies of various BRI countries; carry out even boarder and more sophisticated regional cooperation; and foster a regional framework of open and inclusive economic cooperation (Yan et al., 2018). BRI has effectively facilitated China's in-

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vestment and cooperation with BRI countries (Huang, 2019; Cullinane et al., 2018); however, investment risk will increase due to some problems of business environments of some BRI countries (Li et al., 2019), including unstable political situations, disputes around resource utilisation and development, and frequent changes in regulations and policies (Qu & Yang, 2017). Therefore, conducting comprehensive evaluation on business environments of various BRI countries by utilising scientific methods provides reference for enterprises in making decisions on transnational investment and also promotes BRI countries to improve their business environments to some extent.

In terms of business environment, the World Bank (WB) will issue an annual *Doing Business* every year. The WB measures the ease of doing business (EDB) based on the whole life cycle of an enterprise, from the initial stage of entrepreneurship to acquisition of a business site, financing, daily operation, and operation in a safe business environment. To measure EDB of each country, the WB measures EDB scores of various indicators every year to calculate the sum based on a simple additive weighting method. In this way, the EDB rankings of 190 countries in the world are determined. Various indicators, based on which the WB calculates EDB ranking, are significantly correlated with one another, and various economies show a great difference in terms of various indicators; however, when calculating EDB ranking, the WB just calculates the gap between each country with the country with the frontier score. Moreover, the WB only performs simple additive weighting for various indicator data but also ignores the dependency of various indicators and the distance of various economies to negative ideal points. Obviously, the method for calculating EDB ranking remains to be modified. How best to evaluate the business environments of BRI countries has attracted attention of many scholars.

As for evaluation objects, existing research mostly only evaluates the business environments of a small number of BRI countries. For example, by investigating the business environment of Nepal, Shrestha (2017) found that although the economic growth potential of Nepal is high, there are a series of problems such as unsound rule of law and imperfect infrastructure. By analysing business environments of the five countries in Central Asia, Yue and Qian (2015) showed that the five countries have a significant difference, however, either at an infrastructural level and in terms of financial environment or in political environment and labour market contexts, Kazakhstan's EDB is optimal; Huang (2019) evaluated the business environments of 64 BRI countries and showed that Singapore, Bhutan, Nepal, Myanmar, Laos, and most countries in Central and Eastern Europe have the best business environment while India's business environment is the worst. Some scholars also explored business environments of a minority of BRI countries (Zhong & Fan, 2016; Xu et al., 2015; Du & Zhang, 2018). These scholars carry outed analysis mostly focusing on 64 countries. Among the 64 countries, Singapore and New Zealand exhibit a relatively favourable business environment; by contrast, business environments of Kyrghyzstan, Tajikistan, etc. are relatively poor.

In terms of evaluation method, scholars mostly apply extended gravity models and an analytic hierarchy process (AHP) or evaluate the business environment directly based on the WB's evaluation indicator system. By utilising an extended gravity model, Kong and Dong (2015) validated the promotion effect of trade facilitation on trade between BRI countries is more significant compared with regional economic organisations, national GDP (gross domestic product) brought about by import and export, tariff reduction and exemption,

etc. Cui and Huang (2016) explored the evaluation indicator system for trade and investment facilitation of BRI countries by employing AHP and further measured the trade and investment facilitation levels of various BRI countries. Additionally, in the literature, business environments in different countries were measured mostly according to EDB rankings or EDB scores issued by the WB (Escaleras & Chiang, 2017; Lu & Chen, 2018; Corcoran & Gillanders, 2015). The WB's evaluation system is relatively comprehensive; however, the calculation method for EDB ranking issued by the WB fails to utilise fully raw data to reflect the gap between various countries on the one hand; on the other hand, the method often leads to the occurrence of problems such as information overlapping.

Above all, the existing research exhibits two drawbacks: firstly, scholars evaluate business environments mostly based on EDB rankings issued by the WB, which often causes information overlapping and insufficient information utilisation. Secondly, some 125 countries are participating in the BRI initiative while only a small number of them were systematically evaluated in the existing literature.

Ranking business environments of BRI countries belongs to a multiple attribute decision-making problem: among numerous methods for multiple attribute decision-making, the technique for order preference by similarity to an ideal solution (TOPSIS) method is widely applied to good effect due to its simple principle, intuitive geometrical significance, and imposing no special requirement on sample data (Dwivedi et al., 2018; Sirisawat & Kiatcharoenpol, 2018; Vidal & Sánchez-Pantoja, 2019). Numerous scholars have also improved the traditional TOPSIS method applied the improved method to empirical research. A summary of the literature on improved TOPSIS in recent years is given in Table 1.

By using Mahalanobis distance-based TOPSIS, the method for calculating EDB ranking issued by the WB is modified to solve a series of problems, including high dependency between various indicators and ignoring negative ideal points during calculation. Moreover, the business environments of 121 BRI countries are evaluated and ranked. The innovation in the research is as follows:

1) Based on data concerning all primary indicators in the WB's *Doing Business* database, the business environments of BRI countries are assessed by using traditional TOPSIS method to calculate the closeness of indicators of various countries. On this basis, all BRI countries are ranked, in expecting to solve the problem of only considering gap of each country to the country with frontier score while ignoring that to the country with the lowest score when calculating EDB scores.
2) By introducing the Mahalanobis distance, the traditional TOPSIS method is improved. According to raw data pertaining to various indicators, the closeness of indicators of various countries is separately calculated by using Mahalanobis distance-based TOPSIS. On this basis, all BRI countries are ranked. Mahalanobis distance considers the relationship between various indicators and is dimensionless. Therefore, it can solve the problem of information overlapping, which is not considered in traditional TOPSIS methods or that used in EDB ranking.
3) All BRI countries are ranked separately according to results of similarity obtained by using the traditional TOPSIS method and Mahalanobis distance-based TOPSIS. Additionally, from the statistical and geographical perspectives, a comparison is made to analyse differences in the ranking results of the two methods with the ranking issued by the WB.

Table 1. Summary of the literature regarding improved TOPSIS in recent years

Author(s)	Improvement(s)	Application(s)	Result(s)
Tang, Shi, and Dong (2018)	using entropy and TOPSIS	public blockchain evaluation	Bitcoin, Ethereum and EOS are ranked in the top three public blockchains.
Wang and Wang (2014)	using a TOPSIS Method Based on Entropy Weight and Mahalanobis Distance	the External Performance appraisal of China Energy Regulation	Compared to the social responsibility performance, the fluctuation of external economic performance more sensitive to energy regulation.
Walczak and Rutkowska (2017)	use the fuzzy TOPSIS method	project rankings for participatory budget	The paper describes the application of fuzzy TOPSIS with a modification for PB.
Gupta (2018)	BWM & fuzzy TOPSIS	evaluating organization performance	The paper provides a framework for managers to evaluate their organization's performance.
Piwowarski, Miłaszewicz, Łatuszyńska, Borawski, and Nermend	TOPSIS & VIKOR	study of sustainable development in the EU countries	The paper studies sustainable development in the EU countries.
Sun, Miao, and Yang (2018)	entropy weighted TOPSIS	ecological-economic efficiency evaluation	The highest is the home audio-visual equipment manufacturers and the lowest is the electronic computer manufacturers.
Zeng and Xiao (2018)	HFOWAWAD-TOPSIS	energy policy selection	Reflect the importance of the degrees of the subjective information of attribute and the attitudinal character of decision maker.
dos Santos, Godoy, and Campos (2019)	Entropy-TOPSIS-F	performance evaluation of green suppliers	"Management Commitment to GSCM", "Ecodesign" and "Environmental management system" are the first three criteria in the ranking of selection of sustainable suppliers.
Bai and Sarkis (2018)	Grey-based TOPSIS	evaluating supplier performance	The paper provides support for sustainable supplier selection.
Wang, Hao, Gao, Zhang, and Zhou (2019)	DEA-TOPSIS	shanghai End-of-life vehicles industry	The DEA-TOPSIS method based on TES is effective for multi-attribute decision-making to improve the ELV reverse logistics industry's efficiency.
Khan, Bilal, and Young (2018)	Fuzzy-TOPSIS	mobile wireless sensor networks	Results shows that the proposed scheme improves the network lifetime by 60%, conserve energy by 80%, a significant reduction of frequent Cluster Head (CH) per round selection by 25% is achieved as compared to the conventional Fuzzy and LEACH protocols.

