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Evaluating the Investment Climate for China's Cross-Border E-Commerce: The Application of Back Propagation Neural Network

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Abstract: China's cross-border e-commerce will usher in a new golden age of development. Based on seven countries which include the Russian Federation, Mongolia, Ukraine, Kazakhstan, Tajikistan, Kyrgyzstan and Belarus along the "Belt and Road", an evaluation system for cross-border e-commerce investment climate indicators is established in this study. This research applied the entropy method twice to evaluate the investment climate of seven countries based on 5 years panel data comprehensively and these countries are then classified into politics-oriented and industry-oriented countries, and then the weight of indicators for each category is analyzed. In addition, cross-border e-commerce investors are proposed to prioritize industry-oriented countries. Back propagation neural network algorithm is used to map the existing data and optimize the evaluation index system in combination corresponding to the best overall score, make the established evaluation index system applicable to other countries, and provide reference for cross-border e-commerce investors when evaluating the investment climate in each country. This study provides the important practical implications in the sustainable development of China's cross-border e-commerce environment.

Keywords: "Belt and Road" countries; e-commerce; investment climate evaluation; entropy method; neural network

1. Introduction

China has formulated a new Silk-Road strategy, referred to the "One Belt, One Road" initiative, implemented under the Xi Jinping administration. The move aimed at stimulating growth and improving ties with nations along its geographic periphery [1]. Since the promulgation of the document "Vision and Action on Jointly Building Silk Road Economic Belt and 21st Century Maritime Silk Road" in March 2015, China has been stepping up its efforts to reinforce global open cooperation and actively promote the construction of a partnership of interoperability among countries along the route. To achieve common development and prosperity, China is pushing for innovative approaches in trade, building a cooperative and win-win economic cooperation framework, establishing a comprehensive, multi-level, and complex Unicom-based trading network, and promoting deep-level regional cooperation. Huang [2] pointed out that the "One Belt, One Road" initiative was a new form of international economic cooperation between China and its new partners. It was important to promote economic growth, and it was a significant contribution to the adjustment of the international economic system. Michael et al. [3] argued that the initiative was a sustainable development model that realized international economic, political and cultural development through diversified communication and exchange under the principle of peaceful coexistence among countries. Kamel et al. [4], Herrero et al. [5]



and Huang et al. [6] analyzed the economic and trade impact of the "One Belt, One Road" initiative for the Middle East, Europe, Africa and Central Asia. Most scholars believe that the Belt and Road Initiative will create a mutually beneficial and interconnected platform for cooperation, bringing tremendous economic development opportunities for China and the countries along the routes.

E-commerce, as an efficient business model, has been advancing rapidly in recent years. Especially this year, under the impact of the global epidemic, e-commerce has played an important role in resisting the impact of the epidemic, boosting consumption recovery and driving global economic recovery due to its advantages of being able to break through temporal and spatial limitations, reducing intermediate links and resolving information asymmetry between supply and demand. As a country with massive scale in e-commerce, China boasts a mature logistics system, a gathered manufacturing industry chain, an efficient operation mode, a specialized platform, and a relatively complete business ecosystem, which gives the country a head start in areas like logistics, manpower, payment, etc. In 2019, the scale of e-commerce transactions in China was 34.81 trillion yuan [7], which has taken the top spot in the global e-commerce market for many years. As Yin et al. mentioned, as the basis of trade globalization, e-business carries very important strategic meanings. It not only breaks the boundaries between countries and facilitates international trade, but also brings about changes to the companies and consumers, respectively [8]. In June 2015, the State Council promulgated the "Guiding Opinions on Promoting the Healthy and Rapid Development of Cross-border e-commerce" to support the development of cross-border e-commerce in finance, services, organizations and other aspects and to encourage domestic enterprises to make better use of e-commerce to conduct foreign trade. It can actively promote the development of open economy and promote the healthy and rapid development of cross-border e-commerce in China. According to statistics [9,10], as of July 2019, the Chinese government has signed 197 intergovernmental cooperation agreements with 137 countries and 30 international organizations. In 2019, China's cross-border e-commerce retail import and export volume reached 186.21 billion yuan, five times that of 2015, with an average annual growth rate of 49.5%, and over 6000 new cross-border e-commerce enterprises. It is evident that the Chinese market has become more competitive and global demand for Chinese products continues to expand. It will be an inevitable trend in the future to give full rein to cross-border e-commerce and establish a complete ecosystem, which will make cross-border e-commerce more sustainable. It is foreseeable that China's cross-border e-commerce will usher in a new golden age of development.

