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RESEARCH ARTICLE

Theoretical Basis and Priority Directions for the Development of Economic and Trade Cooperation between China and Uzbekistan

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ABSTRACT

There is a problem of unclear priority development direction in the economic and trade cooperation between China and Uzbekistan. This article aims to analyze the impact of various fields on the economic growth of the two countries through panel data models, identify the most promising areas of cooperation, and propose optimization policy recommendations to promote diversified and high-quality economic and trade cooperation development. By collecting bilateral trade and investment data between China and Uzbekistan, GDP (Gross Domestic Product) growth rate is set as the dependent variable, and fixed effects and random effects models are constructed by combining variables such as bilateral trade volume and Foreign Direct Investment (FDI). This article uses statistical software for regression analysis to calculate the contributions of various variables to economic growth, identify areas of efficient cooperation, and ensure the robustness of the model and the accuracy of the results through empirical testing. The results show that a regression coefficient of 0.35 and an investment return rate of over 20% in the energy sector reflect its dominant position, indicating that the energy sector is currently a priority direction for cooperative development. The diversification index of cooperation also indicates that bilateral cooperation has gradually expanded from a single field to multiple fields. The policy reform and the improvement of market openness further promote the diversification and efficiency of economic and trade cooperation. This article provides data recommendations for the deepening and optimization of future economic and trade cooperation between China and Uzbekistan, which is conducive to promoting the expansion of bilateral cooperation in a wider range of fields.

1. INTRODUCTION

In recent years, China and Uzbekistan are increasingly cooperating economically and commercially. With the promotion of "the Belt and Road Initiative", the bilateral relations have shown a steady upward trend. As an important country along the route, Uzbekistan's strategic position in China's foreign economic and trade cooperation is becoming increasingly prominent. Uzbekistan, located in Central Asia, is an important transportation hub for China to access Europe, the Middle East, and South Asia, with unique geo economic advantages. The cooperation between the two countries in areas such as energy and infrastructure construction has achieved certain results. Data shows that in 2021, China's trade volume with Uzbekistan has reached billions of dollars, and investment projects between the two countries have been increasing year by year (Shao, 2023). At the same time, China and Uzbekistan are gradually cooperating in emerging fields such as agriculture, manufacturing, and digital economy, which provides new growth points for economic and trade cooperation between the two countries (Muhammad, 2024). Despite significant progress, the potential for economic and trade cooperation between China and

Uzbekistan has not been fully tapped (Pomfret, 2020). Most of the existing cooperation is focused on traditional industries, especially energy and infrastructure construction, while there is relatively less cooperation in high-tech industries, manufacturing, agricultural modernization, and other areas (Martynenko, 2019). In addition, the investment environment in Uzbekistan still needs further improvement, and there are obstacles in policy coordination, with some policy barriers affecting the efficiency of investment cooperation between the two countries (Peng, 2023; Oqyulov, 2020). Although the cooperation between the two countries in the field of economy and trade has established a solid foundation, in order to promote the development of China Uzbekistan economic and trade cooperation to a higher level, it is still necessary to explore new areas of cooperation and optimize existing cooperation models (Akhmet, 2021). In addition, existing research mostly focuses on qualitative analysis of the current status of economic and trade cooperation between China and Uzbekistan, with less use of quantitative analysis methods to evaluate the actual effects of bilateral economic and trade cooperation (Fenghe, 2020). The lack of detailed analysis of the impact of different areas of cooperation on the economic growth of the two countries has led to a lack of data support for policy makers in selecting priority areas, which is also an urgent problem that needs to be addressed. This article aims to provide new theoretical basis and policy recommendations for economic and trade cooperation between China and Uzbekistan. Based on panel data model quantitative analysis method, this article can conduct in-depth analysis of the cooperation between China and Uzbekistan in different fields, and identify the most potential cooperation direction according to the actual impact of each field on the economic growth of the two countries.

