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Research Article

An Evaluation Method of International Trade Growth Potential Based on Fuzzy Algorithm

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The new development pattern is a strategic choice to reshape China's new advantages in international cooperation and competition. It is based on China's current development stage, changes in the environment, and other factors. Located deep within China's interior, Xinjiang is a crucial region for the development of the western region and the Belt and Road Initiative. Its agricultural resources are exported to numerous foreign nations. In the context of the new development pattern, this paper first examines the foreign trade issues in Xinjiang. Second, this paper analyzes the current state of Sino-Kazakhstani trade, in particular the current state of trade in agricultural products. In addition, the growth potential of Xinjiang's agricultural international trade is analyzed utilizing the gravity model and fuzzy algorithm. Finally, countermeasures for the mode of development of Xinjiang's international trade are proposed.

1. Introduction

Despite its remote location in the interior of China, the development of Xinjiang is essential to the success of both One Belt One Road (OBOR) and China's far western region. Its agricultural sector is thriving, and its products are exported to numerous nations. In response to the expansion of the separatist movement in Xinjiang, the United States' Central Asia Strategy, the Russian Eurasian Strategy, and Pan-Turkism and Pan-Islamism are converging in the Central Asia region [1, 2]. It has become more challenging for Xinjiang to develop its economy, especially its foreign trade, which must contend with a more complex domestic and international economic environment. This has made the growth of international trade particularly difficult. In the course of its development, Xinjiang has encountered problems such as an unbalanced industrial structure, a lack of market competitiveness, and severe ecological damage. These issues are a result of the province's unique geographical, resource, and policy advantages, which have enabled its rapid expansion of international trade. Improvements must be made to the manner in which the expansion of international trade is conducted [3–5].

China has gradually surpassed Russia to become Kazakhstan's largest trading partner since OBOR Initiative was proposed. In addition, China's trade volume with Kazakhstan has increased from less than $400 million when it first began to $20 billion in 2020, which is an increase of nearly 50 times. China has surpassed Kazakhstan as Kazakhstan's most important trading partner, both in terms of exports and imports. China has recently overtaken Kazakhstan [6]. The volume of goods that are exchanged between Kazakhstan and China represents approximately 16 percent of Kazakhstan's total trade volume. It is anticipated that the economic and trade relations between China and Kazakhstan will continue to expand strongly in the year 2020. According to data from Kazakhstan, it is anticipated that the volume of trade between the two nations will reach approximately 16 billion dollars in the year 2020. This represents a growth of 4 percent in comparison to the volume of trade in the previous year. For instance, Kazakhstan's exports to China totaled 9 billion dollars,

while the country's imports from China totaled 7 billion dollars [7].

OBOR and China's westward construction in Kazakhstan, which is the first overseas stop, both place a significant emphasis on the development of Kazakhstan's agricultural sector. In order to make significant headway in the construction of the Silk Road Economic Belt, it is essential to conduct research into the possibilities of commercial agricultural exchange between the Xinjiang region of China and Kazakhstan [8].

According to existing research, the trade in agricultural products between China and the OBOR countries can be divided into two main categories. A comprehensive analysis of the current state of trade and competition is the first step that must be taken [9]. Some academics believe that this initiative will result in a broadening and deepening of agricultural trade links between countries along the route [10]. In addition, it will lead to a wider space for cooperation and opportunities for countries along the route to grow their agricultural businesses. China and the countries that it trades with have a good complementarity in agricultural products; however, they face challenges such as inadequate infrastructure, low added value for exported agricultural products, and rising green trade barriers. Agricultural products complement each other well [11]. On the other hand, the empirical research conducted by others has led to the conclusion that the complementarity of China's agricultural trade with that of other countries along OBOR is less obvious than it actually is. Xinjiang, China, which is situated in the geographic center of OBOR, has attracted the attention of a number of academics who are curious about the current state of the agricultural products trade there as well as the competitive characteristics of the market. Some researchers have examined the competitiveness of China's and Kazakhstan's agricultural trade using the explicit comparative advantage index and the trade complementarity index [12]. These indices were used to measure the degree to which the two countries complement each other in trade. Fruits and vegetables, oilseeds and olive fruits, and textile fibers are all examples of areas in which the economies of the two countries are highly complementary to one another. According to the findings of a few researchers, the agricultural cooperation between China's Xinjiang and the countries of Central Asia has formed a strong complementarity, and there is a great deal of untapped potential for agricultural trade in this region.