How to better develop cross-border e-commerce against the backdrop of the "Belt and Road Initiative"? According to the location theory [11], it is of great significance to select the suitable countries and make an objective and reasonable assessment of cross-border e-commerce investment climate based on China's national conditions. In terms of industrial sector, in 2018, the total exports of the seven types of labor-intensive products, namely, textile, clothing, footwear, luggage, toys, furniture, plastic goods, reached 3.12 trillion yuan, accounting for 19.0% of China's total exports issued by the Ministry of Commerce of China [12]. China is a big manufacturing country, and its labor-intensive products are the staple goods on the shelf in e-commerce. Therefore, tapping into China's abundant labor and exporting its labor-intensive products is a more reasonable industry choice for cross-border e-commerce. In terms of countries, important considerations are whether it is suitable for e-commerce investment, national demand and infrastructure convenience are important considerations. In northern countries along "The Belt and Road Initiative", the labor-intensive industries are typical of raw material shortage, high cost and outdated technology. They mainly rely on foreign imports. Therefore, country selection can be made according to the proportion of secondary industries in each country. The smaller the proportion of secondary industry, the greater the demand. In terms of infrastructure, the opening of the China-Europe Railway Express has brought down the cost for cross-border e-commerce and opened up the national market. Since 2014, the China-Europe train has operated a total number of 14,691 [13] with its main stops in hinterland countries being Kazakhstan, Russia, Belarus, Poland, Mongolia, Kyrgyzstan, Tajikistan and Ukraine whose proportions of secondary industry are as shown in Table 1. Among them, Russia, Kazakhstan, Mongolia and Belarus are the pivotal countries in the

"three passages" and "five ports" of the Central European class. Kyrgyzstan, Tajikistan and Ukraine have their regular trains and the upcoming railway project. Therefore, considering the demand of the secondary industry, the distance and timeliness, this paper chose seven "the Belt and Road Initiative" land countries including Russian Federation, Mongolia, Ukraine, Kazakhstan, Tajikistan, Kyrgyzstan and Belarus as its research object, to study the cross-border e-commerce investment climate.

Table 1. Proportion of the secondary industry of the main China-Europe Railway Express countries along "the Belt and Road".

Country	Belarus	Slovakia	Poland	Mongolia	Russia	Kazakhstan	Kyrgyzstan	Tajikistan	Ukraine
Proportion	37.70	34.82	34.12	33.82	32.79	32.53	28.43	28.00	25.65
Data source: World Bank									

Artificial neural network, a feed-forward network algorithm simulating the animal nervous system, has been advancing rapidly in recent years. Many scholars at home and abroad have researched various aspects of e-commerce combined with the neural network, which achieve good results. Some scholars [14–16] applied neural networks to e-commerce, which included merchandise, customs classification and advertisement. Some scholars [17–20] used neural networks to study consumer purchasing behavior. Others [21–25] applied it to other fields where engineering and humanities were included. Neural networks have been shown to be effective in mapping nonlinear input and output parameters.

Currently, under the trend of trade globalization and booming e-commerce, there are numerous investable countries. In order to help cross-border e-commerce enterprises make effective investments and improve the quality and efficiency of trade cooperation between countries, an evaluation system for cross-border e-commerce investment climate indicators is established in this paper. The entropy method is used to comprehensively evaluate the investment climate of the seven countries. The neural network method is used to map the existing data, and optimize the evaluation index system in combination with the genetic algorithm, which can make the established evaluation index system applicable to other countries, and provide reference for cross-border e-commerce investors in time of evaluating the investment climate in each country. Previously, few scholars have used neural network to study the cross-border e-commerce investment climate, and no one has used genetic algorithms so as to verify the objectivity of the established evaluation index system and optimize the combination of indicators to make it more applicable.

2. Literature Review

Since China proposed the Belt and Road Initiative in 2013, it has attracted widespread attention from the international community. The initiative has sparked widespread discussions and studies on political systems, commerce, geopolitical factors, etc. Wang [26] examined the existing mechanisms for resolving disputes in "Belt and Road Initiative", pointing out shortcomings and rooms for improvement. Wu et al. [27] discussed the impact of national distance on international trade under the "Belt and Road Initiative". Some scholars [28–30] studied the Belt and Road Initiative in terms of geopolitics, geopolitics and transportation. Julien [31] explored China's investment policy and strategy of three tracks—bilateral agreements, regional agreements and global initiatives. Liu et al. [32] discussed the construction of the Belt and Road Initiative from neo-liberal to inclusive globalization. Ailan et al. [33] analyzed the role of cultural and institutional distance in international trade.

From the above, it can be seen that the Belt and Road Initiative proposed by China is a complex but meaningful project that varies greatly among countries and industries. As an institutionally driven business-oriented behavior, it is important to study the investment environment for Chinese companies in different countries under the initiative.

In 1968, Litvak and Banting proposed the concept of "investment climate" for the first time and constructed an evaluation index system based on seven aspects, such as political stability and legal obstacles, which raised the study of investment climate to a theoretical level [34]. Since then, the evaluation index system of investment climate has been researched extensively at home and abroad. Yang [35] evaluated the importance of investment climate factors, namely, political, infrastructure, cost, and market factors, for firms' intention to invest in international logistics zones. Maung et al. [36] studied how a country's investment climate affects cross-border merger and acquisition premiums. Ershova [37] establishes an evaluation index system consisting of market demand, infrastructure and legal environment. He analyzes the investment climate in Russia and determines the factors that attract foreign investment to Russia and the factors that hinder foreign investment in Russia. Beleska et al. [38] studied the impact of the competitive advantage of the emerging economy, Thailand, and establishes eight competition indicators, including demand conditions, business environment, government and political environment, etc. It is proposed that a country's competitive advantage is also an important factor in evaluating investment climate. Bevan et al. [39] studied the determinants of foreign direct investment from Western countries, mainly in the European Union, found the most important influences to be unit labor costs, gravity factors, market size, and proximity. Jurgita et al. [40] assessed country investment attractiveness through the economic subjects' competences and environment empowering them to attract and maintain investments in the country. These are studies of the factors influencing the investment climate.