The contribution of this article mainly lies in: 1. Unlike previous qualitative analysis studies, this article uses panel data models to systematically and quantitatively analyze the economic and trade cooperation between China and Uzbekistan in various fields. Through quantitative research on data from different fields, this article more accurately identifies which areas of cooperation have a significant driving effect on the economic growth of the two countries. 2. This article focuses on the limitations of traditional areas of cooperation and explores in depth emerging fields such as high-tech, manufacturing, and agriculture. Under the ""the Belt and Road Initiative", the two countries have made considerable progress in energy and infrastructure construction, but cooperation in high-tech industries and manufacturing is still in the initial stage. Quantitative analysis of the economic benefits in these areas can provide scientific basis for decision-makers in both countries, helping them prioritize high benefit areas, optimize cooperation structures, and achieve diversified development of economic and trade cooperation. 3. This article quantitatively evaluates the impact of policy coordination, which helps identify policy barriers and provides direction for policy improvement. The policy coordination issues faced by China and Uzbekistan in economic and trade cooperation have long existed, and there are still policy barriers in areas such as tariffs, market access, and investment environment, which have affected the depth and breadth of bilateral economic and trade cooperation. This article identifies the impact of policy coordination on economic growth through data analysis, providing empirical support for improving the bilateral policy environment. The research results of this article not only have theoretical value, but also provide data support for practical policy formulation. By identifying the priority areas and policy improvement directions in China Uzbekistan economic and trade cooperation, it can provide scientific reference for the two governments in formulating economic and trade cooperation strategies, promote the sustainable development of China Uzbekistan bilateral cooperation, and further strengthen the economic and trade ties between the two countries under "the Belt and Road Initiative" framework.

2. RELATED WORK

Numerous academics have studied China-Uzbekistan trade and economic relations in great detail in recent years. Serıkkalıyeva A analyzed China's deep interaction with the world over the past forty years of reform and opening up, explored the key factors of China's foreign economic strategy in Central Asian countries, and concluded that China needs to strengthen multilateral

cooperation to promote development (Serıkkalıyeva, 2019). Dadabaev T et al. analyzed the cooperation roadmap between Uzbekistan and Russia, China, South Korea, and Japan in the field of energy and transportation infrastructure development, and explored how the country internalized energy and infrastructure related projects with these countries when reintegrating into the international community in the post Karimov era. The conclusion drawn is that Uzbekistan aims to become an industrial and transportation hub for other Central Asian countries and Afghanistan through these projects, while promoting the transformation of the economy from resource-based to export-oriented value-added products (Dadabaev, 2021). Choriev A analyzed the relevant literature on the trade reform and economic impact of Uzbekistan's accession to the WTO by consulting major databases as well as relevant documents from the World Bank and WTO, with a focus on econometric models based on historical data, and drew conclusions based on historical data (Choriev, 2022). Ji Young JEONG et al. analyzed the environment and strategies for attracting foreign investment in Uzbekistan and found that the political situation, financial stability, legal framework, and economic environment are crucial for attracting foreign investment. However, Uzbekistan scored the lowest in globalization and needs to overcome many structural and material flow barriers by implementing selected strategies to utilize foreign investment to promote economic growth (Ji, 2023). Khamdamov S J analyzed historical exchange rate data and export trends to explore the impact of exchange rate fluctuations on Uzbekistan's export-oriented growth. He found that although exchange rate depreciation can temporarily boost exports, sustained fluctuations are not conducive to long-term export-oriented growth. He also proposed exchange rate management policy recommendations to support sustainable export expansion and economic resilience (Khamdamov, 2024). Dadabaev T used a comparative analysis method to study the transformation of the cooperation agenda between Uzbekistan and Russia, China, Japan, and South Korea. He found that Uzbekistan is gradually moving away from the security driven cooperation agenda of the Karimov era and towards a direction of cooperation that is de securitized. Especially after the death of President Islam Karimov, cooperation with these four countries has shown a new trend (Dadabaev, 2020). In addition, some scholars have pointed out through field research that although China's projects in Uzbekistan have achieved certain results, the lack of localized operation affects the sustainability of the projects (Yu, 2023). Overall, existing research has mostly focused on traditional collaborative fields, lacking in-depth quantitative analysis of high value-added areas and their economic impacts.

In order to deeply analyze the economic benefits of China Uzbekistan economic and trade cooperation, researchers have adopted various methods, which have made certain progress in solving problems. Khojamqulov et al. used the method of analyzing multiple economic indicators and social living conditions to study Uzbekistan's current foreign trade development policies, and obtained statistical results on the performance and prospects of its foreign trade policies in various aspects (Khojamqulov,, 2019). Sarvar G used content analysis and comparative analysis methods to study the foreign trade relations between Uzbekistan and BRICS (Bureau of Research Information Control System) countries, and proposed cooperation strategies and potential challenges, including trade growth potential and regional transportation, logistics, and financing issues. They also explored the connections between BRICS countries and other Central Asian countries (Sarvar, 2024). Other studies have analyzed the factors of bilateral economic cooperation between China and Uzbekistan by analyzing scientific literature and Internet data, using the theory and method of trade gravity model, and found that geographical distance and trade registration time have a negative impact on bilateral trade efficiency, while institutional factors and infrastructure construction have an important impact on bilateral trade relations (Yastrubskyy, 2024). Based on the United Nations commodity trade data from 2010 to 2019, Lingzhi Z analyzed the trade relations between Uzbekistan and member states of the Eurasian Economic Union using multiple trade index calculation methods (Lingzhi, 2021). Stephens A R et al. used time series analysis to explore the export specialization situation in Uzbekistan and obtained the results that Uzbekistan has promoted economic development through export diversification since 2017 (Stephens, 2023). Zhou L and others analyzed the trade competitiveness of agricultural products between China and countries along "the Belt and Road

