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Optimization and Benefit Analysis of Regional Economic Cooperation Models under the "Belt and Road" Strategy with the Assistance of Artificial Intelligence

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Abstract With the acceleration of the global integration process and the development of artificial intelligence technology, the regional economic cooperation model under the "Belt and Road" strategy needs to be optimized in order to enhance the benefits of cooperation and promote the coordinated development of the region. This paper discusses the optimization path and benefit analysis of the regional economic cooperation model under the "Belt and Road" strategy with the assistance of artificial intelligence. The study constructs a regional economic readiness evaluation system and a stochastic frontier gravity model, measures the readiness of regional economic cooperation through principal component analysis and efficacy score method, and analyzes the impact of economic cooperation on regional economic growth by using fixed effect model. The results show that Singapore, Estonia and Israel are among the top three countries along the Belt and Road in terms of readiness for regional economic cooperation, while China is in the 14th place due to its low factor endowment and business environment scores. The empirical analysis shows that the GDP level of cross-border regional economic partner countries has a significant negative impact on trade inefficiency factors, and the increase of geographical distance has a significant hindering effect on trade efficiency. Fixed effects model results further confirm that joining the regional economic cooperation model has a significant positive effect on economic growth, with a coefficient of 0.086, and passes the significance test at the 1% level. Based on the findings of the study, this paper proposes optimization suggestions such as strengthening the construction of network infrastructure, promoting the construction of the economic community and building a digital financial service system, in order to promote the higher-quality development of the "Belt and Road" regional economic cooperation.

Index Terms Regional Economic Cooperation, Artificial Intelligence, Belt and Road, Gravity Modeling

I. Introduction

At present, the international political and economic changes are becoming more and more complicated, international trade and investment are weak, the world economy is facing a profound adjustment, and the crisis in front of all countries is still very dangerous [1]-[3]. The "Belt and Road" initiative put forward by China to the world in 2013 responds to the trend of economic globalization, openness and cooperation at that time, and aims to maintain and promote global trade liberalization, investment facilitation, and narrow the gap between the North and the South. The multilateral cooperation advocated by "One Belt, One Road" fully embodies the concepts of inclusiveness, openness, cooperation and win-win situation, and helps to create a multilateral regional cooperation with a wider scope, higher level, higher enthusiasm and deeper level of participation [4], [5]. The implementation of the "Belt and Road" reflects the beautiful vision of the world's people who hope for win-win cooperation, and it is a proactive exploration of global political, economic and cultural cooperation at a deeper level, which will bring positive energy for the change of global economic and political development [6], [7]. The "Belt and Road" is the main strategy of China's current foreign economic development, as of December 2024, the number of countries that have reached the "Belt and Road" cooperative relationship with China has reached 152 countries, with a total economic volume of 21 trillion U.S. dollars, which is a strategy that better meets the requirements of the development of globalization, and has a positive effect on the promotion of global economic and political development. This strategy better meets the requirements of globalization, and brings great energy in promoting regional economic cooperation and development, and creating more welfare for the peoples along the route [8]-[11]. At present, in the process of implementing the development strategy of "One Belt, One Road", there are positive breakthroughs in the field of energy and infrastructure, which also provides great opportunities for regional economic development [12]-[14].

How to better utilize the “Belt and Road” strategy to promote regional economic cooperation is the main direction of current research in the field of economic development.

The promotion of cooperation projects found that the “Belt and Road” strategic regional economic deep cooperation faces multiple challenges. In cross-border cooperation projects, the financial service environment of cross-border economic cooperation is not satisfactory enough, and more than half of the supporting service system of bank account payment has asymmetric information, and the cost of financing is very high [15], [16]. And with the deep development of cooperation, the traditional model of resource coordination can not meet the dynamic changes in demand, and the supply chain fluency is reduced, such as the port cargo stay time is too long, resulting in a decline in trade efficiency [17]-[19]. In addition, in the increasingly tense international situation, political, exchange rate, trade environment turbulence, further increasing the risk of regional economic cooperation, some cooperation projects have delayed delivery, and for different enterprise size, due to the difference in the degree of digital transformation, resulting in unbalanced distribution of benefits in the cooperation, reducing the participation of small and medium-sized enterprises [20]-[23]. It can be seen that the current situation, to promote the “Belt and Road” regional economic cooperation towards intelligence, digitalization. The use of information technology, intelligent technology, through the intelligent collaboration platform for international cooperation management, not only improves the management efficiency, but also reduces the cost [24], [25].