End of Table 1

Author(s)	Improvement(s)	Application(s)	Result(s)
Ouenniche, Pérez-Gladish, and Bouslah (2018)	TOPSIS classifiers	bankruptcy prediction	Empirical results show an outstanding predictive performance both in-sample and out-of-sample and thus opens a new avenue for research and applications in risk modelling and analysis using TOPSIS as a non-parametric classifier and makes it a real contender in industry applications in banking and investment.

Notes: DEA = Data Envelopment Analysis; VIKOR = VIsekrzterijumska Optimizacija i Kompromisno Resenje; BWM = Best Worst Method; F = Fuzzy; TES = Triple Exponential Smoothing; HFOWAWAD-TOPSIS = Hesitant fuzzy ordered weighted averaging weighted averaging distance (HFOWAWAD) measure, a modified hesitant fuzzy TOPSIS.

The rest of the study is organized as follows: Section 1 introduces evaluation methods, involving traditional TOPSIS method and Mahalanobis distance-based TOPSIS; Section 2 empirically analyses the ranking of business environments of BRI countries and discusses the evaluation result from statistical and geographical perspectives; last Section concludes.

1. Evaluation methods

The traditional TOPSIS method inevitably shows the drawback of causing information loss (Wang & Wang, 2014; Wang et al., 2018) while Mahalanobis distance can favourably solve the problem of linear correlation between indicators (Ke et al., 2018; Hamill et al., 2016; González-Arteaga et al., 2016) and compensate for deficiencies in the traditional TOPSIS method. In the present study, the traditional TOPSIS method and Mahalanobis distance-based TOPSIS are introduced.

1.1. Traditional TOPSIS method

TOPSIS is a method for dealing with uncertain multi-attribute decision-making problem, which is applied to conduct ranking based on the distances of an evaluation object to positive and negative ideal solutions (Pelegrina et al., 2019; Zeng et al., 2020b; Yoon & Kim, 2017). A positive ideal solution consists of optimal values of all indicators while the negative ideal solution comprises the worst values of all indicators (Zeng et al., 2020a; Jiang et al., 2019; Zareie et al., 2018).

It is supposed that there are m countries $A=\{A_1,A_2,...,A_m\}$ and n indicators $F=\{f_1,f_2,...,f_n\}$. The decision matrix $X=(x_{ij})_{m\times n}, i=1,2,...,m; j=1,2,...,n$ for decision making is established, in which x_{ij} denotes the value of jth indicator of the ith country. The specific steps of TOPSIS method for evaluation are summarised as follows (Yoon, 1987; Hwang et al., 1993; Hwang & Yoon, 1981):

Normalised decision matrix $R=(r_{ij})_{m\times n}$ is constructed, that is, the decision matrix is normalised, where,

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}x_{ij}^2}}\ . \tag{1}$$

Afterwards, positive and negative ideal solutions S^+ and S^- are determined:

$$S^+ = \left\{s_1^+, s_2^+, \cdots, s_n^+\right\}; \tag{2}$$

$$S^- = \left\{s_1^-, s_2^-, \cdots, s_n^-\right\}, \tag{3}$$

$s_j^+ = \max_i r_{ij},\ j = 1,2,\cdots,n.\ \ s_j^- = \min_i r_{ij},\ \ j = 1,2,\cdots,n.$

Next, Euclidean distances (d_i^+ and d_i^-) of indicators of various countries to positive and negative ideal solutions are separately calculated:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(s_j^+ - r_{ij})^2}, i = 1,2,...,m; \tag{4}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(s_j^- - r_{ij})^2}, i = 1,2,...,m. \tag{5}$$

Subsequently, the relative closeness c_i of indicators of various countries to positive ideal solution is separately calculated:

$$c_i = \frac{d_i^-}{d_i^- + d_i^+}, i = 1,2,...,m. \tag{6}$$

Finally, according to the level of c_i, ranking is carried out: the larger c_i is, the better the scheme.

Traditional TOPSIS evaluation objectively reflects the gap between various countries by introducing positive and negative ideal solutions; however, when there is a significant linear relationship between indicators, column vector consisting of n different attribute indicators fails to make up a group of bases for measuring the linear space. Therefore, in this case, calculating the distances of indicators of various countries to positive and negative ideal solutions according to Euclidean distance will lead to erroneous final rankings for various countries.

1.2. Mahalanobis distance-based TOPSIS

To tackle the problem of information overlapping caused by dependency between variables, Mahalanobis distance is introduced to improve the traditional TOPSIS method (Antuchevičienė et al., 2010; Chang et al., 2010). As a statistical distance, Mahalanobis distance is independent of measurement scale and is unaffected by dimension of coordinates. Moreover, it can eliminate interference caused by dependency between variables (that is, removing the influence induced by linear correlation between attribute indicators).

It is assumed that there are m countries $A = \{A_1, A_2, ..., A_m\}$ and n indicators $F = \{f_1, f_2, ..., f_n\}$. The decision matrix $X = (x_{ij})_{m\times n}, i = 1,2,...,m; j = 1,2,...,n$ for decision making is established, in which x_{ij} denotes the value of jth indicator of the ith country. x_i refers to the spatial coordinates of the corresponding attribute value of the ith country. The specific steps of the Mahalanobis distance-based TOPSIS for evaluation are described below.

Positive and negative ideal solutions $S^{,+}$ and $S^{,-}$ are determined;

$S^{,+} = \left\{ s_1^{+}, s_2^{+}, \cdots, s_n^{+} \right\}$ and $S^{,-} = \left\{ s_1^{-}, s_2^{-}, \cdots, s_n^{-} \right\}$ represent corresponding spatial coordinates of positive and negative ideal solutions,

where, $s_j^{+} = \max_i x_{ij}$, $j = 1,2,\cdots,n$. $s_j^{-} = \min_i x_{ij}$, $j = 1,2,\cdots,n$.

Next, Mahalanobis distances ($mahal_i^{+}$ and $mahal_i^{-}$) of indicators of various countries to positive and negative ideal solutions are separately calculated:

$$mahal(x_i, S^{,+}) = \sqrt{\{x_{ij} - s_j^{+}\}^T \Sigma^{-1} \{x_{ij} - s_j^{+}\}}, i = 1,2,...,m; \tag{7}$$

$$mahal(x_i, S^{,-}) = \sqrt{\{x_{ij} - s_j^{-}\}^T \Sigma^{-1} \{x_{ij} - s_j^{-}\}}, i = 1,2,...,m, \tag{8}$$

where, Σ^{-1} denotes the inverse matrix of covariance matrix Σ of n attribute variables $x_1, x_2, \cdots, x_n$.