Initiative" from 2001 to 2019 and its influencing factors, found that there were significant differences in the trade competitiveness of agricultural products between China and regions and countries along the "Belt and Road", and pointed out policy recommendations to enhance competitiveness (Zhou, 2022). Gulnar Shaimadanovna Kaliakparova et al. used methods such as literature analysis, comparative analysis, retrospective analysis, and expert evaluation to explore the priority areas of international cooperation in Central Asian countries to realize the potential of renewable energy and improve energy system efficiency. The results showed that Central Asian countries have great potential for the development of renewable energy, but their actual application level is relatively low, and cooperation with leading countries in renewable energy development is needed to accelerate transformation (Gulnar, 2020). Through the summary of existing literature methods, it can be seen that there are shortcomings in evaluating the economic impact and policy coordination effects between different fields. This article comprehensively solves the above problems through panel data models.

3. IMPLEMENTATION OF QUANTITATIVE ANALYSIS MODELS

3.1 Data Collection

The research data was collected from the World Bank, the United Nations Comtrade database, and the China Statistical Yearbook. The data obtained includes bilateral trade between China and Uzbekistan from 2000 to 2023, FDI (Okwu, 2020), tariff information, and relevant macroeconomic data. Macroeconomic indicators include GDP growth rate, inflation rate, and unemployment rate, covering energy, manufacturing, agriculture, infrastructure, and high-tech fields (Anh, 2023; Liu, 2020).

The trade data of import and export commodities and commodity types between China and Uzbekistan over the past 23 years can be extracted from the United Nations Trade Database. For FDI, the FDI information in the World Bank database can be used, with data on an annual basis to ensure that all investment amounts are converted into a unified currency, with data units in millions of US dollars (Vijay, 2020; Badwan, 2021). In addition, tariff information is summarized through the China Statistical Yearbook and cross year data from the World Bank, providing a detailed display of changes in the impact of tariff policies on trade flows and investment.

To ensure the coherence of experimental data, interpolation is used to compensate for a small number of missing values and ensure the continuity of the time series. Outlier detection methods are applied to eliminate extreme data with abnormal fluctuations and prevent outliers from affecting subsequent analysis results (Axel, 2021; Boukerche, 2020). By comparing databases from different sources, the consistency of all data can be ensured. Table 1 lists some of the collected raw data:

Table 1. Overview of partial data of china and Uzbekistan from 2000 to 2023

Year	Bilateral Trade Volume (Million USD)	FDI Inflow (Million USD)	GDP Growth Rate (%)	Inflation Rate (%)
2000	650.2	12.5	4.3	7.2
2005	1,200.80	45.3	6.8	5.9
2010	3,400.60	132.7	8.1	4.1
2015	4,600.90	245.5	7.3	5.5
2020	6,800.70	320.8	3.2	11.6

After collecting bilateral trade and investment data, a panel data model was constructed with GDP growth rate as the dependent variable and bilateral trade volume, FDI inflows, and tariff rates as independent variables. Fixed effects and random effects models were used for analysis. Regression analysis can be conducted using Stata statistical software to identify the contribution

rates of different economic variables to GDP growth (Flatt, 2019; Ahrens, 2020). The model selection is based on the Hausman test results and combined with stepwise regression to optimize variables and eliminate redundant variables.

In all analysis processes, multicollinearity between variables is tested, and variance inflation factors are used to evaluate the correlation between variables (Oke, 2019; Shrestha, 2020). The key regression results show that the standard error of bilateral trade and FDI inflows is positive, while the tariff rate is negative. This indicates that bilateral trade and FDI inflows have a significant positive impact on GDP growth, while the increase in tariffs has a negative impact on GDP growth. Through such analysis, efficient areas of cooperation can be identified, providing quantitative support for subsequent policy recommendations.

3.2 Variable Setting

During the variable setting process, the GDP growth rates of China and Uzbekistan were selected as dependent variables to measure changes in the overall economic growth of both countries. This is because the GDP growth rate can comprehensively reflect the performance of economic activities in various fields and is suitable as a core dependent variable in panel data models.