With the accelerating process of global economic integration, regional economic cooperation has become an important driving force for world economic development. As a historical concept connecting Asia, Europe and Africa, the ancient Silk Road was an important channel for the exchange of civilizations between the East and the West and for economic and trade cooperation. In the context of the new era, China has proposed the strategic concepts of “Silk Road Economic Belt” and “21st Century Maritime Silk Road”, which provide an important opportunity to build a new international political and economic order for sustainable development. Since the implementation of the “One Belt, One Road” strategy, regional economic cooperation is facing a new development environment and opportunities, and the rapid development of artificial intelligence and other digital technologies has provided new possibilities for optimizing the regional economic cooperation model. At present, the regional economic cooperation mode is transforming from the traditional cooperation relying on geographic advantages to digitalization and intelligence, which is of great significance to the optimization and efficiency improvement of regional economic cooperation mode. This study focuses on the optimization and benefit analysis of the regional economic cooperation mode of the “Belt and Road” strategy with the assistance of artificial intelligence, and identifies the optimization path of the cooperation mode and evaluates the comprehensive benefits of economic cooperation by constructing a scientific evaluation system and model. First, the study firstly comprehends the basic concepts and theoretical framework of regional economic cooperation, and analyzes the cost structure of the “Belt and Road” regional economic cooperation, including the cost of infrastructure construction and the cost of economic system reform; secondly, it constructs the evaluation system of regional economic readiness, and measures the readiness of regional economic cooperation of countries along the “Belt and Road” through the method of Principal Component Analysis (PCMA) and Efficacy Score Method (ESM) and categorizes the sample countries based on different characteristics; then, based on the Gravitational Force Analysis (GFA), the study analyzes the effectiveness of regional economic cooperation. Then, based on the principle of gravity model, the stochastic frontier gravity model and fixed effect model are established to empirically analyze the impact of regional economic cooperation on economic growth; finally, based on the findings of the study, optimization suggestions are put forward to strengthen the construction of network infrastructure, promote the construction of the economic community, and build a digital financial service system. The theoretical significance of this study is that it enriches the theory of regional economic cooperation and expands the depth and breadth of the research on regional cooperation mode in the context of digital economy; the practical significance is that it provides scientific basis for the countries along the Belt and Road to formulate policies on regional economic cooperation and promotes the development of the regional economy with higher quality. Through in-depth analysis of the readiness and economic benefits of regional economic cooperation, the study reveals the key factors affecting the efficiency of cooperation, providing useful reference for optimizing the regional economic cooperation model and promoting the high-quality development of the “Belt and Road” construction.

II. Optimization and cost analysis of the regional economic cooperation model

Sustained economic growth is one of the long-term goals pursued by a country or region, and is also an important guarantee for achieving full employment, promoting social stability and enhancing social welfare. The ancient Silk Road has changed its former glory into backwardness with the passage of time. With the acceleration of the process of global integration and the continuous improvement of transportation infrastructure such as the Asia-Europe

Continental Bridge, the Silk Road Economic Belt has been formed in the new era. The “One Belt, One Road” strategy can better promote the coordinated development of the regional economy, enhance the economic and cultural exchanges and development of the Eurasian countries, and has far-reaching significance in promoting the stability and unity of all countries in the world.

II. A. Optimization of the regional economic cooperation model

II. A. 1) The concept of regional economic cooperation

Regional economic cooperation encompasses integrated economies with a high degree of cooperation and subregional economies with a low degree of cooperation, which means that regional economic cooperation has a relatively low degree of freedom of movement of factors of production and a relatively narrow scope of functioning, and that regional economic cooperation favours cooperation among economic agents with geographic advantages. The model of regional economic cooperation aims to make use of the geographic advantages of neighboring economies, give full play to their respective comparative advantages, and realize the free flow of economic factors across borders and regions, so as to promote inter-regional economic and trade cooperation, and expand the common interests of the cooperation subjects. Regional economic cooperation is a kind of spontaneous cooperation that is more inclined to the role of the market and in which each economic subject seeks greater economic benefits, and this kind of cooperation can gradually evolve into high-level cooperation in the usual sense of the term, i.e., regional economic cooperation and integrated economic cooperation, as it develops [26].

When a larger scope of regional economic cooperation can not be achieved in one step, it can try a small scope of subregional economic cooperation, through the development of subregional economic cooperation, gradually upgraded to regional economic cooperation, to realize the intention of cooperation from small to large, from point to point. From the perspective of interaction, as a primary mode of cooperation, subregional economic cooperation has a certain role in promoting regional economic cooperation, and the formation of regional economic cooperation will, in turn, drive the operation and development of subregional economic cooperation. Due to the similarity of cooperation modes, the development experiences of subregional economic cooperation and regional economic cooperation can be referred to and borrowed from each other, so as to promote each other and develop together. It is worth noting that, due to the characteristics of subregional economic cooperation itself, when studying the theory of subregional economic cooperation, it is important to combine it with the actual situation of the local region, so as to analyze the situation on a case-by-case basis.

II. A. 2) Framework for regional economic cooperation

The implementation of the “Belt and Road” strategy with the assistance of artificial intelligence technology has enabled the rapid development of regional economic cooperation. As a modular and open agreement, the regional economic cooperation model under the auspices of digital technology is highly interoperable, and its influence on the shaping of economic rules in the Asia-Pacific region and the world should not be underestimated. Figure 1 shows the framework of regional economic cooperation under the “Belt and Road” strategy, centered on the G20 and supported by digital technology, as shown in Figure 1. (c) Realize their digital economy aspirations through more flexible multilateral agreements, forming an “alliance-network” structure centered on the G20 and radiating outwards.

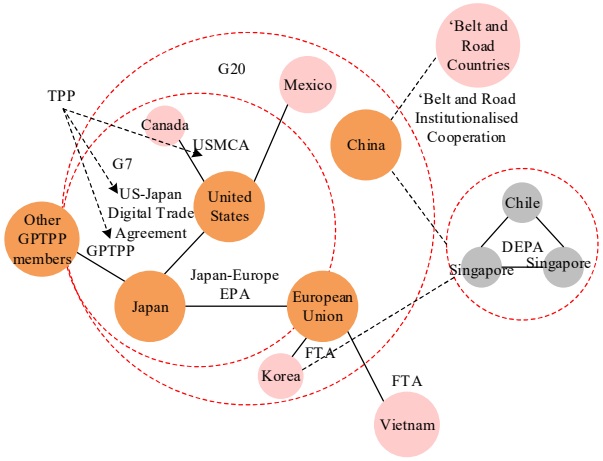

Figure 1: Regional economic cooperation framework

On the one hand, addressing the global digital divide, intellectual property protection, digital ethics and other issues depends on cooperation among the governments of sovereign countries to promote the provision of digital public goods, incentivize digital technological innovation, guide science and technology for the better, and build the development of a model of regional economic cooperation that is inclusive, shared and mutually beneficial. On the other hand, the era of digital economy will emphasize the participation of multiple subjects, especially non-state subjects, more than ever before, and the decentralized distributed governance brought by blockchain technology provides innovative ideas for traditional centralized governance. The concept of community of destiny in digital economy should be adhered to, the old concept of zero-sum game should be discarded, multi-party participation and multi-governance should be adhered to, and the will and interests of multi-party subjects should be reflected, so as to jointly formulate the innovative governance rules for regional economic cooperation [27].