In addition, a significant number of academic researchers have investigated the factors that may influence the success of bilateral trade between China and Kazakhstan. In research, the method of regression based on the gravitational model is the one most frequently employed. Using the gravity model, a number of academics have conducted an empirical analysis of the potential for agricultural product trade between China and OBOR countries [12, 13].

It is believed that factors such as distance, population size, economic size, and government policies in these countries influence agricultural trade between China and the countries along the trade route. There is a lower probability of economic exchange between countries that are geographically distant from one another exhibited a significant connection or link between the two. Using a model known as the stochastic frontier gravity model, some researchers estimate China's agricultural export efficiency and potential with Silk Road countries. Economic growth and population density are viewed as advantages for China's agricultural exports, while the distance from markets is viewed as a disadvantage and political stability is viewed as an advantage [14–17]. Political stability is also seen as a positive. Some of the factors that are preventing China from exporting its agricultural products include indexes, trade and related infrastructure quality indexes, as well as procedures for customs clearance, economic freedom, and free trade agreements. In order to investigate the ways in which China's OBOR Initiative policy variables affect agricultural trade with the five Central Asian countries, some academics have utilized a panel data model in their research. They believe that there will be an increase in the amount of agricultural goods that are traded between China and the United States as a direct result of the OBOR Initiative. The amount of agricultural value added the distance that separates the two countries, and whether or not the countries share a border will all have an impact on the agricultural product trade that occurs between them. A few studies apply the method of overall network analysis to investigate the factors that influence trade and to measure the trade index in order to estimate the amount of potential for trade. Some academics use a method called overall network analysis to better understand how countries along OBOR trade agricultural products. This method suggests that factors such as economic development, distance from one another, shared languages, and whether or not the countries involved have signed free trade agreements (FTAs) are significant [18].

A fuzzy comprehensive evaluation method is the name given to an all-encompassing evaluation strategy that is underpinned by fuzzy mathematics. This all-encompassing method of evaluation converts qualitative evaluation into quantitative evaluation by employing the membership degree theory of fuzzy mathematics [19, 20]. Another way to phrase this is to say that this method of evaluation uses fuzzy mathematics to make a general evaluation of things or objects that are restricted by many factors [21]. Due to the fact that this method produces clear outcomes and has a robust structure, it can be applied to the solution of a wide variety of nondeterministic issues in a manner that is both systematic and clear. The development potential of health tourism in forests was evaluated by some researchers using fuzzy algorithms, and they discovered that the majority of the development value in forest health tourism was comprised of environmental value, resource value, development and construction value, and other values related to the development and construction of the forest. It is not common practice to employ a fuzzy algorithm when estimating the potential expansion of international trade [22, 23].

Therefore, the focus of this paper will initially be on the obstacles that Xinjiang's international trade must overcome. In addition, it investigates the current state of trade between China and Kazakhstan, with a focus on agricultural goods

trade. In this study, a gravity model and fuzzy algorithm are employed to determine the extent to which Xinjiang's agricultural exports have the potential to increase in the future. The countermeasures for Xinjiang's mode of foreign trade development are presented as the last item on the agenda, but they are by no means the least important.

2. Trade Status

2.1. Deficiencies in Trade. Central Asia is the region with which Xinjiang has the most significant economic ties. Because of Xinjiang's unique geographical characteristics, the region's international trade can only develop in a westerly direction, which creates a space-related problem. In recent years, China's share of the Central Asian foreign trade market has been steadily declining as Japan, South Korea, Europe, and the United States have all sought a piece of the action in the region. China's share of the Central Asian international trade market is at an all-time low. Therefore, trade goods originating from Xinjiang must frequently undergo multiple transshipments. This not only increases transportation costs but also increases competition on the Central Asian foreign trade market, which is detrimental to Xinjiang's exports. Adaptations are required for development and progress to continue.

Despite the fact that Xinjiang contains a number of dry and even extremely dry regions, the landscape of the region is almost entirely desert. The Gobi Desert and other deserts cover a vast portion of the region, which receives low annual precipitation on average. Xinjiang's 82 counties (cities) are home to 53 distinct deserts, which both surround and divide the oasis. This makes surviving in the sparsely populated region difficult. More than forty percent of the land in Xinjiang consists of mountains, which have sparse vegetation and a high concentration of surface salt. These factors combine to make the region vulnerable to land salinization and produce an ecologically fragile environment. Xinjiang is home to a large number of coal mines, oil fields, and other types of energy resources; however, the mining techniques employed there are still quite harsh, which will inevitably harm the local ecosystem. In addition, because the local ecological environment is so fragile, it will be more challenging to restore it once it has been damaged. There is a substantial problem with transformation.