Subsequently, the relative closeness c_i of indicators of various countries to positive ideal solution is separately calculated:

$$c_i = \frac{mahal(x_i, S^{,-})}{mahal(x_i, S^{,-}) + mahal(x_i, S^{,+})}, i = 1,2,...,m. \tag{9}$$

Finally, ranking is conducted according to the level of c_i. The larger c_i, the better the scheme.

When evaluation indicators are significantly correlated, Mahalanobis distance is unaffected by dimension of indicators and also eliminates the information overlapping caused by linear correlation of indicators. Therefore, Mahalanobis distance is more applicable for dealing with complex practical problems. Additionally, in practical application, the overall covariance matrix is generally unknown so can be replaced with a sample covariance matrix.

2. Empirical analysis of the business environments of BRI countries

Based on indicator data for business environments of various countries issued by the WB, 121 BRI countries are ranked by separately using a traditional TOPSIS method and Mahalanobis distance-based TOPSIS. Moreover, the list of 121 BRI countries was copied from the Belt and Road Portal (n.d.). The EDB rankings and indicator data for business environments of various BRI countries are all taken from *Doing Business 2019: Training for Reform* (The World Bank, 2018). The organisation of empirical analysis is described below.

At first, the indicator system for empirical analysis is explained and indicator data are subjected to descriptive statistical analysis. The mode and median of indicator data are separately calculated and Pearson correlation analysis is undertaken.

Afterwards, based on various indicator data, the WB's rankings are collected and recorded. By separately utilising the traditional TOPSIS method and Mahalanobis distance-based TOPSIS introduced in the last section, the EDB of various BRI countries is ranked.

Finally, statistical analysis is carried out on empirical results. The BRI countries are divided into nine regions including Northeast Asia and Southeast Asia according to their geographical locations. The results obtained through empirical analysis and statistical analysis are mapped.

2.1. Indicator system and data analysis

2.1.1. Indicator system

The WB's *Doing Business* database has a set of mature and stable indicator system, which is used for measuring and evaluating EDB of various countries. Since 2003, the WB has issued *Doing Business* report every year. The report measures the supervision and regulations of each country (region) for their medium and small-sized enterprises based on ten indicator sets. The measurement indicators cover ten fields of life cycle of an enterprise, which can be partitioned into two aspects. The two aspects are respectively used to measure the effectiveness of government supervision on enterprises and completeness of the legal system of various countries. The former is applied to measure supervisory process and efficiency involved in starting a business, applying for construction permits, getting electricity, registering property, paying taxes and trading across borders; the latter is employed to evaluate the soundness of law and regulation framework in various aspects, including getting credit, protecting minority investors, enforcing contracts and resolving insolvency. These indicators are used to evaluate procedure, time and cost for completing a deal according to related regulations from the perspectives of enterprises, which are sound and perfect. Economic literature is used to validate the economic relevance and importance of the fields in which business environment is measured. By taking starting a business as an example, since 2003, 100 top-level academic journals have published more than 300 research papers describing how to evaluate how the regulation environment for market access influences extensive economic results such as production efficiency, growth, employment and informality (The World Bank, 2018). By taking the indicator system as reference standard, analysis is conducted (Table 2).

Table 2. Indicator system for business environment (source: The World Bank, 2018)

Indicator set	Measurement content
Starting a business (X_1)	Procedures, time, cost and minimum contributed capital required when a male or a female starts a limited liability company.
Applying for construction permits (X_2)	All procedures, time, cost of building warehouse and quality control and safety mechanism in construction permit system.
Getting electricity (X_3)	Procedures, time and cost of connecting to the power grid, reliability of power supply, and transparency of electric charge.
Registering property (X_4)	Procedures, time and cost of dealing with land transfer and quality of land administration by a male or a female.
Getting credit (X_5)	law of chattel mortgage and credit information system.
Protecting minority investors (X_6)	Minority shareholders' rights in related transaction and corporate governance.
Paying taxes (X_7)	The number and time of tax payments, total tax, total amount of levies, and post-filing process during the operation of a company complying with all tax laws and regulations.
Trading across borders (X_8)	Time and cost of exporting relatively superior products and importing auto parts.
Enforcing contracts (X_9)	Time and cost of solving commercial dispute and quality when a male or a female performs judicial process.
Resolving insolvency (X_{10})	Time, cost, result and recovery rate of insolvency and intensity of insolvency legal framework.

2.1.2. Descriptive statistical analysis

Various characteristics (including high dependency) of various indicator data are likely to affect empirical result. To understand the characteristics (such as discrete degree, distribution condition and dependency) of various indicator data, all indicator data are subjected to descriptive statistical analysis before further empirical analysis. The specific descriptive statistical results are shown in Table 3: the maxima and minima of all indicators are all within reasonable ranges and the mean of various indicators is much greater than their standard deviation. This indicates that the discreteness of the data is low and the probability of having extreme outliers is low. The mean, median, and mode of starting a business (X_1) are relatively approximated to those of enforcing contracts (X_9), implying that the data of the two indicators are approximately symmetrically distributed. According to value of skewness, it can be seen that the 10 indicator data values all exhibit a right-skewed distribution.

Furthermore, Pearson correlation analysis is conducted on all indicator data to test the correlation between indicators. The results of correlation analysis are shown in Table 4. There

Table 3. Descriptive statistics

	Mode	Median	Mean	Standard Deviation	Maximum	Minimum	Kurtosis	Skewness
X_1	83.900	85.070	82.976	12.144	99.980	25.000	7.064	–1.709
X_2	0.000	67.640	64.489	15.733	86.960	0.000	10.084	–2.252
X_3	0.000	71.410	67.137	20.834	100.000	0.000	4.249	–1.069
X_4	50.140	63.670	62.324	17.604	94.890	0.000	4.183	–0.571
X_5	70.000	55.000	52.314	24.758	100.000	0.000	2.278	–0.308
X_6	51.670	55.000	55.124	15.498	85.000	0.000	3.195	–0.320
X_7	84.720	71.480	67.706	17.405	99.440	0.000	4.859	–1.081
X_8	100.000	70.360	68.167	22.671	100.000	0.000	3.109	–0.689
X_9	59.330	56.440	55.926	13.510	84.530	6.130	3.011	–0.582
X_{10}	0.000	42.420	42.392	20.925	83.660	0.000	2.876	–0.422

Table 4. Pearson correlation

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	1.000	0.409**	0.494**	0.386**	0.386**	0.604**	0.544**	0.420**	0.367**	0.374**
X_2	0.409**	1.000	0.592**	0.490**	0.436**	0.443**	0.394**	0.431**	0.363**	0.370**
X_3	0.494**	0.592**	1.000	0.483**	0.474**	0.488**	0.529**	0.595**	0.426**	0.502**
X_4	0.386**	0.490**	0.483**	1.000	0.504**	0.440**	0.540**	0.570**	0.679**	0.471**
X_5	0.386**	0.436**	0.474**	0.504**	1.000	0.581**	0.360**	0.483**	0.443**	0.521**
X_6	0.604**	0.443**	0.488**	0.440**	0.581**	1.000	0.506**	0.420**	0.390**	0.593**
X_7	0.544**	0.394**	0.529**	0.540**	0.360**	0.506**	1.000	0.522**	0.478**	0.351**
X_8	0.420**	0.431**	0.595**	0.570**	0.483**	0.420**	0.522**	1.000	0.491**	0.511**
X_9	0.367**	0.363**	0.426**	0.679**	0.443**	0.390**	0.478**	0.491**	1.000	0.406**
X_{10}	0.374**	0.370**	0.502**	0.471**	0.521**	0.593**	0.351**	0.511**	0.406**	1.000

Note: **exhibits a significant correlation under a level of 0.01(bilateral).

is a common correlation between various indicators and the correlation coefficient is statistically significant at the significance level of 1%. Therefore, when selecting indicator evaluation method, it is essential to select a proper method to deal with the correlation of various indicators to eliminate repetitive computation of information.