The independent variable mainly involves five aspects: bilateral trade volume, FDI, tariff changes, policy coordination, and trade policy (Mishra, 2019; Gül et al., 20024). Bilateral trade volume is divided into different sectors such as energy, agriculture, manufacturing, etc., and their contributions to GDP growth are examined separately. The bilateral trade volume of each industry can be processed according to time series data and included in a regression model to analyze its driving effect on the economies of the two countries. The energy trade volume reflects the import and export data of the two countries in energy cooperation, while agricultural trade focuses on the import and export of agricultural products, and manufacturing trade covers the bilateral circulation of industrial products and consumer goods. By distinguishing the trade volume of different fields, the model can identify which fields have a greater driving force for economic growth.

FDI is mainly used to evaluate the distribution of foreign direct investment received by Uzbekistan in different industries. The processing of FDI data adopts bilateral investment flow data from the World Bank and China Statistical Yearbook to ensure the authority of the data. FDI is segmented according to different industries, and in the model, FDI is given weights to different industries. Energy and high-tech industries are given higher weights due to their future impact on economic cooperation.

Tariff changes reflect the impact of tariff policy adjustments between two countries on economic activity (Flaaen, 2020). The data collection of tariff changes has been conducted on various bilateral trade policy adjustments since 2000, with the aim of studying the inhibitory or promoting effects of tariffs on bilateral trade and economic growth. The changes in tariffs are recorded annually, and based on this data, a panel data model is used to analyze the impact of tariff changes on bilateral trade flows and economic growth.

Policy coordination is a variable that reflects policy consistency in economic and trade cooperation between two countries (Domorenok, 2021). By quantifying the quantity, content, and implementation effectiveness of bilateral agreements, policy coordination transforms policy consistency into a measurable variable. The setting method adopts a continuous scoring approach, assigning corresponding scores to the policy coordination between the two countries in different fields. A higher degree of policy coordination represents a high degree of consistency in bilateral policies, which is expected to have a positive effect on GDP growth. When setting these independent variables, weights can be set based on their actual role in bilateral economic cooperation. By setting these weights, the model can more accurately capture the different

contributions of various industries to GDP growth.

3.3 Model Selection and Construction

In terms of model selection, based on bilateral economic cooperation data between China and Uzbekistan, fixed effects models (FEM) and random effects models (REM) were used to evaluate the impact of bilateral cooperation on economic growth (Garashchuk, 2023; Long, 2023; AL-Qadri et al., 2023). The selection of the two models is based on different assumptions. The fixed effects model focuses on the fluctuations of variables within a country in the time dimension, while the random effects model considers the randomness of individual effects between countries. The process of model construction revolves around panel data, with the aim of capturing long-term and short-term economic fluctuations in bilateral cooperation through panel data.

When processing data, bilateral trade, FDI, tariff changes, etc., are used as the main explanatory variables input into the panel data model. By setting GDP growth rate as the dependent variable, regression equations are constructed for different fields. In order to accurately reflect the weights of different fields and their impact on GDP, FEM is used to capture the dynamic changes of bilateral cooperation in the time dimension. The advantage of FEM is that it can control for unobserved country specific time invariant factors, allowing research to focus on changes between variables without interference from time invariant factors. REM assumes in its construction that individual effects are random and independent of explanatory variables, making it suitable for analyzing random differences between countries. By constructing REM, it can further investigate the random impact of cooperation areas at different national levels.

In the process of model selection, the Hausman test is used to determine whether to use FEM or REM. The Hausman test compares the estimation results of two models to determine whether there is a correlation between explanatory variables and individual effects (Alam, 2022; Al-khresheh et al., 2023). In this study, the Hausman test showed that FEM is suitable for data analysis in most collaborative fields, and therefore, in most cases, FEM is used as the preferred model for economic effect evaluation.

In model construction, the panel data regression equation is constructed in the following form:

$$GDPGrowth_{it} = \alpha + \beta_1 Trade_{it} + \beta_2 FDI_{it} + \beta_3 Tariff_{it} + \beta_4 PolicyCoordination_{it} + u_i + \epsilon_{it} \quad (1)$$

In the equation, $GDPGrowth_{it}$ represents the GDP growth rate of the ith country during the t period, $Trade_{it}$ represents bilateral trade volume, $Tariff_{it}$ represents tariff changes, $PolicyCoordination_{it}$ represents policy coordination, u_i and ϵ_{it} are individual effects and random error terms, respectively.

To ensure the robustness of the model, adjustments can be made to the fitting effect of the model. By adjusting the weights, variables from different fields can be refined to ensure that the economic contribution of each field is fully reflected in the model. Meanwhile, heteroscedasticity and autocorrelation tests can be used to evaluate the error terms and eliminate heteroscedasticity and sequence correlation issues in the model.

