Influential factors of multilateral trade between China and Central Asia based on panel data in the context of big data

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Abstract: In recent years, with the promotion of economic and trade integration and globalization, China's multilateral trade with many countries in Central Asia has become increasingly frequent. The type of multilateral trade between China and Central Asia is mainly agricultural products, which export tea, vegetables, fruits, meat and unprocessed products to Central Asian countries, and import grains, textile fibers, olive fruits and oilseeds from Central Asian countries. Such agricultural products account for more than 90 per cent of multilateral trade. In the big data environment, this paper uses panel data to study the influencing factors of multilateral trade between China and Central Asia. First, it briefly introduces data mining algorithms, processes, clustering analysis methods, builds spatial econometric models, panel models, and trade gravity models, analyzes the current situation of multilateral trade between China and the five Central Asian countries, and studies regional differences and hierarchical differences in trade scale. Finally, the panel data of 20 years from 2002 to 2021 are studied. The results show that China's domestic factors have a very significant impact on the multilateral trade between China and Central Asia, with a coefficient of 6.652. The GDP coefficient of Central Asian countries is 0.653. The transport distance factor will negatively affect multilateral trade, with a coefficient of -6.012. Friendly relations will also negatively affect multilateral trade, with a coefficient of -0.495. At the same time, the data from 2015 to 2020 is selected to analyze the degree of correlation of multilateral trade between China and Central Asia. From 2019 to 2020, the highest degree of correlation is port efficiency, followed by e-commerce environment, followed by regulatory environment and customs environment. The corresponding values are 0.532, 0.514, 0.483 and 0.455 respectively.

Keywords: Big data, panel model, China and Central Asia, multilateral trade

1.Introduction

With the rapid development of economic globalization, China's international trade advantages have become the main force to promote China's economic development [1]. China and the five Central Asian countries are traditional agricultural powers. As a pillar industry of the national economy, agricultural development plays an important role in multilateral trade among self economic entities. However, the multilateral trade between China and Central Asia is affected by various factors, such as tariffs, product price fluctuations, economic scale, industrial structure, capital flows, commodity composition and competitiveness, etc. [2].

In the big data environment, this paper collects, obtains, and analyzes multilateral trade data between China and Central Asia based on data mining algorithms, uses panel data to study various factors that affect multilateral trade between China and many countries in Central Asia, constructs panel models, spatial econometric economic models, and trade gravity models, and studies issues that affect trade scale from income level differences [3].

The innovation points in the research process of this paper: (1) First, focus on the algorithm selected in this paper, namely cluster analysis, summarize the concept and calculation process of data mining algorithm, and build spatial measurement model, panel model and trade gravity model on this basis. (2) Describe the current situation of multilateral trade between China and the five Central Asian countries in detail, analyze the impact of regional differences on the trade scale between China and Central Asia, and study the impact of income level differences on the trade scale by setting four different income levels.

2. Related work

With the increasingly frequent trade exchanges among countries, there are many factors that interfere with trade growth and trade scale, mainly including capital flow, economic scale, trade mechanism and industrial structure. The one closely related to trade scale is gross regional product (GDP) [4]. Zhang H X's econometric analysis of China's data over the past 20 years shows that imports and exports can effectively promote China's economic growth. The correlation between economic growth and imports and exports is studied from the perspective of export commodity structure [5]. Dumanska's use of foreign capital and import and export trade affect China's economic situation, pointing out that the factors of rapid economic growth in China lie in increasing foreign exchange, manufacturing labor-intensive products, introducing foreign capital and giving play to China's advantages during the reform and opening up period [6]. Liang J Y et al. studied nearly 30 data in China and found that trade scale economy effect, technology spillover effect and competition effect can significantly improve the economy, and there is a causal relationship between economic growth and trade liberalization, which shows that trade is the main driving force to promote economic development [7]. Wang S M deeply explored the stage of China's economic development and found out that the scale of foreign trade can stimulate economic growth by accumulating a large number of thermal resources, capital resources, optimizing industrial structure, etc. [8]. Antonova and other scholars analyzed the agricultural trade potential between China and the countries of the "Silk Road Economic Belt" based on the CES utility function, and the results showed that China should strengthen agricultural trade with South Asian countries [9]. Gao J X et al. studied the regional economic development structure and product trade structure of China's agricultural products trade using RCA index and GL index, and concluded that China mainly depends on the export of agricultural products from Russia, ASEAN and other countries [10]. Qi W et al. pointed out that religious factors and cultural factors will also have a certain impact on the trade between China and Central Asian countries. Since the languages, nationalities and cultures of the five Central Asian countries are similar to those of Xinjiang minorities in China, there is also a common phenomenon of cross-border residence between residents of the two places [11]. Wen T H et al. analyzed import protection measures such as tariff quotas and tariffs from the perspective of economics by using graphs, and proposed that quotas can better protect trade than tariffs under the premise of continuous rising demand in China [12]. Choi et al. studied various influencing factors for the fluctuation of China's exports to ASEAN products by building a constant market share model [13]. Long Y made in-depth analysis on the fluctuation factors of China's agricultural product trade export. Based on the constant market share model, he analyzed the main factors leading to the fluctuation of agricultural product import from the perspective of product composition, demand and competitiveness [14]. Wang G et al. used the stochastic frontier gravity model to calculate the trade efficiency and trade potential of Central Asian countries. The calculation results show that the main factors affecting multilateral trade are population, GDP, infrastructure, trade agreements, government efficiency, etc. [15].