Entrepreneurs' innovative spirit is essential for reshaping the growth of international trade and enhancing the country's standing on the international stage. Due to the backward economic climate in Xinjiang, there is little room for technological innovation. This indicates that an increase in inputs of resources and production factors is the primary factor driving international trade. It would appear that the local government of Xinjiang is unable to provide adequate funding and support for the technological innovation of businesses, which would allow them to engage in competitive market behavior. In addition, it is challenging to find innovative talents in the field of international trade in Xinjiang, indicating that the region lacks the compound talents required for the expansion of international trade. Internally, there is a lack of motivation for technological innovation within the organization as a whole. To begin with, the majority of Xinjiang's international trade companies employ only basic processing techniques when shipping their wares to neighboring countries. This hinders the region's capacity for scientific and technological innovation. During the time of the industrial transfer, the majority of Xinjiang's industries were textiles, food processing, and other light industries. As a result, the capacity for technological innovation among Xinjiang's international trade enterprises was diminished.

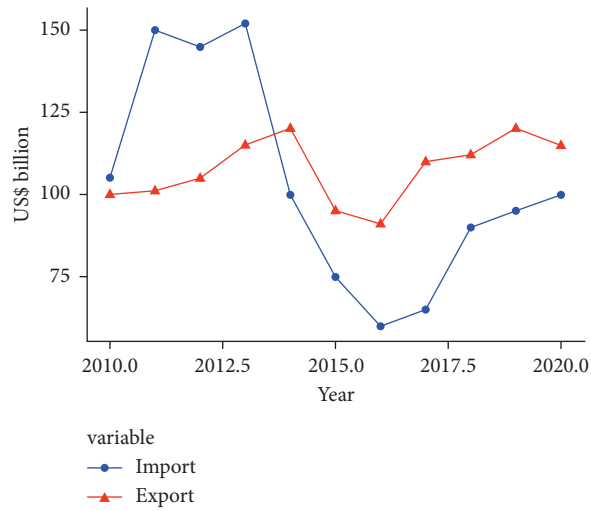

Figure 1: China-Kazakhstan import and export value in 2010–2020.

2.2. China-Kazakhstan Trade. The total volume of trade that took place between China and Kazakhstan from 2010 to 2020 is depicted in Figure 1. As a result of the ongoing trend toward globalization, the overall volume of imports and exports that occurs between the two countries has demonstrated an upward trend. Between the years 2012 and 2013, there was a sizeable rise in both China's exports to Kazakhstan and its imports from that country. During the years 2015 and 2016, the value of imports and exports experienced a significant decline, which was followed by an upward trend in the years that followed. Over the course of the past few years, the trade balance between China and Kazakhstan has shifted from one of a deficit to a surplus. Before 2013, China's trade balance was consistently negative throughout the country's history. After China reached a trade surplus in 2013, the country's economy continued to expand. The expansion of the One Belt One Road initiative is one of the most important factors.

Since the development of bilateral trade between China and Kazakhstan, the structure of trade products has remained relatively stable despite the fact that the trade goods used by both countries have changed and increased over time. Despite the trade imbalance between the two nations, this is the situation. According to the United Nations database, the Kazakh economy is highly dependent on Chinese imports. China was the recipient of 12 percent of Kazakhstan's total global exports in the year 2020. The bulk

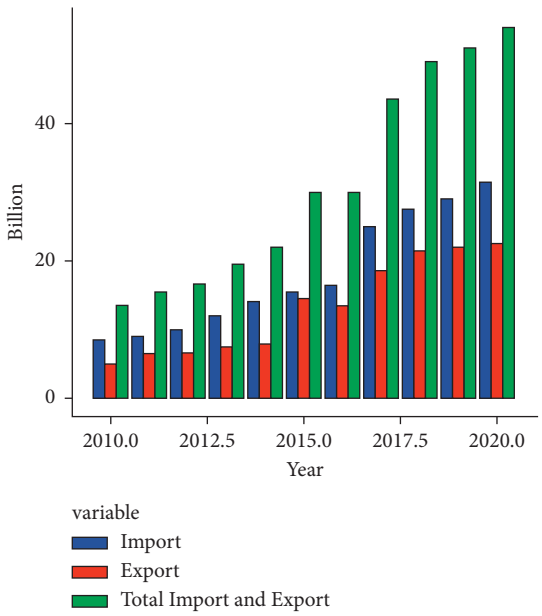

Figure 2: 2010–2020 China-Kazakhstan agricultural products trade situation.