II. B. Cost analysis of regional economic cooperation

II. B. 1) Infrastructure construction costs

In the process of regional economic integration under the Belt and Road Initiative, the integration of infrastructure is fundamental. Compared with other provinces and cities, the north-western region lags behind in terms of infrastructure development and has not yet completed an efficient and smooth domestic and international logistics network with the central and eastern regions and Central Asia, but it is developing rapidly and has great potential.

“The “Belt and Road” regional economic integration construction integrates the highways, railroads, aviation, communications and other infrastructure of the Northwest China region with the Middle East and Central Asia, and creates a transportation network with neighboring regions. A fast and convenient logistics system will be formed to serve the “Belt and Road” region and reduce the cost of economic development in the “Belt and Road” region.

II. B. 2) Costs of economic restructuring

A highly market-oriented economic system is the prerequisite guarantee for economic freedom, and the integrated development of regional economy must rely on the market economy as the main body. Although after nearly 40 years of reform and opening up and the construction and development of the socialist market economy system, China's overall economic level has been improved to a certain extent, but due to the short time of economic development, the development level is low and other factors. Especially by the long-term impact of the planned economic system, prompted by China's market economic system in the long-term development process there are still many imperfections, especially in the northwest of China, this phenomenon is more obvious.

To improve this status quo related government units should actively change their functions, the local government and the central government can be coordinated to build up a new type of service-oriented government, in order to promote the relationship between enterprises and the government can be standardized. Under the current economic system, in order to realize the integrated development of the regional economy must carry out institutional reform, and the resulting cost will be very huge, which should be actively combined with the actual situation, to carry out all-round, multi-angle research work. The cost of reforming the economic system should be minimized, but care should be taken not to overdo it.

III. Assessment and impact of the economic benefits of regional economic cooperation

The "Silk Road" as a historical concept has long been a corridor and bridge for the exchange of Eastern and Western civilizations and economic and trade cooperation. It is also a strategic passage connecting the three continents of Asia, Europe, and Africa, as well as the three oceans: the Pacific, Indian, and Atlantic. The proposal of the "Silk Road Economic Belt" and the "21st Century Maritime Silk Road" strategic concepts reflects China's response to the current complex and changing international geopolitical and economic landscape, aiming to follow international trends, look to the future, and comprehensively strengthen international economic and trade cooperation between China and Central Asia, the Middle East, Europe, North Africa, South Asia, and Southeast Asia. This significant strategic concept benefits the countries along the route, combats the international economic crisis, and aims to construct a new order of international political economy that supports sustainable development.

III. A. Regional economic benefit assessment model

III. A. 1) Indicators of regional economic readiness

In order to scientifically, objectively and comprehensively measure the readiness of regional economic cooperation under the “Belt and Road” strategy, this paper constructs an evaluation system for the readiness of regional economic cooperation, as shown in Table 1, based on the reference to the existing studies on the readiness of regional economic cooperation and the research results of related scholars on regional economic cooperation. The selection of indicators is based on scientific, comprehensive and feasible quantitative indicators that are measurable

and accessible as much as possible. The data for the indicators in the table come from the World Bank database and the World Economic Forum Information Technology Report.

Table 1: Regional economic readiness indicators

Index	Meaning	Code
Fixed broadband penetration rate	The degree of improvement of information infrastructure	FBP
Fixed-line telephone penetration rate	The degree of completeness of information infrastructure	FTP
Enrollment rate in higher education	The abundance of digital professionals	ERE
Secure server for every million people	The degree of network environment security and the intensity of government network supervision and governance	SSE
Proportion of high-tech exports	Openness of the digital economy and international competitiveness of technology	PHE
ICT product exports	The degree of openness of the digital economy and the international competitiveness of technology	ICT
Availability of venture capital	Suitability of the innovation environment	AVC
Availability of the latest technology	The degree of technological transformation and utilization	ALT

III. A. 2) Assessment of regional economic readiness

In order to accurately measure the readiness of regional economic cooperation, this paper adopts the principal component analysis and efficacy score methods. The principal component analysis method was first introduced by Pearson, which fuses diversified indicator information into a few key indicators, generating key factors that both include the main elements of the initial data and reflect the relationship between the initial data and the factors [28]. The advantage of this method is that it not only considers the condensation of information, but also further elucidates the intrinsic correlation structure among these indicators and simplifies the analytical research process.