3. Data Mining Algorithm and Multilateral Trade Panel Model

3.1 Data mining algorithm

The essence of data mining is to extract knowledge and valuable data hidden in various noisy, incomplete, massive and fuzzy data. Common data types include semi-structured data, structured data and heterogeneous data [16]. Structured data is simple data stored in the database; Semi structured data are some of the marked data, but the type is not clear; Heterogeneous data can be of any data type, such as image, text, voice, etc., which cannot be recognized by the database. The summary data mining process includes describing problems, collecting data, preprocessing data, mining data, evaluating results and interpreting data after completion, as shown in Figure 1 below:

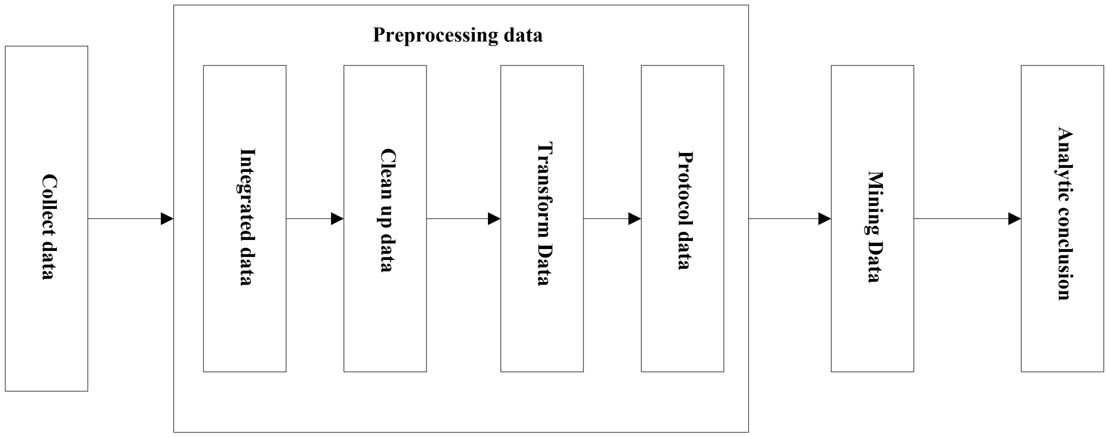

Figure 1 Data mining process

Clustering is a grouping abstract or physical set, which is called cluster. In statistics, cluster is a collection of all data objects. Cluster analysis simplifies post analysis of data by modeling. At present, it is widely used in the research of similarity and distance. The traditional cluster analysis method is shown in Figure 3 below:

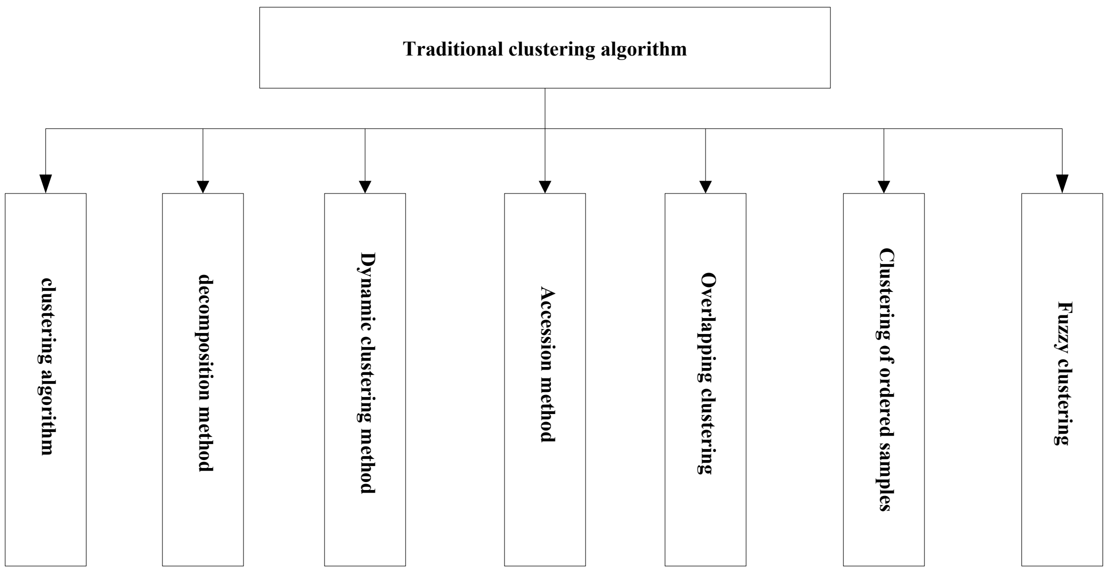

Figure 2 Traditional cluster analysis

3.2 Spatial econometric model

The spatial econometric model is used to deal with the spatial dependency structure and spatial interaction problems in the regression model. When applying, the spatial correlation is tested by Moran'I spatial autocorrelation index. The following is the calculation formula [17]:

$$\text{Moran'I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\left(Y_i - \bar{Y}\right)\left(Y_j - \bar{Y}\right)}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \qquad (1)$$

$$且\ S^2 = \frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \bar{Y}\right) \qquad (2)$$

$$\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i \qquad (3)$$

$W_{ij} = \{1,0\}$, where 1 indicates that region j is adjacent to region i; 0 means that the j area is not adjacent to the i area. The Mroan's index is the sum multiplied by the observations in different regions, and is taken in the range of - 1,1. If there is a positive spatial correlation of economic behavior between different regions, a large positive correlation value, a small negative correlation value, and an independent distribution between location data and attribute value distribution, the spatial self correlation value is 0.

3.3 Panel model

The panel data model is a three-dimensional information data structure, including time, section and variable. It usually illustrates the causal relationship between a given sample and multiple variables in a certain period of time in the population. Its advantage is that it can effectively use the individual observation results in each time sequence and dimension [18]. There are many forms of panel data models, which are used to test whether the sample coefficient is a constant in cross section and time, and whether it changes with individual changes or time. Generally, F is used to test and judge. If the time series parameters are singular, that is, the parameters do not change over time, but there are differences between individuals. The model is as follows:

$$Y_{it} = \alpha_i + \beta^{'} X_{it} + \mu_{it} \qquad (4)$$

The residuals of S_1, S_2 and S_3 are obtained through estimation, and the statistics of F_1 and F_2 are calculated. These values are subject to the F distribution, as shown below:

$$F_2 = \frac{(S_3 - S_1)/[(N-1)(K+1)]}{S_1/[NT - N(K+1)]} \sim F[(N-1)(K+1), N(T-K-1)] \qquad (5)$$

$$F_1 = \frac{(S_2 - S_1)/[(N-1)(K+1)]}{S_1/[NT - N(K+1)]} \sim F[(N-1)(K+1), N(T-K-1)] \qquad (6)$$

The above N represents the sample size, K represents the number of explanatory variables, and T represents the time span length. If F_2 is lower than the critical value, it means that the sample data meets the constant coefficient model without individual influence. If F_2 is higher than the limit value and F_1 is smaller than the critical value, it can be concluded that the sample data meets the requirements of the variable intercept model, otherwise it is a variable coefficient model.

Based on the form setting test method, the F statistic F_1 value is 1.08, F2 value is 2.54, F_2 exceeds the critical value of 1.26, and F_1 is smaller than the critical value of 1.34, so the variable intercept model is adopted. In this paper, we establish a panel data model of factors affecting trade scale between China and many countries in Central Asia, which is in the form of double logarithm:

$$InEXP_{it} = \alpha + \partial^{*}{}_{i} + \beta_{1i} InGDP_{it} + \beta_{2i} InGDP_{it} + u_{ti} \qquad (i = 1,2,...,18) \tag{7}$$

Upper formula α It represents the average trade scale. The deviation of country i i from the average trade scale is determined by $\partial^{*}{}_{i}$ indicates that this value reflects the structural differences among countries. Under the Hausman test, the following estimation structures are obtained by using the random effect model:

$$InEXP = 2.81 + \alpha^{*}{}_{i} + 0.69 InGDP + 0.25 InFDI \tag{8}$$

The value of R^2 is 0.543, the value of $\overline{\mathrm{R}}^2$ is 0.541, and the value of F is 233, α_i^* is the deviation between the intercept term and the average of each country. By analyzing the statistical results of the parameters, the overall effect of the model is significant, so the parameters pass the significance test. Among them, the elasticity coefficient of the trade scale to GDP is 0.69, that is, the trade scale corresponding to 1% GDP growth increases by 0.69% on average. The elasticity coefficient of trade scale to FDI is 0.25, that is, 1% FDI growth, and the corresponding trade scale needs to increase by 0.24%. It can be seen that economic scale can better promote trade growth.