2.2. Empirical results

The empirical results are organised as follows: at first, by looking up rankings of business environments of 190 countries across the world issued by the WB, rankings of business environments of 121 BRI countries are attained; then, using a traditional TOPSIS method, the rankings of business environments of BRI countries are calculated; Finally, the business environments of BRI countries are ranked by applying Mahalanobis distance-based TOPSIS.

2.2.1. Ranking method 1: collecting ranking results issued by the WB

Doing Business issued by the WB synthesised 10 indicators to list two criteria for measuring business environments of various countries (regions): EDB score and EDB ranking. The latter is sorted according to the level of the former: the country (region) with a higher EDB score ranks higher and *vice versa*. The EDB score is calculated by using simple additive weighting after assigning each indicator the same weight.

By looking up *Doing Business 2019: Training for Reform* issued by the WB, the EDB scores of 121 BRI countries are collected. According to scores, the BRI countries are ranked and the result is shown in Table 5.

2.2.2. Ranking method 2: traditional TOPSIS method

Based on the design of traditional TOPSIS method for business environments of BRI countries and construction and selection of the aforementioned evaluation indicators, the business environments of 121 BRI countries are ranked. The specific calculation steps are described below.

At first, by using all indicator data of 121 BRI countries, a 121×10 decision matrix for decision making is established. Where, x_{ij} refers to the value of the jth indicator of the ith BRI country. The decision matrix for decision making is normalised based on (1).

Afterwards, the maximum of each column in the normalised decision matrix for decision making is collected to construct the positive ideal solutions $S^+$of various indicators. Similarly, the minimum of each column is used to establish the negative ideal solutions S^- of various indicators. The results are described below.

S^+ = {0.108 0.119 0.129 0.133 0.157 0.135 0.129 0.127 0.134 0.161};

S^- = {0.027 0.000 0.000 0.000 0.000 0.000 0.000 0.010 0.000}.

Subsequently, according to Eqs (4) and (5), by applying the positive and negative ideal solutions obtained in the last step and the normalised decision matrix for decision making, the Euclidean distances (d_i^+ and d_i^-) of indicators of different countries to positive and negative ideal solutions are calculated.

Finally, according to Equation (6), the relative closeness c_i of indicators of BRI countries to positive ideal solution is separately calculated using d_i^+ and d_i^-. Where, the larger the closeness c_i, the closer the indicators of a country to the positive ideal solution and the higher the EDB ranking of the country. The specific ranking result is displayed in Table 5.

2.2.3. Ranking method 3: Mahalanobis distance-based TOPSIS

According to the indicator system aforementioned and indicator data of the WB's *Doing Business* database, the business environments of BRI countries are evaluated by employing Mahalanobis distance-based TOPSIS. The specific steps for evaluation are as follows:

At first, using all indicator data of 121 BRI countries, a 121×10 decision matrix is established in which, x_{ij} denotes the value of the jth indicator of the ith BRI country.

Afterwards, the maximum of each column in the decision matrix is calculated to build the positive ideal solutions S^+ of various indicators. Here:

S^+ = {99.980 86.960 100.000 94.890 100.000 85.000 99.440 100.000 84.530 83.660}.

The minimum of each column in the decision matrix is derived to determine the negative ideal solutions S^- of various indicators. Here:

S^- = {25.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 6.130 0.000}.

Subsequently, the covariance matrix Σ of the decision matrix is calculated to attain its inverse matrix Σ^{-1} through inverse calculation. Based on Eqs (7) and (8), Mahalanobis distances $mahal_i^+$ and $mahal_i^-$ of indicators of various BRI countries to positive and negative ideal solutions are calculated using the decision matrix and the attained Σ^{-1}, S^+ and S^-.

Finally, according to Eq. (9), based on $mahal_i^+$ and $mahal_i^-$ found above, the closeness c_i of indicators of various BRI countries to the positive ideal solution is separately calculated. The larger the closeness c_i, the better the business environment of a country and the higher the EDB ranking thereof. The specific c_i values and ranking result are listed in Table 5.

Table 5. The EDB ranking results of WB & traditional TOPSIS method & Mahalanobis distance-based TOPSIS

Country	The EDB ranking results of WB		The EDB ranking results of traditional TOPSIS method		The EDB ranking results of Mahalanobis distance-based TOPSIS	
	EDB score	EDB ranking results	closeness	EDB ranking results	closeness	EDB ranking results
New Zealand	86.590	1	0.894	1	0.813	2
Singapore	85.240	2	0.875	2	0.847	1
Korea	84.140	3	0.843	4	0.775	7
Georgia	83.280	4	0.839	5	0.797	4
Republic of Macedonia	81.550	5	0.850	3	0.800	3
United Arab Emirates	81.280	6	0.789	15	0.757	10
Lithuania	80.830	7	0.784	17	0.764	8
Malaysia	80.600	8	0.826	6	0.724	17

Continue of Table 5

Country	The EDB ranking results of WB		The EDB ranking results of traditional TOPSIS method		The EDB ranking results of Mahalanobis distance-based TOPSIS	
	EDB score	EDB ranking results	closeness	EDB ranking results	closeness	EDB ranking results
Estonia	80.500	9	0.802	10	0.754	12
Latvia	79.590	10	0.814	7	0.788	6
Azerbaijan	78.640	11	0.812	8	0.790	5
Austria	78.570	12	0.791	14	0.737	15
Thailand	78.450	13	0.807	9	0.756	11
Kazakhstan	77.890	14	0.793	13	0.760	9
Rwanda	77.880	15	0.793	12	0.686	28
Russia	77.370	16	0.788	16	0.744	14
Poland	76.950	17	0.796	11	0.722	18
Czech Republic	76.100	18	0.771	18	0.628	57
Belarus	75.770	19	0.740	23	0.685	29
Slovenia	75.610	20	0.740	24	0.659	45
Armenia	75.370	21	0.741	22	0.700	23
Slovakia	75.170	22	0.763	19	0.665	44
Turkey	74.330	23	0.737	26	0.719	20
China	73.640	24	0.736	28	0.702	22
Moldova	73.540	25	0.739	25	0.675	36
Serbia	73.490	26	0.736	27	0.696	24
Israel	73.230	27	0.751	21	0.728	16
Montenegro	72.730	28	0.752	20	0.708	21
Romania	72.300	29	0.736	29	0.681	33
Hungary	72.280	30	0.726	30	0.685	32
Brunei	72.030	31	0.723	33	0.671	39
Chile	71.810	32	0.723	32	0.747	13
Croatia	71.400	33	0.716	35	0.666	43
Bulgaria	71.240	34	0.719	34	0.685	31
Morocco	71.020	35	0.694	38	0.721	19
Kenya	70.310	36	0.724	31	0.675	37
Bahrain	69.850	37	0.676	39	0.669	40
Albania	69.510	38	0.708	36	0.646	48
Costa Rica	68.890	39	0.675	41	0.624	60
Vietnam	68.360	40	0.671	42	0.668	41
Kyrgyz Republic	68.330	41	0.676	40	0.610	70
Ukraine	68.250	42	0.666	46	0.694	25
Greece	68.080	43	0.667	45	0.651	46
Indonesia	67.960	44	0.700	37	0.641	51
Mongolia	67.740	45	0.662	48	0.680	34
Uzbekistan	67.400	46	0.671	44	0.688	27
India	67.230	47	0.660	50	0.587	83
Oman	67.190	48	0.639	54	0.674	38
Panama	66.120	49	0.647	52	0.580	89
Tunisia	66.110	50	0.660	49	0.685	30