Specifically, suppose there are N samples, P indicators, $X=(X_1,X_2,\cdots,X_p)^T$ is a random vector, and the common factor to be fused is $F=(F_1,F_2,\cdots,F_m)^T$, then the model is as follows:

$$\begin{aligned} X_1 &= a_{11}F_1 + a_{12}F_2 + \cdots + a_{1m}F_m + \varepsilon_1 \\ X_2 &= a_{21}F_1 + a_{22}F_2 + \cdots + a_{2m}F_m + \varepsilon_2 \\ &\cdots \\ &\cdots \\ X_p &= a_{p1}F_1 + a_{p2}F_2 + \cdots + a_{pm}F_m + \varepsilon_p \end{aligned} \tag{1}$$

where a_{ij} is the factor loading, which is the correlation coefficient between the common factor F_j and X_i. ε is the special factor, which represents the variable changes caused by other influencing factors and is not considered in practice. In this paper, the efficacy score method is used to calculate the efficacy score of F_j for each province and country, and the formula is:

$$(Y_i - Y_{\min}) / (Y_{\max} - Y_{\min}) * 100 \tag{2}$$

where i denotes the country or region, Y_i is the actual value of a particular common factor for the country or region, $Y_{\max}$ denotes the maximum value among all the countries or regions in this indicator, and $Y_{\min}$ denotes the minimum value. An efficacy score of 0 indicates that the country has the lowest value of this common factor, while a score of 100 means that it has the highest value of the common factor indicator among all the countries in the sample.

This paper focuses on the development status of regional economic cooperation and its international competitiveness under the “One Belt, One Road” strategy, using data from 31 Chinese provinces and 158 countries from 2012 to 2024. For the missing and outliers in individual samples, this paper corrects the missing values and outliers according to the arithmetic mean method. The inter-provincial data are from the China Statistical Yearbook and the country data are from the World Bank database.

III. B. Regional economic efficiency impact model

III. B. 1) Standard gravitational modeling principles

Gravity model is the basic theory for analyzing regional integration through inter-regional trade. As the most successful empirical model in trade theory, i.e., trade between two places is directly proportional to the size of the economy between these two places and inversely proportional to the distance between them [29]. The specific model is:

$$\ln Trade_{ij} = \alpha_0 + \alpha_1 \ln GDP_i + \alpha_2 \ln GDP_j + \alpha_3 \ln Dis_{ij} + \varepsilon_{ij} \tag{3}$$

where $Trade_{ij}$ denotes the export trade from region i to region j, and GDP_i and GDP_j are the GDPs of region i and region j. Here, other factors affecting the inter-city trade are placed into the residual term. Since trade status affects the spatial agglomeration of industries, which in turn can affect economic growth, Dis_{ij} denotes the trade distance between regions i and j.

III. B. 2) Model Construction and Description of Variables

In the traditional trade gravity model, the relative trade distance between trading countries and the total economic volume are the original explanatory variables, but in the “Belt and Road” regional economic cooperation and trade under the support of artificial intelligence, the relevant influencing factors have changed considerably, especially the use of the Internet and the per capita GDP level of each country are not to be underestimated. The impact of GDP level should not be underestimated. Therefore, based on the research of existing scholars, this paper improves the traditional trade gravity model, focusing on analyzing the impact of distance between trading countries, economic level gap, population size, Internet usage and economic market size on the economic efficiency and trade potential of regional economic cooperation. The improved trade gravity model is expressed as follows:

$$\begin{aligned} \ln ET_{it} &= \alpha_0 + \alpha_1 \ln GDP_i + \alpha_2 \ln IF_i + \alpha_3 \ln P_i \\ &+ \alpha_4 \ln NET_i + \alpha_5 \ln DIS_i \ln DIS_i + \varphi_i \end{aligned} \tag{4}$$

where i represents the partner countries with which cross-border products are more frequently traded for export, ET_i represents the export trade volume with the cross-border economic export trade partner countries, GDP_i represents the GDP level of the cross-border economic export trade partner countries, and IF_i represents the absolute value of the difference in the GDP level with the cross-border digital economic export trade partner countries as a means of reflecting the degree of similarity in the level of cross-border economy trade demand level similarity. P_i represents the population size of the cross-border economic export trade partner country as a reflection of its market size. NET_i represents the number of Internet servers in the cross-border economic export trade partner country, which reflects the Internet usage in the country. DIS_i represents the geographic distance between Hongshanzui port and Mongolian and Russian ports.

On this basis, this paper constructs a fixed-effects model with the total output of regional economic cooperation as the explanatory variable and whether to join the regional economic cooperation model as the core explanatory variable. Namely:

$$\ln Output = \beta_0 + \beta_1 \ln KGF + \beta_2 \ln EX + \beta_3 \ln IM + \beta_4 Labor + \beta_5 \ln LP + \beta_6 \ln DM \tag{5}$$

where $Output$ is the total output of regional economic cooperation, KGF is the model of regional economic cooperation, $EX, IM, Labor, LP$ is each control variable fixed capital stock, total imports and exports, employment rate, labor productivity, respectively, and DM is a dummy variable.

IV. Benefits analysis and recommendations of the regional economic cooperation model

We should follow the development trend of the fourth industrial revolution, jointly grasp the opportunities of digitalization, networking and intelligence, jointly explore new technologies, new business forms and new modes, explore new growth momentum and development paths, and build a digital Silk Road and an innovative Silk Road. This points out the direction for the construction of the digital “Belt and Road”, and also provides a new path for further optimizing the regional economic cooperation model.

IV. A. Analysis of regional economic readiness

IV. A. 1) Principal component matrix after rotation

This section uses factor analysis to statistically analyze the above indicators through IBM SPSS Statistics. The specific idea is to first test the data of each indicator to determine whether it can be statistically analyzed by factor analysis, and then use factor analysis to categorize each indicator to form a number of principal components. Then the weights are assigned to each principal component, and the score of each component and the total score of each country are calculated using the comprehensive evaluation method of efficacy coefficient.

