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A study on the trade environments and efficiency of factor markets of The Belt and Road regional countries

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Abstract
Through the construction of the index evaluation system of trade environment competitiveness of The Belt and Road regional countries, this paper estimates the index of trade environment competitiveness of the 52 countries among The Belt and Road regional countries by using the factor analysis. And this paper also measures the efficiency of factor markets of these countries, using data envelopment analysis method to explore the deep reason .The index of trade environment competitiveness of The Belt and Road is quite low and different.
Keywords: *The Belt and Road; trade environments; factor markets*

1 Introduction

The Belt and Road is regarded as an important national development strategy, many scholars have done a lot of research and prediction from different perspectives. [1] Zhao Dongqi, Sang Taichung (2016), from the perspective of the capacity of international cooperation, divided The Belt and Road regional countries into 7 region and studied empirically the present situation of comparative advantage and variation trend of the international competitiveness of ten sectors. [2] Han Youngish, Duo Ofelia, Lou Lithuania (2015), from the national perspective, based on the United Nations Database, estimated the many indexes, like the export similarity, trade balance and other indicators, in order to analyze the complementary and competitive of the trade between China and the west Asian countries. The Belt and Road cannot develop very well without the support of a good trading environment. Scholars have done more in-depth research in this field. [3] Azmat Gani (2011) based on the 2003-2009 annual data about trade and business environment index of Kuwait, Oman, Saudi Arabia, the United Arab

Emirates, using a fixed effects model, studied the effects of the country's trade competitiveness. [4]Andreas Loschel, Sascha Rexhauser, Michael, Schymura (2013) based on the WIOD database, focused on the influence of trade environments in scientific and technological strength and policy factors on the national trades.

In this paper, based on the existing research, we estimated the comprehensive strength of domestic resources and factor markets in participating in the international division through the calculation and analysis of national trade environment competitiveness index.

2 The estimation of The Belt and Road countries trade environment competitiveness index

2.1 Construction of index system of trade environment competitiveness

Based on the existing research, according to the actual level of economic development of The Belt and Road regional countries, this paper constructed the trade environment competitiveness index system based on the Global Competitiveness Report in world economic forum. These first-level indexes are mainly divided into macro economy, Legal, Infrastructure, Technology and Culture with 50 second-level indicators (see Table 1-1 and Table 1-2).

Table 1-1 The Belt and Road countries' trade environment competitiveness index system

First-level indicators	Second-level indicators
Macro economy	M1 Government budget balance
	M2 Gross national savings
	M3 General government debt
	M4 National credit rating
	M5 Market dominance
	M6 Effectiveness of antitrust policy
	M7 The incentive effect of tax on investment
	M8 Overall tax rate
	M9 The extent of non-tariff barriers
	M10 Trade tariff
	M11 The extent of foreign ownership
	M12 The impact of business rules on FDI
	M13 Burden of customs procedures
	M14 Investor protection intensity
	M15 Domestic market scale index
	M16 Foreign market scale index
	M17 Number of local producers
	M18 Local producer quality

Table 1-2 (Follows Table 1-1) The Belt and Road countries' trade environment competitiveness index system

First-level indicators	Second-level indicators
Macro economy	M19 Value chain width
	M20 Degree of international division of labor control
	M21 Proficiency in the production process
	M22 Marketing degree
	M23 Payment and productivity
Legal	G1 Transparency of government decision-making
	G2 Efficiency of legal framework in settling disputes
	G3 Non compliant payments and bribes
	G4 Judicial independence
	G5 Favoritism in decisions of government officials
	G6 Burden of government regulation
	G7 Efficiency of board of directors
Infrastructure	I1 Overall quality of infrastructure
	I2 Air transport infrastructure quality
	I3 Port infrastructure quality
	I4 Quality of highway infrastructure
	I5 Quality of railway infrastructure
Technology and Culture	T1 Education system quality
	T2 Availability of the latest technology
	T3 FDI and technology transfer
	T4 Management school quality
	T5 Availability of professional training services
	T6 Employee training level
	T7 Availability of financial services
	T8 Ease of access to loans
	T9 Financing through the local stock market
	T10 Convenience of obtaining loans
	T11 Bank stability
	T12 Innovation ability
	T13 Scientific research quality
	T14 R&D investment
	T15 R&D cooperation with universities