3.4 Trade Gravity Model

A trade gravity model is proposed based on the law of universal gravitation of physics. The law of universal gravitation points out that the force and mass between two different objects are in direct proportion, and the distance between them is in inverse proportion. Based on the law of universal gravitation, scholars put forward the trade gravitation model, which points out that the trade volume between two countries is in direct proportion to the total economic volume, and the distance between two countries is in inverse proportion. The following is the trade gravity model:

$$T_{ij} = A \frac{GDP_i GDP_j}{D_{ij}} \tag{9}$$

The above formula GDP_i and GDP_j represent the gross domestic product of countries i and j, T_{ij} represents the bilateral trade volume between countries i and j, and D_{ij} represents the space distance between countries i and j. A is the scaling constant.

In the process of empirical analysis, the trade gravity model is expressed in the logarithmic form, because the logarithmic form is convenient for linearizing the trade gravity formula and can reduce heteroscedasticity. The following is the logarithmic form of the trade gravity model:

$$InT_{ij} = \alpha_0 + \alpha_1 InGDP_i + \alpha_2 InGDP_j + \alpha_3 InD_{ij} + \mu_{ij} \qquad (10)$$

Upper formula α_1、α_2、α_3 represents the regression coefficient of the corresponding variable, α_0 represents a constant term, μ_{ij} represents the error term.

4. An Analysis of the Factors Affecting Multilateral Trade between China and Central Asia Based on Panel Data

4.1 Current situation of multilateral trade between China and five Central Asian countries

This paper takes 2017's data as an example to analyze the distribution of trade between China and the five Central Asian countries. The specific proportion is shown in Figure 3 below:

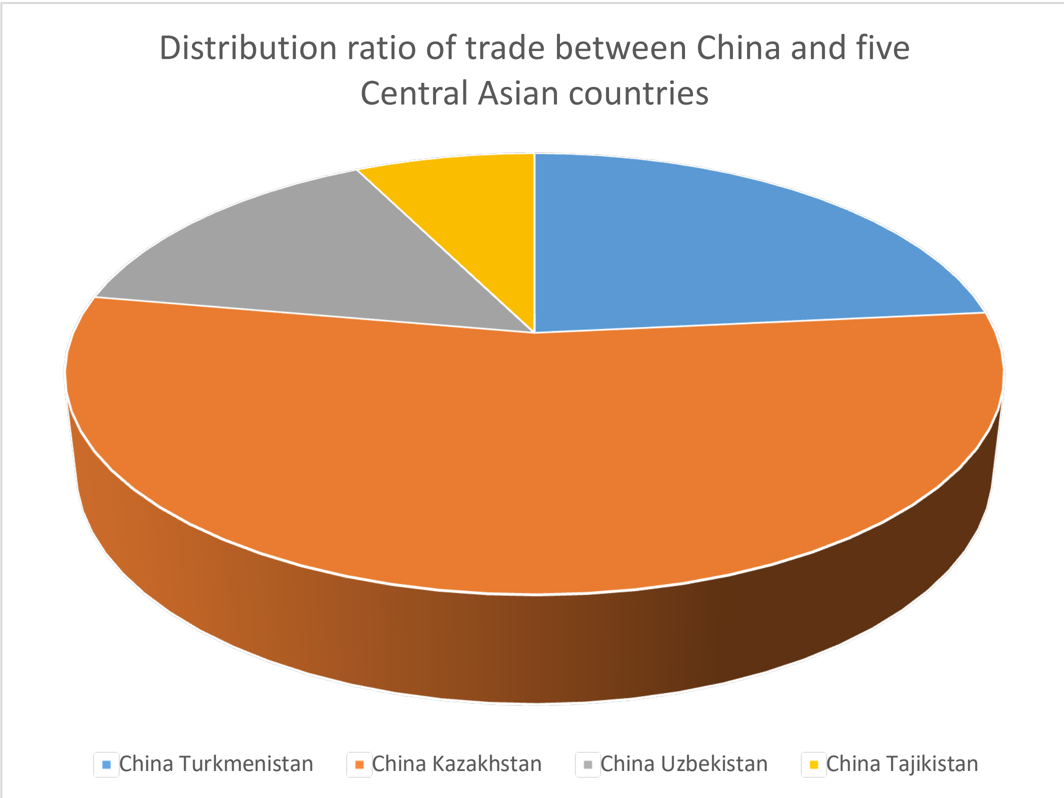

Figure 3 Distribution ratio of trade between China and five Central Asian countries

Figure 3 The highest proportion of trade distribution between China and the five Central Asian countries is China Kazakhstan, accounting for 44%, followed by China Turkey trade accounting for 19%, and the lowest proportion is China Tajikistan trade, accounting for 6%. With the continued downturn of the global economy, the low price of bulk commodities in the international market, the decline of the export economy of Central Asian countries, and the slow economic growth, export trade has been seriously affected, and the multilateral trade between China and the five Central Asian countries has been hampered [19].