Some scholars [41–43] focused on the investment climate in a particular industry, such as new energy, natural gas and mining. In addition, Deng et al. [44] presented a practical for evaluating investment climate from the viewpoint of a host region or country. Nam et al. [45] introduced and validated a scale for measuring entrepreneurial investment climate, consisting of four factors: Societal stability, Labor and Regulations, Quality of Infrastructure, and Ease of Finance. Varoudakis [46] revisited the link between firm-level investment climate and productive performance.

A summary of the references shows that the investment climate has been studied from different perspectives, from the point of view of influencing factors, evaluation methods, enterprise level and generally through the establishment of evaluation index systems. However, so far, a fixed and unified index system is absent, and there is very limited research on the evaluation index system based on the cross-border e-commerce investment climate. Given the fact that e-commerce has its unique demand, namely, a fairly high requirement for industry environment like internet penetration rate and logistics environment, the traditional indicator system, therefore, is no longer applicable, and it is urgent to establish a set of investment evaluation index system based on cross-border e-commerce.

3. Materials and Methods

3.1. Materials

On the basis of data availability and quantifiability, and the special needs of e-commerce for indicators, based on an integrative study of evaluation index system proposed by scholars at home and abroad, an evaluation system including four first-level indicators namely, economic environment, political environment, legal environment and industrial environment is established in this paper, which contains eight secondary indicators, 17 third-level indicators. This meets the specific needs of cross-border e-commerce. All data in this paper are invariable from official channels including the World Bank database, official report from "Worldwide Governance Indicators", Census Bureau in each country, the website of "the Belt and Road Initiative", etc. The detailed indicator system is shown below in Table 2.

The economic environment has a direct impact on cross-border e-commerce investment, and its situation directly affects investment returns. A stable political environment plays an essential role in safeguarding investment, which is sometimes disrupted by the political environment especially in turbulent countries. The sound legal environment can keep each link in the chain well-oiled through regulation, restriction and maintenance. The industry environment, as a prerequisite for investment, has an immediate influence on the efficiency and development of e-commerce investors.

Primary Indicator	Secondary Indicator	Three-Level Indicator		
Economic environment	Economic strength	Total GDP X_1 GDP growth rate X_2 Per capita GDP X_3		
	Economic stability	Inflation (measured by consumer price index) X_4		
	Economic openness	Foreign direct investment X_5 Dependence on foreign trade X_6		
Political Environment	Government execution	Government accountability X ₇ Government efficiency X ₈ Supervision quality X ₉		
	Political stability	Political stability, absence of violence X ₁₀		
Legal environment	Legal factors	Law-ruled environment X ₁₁ Legal power index X ₁₂		
Industry environment	Telecommunication condition	Mobile cellular subscriptions per 100 people X ₁₃ Number of secure internet servers X ₁₄ Internet penetration rate X ₁₅		
	Logistics conditions	Railway (total kilometers) X ₁₆ Airline passenger volume X ₁₇		

 Table 2. Investment environment evaluation index system for cross-border e-commerce investment in seven countries.

3.2. Methods

3.2.1. Entropy Method

Entropy method is an objective weighting method, which can calculate the weight of each indicator and provide a basis for comprehensive evaluation of multi-indicators. The advantage of the method is that it can avoid the deviation which is caused by human factors, and it has high credibility and accuracy. In this paper, the entropy method is used to evaluate the weight of each indicator and it is on this basis that seven countries are given a comprehensive assessment. According to the scores, the seven countries are classified, the investment climate of different countries are discussed, and the index weight analysis is carried out for each category of countries by the second entropy method. In order to minimize errors, the five-year data from 2013 to 2017 are selected for analysis.

(1) Data standardization

Standardize data with Z-SCORE:

$$x_{ij}^* = \frac{x_{ij} - x_i}{S_i},\tag{1}$$

where:

 x_{ii}^* —Standardized value

 x_{ij} —Raw data of the indicator *j* sample *i*

 x_i —The arithmetic means of the *j*th indicator data

 S_i —Standard deviation of the *j*th indicator data

The above-mentioned "samples" denote countries, and the word "indicator" refers to the three-level evaluation index of the e-commerce investment climate. Given the negative data that come as a result of standardization, according to the scholar's research on improving the entropy weight method [47] and other scholars' handling of the problem [48,49], the data can be translated to avoid meaningless calculation, and the translation value is the absolute value of min(x_{ii}^*).