This article selected the data of Global Competitiveness Report (2011-2016) to carry on the computation. Since the score range of each index is different and the direction of data is different, we need to carry on the standardized process of the data to eliminate the influence of each index in the level and dimension.This paper selected the method of deviation normalization, and make all the data between 0 and 1 by linear transformation of the original index. Using this method, we can clearly determine the location of the index data among different countries, and facilitate the comparison between these countries.

Specific methods are as follows:

$$Xi=(X-Min)/(Max-Min) \quad (1)$$

Max, Min is the maximum and minimum value in the indicators of all the data. Due to lack of data in some countries, this paper only discusses 52 countries as the research sample to analyze the trade environment competitiveness index in The Belt and Road regional countries. Among them, there are 22 countries belonging to East Asia, 4 belonging to South Asia, 3 belonging to Mid-Asia, 6 belonging to the CIS,17 belonging to the Middle East&Europe. The specific country list is shown in Table 3.

2.2 Measurement of index of trade environment competitiveness

50 indicators of trade environment competitiveness have been collected in two levels. There will be more or less correlation between data, so in order to solve the above problems and achieve the integrity of information, this paper uses method of factor analysis,which can reduces the dimension of the original data according to the eigenvalue, so the calculation amount in the process reduced greatly. We can get the corresponding coefficient of each index of different principal components obtained by software running results. Then we need to finish each factor scoring formula, calculate the factor scores, sum each factor score and multiply the corresponding contribution rate to get the computational formula. And in the end, the coefficients of each formula divided by the cumulative contribution rate is the comprehensive evaluation model of trade environments competitiveness index of The Belt and Road regional countries model. The specific process is as follows:

2.2.1 Bartlett sphericity test and KMO test

Based on the SPSS16.0, we need to carry on the factor analysis of 2015-2016 index data which is standardized of The Belt and Road regional countries. First, verify whether the index data meets the premise of factor analysis, and conduct the Bartlett Sphericity test and KMO test on the data (see Table 2.).

Table 2 - KMO and bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.705
Bartlett's Test of Sphericity	Approx. Chi-Square	3.950E3
	Df	1225
	Sig.	.000

From Table 2, we can see that the number of observation value of the Bartlett Sphericity test statistic is 3950, and the corresponding P value is close to 0, which is obviously smaller than

the significant level alpha, so the original hypothesis is rejected. Secondly, the KMO test value is 0.705, according to Kaiser's KMO metric, the data is suitable for factor analysis.

2.2.2 Factor extraction and score calculation

The results showed there are 9 factors' eigenvalues more than 1, but in order to reduce computation later, we extracted 3 main factors, named F1, F2, F3, which can keep the 86.97% information of original data. The coefficient of factor score was estimated by regression method, and the final score function of F1, F2, F3 were obtained according to the factor score coefficient matrix of the software output.

2.2.3 Comprehensive evaluation model

By multiplying the index coefficients by the corresponding contribution rate and then add F1, F2, F3 to the final value. Finally, the final value divided by the factors' cumulative contribution rate is the comprehensive evaluation model of trade environment competitiveness index of The Belt and Road regional countries:

TECI = (F1*54.33%+F2*6.64%+F3*6.00%)/86.97%

2.3 The analysis of index of trade environment competitiveness

We calculated index of trade environment competitiveness of The Belt and Road regional countries according to the model of the trade environment competitiveness evaluation index. To save space, there is showing only 2015-2016 trade environment competitiveness index(see Table 3.).