The trade development between China and the five Central Asian countries can be divided into several stages, namely, the slow start stage, the rapid growth stage and the stable growth stage. Before 2001, China and the five Central Asian countries began to establish trade relations. From 2002 to 2008, the trade between China and the five Central Asian countries continued to grow. The amount of trade also increased from US $23.389 billion to US $30.825 billion, an average annual increase of 54%. After 2010, the trade volume maintained a steady growth, which was slower than the previous stage. The following figure shows the growth rate of China's trade with the five Central Asian countries and China's multi foreign trade in 2020.

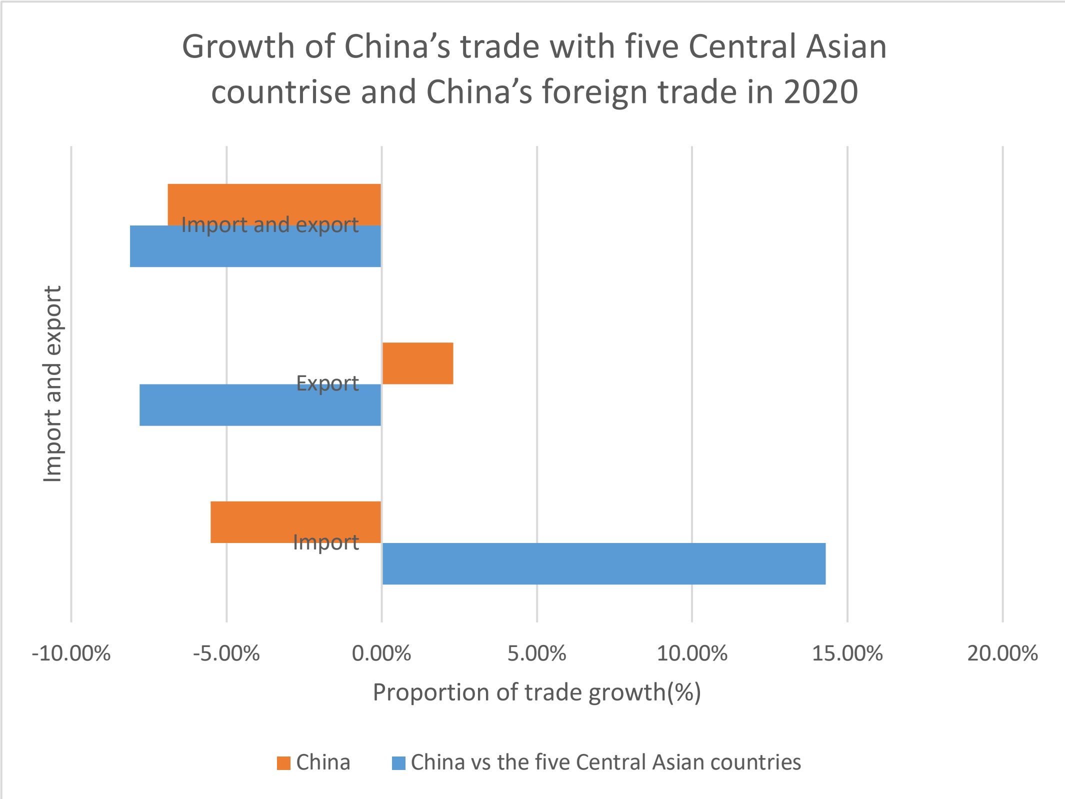

Figure 4 Growth of China's trade with five Central Asian countries and China's foreign trade in 2020

Overall, in 2020, China's trade imports to the five Central Asian countries will increase by 14.3%, and China's foreign trade will also increase by - 5.5%; China's trade exports to Central Asia increased by 2.3%, while China's foreign trade grew by 7.8%. According to the summary, China's foreign trade with the five Central Asian countries is in a negative growth state, with an increase of 8.1%. China's foreign trade is also in a negative growth state of 6.9%, which is generally in a negative growth state.

4.2 Analysis of regional differences of influencing factors of trade scale

This paper takes Central Asia as an example to illustrate and analyze the impact of various factors on the trade scale between China and Central Asia, and constructs a trade model based on the indicator data of each country. First check the model form, and the F_2 value in the model is taken at the 5% or 10% significance level. The F_1 value is lower than the critical value. The model is a variable intercept model. Table 1 below shows the test results of the Central Asian regional trade model.

Table 1 Central Asia Regional Trade Model Format Setting Test Results

Test statistics	Central Asia

F2	3.67
	(2.65)
F1	1.07
	1.57
Hausman test	3.51

Hausman test model. According to the data, the statistics of the model is lower than the critical value, indicating that explanatory variables and individuals interfere with the model. Therefore, the Central Asian regional trade model uses the random effect variable intercept model. The following is the basic form of the model:

$$InEXP_{j,it} = \alpha_i + \beta_i InGDP_{j,it} + \gamma_i InFDI_{j,it} + v_{j,i} + \mu_{j,it} \qquad (11)$$

In this paper, Swamy Arora method is used to estimate the variance of the above model and estimate the parameters of the random impact variable intercept model. The results are shown in Table 2 below:

Table 2 Parameter Estimation Results of Central Asia Regional Trade Model

	Central Asia
α_i	9.07
	(1.47)
β_i	0.59
	11.77
γ_i	0.07
	4.66
R^2	0.85
F value	113.35

Analyzing the estimated results in Table 2 above, we can see that the regional coefficients of Central Asia have passed the significance test, and FDI in the Central Asia model has a low contribution to the trade scale. There are regional differences in the impact of foreign investment and economic aggregate on trade. The factors leading to this difference are the export oriented strategy, processing trade mode, foreign capital introduction mode, etc. The scale of introducing foreign capital in Central Asia is small, so the advantages in export trade are not obvious.