(2) The *i*th sample under the *j*th indicator accounts for the proportion of the indicator

$$P_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \tag{2}$$

where: *n*—Number of samples

(3) Entropy of the *j*th indicator

$$e_j = -k \sum_{i=1}^n P_{ij} Ln(P_{ij}) \tag{3}$$

where: $k = \frac{1}{Ln(n)}$

(4) Information entropy redundancy

$$d_j = 1 - e_j \tag{4}$$

(5) Indicator weight

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j} \tag{5}$$

where: *m*—Number of third-level indicators

(6) Comprehensive scores of countries

$$S_i = \sum_{j=1}^m w_i P_{ij} \tag{6}$$

3.2.2. Back Propagation Neural Network and Genetic Algorithm

The components of a back propagation (hereafter BP) neural network consists of input layer neuron, output layer neuron, and hide layer neuron, which are interconnected through weights. Figure 1 illustrates the structure diagram of BP neural network model. The input parameters are 17 three-level indicators of the seven-country cross-border e-commerce investment climate assessment system, which are assigned to X_1 – X_{17} . The output layer is the corresponding total score of each country. The Sigmoid function is selected as the activation function, the tansig function is used as the hide layer transfer function, and the purelin function is selected as the node transfer function in the output layer.



Figure 1. Structure diagram of back propagation (BP) neural network model.

Calculate the number of hide layer nodes *l*:

$$l = \sqrt{(n+m)} + a, \tag{7}$$

where:

m—the number of nodes in the output layer*n*—the number of nodes in the input layer*a*—adjustment constant of 1–10

Equation (7) is the empirical formula for the hide layer nodes of the BP neural network. "*n*" is the number of nodes in the input layer which represents the number of indicator factors in the research. "*m*" is the number of nodes in the output layer which means the score of investment climate. That is, n = 17, m = 1. "*a*" is specified as an adjustment constant between 1–10. Therefore, the value of *l* ranges

from 5 to 15. Through the training of different node sample models, an LM optimization algorithm with fast convergence and high accuracy is used to compare the number of different hide layer nodes, and the one with the smallest error value is selected as the number of hide layer nodes.

Based on Darwin's theory of biological evolution, Genetic Algorithm is intended to seek the optimal solution by processing data through natural selection, inheritance and evolution, an approach that simulates the biological evolution in nature and is featured by the survival of the fittest. In this paper, the three-level evaluation index is used as a design variable, and the established BP neural network model is used to find the optimal solution of the fitting results of non-linear data by further expanding the parameter range.

For the evaluation indicators of cross-border e-commerce investment climate, we determine the scope of optimization parameters from the perspective of practicability and feasibility. For the percentage index, the range is from 0 to 100, and for the numerical index, the range is between 1.5 times the maximum value and 0.5 times the minimum value. The 50 individuals randomly generated by 17 design variables are used as the initial population, and are substituted into the BP neural network model. The network output is used as the target value, and is fitted to the fitness function. By choosing individuals with high fitness through selection and crossover, we iterate, evolve, and optimize mutation processes that randomly change individual genes.

4. Results

4.1. Results of Entropy Method

The analysis and calculation of entropy method can generate the weight of each indicator and the comprehensive score of each country which are shown below in Table 3.

Time	203	17	201	16	20	15	20	14	20	13	Avg
Country	Score	Rank	Score								
Belarus	0.133	5	0.133	5	0.129	6	0.136	5	0.124	6	0.131
Kazakhstan	0.163	2	0.155	4	0.166	2	0.158	3	0.152	3	0.159
Kyrgyzstan	0.123	6	0.128	6	0.129	5	0.128	6	0.142	4	0.130
Mongolia	0.161	3	0.159	3	0.151	3	0.164	2	0.172	2	0.162
Russia	0.189	1	0.174	1	0.197	1	0.188	1	0.202	1	0.190
Tajikistan	0.078	7	0.087	7	0.086	7	0.089	7	0.070	7	0.082
Likraine	0 154	4	0.163	2	0 142	4	0 137	4	0 137	5	0.147

Table 3. Comprehensive rating and ranking of cross-border e-commerce investment climate of seven countries from 2013 to 2017.

4.2. Results of Optimization

We set up a neural network model, train the data with the trainlm function, set the expected error to 10^{-3} , and the learning rate to 0.01. The five-year data of the seven countries total 35 groups with 20 groups of them are selected as training samples, and the rest test samples. Train the network with different numbers of hide layer nodes. When l = 11, the minimum value of MSE is 0.1883×10^{-3} . It can be determined that the number of hide layer nodes is 11, and a 17-11-1-1 neural network prediction model is established. The model has the smallest average error of 0.202%, which illustrates the effectiveness of the BP neural network for the evaluation of cross-border e-commerce investment climates in various countries. The predicted output and error of BP neural network is shown in Figure 2.

Set the genetic algorithm parameters, evolution algebra MAXGEN = 100, cross probability Pc = 0.4, mutation probability Pm = 0.2. Considering the high degree of differences in national economic and political structures, as well as the variation in the magnitude of each indicator, 10 sets of parameter combinations with a comprehensive score of more than 0.29 are selected as the best parameter

combinations of the cross-border e-commerce investment climate evaluation model by optimizing the specified domain of BP neural network with genetic algorithm, as shown in Table 4.