of Kazakhstan's imports to China consists of mineral and metal products. The majority of China's exports to Kazakhstan, on the other hand, consist of textiles and mechanical and electrical goods.

Both China and Kazakhstan place a high priority on bilateral trade from the point of view of working together to develop policies governing bilateral trade. There have been 45 strategic agreements signed between the two nations ever since the establishment of the Shanghai Cooperation Organization. The Shanghai Cooperation Organization, which was initially established for political reasons but now serves primarily as a clearinghouse for financial and trade agreements, has signed twenty percent of all agreements. This makes it the organization responsible for one-fifth of all agreements. It is clear that the conditions are perfect for China and Kazakhstan's cooperation in their respective trade sectors at the bilateral level. As a direct consequence of this, the volume of trade between the two countries saw very little change as a direct result of the agreement.

In comparison to the ports and infrastructure of the other countries in the region, China and Kazakhstan have a greater number of ports, a greater variety of ports, and a more developed economy. There are currently seven ports between China and Kazakhstan, and this number was determined using a schedule that was approved by the State Council. Both Horgos and Alashankou are responsible for the majority of Xinjiang's cargo at the moment. When Alashankou was first established, the port's cargo volume was ahead of that of any other port in Greece; however, in 2014, Horgos surpassed it, and now Horgos is the largest port in Greece. From the perspective of cross-border and international cooperation, the joint production capacity cooperation that is part of the Silk Road Economic Belt has grown rapidly in recent years. The Khorgos Border Cooperation Center is the primary platform for cross-border cooperation between China and Kazakhstan. The center's primary focus is on promoting cross-border cooperation in the areas of e-commerce, logistics, and natural resources. Industrial parks, which are one of the future development trends of the economies of both China and Kazakhstan, are currently the most effective model for economic cooperation between the two countries. According to some incomplete data, there are currently operating in the world three industrial parks.

Agricultural goods will be traded between the Xinjiang region of China and Kazakhstan between 2010 and 2020, as shown in Figure 2. From 800 million yuan to approximately 3 billion yuan, the overall volume of import and export trade has increased by 2.98 times. This represents a 2.98-fold growth in the overall trade market. It also experienced a period of rapid expansion in the years that followed 2013. Throughout this time frame, China continued its process of opening up, and in 2016, it formalized a docking partnership with Kazakhstan. Recent years have witnessed a rise in the fervor of demand for trade in both directions. The amount of trade that occurs in Xinjiang, a key entry point to Kazakhstan, as well as the volume of imported and exported goods, has increased.

The volume of agricultural goods traded between China and Kazakhstan has increased consistently over the past several years. In recent years, China's importance as a trading partner for agricultural products exchanged between China and Kazakhstan has increased significantly. Since 2010, when it accounted for only 10 percent of Kazakhstan's total agricultural product trade volume, the volume of agricultural products traded between China and Kazakhstan has been increasing. Since then, this proportion has increased to approximately 25% of Kazakhstan's total agricultural product trade volume. This demonstrates how dependent Kazakhstan Stan is on the Chinese market, which in turn demonstrates that China is much more dependent on Kazakhstan's market than vice versa, despite China's agricultural product trade volume with Kazakhstan being significantly smaller.

3. Method

In order to evaluate the growth potential of China-Kazakhstan international trade, this chapter introduces the fuzzy evaluation method. The evaluation factor set and comment set are

$$\begin{aligned} U &= \{u_1, u_2, \cdots, u_m\}, \\ V &= \{v_1, v_2, \cdots, v_n\}, \end{aligned} \tag{1}$$

where u_m is the evaluation index, and v_i is the i-th evaluation result.

The weight distribution vector of each indicator u_m is

$$W = (w_1, w_2, \cdots, w_m), \tag{2}$$

where w_m is the weight corresponding to u_m.