4.3 Analysis on the Income Grade Differences of the Factors Affecting Trade Scale

By setting up four income groups, namely, low income, middle low income, middle high income and high income, this paper conducts difference analysis according to four different income levels, inputs statistical test in the model, and lists the test results obtained in Table 3 below.

Table 3 Formal test results of trade models at different income levels

Test statistics	low-income	Low and middle income	Medium and high income	high-income
F2	3.67	3.05	2.86	2.72
	（2.08）	（2.08）	（2.62）	（2.08）
F1	1.11	1.04	1.22	1.03
	（1.13）	（1.13）	（1.36）	（1.13）
Hausman test	2.17	1.49	1.74	0.41
	3.03	3.03	3.03	3.03

The Hausman test shows that the statistics of this model are relatively low compared with the critical value, which fully proves that it is impossible to reject the assumption that explanatory variables are not related to individual influence, so the individual is affected by random effects, and the models of four countries with different income levels are all random effect variable intercept models, and the specific form is the above formula (11). Then Swamy Arora method is used to estimate the variance of each model, and the estimated results of four different income level trade models are shown in Table 4 below.

Table 4 Estimated results of four trade models with different income levels

	low-income	Low and middle income	Medium and high income	high-income
α_i	4.32	1.08	4.04	3.27
	(1.47)	（8.51）	（6.66）	（8.04）
β_i	0.73	0.56	0.93	0.83
	（8.58）	（1.45）	（14.8）	（14.57）
γ_i	0.10	0.54	-0.09	0.08
	（1.96）	（7.94）	（7.79）	（5.51）
R^2	0.89	0.52	0.81	0.79
F value	71.67	84.09	200.16	195.85

The above data shows that there are large differences among the four countries with different income levels. According to the analysis of export trade tendency, high-income countries and high-income countries contribute more to the GDP of trade scale, so countries with higher income can promote economic growth [20]. FDI from low - and middle-income countries contributes the most to the scale of trade, while FDI from high-income countries and low-income countries contributes the least to the scale of trade. This shows that low - and middle-income countries have the economic foundation to accelerate their industrial development and promote trade growth by attracting foreign capital. FDI from high-income countries has a negative impact on trade.

5. An Analysis of the Factors Affecting Multilateral Trade between China and Central Asia Based on Panel Data

5.1 The impact of various factors on trade between China and Central Asia

This paper chooses panel data of five Central Asian countries from 2002 to 2021, uses EVIEWS regression to analyze the influencing factors of China's multilateral trade with Central Asia, and establishes a panel model. The P and T test values for different explanatory variables are listed in Table 5 below.

Table 5 Model regression results

Variable	coefficient	standard deviation	T test value	P value
C	-87.156	65.067	-1.342	0.184
In(China)	6.652	3.072	2.167	0.035
In(G_j)	0.653	0.118	5.542	0.000
In(N_j)	0.298	0.158	1.892	0.064
In(D_{cj})	-6.102	0.591	-10.371	0.000
In(L_j)	-0.167	0.124	-1.355	0.179
R_{cj}	-0.495	0.242	-2.041	0.045

The two most significant variables in Table 5 above are G_j and D_{cj}, which fully proves that the trade GDP of the five Central Asian countries and their geographical location are directly related to

China, and the explanation in the model is strong. R_{ij} variable, G_j variable and CHINA variable are all very significant, which indicates that the per capita income, trade GDP and China's domestic factors of the five Central Asian countries have a strong explanation for the establishment of multilateral trade relations. However, the variable and constant of L_j geographical area of the five Central Asian countries are not significant, which has little impact on the trade between China and Central Asia. In this analysis of two variables with insignificant regression, firstly, because there are many factors such as intercept, for example, different countries have different preferences in agricultural products, the constant coefficient T test value is not significant; Secondly, the factor that the L_j variable is not significant is that there are few countries in Central Asia, and the land area of all countries is basically the same, so the T test value of the variable coefficient is not significant, and the following regression equation can be obtained:

$$InT_{cj} = -87.156 + 6.652 InChina + 0.653 \mathrm{InG_j} + 0.298 \mathrm{InN_j} - 6.102 \mathrm{InD_{cj}} \\ - 0.167 \mathrm{InL_j} - 0.495 \mathrm{R_{cj}}$$

Draw the coefficient of each influencing factor in Figure 5 below, and compare the results obtained to determine which factors have greater impact on the multilateral trade between China and Central Asia.