Figure 2. (a) The predicted output; (b) The error (Source: own work).

Group Total GDP		GDP Growth Rate	Per Capita GDP	Inflation (Measured by	Foreign Direct	Dependence on Foreign
				Consumer Price Index)	Investment	Trade
1	14,873.74	5.900016	10,502.75	31.53972	151.6056	98.89116
2	15,814.69	1.199463	12,733.31	49.94916	-84.8603	41.45225
3	14,355.06	-9.10025	1707.868	-19.2633	-17.5769	10.16694
4	6344.333	-13.1523	14,049.75	-16.2416	43.14636	74.1254
5	8891.807	-9.46699	3840.194	42.2653	165.5202	70.67152
6	15,030.37	-14.4547	12,318.58	-28.3736	13.65503	88.53595
7	5709.904	4.879615	5088.583	-26.9617	84.45142	62.45729
8	10,340.83	0.636089	6720.459	43.71347	131.8131	84.90855
9	10,098.26	10.77961	17,536.76	7.083843	198.7401	55.35416
10	901.4883	-10.425	382.5906	-6.48245	132.8886	61.73902
	Covernment	Covernment	Supervision	Political Stability	Law-Ruled	Legal
Group	Accountability	Efficiency	Quality	Absence of Violence	Environment	Power
		Emerency	Quanty		Environment	Index
1	0.052238	86.54386	61.25665	98.99502	52.76801	6.274757
2	46.48399	76.39571	81.8204	10.02215	17.8117	4.955984
3	99.53897	33.20928	29.73468	6.204522	29.8244	1.509864
4	10.48132	12.78884	54.95401	48.52294	89.04757	9.788563
5	55.7789	31.3429	16.62036	62.24973	98.79347	2.874752
6	89.90049	62.59376	13.7869	21.78016	18.21411	1.460019
7	59.06087	66.0438	4.755467	34.87848	45.13406	3.649955
8	37.25342	59.31846	87.25526	93.35016	66.84643	3.274541
9	51.54585	33.06821	43.00018	49.18063	7.103708	10.76513
10	52.01294	86.38682	9.769792	90.80522	10.80167	6.686964
Group	Mobile Cellular Subscriptions per 100 People	Number of Secure Internet Servers	Internet Penetration Rate	Railway (Total Kilometers)	Airline Passenger Volume	Score
1	170.2021	911.3717	49.80943	900.8525	57,466.12	0.292259
2	58.5057	2087.543	33.5849	175.669	20,894.67	0.295258
3	125.8142	3045.704	63.107	89.89165	8086.242	0.290062
4	160.1512	205.3275	7.28853	88.52746	79,835.09	0.297150
5	88.66884	1587.197	7.399477	684.0961	40,238.83	0.299142
6	66.04125	2465.774	93.9661	354.4557	41,062.91	0.299217
7	157.2568	3424.729	28.15077	731.0508	13,776.29	0.291836
8	148.0776	288.2062	40.67269	666.9315	93,372.57	0.290548
9	59.69504	1744.74	82.66295	394.5347	61,347.49	0.290932
10	71.4734	2237.482	0.457962	766.682	84,870.92	0.295841

Table 4. Optimal	indicator	combinations.
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5. Discussion

According to the results of entropy method (Table 3), Russia tops the seven countries in e-commerce investment climate with the highest score for five consecutive years. Mongolia and Kazakhstan are

second to Russia with a stable five-year comprehensive score of the two countries. Ukraine, Belarus and Kyrgyzstan rank from 4th to 6th, respectively. Tajikistan remains at the bottom over the five-year period. The e-commerce investment climate varies slightly from country to country, but the integration is obvious. According to the 5-year score data, except for Tajikistan which scores the lowest, the average scores of other countries are within the range of 0.13–0.20. Belarus has almost the same scores with Kyrgyzstan.

To further analyze the cross-border e-commerce investment climate, and to clarify the relationship between each indicator weight and different country types, the seven countries are divided into three categories according to the national e-commerce investment climate comprehensive score. The boundary line is set at 0.1 and 0.15. Those scoring above 0.15 are identified as first-category countries and they include Russia, Mongolia, and Kazakhstan. They are countries with the most desirable e-commerce investment climate. The second-category countries include Belarus, Kyrgyzstan, and Ukraine, whose score is in the range of 0.1 and 0.15. The third-category country scores 0.1 or less, namely, Tajikistan, whose e-commerce investment climate is the least well-suited for investment. The country, therefore, is not considered in subsequent analysis.

The first and second category countries are re-analyzed for their index weight of each index by using the second entropy method. The results are shown in Tables 5 and 6. Seen from these two tables, the economic environment is the most important factor in the evaluation of cross-border e-commerce investments with the scores of the surveys accounting for more than 30% of the total. The legal environment is the weakest, and the political environment and the industrial environment fall in between. Further analysis reveals that both types of countries have the following commonalities. In the comprehensive evaluation, the economic strength has the largest proportion in economic indicators, the economic openness is second, and the economic stability is the weakest. Among the political environmental factors, government executive power has the highest impact, and political stability has a weaker impact. In both types of countries, the legal environment has the same degree of influence, and is an important influencing factor in both types of countries. As for the industrial environmental indicators, the communication conditions have a greater degree of influence, and the logistics conditions are second. By analyzing the secondary evaluation indicators in both types of countries, it can be concluded that the main indicators affecting the e-commerce investment climate evaluation are economic strength, government execution, legal factors and communication conditions (Screening with factors greater than 10%).