3.4 Empirical Testing

Empirical testing is a guarantee of whether the constructed model can be used. To ensure the rationality of the panel data model in explaining the impact of China Uzbekistan economic and trade cooperation on the economic growth of the two countries, the validation of regression results can be used to avoid result bias caused by data fluctuations or potential error term correlations, ensuring the explanatory and predictive power of the model.

In the experiment, the Variance Inflation Factor (VIF) test was used to verify whether there is a

high correlation between independent variables (Gokmen, 2022; Jam et al., 2019). The existence of multicollinearity can be determined by calculating the variance inflation factor (VIF value) of each variable. It can be determined whether certain independent variables need to be adjusted or eliminated based on the set threshold (usually VIF>10). In the study, the VIF values of bilateral trade volume, FDI, and tariffs in fields such as energy, agriculture, and manufacturing were all below the set threshold, indicating that the problem of multicollinearity is relatively mild and can be ignored. Therefore, the data and model results were not significantly affected by the high correlation between the independent variables. In addition, to address the issue of autocorrelation, the Durbin-Watson test was used to examine the autocorrelation of the error term. After calculating the Durbin-Watson statistic on the regression results, it was found that there was no significant autocorrelation between the error terms, and the model error terms met the assumption of independence.

To further validate the rationality of the model, heteroscedasticity testing was performed. The White Test and Breusch-Pagan Test can be used to detect heteroscedasticity in the model. The results indicate that there is no systematic change in the variance of the residuals, and the model results are reliable. In addition, robust standard error regression was also performed. By adjusting the standard error in the model, the potential impact of heteroscedasticity on standard error and statistical inference can be overcome, further improving the explanatory power and accuracy of regression results.

Table 2 presents the data of some empirical test results:

Table 2. Empirical test results of regression model

Test Type	Statistic	Threshold	Conclusion
VIF Test	2.45	10	No multicollinearity
Durbin-Watson Test	1.98	2	No autocorrelation
White Test	5.67	0.05	No heteroskedasticity
Breusch-Pagan Test	4.32	0.05	No heteroskedasticity
Robust standard error regression	-	-	Results are robust

Through empirical testing, it was found that the model passed the necessary statistical tests in all aspects, and no significant multicollinearity, autocorrelation, or heteroscedasticity issues were found. And the application of robust standard errors further ensures the reliability of the model results, verifying the contribution of cooperation in different fields to the economic growth of China and Uzbekistan.

4. Assessment of Economic Cooperation Potential

4.1 Contribution Rate to Economic Growth

The contribution rate of economic growth can objectively and quantitatively evaluate the driving effect of economic and trade cooperation on the economic growth of both sides, and reveal the key areas and potential directions of cooperation, providing strong support for the governments and enterprises of both sides to formulate and adjust cooperation strategies. When examining the rate of economic growth contribution to China- Uzbekistan trade and economic cooperation, regression analysis models are used to determine the contribution rates of different cooperation areas such as energy, manufacturing, and agriculture to GDP growth.

The experimental data uses actual economic statistics and specific data from bilateral cooperation

fields that have been collected and processed. In the experiment shown in Figure 1, publicly available data from the statistical departments of China and Uzbekistan, as well as the World Bank, from 2018 to 2022 were used to collect bilateral trade volume and GDP growth rates in the fields of energy, manufacturing, agriculture, and other areas between the two countries.

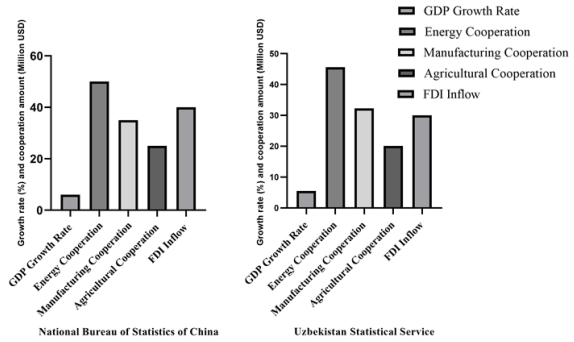

Figure 1. Bilateral trade, gdp growth rate, and fdi data

A panel data regression model can be used to conduct regression analysis with GDP growth rate as the dependent variable and bilateral cooperation amount in various fields as the independent variable. Based on experimental results, this article calculates regression coefficients for each field to reflect the contribution rate of each cooperative field to the economic growth of the two countries. The experimental results are shown in Figure 2:

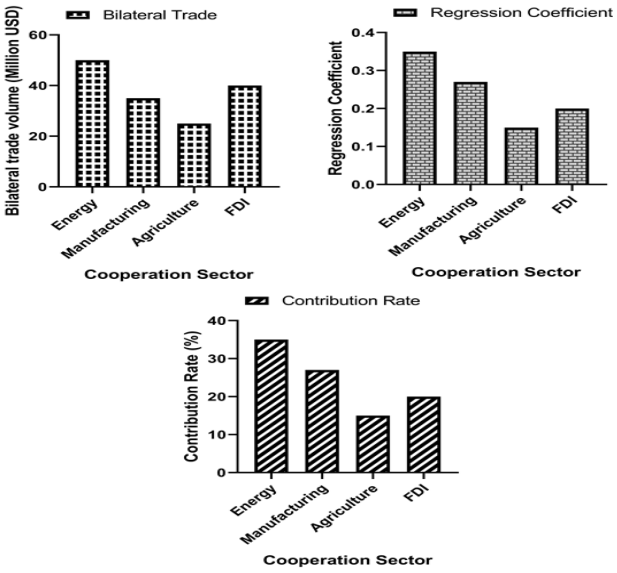

Figure 2. Bilateral trade volume, regression coefficient, and contribution rate of various industries to GDP growth

The experimental results in Figure 2 show that the regression coefficient for the energy sector is 0.35, for manufacturing it is 0.27, and for agriculture it is 0.15. The analysis results indicate that energy cooperation is clearly the most important factor driving economic growth between China and Uzbekistan, followed by manufacturing, while the contributions of agriculture and FDI are relatively small. The above results reflect the current situation of economic and trade cooperation, and provide important basis for future policy formulation and cooperation direction. In the future, attention should be paid to enhancing the depth and breadth of cooperation in agriculture and FDI fields, and achieving higher quality economic and trade cooperation.

4.2 Return on Investment

The return on investment (ROI) plays a crucial role in evaluating the economic and trade

cooperation between China and Uzbekistan. In order to clarify the investment benefits of China in different fields of Uzbekistan, the investment return rate formula is used:

$$ROI = \frac{Income - Investment\ \ cost}{Investment\ \ cost} \times 100\% \quad (2)$$

Through the calculation of this formula, regression analysis is conducted on FDI data in five major fields including energy, manufacturing, agriculture, infrastructure, and high-tech to determine the investment efficiency of each industry.

In the study, the amount of capital inflows from China to various industries in Uzbekistan during each year determines the amount of FDI investment, and the returns are evaluated based on the contribution of the industry to Uzbekistan's GDP growth. The measurement of revenue data adopts a panel data regression model, with specific variables consisting of the gross domestic product and FDI input in five cooperation areas: energy, manufacturing, agriculture, infrastructure, and high-tech. Calculate the ROI by measuring the input-output ratio in different fields.

To ensure comparability, FDI data from five major areas of cooperation between China and Uzbekistan in 2000 and 2023 were selected for calculation. As shown in Figure 3, the data shows that in 2000, the investment return rate of the energy industry was significantly higher than other fields, reaching 25%. The return rates of manufacturing and agriculture were relatively close to those of the energy industry, while the return rate of infrastructure was relatively low. Although high-tech is emerging, its ROI has not yet reached a high level. In 2023, the investment return rate of the energy industry is only 23%, but it still ranks second among the five major sectors. The return rate of the high-tech industry has increased significantly, reaching 30%, demonstrating the rapid development of this field. The return rate of manufacturing and agriculture has not changed significantly, but it is still lower than that of energy and high-tech industries, while the return rate of infrastructure has decreased.

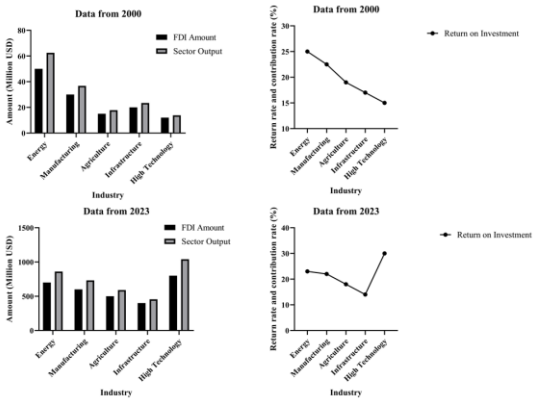

Figure 3. FDI and ROI in the five major areas of cooperation between the two countries in 2000 and 2023

Analysis of the data reveals that the investment return rate of the energy industry is relatively stable and maintains a high level, with long-term stability. The manufacturing industry has achieved a high level of return through technological innovation and international market expansion. The investment return of agriculture is lower than that of manufacturing and energy industries due to the lower capital intensity of the industry. The return cycle in the infrastructure

sector is relatively long, and the return rate remains at a low level. In recent years, the ROI in high-tech fields has rapidly increased, becoming a potential area for future investments. However, overall, the high return rate maintained by the energy industry remains the preferred investment option.