The country's trade environment competitiveness index is closer to 1, indicating that the country's trade environment competitiveness is stronger. The data in Table 3 showed that the average value of index of trade environment competitiveness of The Belt and Road regional countries was 0.41, the average level is low and the national differences are obvious. Such as Singapore, a new type of industrialized countries, is the most economically developed countries of The Belt and Road regional countries. And the index of trade competitiveness environment is the highest (0.87), closely related to the technical efficiency of the factors market which has global competitiveness. Therefore, Singapore's labor market, capital market, technology market development level is significantly higher than other countries in Table 3. Malaysia is an important member of ASEAN. Its technology and industry are strong, the commodity market and the labor market are more perfect, and the index of its trade

Table 3 -The index of trade environment competitiveness of The Belt and Road regional countries

Region	Country	Index	Country	Index
East Asia (0.37)	China	0.54	Myanmar	0.01
	Mongolia	0.29	Thailand	0.43
	Singapore	0.87	Cambodia	0.23
	Malaysia	0.77	Vietnam	0.26
	Indonesia	0.43	Philippines	0.44
West Africa(0.45)	Turkey	0.47	Qatar	0.68
	Jordan	0.44	Kuwait	0.23
	Lebanon	0.41	Bahrain	0.56
	Israel	0.71	Greece	0.47
	Saudi Arabia	0.44	Egypt	0.56
	Oman	0.31	Cyprus	0.15
South Asia(0.31)	India	0.39		
	Pakistan	0.26		
	Sri Lanka	0.48		
	Nepal	0.09		
	China	0.54	Myanmar	0.01
	Mongolia	0.29	Thailand	0.43
	Singapore	0.87	Cambodia	0.23
	Malaysia	0.77	Vietnam	0.26
	Indonesia	0.43	Philippines	0.44
	Turkey	0.47	Qatar	0.68
	Jordan	0.44	Kuwait	0.23
	Lebanon	0.41	Bahrain	0.56
	Israel	0.71	Greece	0.47
	Saudi Arabia	0.44	Egypt	0.56
	Oman	0.31	Cyprus	0.15
	India	0.39		
	Pakistan	0.26		
	Sri Lanka	0.48		
	Nepal	0.09		
	Kazakhstan	0.35		
	Tajikistan	0.33		
	Kyrgyzstan	0.19		
	Russia	0.33	Armenia	0.32
	Ukraine	0.35	Moldova	0.25
	Georgia	0.33	Belarus	0.32
	Azerbaijan	0.35		
	Poland	0.51	Croatia	0.46
	Lithuania	0.62	Bosnia and Herzegovina	0.19
	Estonia	0.62	Montenegro	0.37
	Latvia	0.59	Serbia	0.27
	Czech	0.67	Albania	0.33
	Slovakia	0.59	Romania	0.39
	Hungary	0.49	Bulgaria	0.35
	Slovenia	0.56	Macedonia	0.40

environment competitiveness is also higher. The overall ranking is second (0.77). [5] Israeli, the national industrialization level is higher, and the comprehensive economic strength is strong. It has been committed to the development of science and technology research, so the technology market is developed, ant the degree of national economic development and the overall human development index is the highest in the Middle East. Its index of trade environment competitiveness ranked third overall (0.71).The rest countries whose index of trade environment competitiveness are more than 0.6 is Qatar (0.68), Czech (0.67), Lithuania (0.62), Estonia (0.62), the index of trade environment competitiveness are consistent with the actual development of elements market. From the regional perspective, central and Eastern Europe (0.46) has the highest trade environment competitiveness mean, its macro economy, legal system, science and technology environment is at the leading level in the area of the Belt and Road. And he remaining rankings are West Asia&North Africa (0.45), East Asia (0.37), CIS (0.32), South Asia (0.31) and Central Asia (0.29).

3 The calculation of the elements market efficiency of the Belt and Road regional countries

For further verification of the relation of trade environment competitiveness index and the national efficiency of elements market of The Belt and Road regional countries, we uses input-output method to calculate.

3.1 Calculation methods and models

Data Envelopment Analysis, as a non-parametric techniques for efficiency analysis, it has certain advantages in analyzing the same type of multiple inputs and multiple outputs. The basic principle is to measure the efficiency level by calculating the ratio of input to out of each decision making units. In this paper, a production oriented BCC model based on variable returns to scale is adopted. Through the use of one stage method, the comprehensive efficiency is decomposed into technical efficiency and scale efficiency, so the technical efficiency can be excluded from the the effects of scale.