Indicator Level	Primary		Secondary		Primary	Secondary
Indicator	Econ Env	Econ Strength	Econ Stability	Econ Openness	Legal Env	Legal Factors
2013	34.6	19.3	5.1	10.3	11.8	11.8
2014	32.4	18.3	4.8	9.4	11.2	11.2
2015	33.8	19.6	4.6	9.6	12.9	12.9
2016	34.5	19.6	5.5	9.4	11.3	11.3
2017	32.3	18.4	4.6	9.4	15.5	15.5
Indicator Level	Indicator Level Primary		Secondary Prima		Secondary	
Indicator	Political Env	Gov Execution	Political Stability	Industry Env	Comm Cond.	Logistics Cond.
2013	21.8	16.4	5.4	31.8	21.8	10.0
2014	26.0	19.8	6.3	30.3	21.0	9.3
2015	23.6	17.4	6.2	29.7	20.4	9.4
2016	26.2	20.1	6.1	28.0	18.9	9.1
2017	23.8	18.2	5.6	28.4	19.2	9.2

Table 5. Weights of indicators of the first-category countries.

Indicator Level	Primary		Secondary		Primary	Secondary
Indicator	Econ Env	Econ Strength	Econ Stability	Econ Openness	Legal Env	Legal Factors
2013	32.2	15.4	5.3	11.6	14.7	14.7
2014	34.6	17.4	5.2	11.9	13.6	13.6
2015	32.9	15.9	4.5	12.6	15.2	15.2
2016	37.4	16.3	7.0	14.1	14.3	14.3
2017	32.7	15.0	4.8	12.9	13.6	13.6
Indicator Level	licator Level Primary Secondary		ndary	Primary Second		ondary
Indicator	Political Env	Gov Execution	Political Stability	Industry Env	Comm Cond.	Logistics Cond.
2013	26.1	21.5	4.6	27.1	17.7	9.4
2014	24.7	20.0	47	27.1	18.2	89
2014	41.7	20.0	I ./	4/.1	10.2	0.7
2014	25.6	20.8	4.7	26.4	17.3	9.0
2014 2015 2016	25.6 24.4	20.8 19.5	4.7 4.9	26.4 24.0	17.3 15.1	9.0 8.8

Table 6. Weights of indicators of the second-category countries.

From the analysis of the differences between the two types of countries, we find that the industrial environment has more impact on investment climate than the political environment in the first-category countries. Things, however, are the other way around in the second-category countries. To distinguish the characteristics of the cross-border e-commerce investment climate between these two types of countries, the first-category countries are referred to as industry-oriented countries, and the-second category countries as politics-oriented countries and relevant content is shown as follows.

(1) Industry-oriented countries

Countries of this category include Russia, Mongolia and Kazakhstan, whose telecommunication conditions and economic strength have the highest weight, with the government's executive power is in the second place. In practical terms, internet is better developed in these countries, where there is a larger proportion of customer base online and the market is more dynamic.

As a country adjacent to China, Russia has abundant reserves in the economic, military and natural resources. Russia and China have a borderline that stretches as long as 4300 km. Russia has long used its vast territorial span to form a very rich communication culture, and developed a unique communication and e-commerce market. Russia is one of the seven countries in the world with over 100 million Internet users, and its well-developed communication industry and the huge number of Internet users serve a strong basis for the development of the e-commerce market. Since the launch of "the Belt and Road" Initiative, China and Russia have established comprehensive exchange and cooperation mechanisms at various levels such as energy, investment, economy, trade, local and strategic security. At the end of 2016, Russian President Putin proposed to build a digital economy. The Digital Economy Plan was approved in Russia in July 2017 and identified as an important political task in the state of the Union address in March 2018. Better communication and network conditions will greatly facilitate investment and operations of cross-border e-commerce.

Mongolia, a country located to the north of China, boasts unique natural geographical advantage. Mongolia has been connected to the Internet since 1995, and currently, wireless networks, mobile 3G and 4G networks have been popularized in the country. Mongolia is complete with a logistics distribution system. The household-based postal plan has been carried out across the country since 2011. The country, therefore, has the conditions for communication services and logistics conditions. In recent years, Mongolia has made great efforts to develop e-commerce by tapping into the "Belt and Road Initiative". E-commerce companies have emerged such as NEW SILKROAD, UBMALL, and APM, which come in various forms including B2C and C2C, and the products are mainly labor-intensive. Although the development of cross-border e-commerce is still in the initial stage, it has high user vitality and huge market demand. Kazakhstan is mainly based on heavy industry, and rather weak in processing industry and light industry. The country is heavily reliant on foreign commodity with most of its domestic consumer goods coming from abroad and it has a huge demand for labor-intensive products. High-tech products, daily necessities, and light industrial products circulating in the market mainly come from the United States, Germany, Japan, Russia, China and other countries. Since the advent of the "Belt and Road Initiative", "digitalization" has been listed by Kazakhstan as one of the five main directions for the country's future development. The government has formulated "Digital Kazakhstan", a national plan for this purpose. From 2013 to 2017, the number of internet users in Kazakhstan soared to 77% of its population, which puts the country in the 17th place in the world in net user density. The internet users increase steadily in numbers, which offers a great momentum for the future growth.