4.3 Trade Complementarity Index

When evaluating the complementarity between China and Uzbekistan, the Trade Complementarity Index (TCI) is used to measure the degree of match between the two countries' export products and import demand, and to assess the degree of complementarity in various industrial chains.

TCI calculation formula:

$$TCI = 100 - \sum_i |(\frac{X_i^A}{\sum X^A} - \frac{M_i^B}{\sum M^B})| \quad (3)$$

X_i^A is the export value of product i from country A (China), and M_i^B is the import value of product TCI from country B (Uzbekistan). The higher the value, the stronger the complementarity between the two countries in trade.

For analysis, export data from the two countries in the fields of energy, manufacturing, agriculture, infrastructure, and high-tech in 2000 and 2023 were used, and compared with each other's import demand. As shown in Figure 4, the TCI data for the past two years shows that the trade complementarity index in the energy sector was 70% in 2000, indicating a high potential for cooperation in this field. The complementarity index between manufacturing and infrastructure is also relatively close to that of the energy sector, indicating that these sectors have a good match in China-Ukrainian trade. The complementarity index between agriculture and high-tech fields is slightly lower, but there is still room for cooperation. By 2023, the trade complementarity index in the energy sector can increase to 85%, indicating a significant expansion of cooperation space in this field between the two countries. The complementarity index of the manufacturing industry has also increased to 80%, indicating a closer trade relationship between China and Uzbekistan in this field. The complementarity index in the high-tech field has also increased, although the increase is relatively small, it still shows a positive trend.

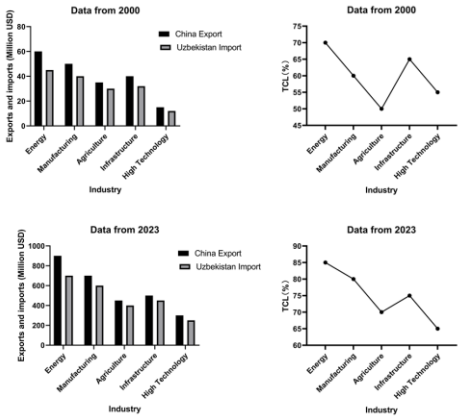

Figure 4. TCI data for the five major fields of the two countries in 2000 and 2023

TCI data shows that the trade complementarity index between the two countries has improved in the fields of energy, manufacturing, and infrastructure. The energy sector has the greatest potential for cooperation, showing a significant improvement in matching, followed closely by the manufacturing industry, with broad prospects for cooperation. Although there has been progress

in the high-tech field, its development is relatively slow compared to other fields.

4.4 Policy Coordination Efficiency

The quantification of policy coordination efficiency can analyze the coordination degree between China and Uzbekistan in bilateral trade policies, tariff policies, and investment environment. The efficiency of policy coordination is calculated through the Policy Coordination Index (PCI), which sets multiple influencing variables such as policy reform time, market openness, and investment facilitation level.

One of the main variables in the dataset is changes in tariff policies. The timing of tariff policy reform has affected the liquidity of bilateral trade, therefore, these nodes are included in the core variables for calculating PCI. The tariff changes of the two countries from 2000 to 2023 showed a relatively significant phased adjustment, and the cooperation policy reform after "the Belt and Road Initiative" significantly promoted the efficiency of trade flows.

The calculation formula for PCI is:

$$PCI = \sum_{i=1}^{n} (\frac{R_i}{T_i} \times W_i) \quad (4)$$

Among them, R_i represents the impact time of a certain policy reform, T_i is the total policy change in the response area, and W_i is the weight of each policy.

In practical operation, the market openness index of the investment environment is introduced into the model, mainly referring to the bilateral investment treaty (BIT) between the two countries and their market openness after signing. The signing and implementation of BIT play an important role in improving the efficiency of policy coordination. The timing of such policy adjustments is included as a variable, and the effect of policy coordination is obtained through regression analysis.

In order to more accurately evaluate the efficiency of policy coordination, further regression analysis is conducted, taking into account the reform time of tariff policies, changes in investment environment, and the degree of market opening. Through model calculations, it is found that the efficiency of policy coordination between the two countries has been increasing year by year. As shown in Figure 5, the efficiency of policy coordination between China and Uzbekistan has changed over six years. The data shows that from 2000 to 2023, the time of tariff policy reform between China and Uzbekistan has been extended year by year. After "the Belt and Road Initiative", policy changes have accelerated. In 2023, the reform period can reach 3.4 years, the market openness can increase from 40% to 65%, and the investment environment improvement index can also increase from 2.3 to 4.7. The policy coordination index has increased from 0.45 to 0.78, indicating a significant improvement in the efficiency of policy coordination. This growth trend reflects the coordinated efforts of the two countries in multi-level policy areas, which significantly influence economic cooperation development between the two nations.