Continue of Table 5

Country	The EDB ranking results of WB		The EDB ranking results of traditional TOPSIS method		The EDB ranking results of Mahalanobis distance-based TOPSIS	
	EDB score	EDB ranking results	closeness	EDB ranking results	closeness	EDB ranking results
Bhutan	66.080	51	0.595	66	0.622	62
South Africa	66.030	52	0.671	43	0.690	26
Qatar	65.890	53	0.617	57	0.604	71
Malta	65.430	54	0.626	56	0.647	47
Salvador	65.410	55	0.652	51	0.686	84
Zambia	65.080	56	0.645	53	0.611	69
Bosnia	63.820	57	0.662	47	0.562	98
Samoa	63.770	58	0.616	58	0.680	35
Saudi Arabia	63.500	59	0.584	70	0.592	80
Uruguay	62.600	60	0.627	55	0.628	56
Republic of Seychelles	62.410	61	0.615	59	0.640	52
Kuwait	62.200	62	0.605	61	0.666	42
Djibouti	62.020	63	0.610	60	0.623	61
Sri Lanka	61.220	64	0.598	64	0.615	65
Dominican Republic	61.120	65	0.596	65	0.611	67
Dominia	61.070	66	0.581	72	0.642	50
Jordan	60.980	67	0.582	71	0.626	59
Trinidad and Tobago	60.810	68	0.604	62	0.576	91
Namibia	60.530	69	0.601	63	0.611	68
Papua New Guinea	60.120	70	0.591	68	0.576	92
Nepal	59.630	71	0.594	67	0.597	76
Antigua and Barbuda	59.480	72	0.572	75	0.635	55
Ghana	59.220	73	0.576	74	0.643	49
Palestine	59.110	74	0.555	81	0.536	104
Arab republic of egypt	58.560	75	0.584	69	0.611	66
Cote d'Ivoire	58.000	76	0.579	73	0.598	74
Philippines	57.680	77	0.554	82	0.571	96
Tajikistan	57.110	78	0.556	80	0.640	53
Uganda	57.060	79	0.571	76	0.620	64
Islamic Republic of Iran	56.980	80	0.560	78	0.596	77
Cape Verde	55.950	81	0.520	91	0.621	63
Guyana	55.570	82	0.540	84	0.638	54
Mozambique	55.530	83	0.541	83	0.560	99
Pakistan	55.310	84	0.559	79	0.581	88
Togo	55.200	85	0.537	86	0.590	81
Cambodia	54.800	86	0.561	77	0.451	119

End of Table 5

Country	The EDB ranking results of WB		The EDB ranking results of traditional TOPSIS method		The EDB ranking results of Mahalanobis distance-based TOPSIS	
	EDB score	EDB ranking results	closeness	EDB ranking results	closeness	EDB ranking results
Maldives	54.430	87	0.524	90	0.626	58
Senegal	54.150	88	0.526	88	0.593	79
Lebanon	54.040	89	0.524	89	0.603	63
Tanzania	53.630	90	0.538	85	0.575	93
Nigeria	52.890	91	0.530	87	0.586	85
Grenada	52.710	92	0.493	96	0.595	78
Mauritania	51.990	93	0.489	97	0.589	82
Gambia	51.720	94	0.505	92	0.582	87
Guinea	51.510	95	0.501	93	0.598	75
Laos	51.260	96	0.489	98	0.515	111
Zimbabwe	50.440	97	0.497	95	0.527	108
Bolivia	50.320	98	0.497	94	0.513	112
Algeria	49.650	99	0.468	102	0.523	110
Ethiopia	49.060	100	0.473	105	0.583	86
Madagascar	48.890	101	0.477	101	0.572	95
Sudan	48.840	102	0.479	100	0.570	97
Sierra Leone	48.740	103	0.472	104	0.603	72
Suriname	48.050	104	0.463	106	0.505	113
Cameroon	47.780	105	0.472	103	0.550	101
Afghanistan	47.770	106	0.482	99	0.534	105
Burundi	47.410	107	0.457	107	0.579	90
Gabon	45.580	108	0.441	108	0.533	106
Myanmar	44.720	109	0.427	110	0.531	107
Iraq	44.720	110	0.436	109	0.573	94
Angola	43.860	111	0.426	111	0.551	100
Bangladesh	41.940	112	0.411	113	0.539	103
East Timor	41.060	113	0.415	112	0.501	115
Syrian Arab Republic	41.570	114	0.408	114	0.502	114
Congo	39.830	115	0.398	115	0.526	109
Chad	39.360	116	0.389	116	0.478	118
South Sudan	35.340	117	0.370	117	0.549	102
Libya	33.440	118	0.355	119	0.479	117
Yemen	32.410	119	0.366	118	0.501	116
Venezuela Bolivarian Republic	30.610	120	0.323	120	0.439	120
Somalia	20.040	121	0.265	121	0.421	121

2.3. Analysis on empirical results

2.3.1. Statistical analysis

It can be seen from Table 5 that the EDB rankings obtained according to EDB scores issued by the WB are different from those attained by using the traditional TOPSIS method and Mahalanobis distance-based TOPSIS. The better to judge the differentiation of the ranking results obtained through the three methods, the ranking results attained according to WB, traditional TOPSIS method, and Mahalanobis distance-based TOPSIS are shown in Figure 1 where the left and right-hand figures show scatter diagrams for the comparisons of the ranking results obtained through the traditional TOPSIS method and Mahalanobis distance-based TOPSIS with the ranking result issued by the WB, respectively. Furthermore, the Pearson correlation coefficients between the traditional TOPSIS method ranking and Mahalanobis distance-based TOPSIS and the WB's EDB ranking are 0.993 and 0.908, both of them are statistically significant at the 1% level.

The WB attained the EDB scores of various countries based on simple additive weighting method by synthesising data pertaining to the aforementioned 10 indicators. The method used by the WB for calculating the EDB scores of various countries ignores the problem of information overlap between various indicators, which can cause certain common information to be overestimated in the evaluation. Additionally, the effect of negative ideal points is ignored, so the ranking result obtained according to the EDB scores will differ from those attained by using the other two methods to some extent. Moreover, the presence of correlation between indicators also results in a significant difference between ranking results acquired through traditional TOPSIS method and Mahalanobis distance-based TOPSIS. Due to having eliminated overlapping information, the Mahalanobis distance-based TOPSIS generally attains a higher level of relative closeness compared with the traditional methods.

As shown in Figure 2, the left-hand figure shows the scatter diagram of the EDB scores and ranking result issued by the WB; the right-hand figure presents the scatter diagram of closeness obtained through use of the traditional TOPSIS method and WB ranking result; furthermore, the Pearson correlation coefficients between EDB score and traditional closeness and WB's EDB ranking are –0.979 and –0.986, both of them are statistically significant at the 1% level.

It can be seen from the figure that a country with a lower ranking generally shows a lower EDB score and the relative closeness obtained through the traditional TOPSIS method. Moreover, the discreteness seen in the right-hand figure is higher than that in the left-hand figure. The reason for this is that the traditional TOPSIS method not only considers the distances of indicators of various countries to positive ideal solutions, but also takes into account those to the negative ideal solutions. Furthermore, Figure 3 shows the scatter diagrams of the distances of indicators of various countries to the positive and negative ideal solutions obtained according to the traditional TOPSIS method with the ranking result issued by the WB, respectively. The Pearson correlation coefficients between the positive distance and the negative distance of the traditional TOPSIS method and WB's EDB ranking are 0.318 and –0.344, both of them are statistically significant at the 1% level.