Using the graded fuzzy subset, quantify the evaluated object for each factor u_m, determine the degree of

membership and then calculate the following fuzzy relationship matrix:

$$\mathbf{R} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}. \tag{3}$$

The calculation formula between $\mathbf{R}$, W and V is

$$V = W \cdot R = (w_1, w_2, \cdots, w_m) \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix}. \tag{4}$$

In the vast majority of instances, membership degree is represented by a squishy vector. Compared to other types of evaluations, a fuzzy comprehensive evaluation can produce significantly more detailed and specific information. As a result, the evaluation criteria with the highest total scores are chosen for use in the final decision. It is difficult to obtain a satisfactory judgment matrix all at once due to the traditional AHP's imprecise evaluation of significant scales when determining the significance of indicators. This makes it more challenging to utilize. Due to this issue, a number of academics have developed a three-scale method that allows specialists to compare two factors without evaluating their relative significance. Consequently, it is significantly easier for specialists to compare relatively important factors. The accuracy and rationality of the evaluation are enhanced when a matrix is used to determine consistency. In this paper, we apply this methodology. The following is the expert scoring matrix:

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}, \quad r_i = \sum_{j=1}^{n} a_{ij}, \tag{5}$$

where α_{ij} is the importance scale value.

Next, we get the indirect matrix according to $\mathbf{A}$.

$$\mathbf{B} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{bmatrix}, \quad b_{ij} = \begin{cases} \dfrac{r_i - r_j}{r_{\max} - r_{\min}} \dfrac{r_{\max} - r_{\min}}{r_{\min}} + 1, & r_i > r_j, \\ \left| \dfrac{r_i - r_j}{r_{\max} - r_{\min}} \dfrac{r_{\max} - r_{\min}}{r_{\min}} + 1 \right|^{-1}, & r_i < r_j. \end{cases} \tag{6}$$

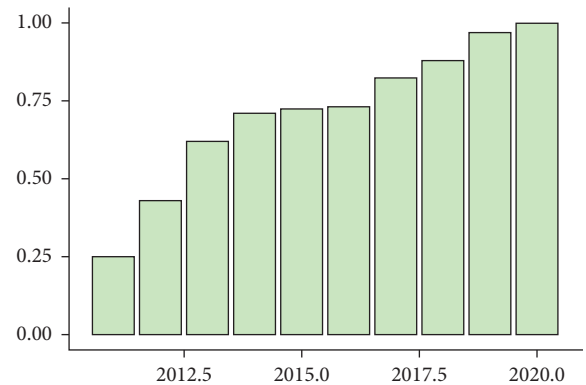

Figure 3: China-Kazakhstan bilateral trade level from 2010 to 2019.

Furthermore, according to the most transfer matrix calculation method in Reference [13], we obtain the quasioptimal transfer matrix of matrix B.

$$B' = \begin{bmatrix} b_{11}' & b_{12}' & \cdots & b_{1n}' \\ b_{21}' & b_{22}' & \cdots & b_{2n}' \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1}' & b_{n2}' & \cdots & b_{nn}' \end{bmatrix}, \quad l_p = (r - \hat{r})^2 + \lambda (y - \hat{y})^2, \tag{7}$$

Where a and b are parameters that control the weights, $\hat{y}$ is the true label, and $\hat{r}$ is the label of the rotation angle.

In terms of index selection, drawing on the gravity model and references 7, 12, 14, etc., this paper selects the trade volume of agricultural products (A), China-Kazakhstan nominal GDP (B), China-Kazakhstan spatial distance (C), China-Kazakhstan population size (D), and the same number of trade organizations (E).

4. Results

The trade gravity model can estimate the trade potential between the two parties, that is, the trade potential coefficient (Q) is obtained by comparing the actual value of the trade value with the simulated value. According to the usual classification of trade potential, $Q \geq 1.5$, $0.7 \leq Q \leq 1.5$, and $Q \leq 0.7$ belong to weak potential, medium potential, and huge potential, respectively.

To make it easier and more efficient for us to evaluate the level of bilateral trade that has occurred between China and Kazakhstan over the past decade, we will begin by calculating the level of bilateral trade between China and Kazakhstan from 2010 to 2019, as shown in Figure 3. The volume of trade between China and Kazakhstan will increase steadily from 2010 to 2020, as depicted in Figure 3. Among them is the fact that the level of bilateral trade entered a period of high cooperation in 2013 and subsequent years, which has continued to expand since then. The period from 2013 to 2016 was characterized by relatively slow development, whereas the period from 2017 to 2020 was characterized by relatively rapid development.