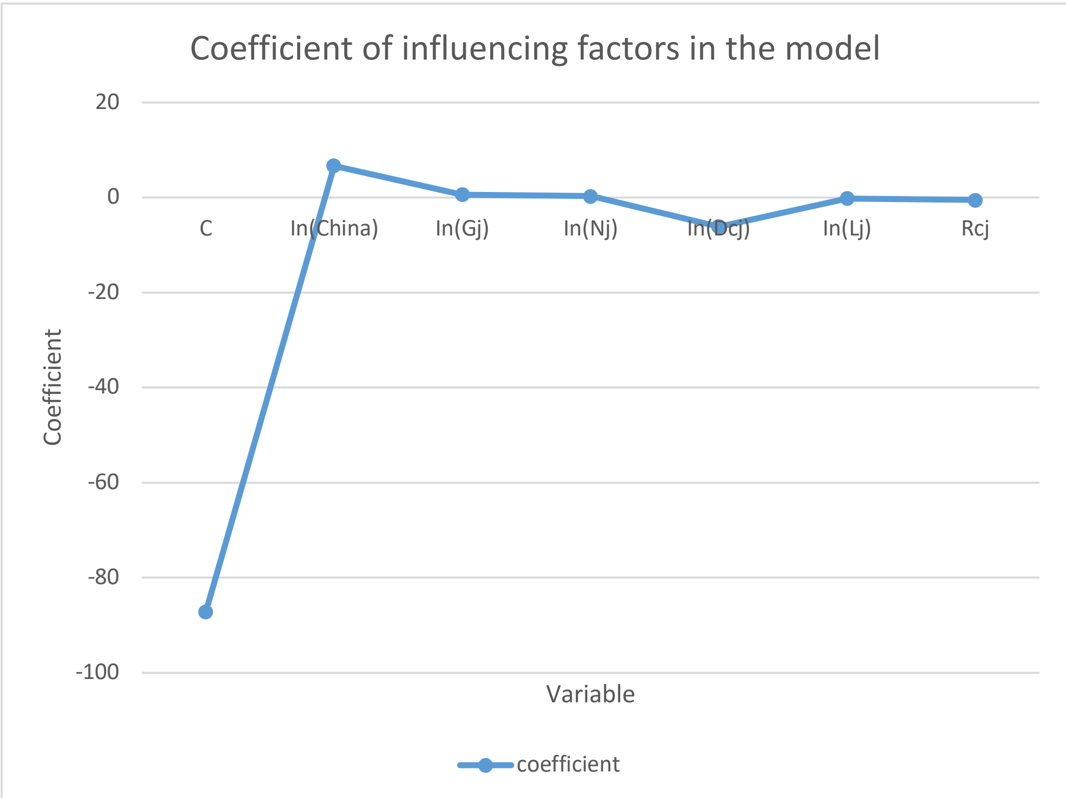

Figure 5 Coefficients of influencing factors in the model

According to the data in Figure 5 above, China's domestic factors are very significant in influencing the multilateral trade between China and Central Asia. The factor coefficient is 6.652. In recent years, China's GDP has grown at a rapid rate, and the economic level is getting higher and higher.

The competitiveness of China's agricultural exports in the international arena has also continued to improve, thus promoting trade between China and many countries in Central Asia. The GDP of Central Asian countries has a positive impact on the multilateral trade between China and Central Asia. The GDP coefficient of Central Asian countries is 0.653, that is, the economic development of Central Asian countries can promote the import of Chinese products and accelerate the trade between countries. Therefore, the rising per capita GDP income of the five Central Asian countries will positively affect the multilateral trade between China and Central Asia. The main factor affecting multilateral trade is transportation cost, that is, the farther the geographical distance is, the higher the transportation cost will be, and the trade cost will also increase, which will hinder the multilateral trade between China and Central Asia. Therefore, the D_{cj} transportation distance factor has a negative impact on the multilateral trade between China and Central Asia, and the corresponding coefficient is -6.012. R_{cj} is the factor that determines whether China and Central Asia will establish a friendly relationship. Its coefficient is -0.495, which is negative, indicating that it will negatively affect the multilateral trade between China and Central Asia

5.2 Correlation value of multilateral trade facilitation indicators between China and Central Asia

This paper selects the five years from 2015 to 2020 to analyze the multilateral trade correlation between China and Central Asia. The selected indicators mainly include the e-commerce environment (SI), regulatory environment (RE), customs environment (CE), and port efficiency (PE). Through the above four indicators, the degree of trade facilitation between China and Central Asia is studied. The results are shown in Figure 6 below.