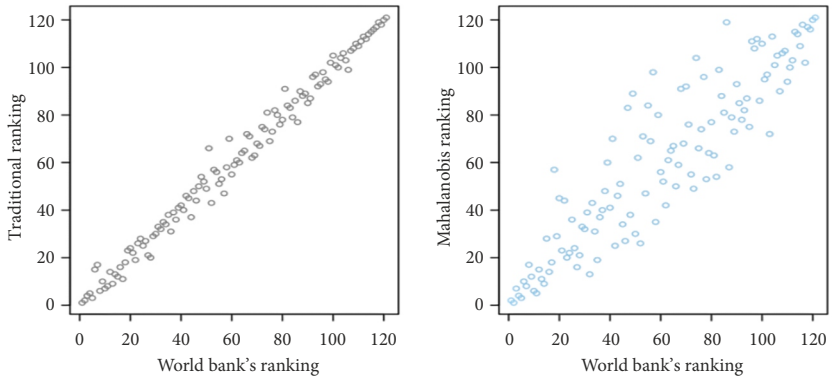

Figure 1. Scatter plot between traditional TOPSIS method ranking & Mahalanobis distance-based TOPSIS and WB' EDB ranking

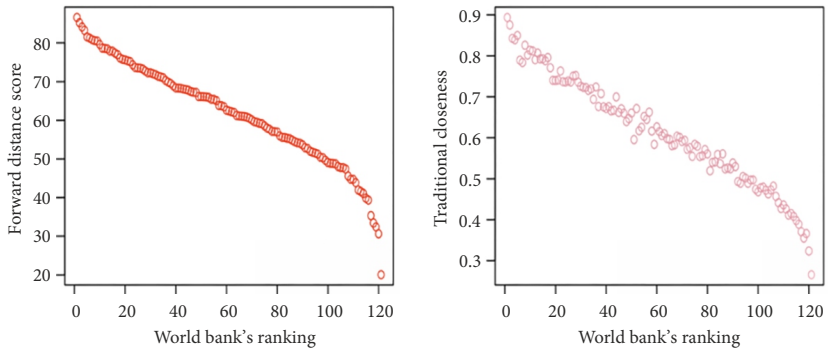

Figure 2. Scatter plot between EDB score & traditional closeness and WB' EDB ranking

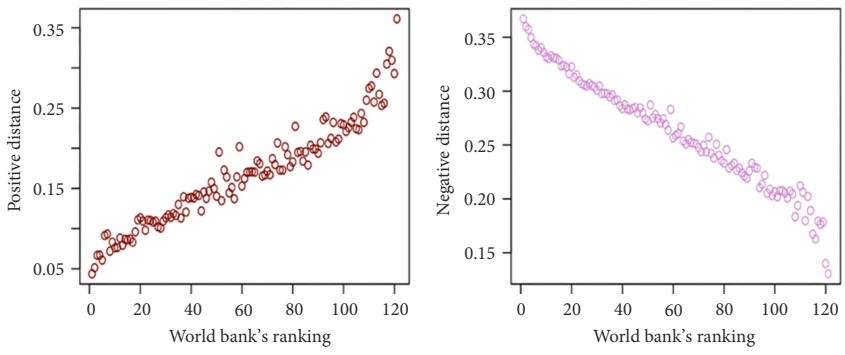

Figure 3. Scatter plot between the positive distance & the negative distance of traditional TOPSIS method and WB' EDB ranking

The indicator of a country with a higher ranking issued by the WB is closer to the positive ideal point while further from the negative ideal point: however, the data in Figure 3 still show a certain discreteness. The reason for this is that the ranking provided by the WB only takes the positive ideal solution into account while apart from this, the TOPSIS method also considers the distances of an indicator of various countries to the lowest value of the indicator during ranking. In this way, a better evaluation and ranking result with comparability is attained. The TOPSIS method more sufficiently utilises the raw data and this better reflects the gaps among various countries.

In Figure 4, the left and right-hand figures show the scatter diagrams of the closeness obtained through the traditional TOPSIS method and Mahalanobis distance-based TOPSIS with the ranking result issued by the WB, respectively. The Pearson correlation coefficients between the closeness obtained through the traditional TOPSIS method and Mahalanobis distance-based TOPSIS with the ranking result issued by the WB are –0.986 and –0.897, both of them are statistically significant at the 1% level.

The discreteness of the data seen in the right-hand figure is much greater than that in the left-hand figure, which is because the correlation between indicators is taken into account in the right-hand figure. As shown in Table 3, the information overlap between various indicators is significant and correlation between indicators cannot be ignored, therefore, Mahalanobis distance-based TOPSIS can better evaluate the levels of EDB of different countries, the ranking result obtained through the Mahalanobis distance-based TOPSIS is taken as the actual ranking of BRI countries in the present research.

The better to compare differences between the ranking result issued by the WB and the actual ranking result, the ranking result issued by the WB and the actual ranking result are shown on the same scatter diagram (Figure 5). The green scattered points refer to the ranking result issued by the WB while the blue points represent the actual ranking result. The business environments of countries corresponding to the blue scattered points below and above the green scattered point are underestimated and overestimated, respectively. The Pearson correlation coefficient between the EDB ranking results of Mahalanobis distance-based TOPSIS and the WB's EDB ranking is 0.908, which is statistically significant at the 1% level.

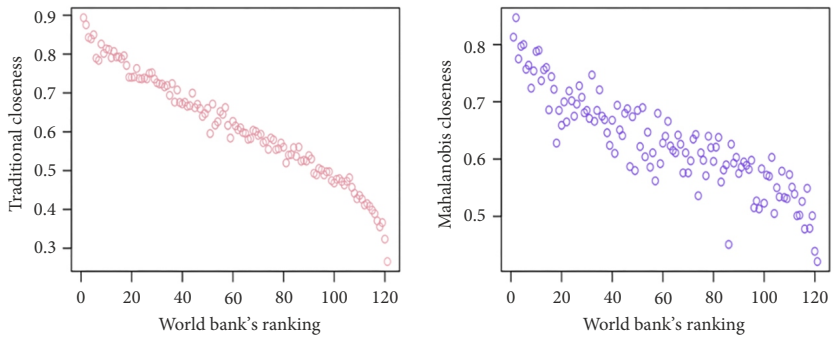

Figure 4. Scatter plot of the closeness obtained through traditional TOPSIS method and Mahalanobis distance-based TOPSIS with the ranking result issued by the WB

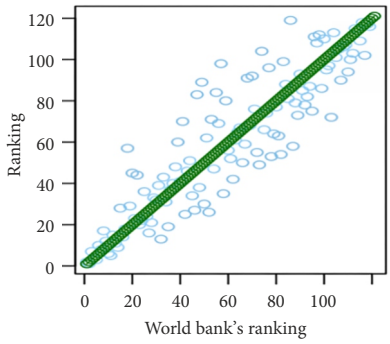

Figure 5. Scatter plot between The EDB ranking results of Mahalanobis distance-based TOPSIS and WB's EDB ranking

As seen from Figure 5, the results of EDB ranking of most countries issued by the WB differ slightly from the actual results.

According to Table 5 and Figure 5, except for Georgia, Syria, Venezuela, and Somalia, the ranking results of business environments of the other countries are all likely to be either overestimated or underestimated. The rankings of New Zealand and South Korea are overestimated while those of Singapore, Macedonia, etc. are underestimated. There are 53 and 64 countries whose rankings are overestimated and underestimated, respectively: the number of countries whose ranking is underestimated is far larger than that whose ranking is overestimated. The specific conditions are summarised in Table 6 where the gap is obtained by subtracting the actual ranking from the WB's EDB ranking.