Thus, the commonality among this type of countries is a great impact on its e-commerce investment climate, a more open economy, a desirable industrial environment and great market potential which may serve key factors in cross-border e-commerce investment.

(2) Politics-oriented countries

Countries of this type include Ukraine, Belarus and Kyrgyzstan. The index of the government executive power has the highest weight, which plays a more significant role in government accountability, government effectiveness, and government supervision quality.

Ukrainian heavy industry and agriculture are more developed, labor-intensive industries and light industries are underdeveloped, its market has plenty of room for expansion. E-commerce has been advancing rapidly in Ukraine and the number of online customers is rising year by year, making the country the second largest e-commerce market after Russia in Eastern Europe. However, since 2014, as a result of geopolitical influence, Don-bass and Crimea, the war stricken regions, have taken away 20% of Ukraine's online sales. At the same time, electronic payment system has yet to be legitimized in the country, which to some extent has taken a toll on its e-commerce investment climate. In 2015, Ukraine passed the "On E-commerce" (Act No. 675), which will legally pave the way for trade dispute settlement. At the same time, the country established "the Belt and Road Initiative" Trade and Investment Promotion Center which creates a favorable environment for cross-border e-commerce investors.

Belarus is faced with a grim situation in trade law. Since choices are few in the market, and commodity prices are high, e-commerce has become a new option for Belarusian customers. As Belarus' third largest trading partner and second largest source of imports, China is recognized as one of the friendliest countries to Belarus. The trade between the two countries is complementary. Belarus and China have maintained a good cooperative relationship by establishing the "China-Belarus Industrial Park". Since the launch of "the Belt and Road Initiative", Belarus has phased in new policies and laws and formulated new e-commerce regulations to secure e-commerce development. In June 2020, China and Belarus reached consensus on continuing to deepen cooperation in building the "Belt and Road". However, in recent times, there have been manifestations in Belarus for political reasons and the protests have become increasingly radical. At the same time, the Belarusian government has demanded restrictions on Internet during the protests. This further confirms our findings that the political environment is unstable and that discretion is needed when making investments.

Kyrgyzstan has a weak industrial base, and is predominantly dependent on agriculture and animal husbandry. Though it is underdeveloped in economy, Kyrgyzstan is a coveted spot for foreign investors, thanks to its unique geographical location, free trade port and processing zone. However, the country is faced with multiple difficulties given the fact that it has no complete and convenient telecommunication network, a government-led plan, and it has undergone a significant amount of political turmoil.

The commonality of investment in this type of countries is that there is great market potential but the political environment is unstable. Investors need remain cautious.

In general, industry-oriented countries generally outweigh politics-oriented countries in term of cross-border e-commerce investment climates. It is our recommendation that investors give priority to industry development and freedom instead of relying heavily on regulation.

Based on the results of the neural network with genetic algorithm, we can draw the following conclusions.

- (1) From a macro perspective, we do not find a single positive correlation between the final score and the purely quantitative indicators such as total GDP, per capita GDP, railway mileage, aviation mileage, etc., which indicates that there is not a strong link between the comprehensive score of the market investment climate and the absolute quantity of indicators and the entropy evaluation method is objectivity.
- (2) From the perspective of economic environment, these 10 sets of data reveal that the total GDP value fluctuates within the range from several hundred to tens of thousands, but there is correlation between the corresponding GDP growth rate and the annual inflation. If the total economic volume is huge and its GDP is growing steadily with a high per capita GDP and corresponding rise in inflation rate, the score will be high, as shown in the 2th and 8th sets of data. This shows that the country's economic development is stable with a high economic level, people have strong consumption power, which is a good opportunity for cross-border e-commerce investors. Seen from the 1st and 5th sets of data, its GDP growth rate is lower than the inflation rate, and it has a relatively high score in legal environment, which indicates that, despite its low economic growth rate, the sound legal environment can help improve and optimize the investment climate, enhance the impact, which suggests that the country is worth considering an investment destination. In addition, it can be found from the 3rd, 4th and 6th sets of data that the GDP growth rate is negative, and the inflation rate is more obvious than the negative growth rate of GDP growth rate. Therefore, it can be inferred that such countries may have problems such as overall social production overcapacity, government tightening budgets, decline in aggregate social demand, lower investment and consumption expectations, and higher exchange rates. When deflation reaches its limit, the economy will gradually recover under the stimulation of demand. Therefore, investors can invest at the right time.
- (3) From the perspective of the political environment and the legal environment, four three-level evaluation indicators of the political environment complement each other. It can be seen from the 1st, 2nd, 3rd, 6th, 8th, and 10th sets of data that at least one of the four indicators are above 80%, which can reflect the great impact of the political environment in a certain direction. Political stability, good quality of supervision, high government accountability and government efficiency are the prerequisites for a sound e-commerce market environment. The legal environment scores for groups 4 and 5 are higher than 85%, indicating that a good legal environment has greater benefits for e-commerce investment.
- (4) From the perspective of the industry environment, it can be seen from the 2nd, 3rd, 6th, 7th, 9th and 10th sets of data that a relatively large number of secure internet servers can serve a good channel for e-commerce and promote convenience in online shopping. The rest sets of data do not show a decided advantage in the number of secure internet servers and internet penetration rate, but the high passenger volume in railway and airline transport, and convenient logistics add weight to cross-border e-commerce investment climate.
- (5) A comprehensive analysis of the four major types of environment reveals that a large number in the combined volume of both railway and airline passenger tends to generate high comprehensive scores, from which we can infer that logistics infrastructure is the most fundamental factor in cross-border e-commerce investment. After the requirement for the logistics conditions is met, it can be seen from a comparative analysis of groups 5, 6 and group 9 that a country may have a poor economic environment and deflation, but it can attain a higher score provided that either government or legal environment is given prominence. In a time of