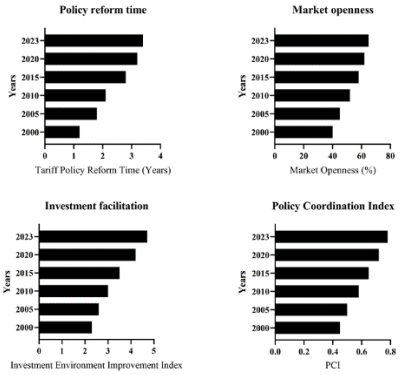

Figure 5. Policy coordination index between china and uzbekistan

A series of policy changes from 2000 to 2023 have promoted the deepening of bilateral trade and investment cooperation, laying a solid foundation for the further development of economic cooperation between China and Uzbekistan.

4.5 Cooperative Diversification Index

When analyzing the degree of diversification in cooperation between China and Uzbekistan, the Herfindahl-Hirschman Index (HHI) is used to evaluate whether cooperation is too concentrated in a single field. The formula for the HHI is as follows:

$$HHI = \sum_{i=1}^{n} S_i^2 \quad (5)$$

Among them, S_i represents the market share in a certain field. The proportion of cooperation in various fields during the year can be calculated using this formula.

In the calculation of the index, data from six years from 2000 to 2023 were used, and the proportions of each field in these six years are shown in Figure 6. After calculation, the HHI index for each year is shown in Figure 7.

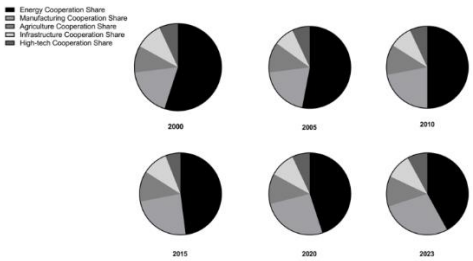

Figure 6. Proportion of cooperation areas

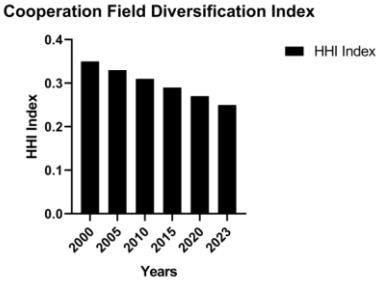

Figure 7. HHI index for each year

By analyzing the data in Figures 6 and 7, it can be concluded that the energy sector accounted for 55% in 2000, making it the dominant area of cooperation between the two countries. The HHI index reached 0.35, indicating a high concentration of cooperation. By 2023, although the proportion of energy sector has decreased, it can still be the area with the highest proportion of cooperation. This indicates that energy remains the core of cooperation between the two countries, but cooperation in other fields is gradually developing. The proportion of manufacturing industry has increased from 18% in 2000 to 28% in 2023, and infrastructure and high-tech fields have also grown, showing a trend of diversified cooperation. This diversified cooperation can reduce dependence on a single field, expand the area available for future economic cooperation, and strengthen the resiliency of the two nations' current economic collaboration.

5. CONCLUSION

This article quantitatively analyzes the economic and trade cooperation between China and Uzbekistan in different fields, using panel data models, investment return rate calculations, trade complementarity indices, and HHI methods to evaluate the potential for cooperation in each field. Research has found that the energy sector remains the core of economic and trade cooperation between the two countries, although the proportion of cooperation in this field has been decreasing year by year, it still maintains a dominant position. At the same time, the proportion of cooperation in manufacturing, infrastructure, high-tech and other fields is gradually increasing, demonstrating the diversified trend of cooperation between the two countries. Through the analysis of policy coordination efficiency, the study also points out that improving policy coordination can help further optimize the efficiency of cooperation between the two countries. Research shows that promoting cooperation in multiple fields and diversification can reduce the dependence of both countries on a single field and strengthen the trade and economic cooperation's resilience. However, in data analysis, there are limitations in obtaining some data, and detailed data in some fields is not yet sufficient. Future research should further refine the long-term impact assessment of investment returns and policy coordination in various fields to ensure the comprehensiveness and accuracy of the research. With the deepening of "the Belt and Road Initiative", China Uzbekistan economic and trade cooperation has broad prospects. The future policy optimization and innovation of cooperation models can bring more opportunities and challenges to the two economies.

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