Table 6. EBD is underrated and overrated by the WB[1]

Overrated		Underrated	
country	gap	country	gap
New Zealand	–1	Singapore	1
Korea	–4	Republic of Macedonia	2
United Arab Emirates	–4	Latvia	4
Lithuania	–1	Azerbaijan	6
Malaysia	–9	Thailand	2
Estonia	–3	Kazakhstan	5
Austria	–3	Russia	2
Rwanda	–13	Turkey	3
Poland	–1	China	2
Czech Republic	–39	Serbia	2
Belarus	–10	Israel	11
Slovenia	–25	Montenegro	7
Armenia	–2	Chile	19
Slovakia	–22	Bulgaria	3
Moldova	–11	Morocco	16
Romania	–4	Ukraine	17
Hungary	–2	Mongolia	11
Brunei	–8	Uzbekistan	19
Croatia	-10	Oman	10
Kenya	–1	Tunisia	20
Bahrain	–3	South Africa	26
Albania	–10	Malta	7

[1] The statements "Underrated" and "overrated" here imply the gaps between WB's EDB ranking and actual ranking.

End of Table 6

Overrated		Underrated	
country	gap	country	gap
Costa Rica	–21	Samoa	23
Vietnam	–1	Uruguay	4
Kyrgyzstan	–29	Republic of Seychelles	9
Greece	–3	Kuwait	20
Indonesia	–7	Djibouti	2
India	–36	Dominia	16
Panama	–40	Jordan	8
Bhutan	–11	Namibia	1
Qatar	–18	Antigua and Barbuda	17
Salvador	–29	Ghana	24
Zambia	–13	Arab republic of egypt	9
Bosnia	–41	Cote d'Ivoire	2
Saudi Arabia	–21	Tajikistan	25
Sri Lanka	–1	Uganda	15
Dominican Republic	–2	Islamic Republic of Iran	3
Trinidad and Tobago	–23	Cape Verde	18
Papua New Guinea	–22	Guyana	28
Nepal	–5	Togo	4
Palestine	–30	Maldives	29
Philippines	–19	Senegal	9
Mozambique	–16	Lebanon	26
Cambodia	–33	Nigeria	6
Tanzania	–3	Grenada	14
Laos	–15	Mauritania	11
Zimbabwe	–11	Gambia	7
Bolivia	–14	Guinea	20
Algeria	–11	Ethiopia	14
Suriname	–9	Madagascar	6
East Timor	–2	Sudan	5
Chad	–2	Sierra Leone	31
Pakistan	–4	Cameroon	4
		Afghanistan	1
		Burundi	17
		Gabon	2
		Myanmar	2
		Iraq	16
		Angola	11
		Bangladesh	9
		Congo	6
		South Sudan	15
		Libya	1
		Yemen	3

The traditional TOPSIS method or the equal weighted average method adopted by the World Bank repeatedly calculates the common information of the evaluation indicators, which means that the larger the value of the most relevant indicator, the larger the overestimated value of the evaluation result, resulting in a larger ranking gap.

If the absolute value of an overvalued gap in a country exceeds 30, it means that the country's business environment is seriously overvalued by the World Bank. According to Table 6, the business environments of the Czechia, India, Panama, Bosnia, Palestine, Cambodia, and another six countries are greatly overestimated. Table 4 shows that there is a significant correlation between the indicators. To explore why the business environments of these countries are so overestimated from the perspective of indicators, the average of 10 indicators for the countries that are greatly overrated and moderately estimated is calculated. From Table 7, the average of the indicators of moderately estimated countries is significantly smaller than the average of the countries of severely overrated countries.

Table 7. The means of countries which are largest Underrated and overrated country by WB

indicators	the means of 10 indicators
overrated countries	0.095
moderately estimated countries	0.084

2.3.2. Geographic analysis

In this study, 121 BRI countries are mapped (Figure 6): if a country is labelled in green, the country is a BRI member. If a country is marked in grey, it does not participate in BRI. It can be found from Figure 6 that BRI countries are mostly located in Asia, Africa, and Central and Eastern Europe and their distribution exhibits a significant regional characteristic. The areas of the BRI countries can be divided into nine regions including North East Asia, South East Asia, South Asia, West Asia, Africa, Central and Eastern Europe, Central Asia, South America and New Zealand.

In this section, the ranking result of BRI countries based on EDB scores issued by the WB (hereinafter called the ranking result issued by the WB) is mapped: thereafter, the ranking result of BRI countries acquired by applying Mahalanobis distance-based TOPSIS is described in the map and analysed. Finally, the countries whose rankings are overestimated or underestimated in statistical analyses are presented.

(1) Geographic analysis of the ranking result issued by the WB

The ranking result issued by the WB obtained above is mapped (Figure 7). The country whose colour is closest to blue has a higher ranking while that closer to red has a lower ranking; grey denotes non-BRI countries. Figure 7 shows that among the BRI countries, New Zealand exhibits the optimal EDB; the EDB of countries in North East Asia, South East Asia, and Central Asia is generally favourable and there is an insignificant difference among various countries within these regions; the EDB of countries in South Asia is at a common level while that in West Asia is significantly different. Countries in Africa generally show a poor EDB and the EDB of countries in the south of Africa is superior to that in the north. There is a favourable EDB for countries in Central and Eastern Europe; the EDB of countries in the south of South America is better than that in the north; the country with the worst EDB is

Figure 6. Schematic diagram of the geographical distribution of countries along the Belt and Road

situated in the north of Africa; the EDB of China is dominant among all BRI countries; the countries bordering China exhibit different levels of EDB. On the whole, the EDB of neighbouring countries to the north of China is better than that of those to the south of China.

(2) Geographic analysis of actual ranking result

The actual ranking result attained above is mapped (Figure 8). The country whose colour is closest to blue has a higher ranking while that closer to red has a lower ranking; grey denotes non-BRI countries. As shown in Figure 8, among BRI countries, countries in North East Asia, South East Asia, Central Asia, and Central and Eastern Europe have a favourable EDB and insignificant differences exist within these regions. The business environments of countries in South Asia are unfavourable on the whole and their EDB values are significantly different; New Zealand exhibits a favourable EDB; countries in West Asia and Africa generally have a poor EDB, especially countries in North Africa, with insignificant internal differences therein; the EDB of countries in South America shows a great difference, and there are, separately, both high and low levels of EDB in the south and middle of the region. The country with the optimal business environment is located in South East Asia while that with the worst business environment is situated in Africa. The EDB of countries bordering China differs remarkably: the EDB of neighbouring countries to the South West of China is poor while that to the south of China is favourable. The EDB of China is dominant among BRI countries.

(3) Geographic analysis of countries whose EDB ranking is overestimated or underestimated

According to Tables 5 and 6, a list is obtained, in which there are 53 and 64 countries with separately overestimated and underestimated EDB and four countries whose EDB values are moderately well estimated. According to the list, all countries are marked in a map to further conduct geographic analysis. The specific distribution of geographical locations of different countries is displayed in Figure 9 where, yellow, blue, and red denote countries whose EDB is underestimated, overestimated and moderately estimated, respectively, and grey represents non-BRI countries.