First of all, the KMO and Bartlett sphericity test was conducted on the data of each indicator, the KMO sampling fitness quantile 0.824>0.65, and the significance of Bartlett sphericity test was 0.002, which indicates that the indicators have passed the test, and there is a strong correlation between the indicator variables, which can be categorized and empowered by the method of principal component analysis. Then, the indicators designed in the previous section were factor analyzed using the maximum variance rotation method, and the regression method was used to calculate the scores of each principal component after the completion of the analysis. Table 2 shows the principal component matrix after rotation. The results of factor analysis show that the cumulative contribution of variance of the first three principal components is 90.43% > 80%, so these three principal components can represent the information of the eight indicators.

According to the rotated component matrix, principal component 1 includes the four indicators of fixed broadband penetration, fixed telephone penetration, higher education enrollment, and secure servers per million people. Therefore, principal component 1 mainly represents the degree of network facilities improvement and the degree of government regulation on information security, so the principal component 1 is named factor endowment and infrastructure factor (FEI). Network infrastructure and security is the foremost prerequisite for the development of regional economic cooperation supported by AI technology, and the informatization and dataization on which the regional economy relies are based on a more complete network infrastructure and a guaranteed network security order. Principal component 2 includes two indicators: the proportion of high-tech exports and the proportion of exports of information and communication technology (ICT) products, which measure the level of information and communication technology used by the country to develop its digital economy and its position in the international market, and also reflect the degree of the country's digital economy's outward orientation, so this paper names the second principal component as the information technology outward competitiveness factor (ITE). Therefore, the second principal component is named IT Extroversion Competitiveness Factor (ITE). Principal component 3 includes the indicators of venture capital availability and latest technology availability, which indicate that no field or form of innovation can be separated from the participation and support of venture capital, and the higher the availability of venture capital, the higher the country's innovation activity. The availability of the latest technology not only reflects the transformation rate of the country's innovation achievements, but also reflects the country's business environment from another side. Therefore, this paper names the third principal component as Business and Innovation Environment (BIE).

Table 2: The principal component matrix after rotation

Code	Factor 1	Factor 2	Factor 3
Fixed broadband penetration rate	0.962	0.063	0.079
Fixed-line telephone penetration rate	0.935	0.015	0.052
Enrollment rate in higher education	0.843	0.042	-0.168
Secure server for every million people	0.816	0.087	0.281
Proportion of high-tech exports	0.104	0.934	0.117
ICT product exports	0.085	0.929	0.196
Availability of venture capital	-0.317	0.038	0.934
Availability of the latest technology	0.571	0.106	0.885

IV. A. 2) Regional economic readiness score

After defining each principal component and confirming its economic scientificity, weights were assigned to each principal component. Using SPSS software, the scores of the three main factors of each country are automatically calculated by regression method, and then the total score of each country's readiness for regional economic cooperation is weighted according to the corresponding variance contribution ratio of each common factor. Combined with the efficacy score method given in the previous section, the efficacy scores of the indicators of readiness for regional economic cooperation of the countries along the “Belt and Road” are shown in Table 3.

The results show that Singapore, Estonia and Israel rank among the top three countries along the “Belt and Road” in terms of readiness for regional economic cooperation, with Singapore maintaining a high level of readiness in the three main factors, and the efficacy scores of the three main factors are all over 75 points. The top 10 countries in the list belong to ASEAN, West Asia and Central and Eastern Europe, while no country in Central Asia, East Asia, South Asia and the CIS is in the top 10, which fully demonstrates the serious regional imbalance in the conditions necessary for the development of regional economic cooperation in the countries along the “Belt and Road”. China falls out of the top 10 and ends up in 14th place due to its low factor endowment and infrastructure scores and business and innovation environment scores. There are also large differences in readiness for digital economy development between different countries in the same region, for example, Singapore is ranked first in the readiness

ranking, while Cambodia, also a member of the 10 ASEAN countries, is at 40th place. At the bottom of the list in the 36th to 40th places are Kyrgyzstan, India, Tajikistan, Pakistan and Bhutan, three of which are located in South Asia, indicating that the conditions for the development of regional economic cooperation in South Asian countries are at a lower level among the countries along the “Belt and Road”.

Table 3: Regional economic readiness score

Rank	Country	FEI	ITE	BIE	Total score
1	Singapore	81.024	76.304	75.426	100.000
2	Estonia	88.167	23.316	64.381	74.358
3	Israel	73.938	30.072	75.912	71.472
4	Greece	100.000	24.096	1.087	66.212
5	Slovenia	93.024	13.201	35.326	64.305
6	Cyprus	85.194	17.335	32.209	61.316
7	Latvia	64.537	30.573	43.474	56.723
8	Malaysia	18.536	74.316	68.331	56.386
9	Hungary	67.426	31.486	27.196	55.219
10	Philippines	10.637	100.000	17.224	51.415
11	Lithuania	63.685	18.927	45.416	50.376
12	Croatia	72.017	19.865	20.963	49.182
13	Poland	63.884	26.174	21.793	48.452
14	China	32.105	63.626	29.853	47.379
15	Bulgaria	59.857	23.096	21.326	41.938
16	Kazakhstan	38.242	44.692	17.435	40.106
17	Romania	50.216	20.217	21.082	35.784
18	Vietnam	12.137	68.048	16.155	35.217
19	Thailand	22.358	46.815	31.027	35.462
20	Turkey	50.276	15.173	20.287	32.939
21	Ukraine	48.943	20.994	7.436	32.463
22	Serbia	57.261	14.873	0.758	32.315
23	Montenegro	47.914	11.527	26.193	30.936
24	Lebanon	42.206	12.938	30.962	29.118
25	Saudi Arabia	38.426	8.914	48.816	28.516
26	Qatar	25.431	0.001	100.000	28.367
27	Azerbaijan	36.617	14.315	35.714	27.351
28	Mongolia	35.942	31.728	0.000	26.862
29	Armenia	32.353	14.526	20.784	21.274
30	Jordan	17.296	12.079	51.521	17.323
31	Kuwait	21.854	8.153	41.739	16.556
32	Albania	29.514	17.658	0.936	14.658
33	Indonesia	7.853	18.916	50.063	14.443
34	Sri Lanka	18.327	9.172	39.635	12.376
35	Oman	12.186	11.346	49.616	13.021
36	Kyrgyzstan	17.181	17.036	10.428	8.493
37	India	0.002	21.015	42.267	8.056
38	Tajikistan	7.214	12.152	36.935	6.338
39	Pakistan	4.306	11.169	34.616	3.637
40	Bhutan	5.341	11.837	26.937	2.653