economic austerity, politically-oriented countries with better logistics conditions can also serve investment destinations.

6. Conclusions

Conclusions can be drawn as below after evaluating and analyzing the cross-border e-commerce investment climate of the countries along "the Belt and Road Initiative". First, of the seven countries, Russia has the best cross-border e-commerce investment climate, followed by Kazakhstan and Mongolia. Tajikistan has the worst investment climate.

Second, in all of the seven countries, the economic environment has the greatest impact on the e-commerce investment climate, the legal environment has the weakest impact, and the industrial environment and political environment have a moderate impact on the e-commerce investment climate. Investors should give priority to the national economic situation when selecting an investment destination among the seven countries. The better the economic environment, the more conducive to e-commerce investment.

Third, seven countries are classified by comprehensive score. For the first type of industry-led countries, namely, Russia, Mongolia and Kazakhstan, the national industrial environment has a greater impact than the political environment. They are more conducive to e-commerce investment. Such countries have higher openness and network communication level, the development of the network platform is relatively good. They have the industry environment for e-commerce. For the second type of politically-oriented countries, including Ukraine, Belarus and Kyrgyzstan, they have relatively more prominent political influences. Such countries are relatively weak in openness, more inclined to the government, and have poor communication and network foundations. Additionally, some countries have political and territorial disputes, which increase the risk in investment. Ukraine is typical of this type. Cross-border e-commerce investors need remain cautious in choosing the destination country.

Fourth, we use a neural network in combination with genetic algorithm to optimize the established index evaluation system and make it applicable to other countries. It can be seen from the results that the indicators interact and correlate each other, which reflects the objectivity of the entropy method. In assessment of the investment climate in each country, the following characteristics of indicators and their relevance can be used for selection and judgment. In terms of economic environment, if the country has stable economic growth and high inflation rate, the overall score tends to be relatively high and the investment risk is relatively low. If economic growth is slow and deflation occurs, timely investment can be made in conjunction with legal environment. Investment is an option if a country shows obvious advantage in any one of the following three areas, namely, political stability, government enforcement, or legal environment. For investors, a country is worth considering if it is competitive in either logistics or communication conditions. Politically-oriented countries, despite their poor economy and deflation, still merit consideration provided that their logistics conditions are desirable.

Investment climate for China's cross-border e-commerce is studied in this paper. An evaluation system is established and seven "the Belt and Road Initiative" land countries are analyzed including Russian Federation, Mongolia, Ukraine, Kazakhstan, Tajikistan, Kyrgyzstan and Belarus. The importance of indicators that affect the investment climate is researched, and the weight of each indicator is obtained. Prior to this, there has been no relevant research to establish an indicator system for cross-border e-commerce. This is an innovation of the paper. To verify the objectivity of the model and make it applicable to the evaluation of many other countries, the back propagation neural network method is used to map the existing index data and the genetic algorithm is used to optimize the evaluation index system, which is new in this field. In the current trend of trade globalization and booming e-commerce, the research can help cross-border e-commerce companies to make effective investments and improve the quality and efficiency of trade cooperation between countries.

Some limitations of this study should be addressed in the future. First, in the research, the number of samples is limited, and only seven representative countries are selected. There are many people

around the world that order products from China via the Internet, so the analysis of seven countries may not be enough. Secondly, the study was not conducted by industry, and the investment climate evaluation indicators may be different in different industries. Therefore, there are some future research directions available. Researchers can choose more countries to study the investment climate of cross-border e-commerce, which can be explored by continent, or can be discussed based on the use of e-commerce by people in different countries. At the same time, the study can be conducted by industry category. For example, electronics and apparel may have different needs for the industry environment. Moreover, different countries have different customs and cultures, factors such as the cultural environment of investee countries can be taken into account in the evaluation index system.

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