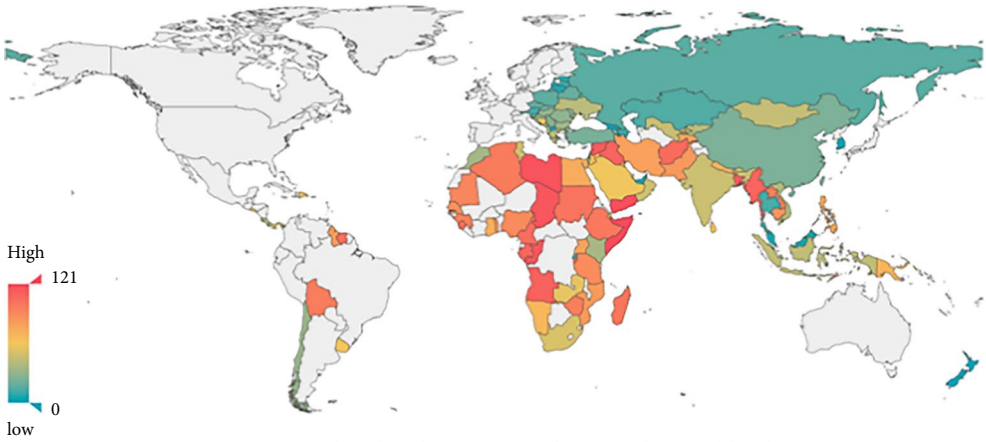

Figure 7. Geographic distribution on ranking result issued by the WB

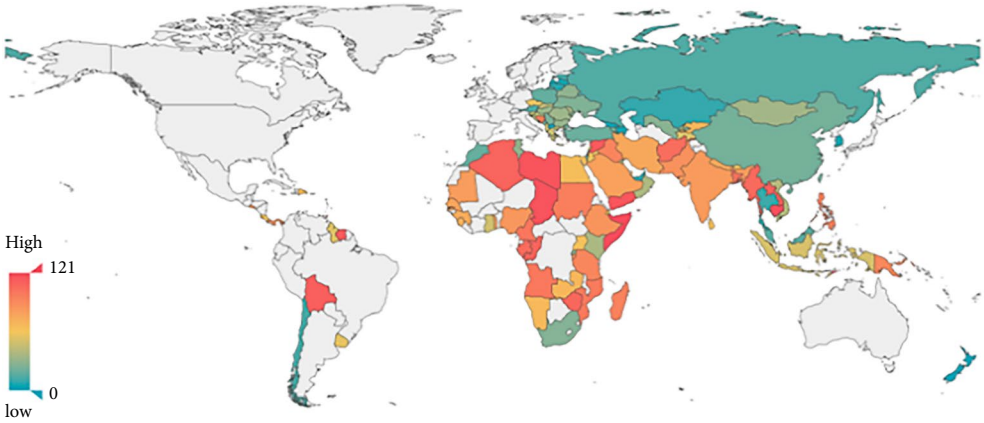

Figure 8. Geographic distribution on actual ranking result

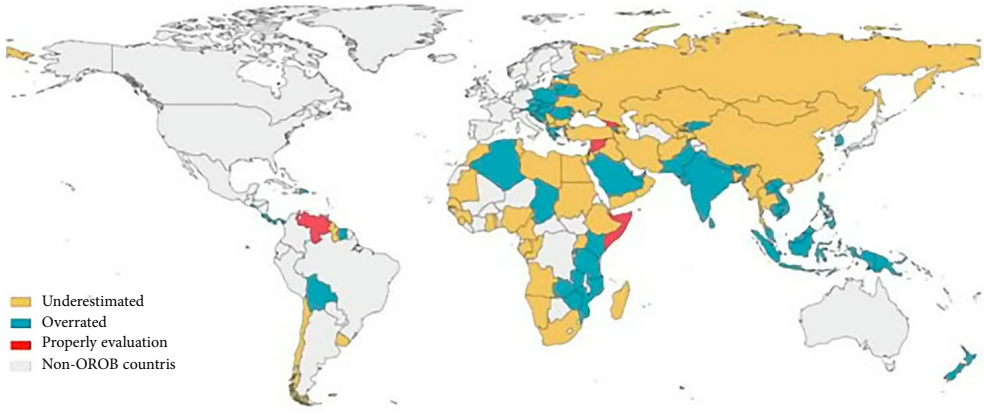

Figure 9. Geographic distribution on the Underrated and overrated country by WB

As shown in Figure 9, there is significant regional distribution characteristics between the countries whose ranking is overestimated and underestimated: the EDB of countries in North East Asia and Central Asia is generally underestimated while that in South East Asia is commonly overestimated. In South Asia, the proportion of countries whose EDB is underestimated is larger than that of countries whose EDB is overestimated. In West Asia, the proportion of countries whose EDB is overestimated is equivalent to that of countries whose EDB is underestimated. The EDB of New Zealand is overestimated; in Central and Eastern Europe, the proportion of countries whose EDB is overestimated is greater than that whose EDB is underestimated; in Africa, far more countries have underestimated EDB than overestimated EDB. The EDB of countries in the west of Africa is generally underestimated while those in the south east of Africa are commonly overestimated; in South America, the proportion of countries whose EDB is overestimated is equivalent to that with underestimated EDB, in which the EDB of countries in the south is underestimated. According to Table 6, 50% of the countries that are greatly overvalued are in Asia, 33.33% in Europe, and 16.67% in North America: this shows that the countries with more repeated indicators have the characteristics of geographical distribution, which directly results in the countries with severe overestimation having regional characteristics.

Conclusions and future work

The ranking issued by the WB was collected and using the traditional TOPSIS method and Mahalanobis distance-based TOPSIS, the EDB of 121 BRI countries is ranked. Furthermore, the ranking results are analysed from statistical and geographic perspectives, thus drawing the following conclusions:

(1) The ranking results of business environments of various countries obtained by the WB, traditional TOPSIS method, and Mahalanobis distance-based TOPSIS are compared. On this basis, when considering negative ideal points, the traditional TOPSIS method exhibits a ranking result superior to that issued by the WB. Mahalanobis distance-based TOPSIS not only takes negative ideal points into account but also considers the correlation between various indicators, thus yielding a better ranking result than that attained by using the traditional TOPSIS method. That is, among the three ranking results, the ranking result attained by employing Mahalanobis distance-based TOPSIS is closest to the actual situation. Accurate assessment of the business environment is conducive to better investment decisions and more effective government policies. Therefore, the WB is advised to modify their existing method for calculating EDB rankings and EDB scores.

(2) The ranking issued by the WB and actual ranking both exhibit significant regional characteristics. Among BRI countries, New Zealand and countries in North East Asia, Central Asia, South East Asia, and Central and Eastern Europe have a relatively favourable business environment; the business environments of countries in West Asia and Africa are generally unfavourable, having huge potential for improvement. By comparing the ranking result issued by the WB with the actual ranking result, it can be found that countries whose ranking is overestimated and underestimated

also exhibit remarkable regional characteristics, that is, the business environments of countries in Central and Eastern Europe, New Zealand, *etc*. are generally overestimated while those in North East Asia, Central Asia, South East Asia, and the south of Africa are underestimated. If the EDB project had been undertaken using the Mahalonobis-TOPSIS method at an earlier juncture, it will enable companies to make better investment decisions and reduce the investment losses caused by erroneous assessment of the prevailing business environment. On the other hand, it will prompt government to formulate policies related to the business environment that are more suitable for the country.

(3) Evaluating EDB as an MCDM problem should maintain the convention of solving MCDM problems, which consists of measurement, weighting, and evaluation: this may be extended to forecasting and risk analysis, so future work should include building reasonable and reliable models to improve evaluation of EDB weighting, forecasting, and risk analysis. On the other hand, future work should introduce possible uncertainties such as the China-US trade dispute into the model.

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