It is not enough to analyze the differences in the development level and conditions of regional economic cooperation among the countries along the Belt and Road only from the overall score and ranking of the readiness of regional economic cooperation, but it is necessary to go deeper into the three main factor indicators to find out the characteristics of the differences in the development conditions of regional economic cooperation and the reasons for the big differences in the development level of different countries along the Belt and Road. It is necessary to go deeper into the three main factor indicators to find out the characteristics of the differences in the development

conditions of regional economic cooperation among different countries along the “Belt and Road”, as well as the reasons for the large differences in the development levels. In this paper, all the countries in the sample are divided into six categories according to their performance on the three main factor scores. The specifics are as follows:

Category 1: Singapore, Singapore's regional economic cooperation development readiness efficacy score ranks first among all sample countries, by virtue of its balanced and high level scores on the three main factors, its informationization infrastructure is more complete, and there is an abundance of talents with digital knowledge, and the country's information and communication technology has a strong competitiveness in the international arena.

The second category: Estonia, Israel, Lithuania, Lebanon, Saudi Arabia, Azerbaijan, Armenia, these countries have higher scores on the factor of factor endowment and infrastructure, the factor of business and innovation environment, and lower efficacy scores on the factor of competitiveness of information technology outward orientation. It shows that the higher level of soft (hard) infrastructure in these countries has not been exchanged for a high level of ICT capabilities in these countries, and there is a serious problem of disproportion between inputs and outputs in these countries in terms of ICT.

Category III: Greece, Slovenia, Cyprus, Latvia, Hungary, Croatia, Poland, Bulgaria, Romania, Turkey, Ukraine, Serbia, Montenegro. These countries have relatively high scores in the factor endowment and infrastructure factor, and low scores in the business and innovation environment factor and IT outward competitiveness factor. These countries need to further improve their innovation incentives, continue to improve the business environment and market order, encourage technological innovation, and fully utilize their information infrastructure to stimulate the development potential of their regional economic cooperation.

Category 4: Malaysia and Thailand, which have lower scores on the factor endowment and infrastructure factor, but higher scores on the business and innovation environment factor and the IT outward competitiveness factor. That is, the shortcomings of these two countries in terms of the development conditions of regional economic cooperation are their hardware and software infrastructure. If the domestic infrastructure conditions can be further improved, the shortcomings of regional economic cooperation can be solved, and the “barrel effect” can be avoided, the regional economic cooperation of Thailand and Malaysia is expected to show a more rapid development speed.

The fifth category: the Philippines, China, Vietnam, these three countries have higher efficacy scores for the IT outward competitiveness factor and lower efficacy scores for the other two main factors. This indicates that these three countries have relatively strong ICT strength and their technology products occupy an important position in their own export share, but the infrastructure and business and innovation environment conditions in these three countries are not satisfactory, and there is still a lot of room for improvement.

Category 6: All remaining countries. The common feature of their digital economy development conditions is that they have better business and innovation environments, but their information network infrastructure, talent factor endowment and national ICT strength are poor.

IV. B. Impact of the benefits of regional economic cooperation

IV. B. 1) Estimated results for the regional economy

In order to verify the applicability and validity of the constructed stochastic frontier gravity model, this paper conducts a likelihood ratio test for two key assumptions, one is the assumption on the non-existence of trade inefficiency terms in the model, and the other is the assumption on the non-change of trade inefficiency terms over time. From the test results, it can be found that the test results rejected the original hypothesis that there is no REC trade inefficiency term, which directly proves that it is necessary to consider the REC trade inefficiency factor in the context of this study, and that the choice of the stochastic frontier gravity model is reasonable and appropriate and suitable for further use of the REC trade inefficiency model. The test results reject the original hypothesis that regional economic cooperation trade non-efficiency does not change, and it can be seen that regional economic cooperation trade efficiency also produces changes in the process of changing time, so the results of the time-varying model that changes over time should be used. After comprehensive validation and assessment, it is confirmed that the previously set stochastic frontier gravity model is logically rigorous, applicable in reality, and can accurately reflect the actual situation. Therefore, it was decided to adopt the model as the basic framework for the subsequent analysis to ensure the accuracy and reliability of the research results.

Given that the rigorous model applicability test has been passed, confirming that the original hypothesis of the non-existence of regional economic cooperation trade inefficiency terms has been rejected, we have adopted a one-step regional economic cooperation trade inefficiency model for analysis, integrating the regional economic cooperation trade inefficiency terms into the stochastic frontier gravity model, and obtaining the estimation results of the regional economic cooperation trade inefficiency model, as shown in Table 4. In the table, ***, ** and * indicate that the statistical values of the coefficients have passed the significance level tests of 1%, 5% and 10%, respectively, and the same as in the following.