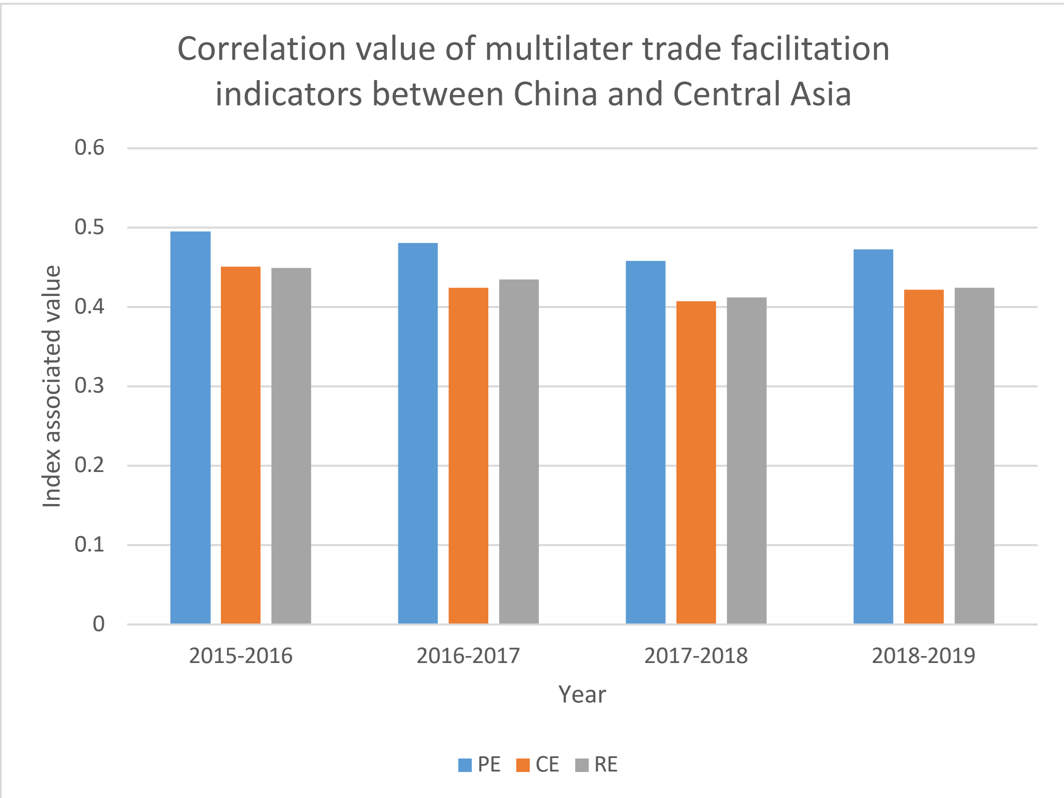

Figure 6 Correlation value of multilateral trade facilitation indicators between China and Central Asia

According to the data in Figure 6 above, the port efficiency ranked highest from 2015 to 2016, with a value of 0.495; The second is the e-commerce environment index value of 0.486, followed by the customs environment and regulatory environment, with corresponding values of 0.451 and 0.449. After five years to 2019 and 2020, the ranking of various indicators has changed to some extent, and the port efficiency is still the highest, rising to 0.532, followed by the e-commerce environment, increasing from 0.495 to 0.514, then the regulatory environment from 0.449 to 0.483, and finally the customs environment from 0.451 to 0.455. The reason for this result is that China and Central Asian countries pay attention to bilateral trade transport equipment, which makes the e-commerce environment increasingly perfect.

6. Conclusions

With the rapid development of China's economy and the increasingly close trade between Central Asian countries, export trade has become an important pillar industry of China's economic development. China's dependence on foreign trade has increased, but also faces many obstacles. The multilateral trade between China and Central Asia is affected by various factors, resulting in small trade scale. Therefore, under the background of big data, this paper studies the influencing factors of multilateral trade between China and Central Asia based on panel data, and based on the results, strengthens multilateral trade between China and Central Asian countries, promotes economic growth and trade exchanges, and expands trade scale. This paper constructs a spatial econometric model, a panel model, and a trade gravity model, and selects panel data from 2002 to 2021 for research. The results show that China's domestic factors have a significant impact on multilateral trade between China and Central Asia, with a coefficient of 6.652. The GDP coefficient of Central Asian countries is 0.653. The factor of transportation distance will negatively affect multilateral trade, with a coefficient of -6.012, Friendly relations also negatively affect multilateral trade, with a coefficient of -0.495. At the same time, the data from 2015 to 2020 is selected to analyze the degree of correlation of multilateral trade between China and Central Asia. From 2019 to 2020, the highest degree of correlation is port efficiency, followed by e-commerce environment, followed by regulatory environment and customs environment. The corresponding values are 0.532, 0.514, 0.483 and 0.455 respectively. Therefore, China should adjust its industrial structure, transform its economic model and reduce its transport costs in order to better expand the scale of multilateral trade between China and Central Asia.

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