This paper measures the efficiency of factor market in 52 countries.These countries are marked as DMUj(j=1, 2, …, 50)Each DMU has m inputs and q outputs, marked as xi(i=1, 2, …, m), yr(r=1, 2, …, q).

The formula of output oriented BCC model is:

$$\min \Phi \tag{2}$$

$$\text{s.t.} \quad \sum_{j=1}^{n} \lambda_j x_{ij} \leqslant x_{ik}$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \geqslant \Phi y_{rk}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda \geqslant 0$$

i = 1, 2, …, m; r = 1, 2, …, q; j = 1, 2, …, n

The weight of the input is expressed as vi (i=1, 2),... (m); the weight of the output is expressed as ur (r=1, 2),... (q).

Multiplier form of output oriented BCC model (dual expression) is:

$$\min \sum_{i=1}^{m} v_i x_{ik} + v_0 \tag{3}$$

$$\text{s.t.} \quad \sum_{r=1}^{q} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} - v_o \leqslant 0$$

$$\sum_{r=1}^{s} u_r y_{rk} = 1$$

$$v \geqslant 0;\ u \geqslant 0;\ v_0 \text{ free}$$

i = 1, 2, …, m; r = 1, 2, …, q; j = 1, 2, …, n

3.2 The data source of inputs and outputs and quantity requirements of DMU

3.2.1 Index description of inputs and outputs

As mentioned before, to a great extent, a national domestic efficiency level of factor market can affect a country's ability and the condition of the participation in the international division of labor and always play the role of guidance, decision, influence and restriction. [6] In order to measure the efficiency level of factor markets of The Belt and Road regional countries, we use the index of the trade environment competitiveness as input indicators and choose the export volume as output indicators to analyze the the efficiency level of factor markets of The Belt and Road regional countries by using DEA model.

The quantity requirement of DMU in DEA model

This paper’s DMU is the 52 countries in the The Belt and Road region.Generally speaking, in order to prevent DEA from losing the ability to distinguish DMU efficiency, the quantity of DMU should be no less than the product of the quantity of inputs and outputs, and should meet no less than 3 times the number of inputs and outputs.

$$n \geqslant \max\{ m*q,\ 3*(m + q)\}$$

In order to prevent a large number of indicators would cause the lack of the ability to distinguish between models, we choose the score data of trade environment competitiveness

as input indicators has good applicability, which contains more production factors, also appeared to solve related problems among the index. Using MaxDEA software, operating the data of input and output index, through calculation, consolidation, we can get the efficiency level of the factor markets of The Belt and Road regional countries. To save space, there is showing only 2015-2016 efficiency of factor markets of The Belt and Road regional countries (see Table 4).

Table 4 lists the comprehensive efficiency, technical efficiency and scale efficiency of 2015-2016 annual factor markets of The Belt and Road regional countries. The relationship between the three indicators is: scale efficiency value = integrated efficiency / technical efficiency.

4 Research conclusions and policy recommendations

4.1 Research conclusions

1. From perspective of national average the average comprehensive efficiency of factor market of The Belt and Road regional countries is low, the efficiency is 0.514, so there are 48.6% waste, which indicates The Belt and Road regional countries need to enhance the level of input factors. And the technical efficiency value is 0.603, so the fundamental reason why the comprehensive efficiency of factor market is low is the low technical efficiency. Technical efficiency is the main factor to inhibit the synthesis efficiency. The scale efficiency average is 0.857, generally speaking, each country's factor investment scale is quite reasonable.
2. From the perspective of national situation: (1) only Singapore reached a effective level, namely the technology and scale are effective, and scale returns is constant.That shows the country inputs properly and use reasonably, which can produce efficient and stable scale returns. (2) The comprehensive efficiency of Malaysia, Israel, Lithuania is more than 0.80, compared with the technical efficiency, scale efficiency is low, thus affecting the comprehensive efficiency. It shows the efficiency of factor market has good input configuration, integration and management performance, but the inputs scale is not reasonable, and it need to be optimized further . (3) The scale efficiency of Egypt, India, Pakistan, Nepal, Tajikistan, Kyrgyzstan, Georgia, Armenia, Moldova, Bosnia and Herzegovina, Montenegro, Albania are close to 1, scale returns is increasing, but the technical efficiency level is low, indicating that these countries should expand the scale