From the data in the table, it can be seen that:

(1) The level of GDP of cross-border regional economic cooperation export trade partner countries. The country's GDP level has a significant impact on trade inefficiency factors, which reaches a statistical significance level of 1% and shows a negative relationship. This means that with the continuous improvement of the country's GDP level, the non-efficiency problems in the trade process will be alleviated, which in turn promotes the improvement of regional economic cooperation trade efficiency.

(2) The absolute value of the difference in the GDP level of the cross-border regional economic cooperation export trade partner countries. Its effect on the non-efficiency term of regional economic cooperation trade is significant and positive at the 1% level.

(3) Population size of cross-border REC export trade partner countries. This indicator significantly shows the market size of partner countries under regional economic cooperation and exhibits a significant effect on the regional economic cooperation trade inefficiency term at the 1% significance level.

(4) Number of Internet servers in partner countries for cross-border REC export trade. The impact of this indicator on the non-efficiency term of regional economic cooperation trade is significant at the 5% level of significance and its impact coefficient is positive.

(5) Geographic distance between Hongshanzui port and partner countries' ports. Its effect on the non-efficiency term of regional economic cooperation trade is significant at 1% level of significance and its sign of influence is positive, which indicates that higher geographic distance exacerbates the non-efficiency situation in the trade process, thus increasing the complexity and cost of regional economic cooperation trade. In other words, geographic distance, as a form of trade barriers, increases the level of which directly increases the inefficiency of trade and constitutes an obstacle to the smooth conduct of trade.

Table 4 Empirical results of the trade inefficiency model

Random frontier function			Inefficiency model		
Variable	Coefficient	t	Variable	Coefficient	t
(Con_)	-395.467***	-392.612	(Con_)	-5.429***	-5.637
$\ln GDP_{it}$	-3.481***	-15.403	$\ln GDP_i$	-7.492***	-8.271
$\ln GDP_j$	0.893***	13.625	$\ln IF_i$	2.163***	2.086
$\ln Dis_{ij}$	0.554***	8.756	$\ln P_i$	6.734***	8.354
-	-	-	$\ln NET_i$	2.315**	2.318
-	-	-	$\ln Dis_i$	3.198***	9.542
-	Coefficient		t		
σ^2	1.481***		6.423		
γ	1.005***		761563.638		
Logarithmic likelihood value			-60.759		
LR test value			144.537		

IV. B. 2) Overall effect of economic benefits

In this paper, fixed effects (FE), random effects (RE), and mixed effects (Mix) of the panel data are used for estimation and regression using Stata software, and to eliminate the effect of heteroskedasticity in the series, all the data are taken in logarithmic form except for the dummy variable DM. The regression results are shown in Table 5.

According to the Housman test, the regression with fixed effects is better, so the analysis for the regression in this paper is dominated by fixed effects. From the regression results in the table, it can be clearly concluded that a country joining the regional economic cooperation model has a very obvious positive economic effect on the country, and joining the regional economic cooperation model is beneficial to the improvement of the living standard of the people in the country, as well as the improvement of the economic efficiency and industrial competitiveness of the whole country. The regression coefficient of the dummy variable (DM) represents the overall effect of the REC mode on economic growth, which is used to measure the effect of joining or not joining the REC mode on the country. As can be seen from the table, its fixed, random and mixed effect parameter estimates are all positive at 1% level of significance. This indicates that for the countries under the Belt and Road strategy, joining RECs has a significant positive effect on the economic growth of the country.

At the same time, the effects of other control variables on economic growth are also examined. The increase in fixed capital stock contributes significantly to economic growth and passes the test of significance at the 1% level. The possible explanation is that after joining the Regional Economic Cooperation Organization, investment and

trade barriers fall, factors of production such as capital and labor flow freely, and resource allocation is optimized. Due to the profit-seeking nature of capital, capital will flow to sectors and regions with higher marginal returns, economic efficiency and labor productivity in each country will increase, output will increase, and the fixed capital stock in each country will increase. As the fixed capital stock rises, firms have funds that can be used to continuously introduce advanced technology and advanced management experience, enterprise restructuring, rising productivity, increased output for society as a whole, and increased economic efficiency within the region.

In addition, the increase in total exports does not have a significant contribution to regional economic growth. According to the regression results, it can be seen that the fixed effect coefficient of total exports is 0.013, and the regression results of random effect and mixed effect are also significantly positive, but all three do not meet the significance test. That is to say that after joining the Regional Economic Cooperation Organization, the explanation of changes in a country's economic aggregate by total exports is not convincing. On the other hand, total imports, employment and labor productivity increases have a significant contribution to regional economic growth.

Table 5 Test results of the overall effect of the spoon

Variable	FE	RE	Mix
$\ln KGF$	0.086***(2.741)	0.034(1.328)	0.053(1.469)
$\ln EX$	0.193***(5.406)	0.214***(7.216)	0.217***(7.358)
$\ln IM$	0.013(0.932)	0.026(0.935)	0.031(0.942)
$\ln Labor$	0.536***(6.635)	0.735***(8.469)	0.742***(8.683)
$\ln LP$	0.006(0.217)	0.053(1.425)	0.053(1.425)
DM	0.051***(2.438)	0.051***(3.282)	0.051***(3.282)
(Con_)	4.816***(8.125)	3.462***(6.379)	3.458***(6.163)
Industry	YES	YES	YES
Year	YES	YES	YES
R-squared	0.8841	0.8865	0.8872

IV. C. Recommendations for advancing regional economic cooperation

IV. C. 1) Strengthening network infrastructure

The Internet is an important foundation for the realization of network interconnection and information interoperability, but also a fundamental guarantee for the development of the digital economy. The current status of network infrastructure construction in countries along the “Belt and Road” varies greatly, and it is necessary to carry out cooperation at different levels according to the different situations of different countries. In some African countries with poor network infrastructure, it is possible to increase investment in emerging communication technologies, promote the balanced development of local broadbandization in Africa, and carry out the laying of submarine optical fibre cables, so as to realize information interconnection in the true sense. First solve the informatization, and then talk about data, intelligence and cloud, the step should not be too fast and too big. For the new emerging economies in the "Belt and Road Initiative", based on certain network infrastructure conditions, efforts should be made to accelerate the integration and establishment of cloud computing and data centers, deploying data nodes along the "Belt and Road" to provide quality cloud computing services for all digital cooperation under the initiative.

The technological threshold of cloud computing is very high, and many developing countries along the “Belt and Road” are not yet able to master it, while Chinese enterprises have leading technology and accumulated a lot of successful experience after years of construction and operation practice of domestic cloud computing centers, which is an opportunity for China's cloud computing to go out and an opportunity for the “Belt and Road” countries to realize social intelligence and data. This is an opportunity for China's cloud computing to go abroad, and also an opportunity for the “Belt and Road” countries to realize social intelligence and data. To strengthen the construction and cooperation of cloud computing in the “Belt and Road” and to create a more effective big data economic ecosystem, a more perfect, efficient and cross-border security system should be used to realize the security of computation and data, and to truly eliminate the “digital divide” between countries and regions.

IV. C. 2) Active promotion of the economic community

Countries along the “Belt and Road” have historically formed close economic ties spontaneously. This market-driven integration has circumvented institutional and legal barriers that affect trade, capital flows, and other economic exchanges. Based on the above foundation, it is suggested to establish a “Belt and Road” regional economic cooperation community.

The long-term goal of the "Belt and Road" regional economic cooperation community is to strengthen external connections and accelerate the establishment of new strategic partnerships with the North American Free Trade Area and the European Union. The core radiation ASEAN, MERCOSUR, the Mexico-Central America Free Trade

Area, the Economic Community of Central African States, the East African Community, the Community of West African States and the Southern African Development Community. From China's perspective, this phase should continue to strengthen economic cooperation with Japan, South Korea and ASEAN countries on the basis of the established East Asian economic cooperation, and enhance the overall integration level of the East Asian economy. On the basis of the BRICS and G20 cooperation mechanisms, it should strengthen integration cooperation with India and Pakistan. It will also strengthen integration and cooperation with West Asian countries in key areas such as energy and minerals, advanced manufacturing, and high technology, and will strengthen all-round regional economic cooperation with European Union countries by effectively utilizing the mature Eurasian corridors.

IV. C. 3) Building a digital financial services system

Digital finance is one of the most effective financial tools for serving regional economic cooperation and development. As regional economic cooperation deepens in the countries along the “Belt and Road”, there is an urgent need to establish a digital financial service system that is compatible with the digital economy.

(1) Improvement of digital payment function. Payment is the most basic function of the financial system, and any market transaction behavior must ultimately be realized through the payment and clearing system. Efficient and convenient digital payment is the financial service most directly related to e-commerce. With the increasing frequency of cross-border e-commerce activities, there is an urgent need to establish a digital payment system in the countries along the route, and to promote the public's understanding and use of digital payment.

(2) Build a social credit system. In countries along the border where credit culture is lacking, digital finance plays a unique role in shaping the social credit culture. Big data technology provides sufficient conditions to promote the construction of social credit system through massive data resources and rapid update of information technology. The social credit mechanism established by the introduction of blockchain technology into the financial sector can effectively solve the problems of lack of government credit and commercial credit along the Belt and Road.

(3) Vigorously develop financial technology. Based on the new generation of information technology, financial science and technology can control the cross-border e-commerce dynamics and economic and trade information in real time, and quickly analyze the macro-economy, financial market and business operation of the countries along the routes, so as to solve the problem of risk prevention and control of cross-border business of financial institutions from the three dimensions of technology, data and platform. The digital financial system driven by technology application and big data analysis will surely become an important financial model to serve the “Belt and Road” and inject new vitality into the “Belt and Road” regional economic cooperation.

V. Conclusion

This study systematically analyzes the regional economic cooperation model of the “Belt and Road” strategy with the assistance of artificial intelligence by constructing a regional economic readiness evaluation system and a gravity model. The study finds that there are significant differences in the readiness of regional economic cooperation among the countries along the “Belt and Road”, with Singapore maintaining a high level of readiness in all three main factors, and topping the list with an efficacy score of more than 75 in all three main factors. China is at the 14th place in the list, and its IT outward competitiveness factor has a higher efficacy score of 63.626, but its factor endowment and infrastructure factor and business and innovation environment factor have lower efficacy scores. The empirical results show that the GDP level of cross-border regional economic cooperation export trade partner countries has a significant negative impact on the trade inefficiency factor, with a coefficient of -7.492, while the impact coefficient of geographic distance on trade inefficiency is 3.198, indicating that the increase in distance significantly hinders trade efficiency. Fixed effects model analysis shows that joining the regional economic cooperation model has a significant positive economic effect of 0.086 on the country. Based on the results of the study, this paper proposes to strengthen the construction of network infrastructure, actively promote the construction of the “Belt and Road” regional economic cooperation community, and build a digital financial service system including digital payment, social credit system and financial technology, in order to promote the regional economic cooperation to be more efficient, inclusive, and sustainable, and ultimately to realize the goal of coordinated development of regional economy under the “Belt and Road” strategy.

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