Table 4- The efficiency level of factor markets of The Belt and Road

country	CE	TE	SE	Scale Income
China	0.52	0.63	0.83	Decreasing
Mongolia	0.61	0.79	0.77	Decreasing
Singapore	1	1	1	Constant
Malaysia	0.87	0.94	0.92	Decreasing
Indonesia	0.67	0.74	0.9	Decreasing
Myanmar	0.13	0.56	0.23	Decreasing
Thailand	0.68	0.74	0.92	Decreasing
Cambodia	0.24	0.26	0.94	Decreasing
Vietnam	0.36	0.47	0.76	Decreasing
Philippines	0.35	0.44	0.79	Decreasing
Turkey	0.47	0.57	0.82	Decreasing
Jordan	0.54	0.64	0.89	Decreasing
Lebanon	0.41	0.43	0.94	Decreasing
Israel	0.88	0.98	0.89	Decreasing
Saudi Arabia	0.46	0.66	0.74	Decreasing
Oman	0.39	0.48	0.81	Decreasing
Qatar	0.78	0.92	0.84	Decreasing
Kuwait	0.37	0.52	0.71	Decreasing
Bahrain	0.65	0.61	0.73	Decreasing
Greece	0.50	0.61	0.82	Decreasing
Cyprus	0.24	0.35	0.69	Decreasing
Egypt	0.60	0.61	0.99	Increasing
India	0.48	0.49	0.98	Decreasing
Pakistan	0.34	0.34	0.99	Increasing
Sri Lanka	0.49	0.61	0.8	Decreasing
Nepal	0.18	0.18	0.99	Increasing
Kazakhstan	0.44	0.64	0.69	Decreasing
Tajikistan	0.41	0.41	0.99	Increasing
Kyrgyzstan	0.27	0.27	0.99	Increasing
Russia	0.77	0.97	0.79	Decreasing
Ukraine	0.45	0.54	0.84	Decreasing
Georgia	0.53	0.53	0.99	Increasing
Azerbaijan	0.46	0.60	0.77	Decreasing
Armenia	0.38	0.38	0.99	Increasing
Moldova	0.32	0.32	0.99	Increasing
Belarus	0.29	0.32	0.91	Increasing
poland	0.68	0.76	0.89	Decreasing
Lithuania	0.80	0.90	0.89	Decreasing
Estonia	0.78	0.91	0.86	Decreasing
Latvia	0.63	0.91	0.69	Decreasing
Czech	0.75	0.78	0.96	Decreasing
Slovakia	0.68	0.92	0.74	Decreasing
Hungary	0.56	0.93	0.6	Decreasing
Slovenia	0.65	0.86	0.76	Decreasing
Croatia	0.51	0.60	0.85	Decreasing
Bosnia and Herzegovina	0.27	0.27	0.99	Increasing
Montenegro	0.44	0.44	0.99	Increasing
Serbia	0.38	0.39	0.97	Decreasing
Albania	0.48	0.48	0.99	Increasing
Romania	0.43	0.50	0.86	Decreasing
Bulgaria	0.44	0.49	0.89	Decreasing
Macedonia	0.51	0.54	0.94	Decreasing
mean value	0.514	0.603	0.857	

of investment in technological upgrading and can not increase inputs blindly, which needs to pay more attention to the technical investment and support in the factors market.

4.2 Policy recommendations

China should adopt The Belt and Road strategy to help the regional countries improve infrastructure construction and upgrade infrastructure quality and to help the regional countries develop the logistics industry, modified the efficiency of logistics and the logistics chain service system, speed up the transportation of goods, make the efficiency of customs clearance of goods better, and to make progressive of the efficiency level of factor markets. At the same time, China should strengthen the cooperation with The Belt and Road regional countries to promote mutual understanding, deepen friendship and enhance the level of market efficiency in order to achieve mutual benefit.

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