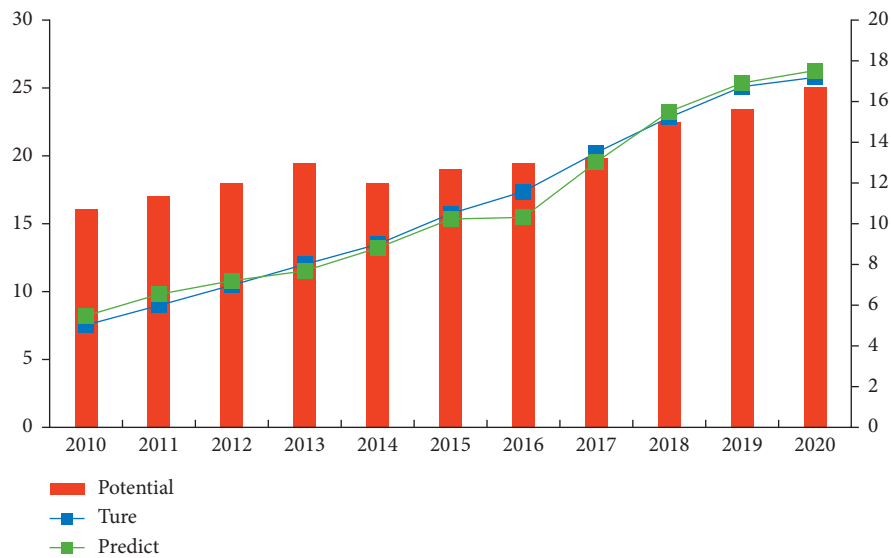

Figure 4: 2010–2020 potential calculation chart.

The fuzzy algorithm is employed to perform a simulation of the volume of bilaterally traded agricultural goods in order to determine the potential value depicted in Figure 4. The volume of trade between Xinjiang, China, and agricultural products from Kazakhstan is stable relative to their actual value, and the general trend is to increase gradually before increasing further. Between 2010 and 2013, the simulated value of the volume of bilateral trade increased gradually. The actual value of trade volume decreased slightly between 2013 and 2014, while the simulated value of bilateral agricultural trade increased slightly over the same period. It is possible that the problem lies in the model's variable selection. The condition of the global economy has a negligible impact on international trade patterns. Based on the simulated value of bilateral trade volume from 2014 to 2020, which indicates that there is ample room for growth in agricultural product trade between China's Xinjiang and Kazakhstan, there is ample room for growth in agricultural product trade between the two countries.

Using each of the three possible perspectives on the topic, this paper will assess the value of China and Kazakhstan's bilateral trade. Using each of the three possible perspectives, the purpose of this paper is to determine how much the trade between China and Kazakhstan is worth to both countries. Figure 5 illustrates the year-by-year evaluation value and the ranking for each year. Figure 5 depicts that the volume of trade between China and Kazakhstan is increasing at a rate comparable to the overall trend in bilateral trade. As trade between China and Kazakhstan continues to expand, it becomes more efficient. The nature and volume of trade between two nations have negative effects on economic growth. Overall, trade between China and Kazakhstan is growing, and it is reasonable to expect that bilateral trade and relations will continue to improve in the future. As the commercial relationship between China and Kazakhstan continues to develop, it is crucial that we place an emphasis on expanding the volume and value of trade, maximizing the benefits of trade, and streamlining trade structures.

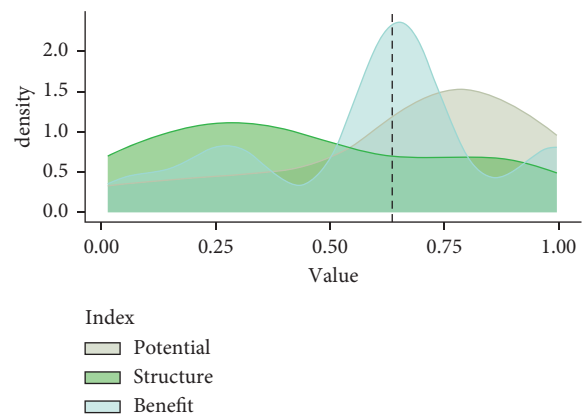

Figure 5: Comparison of China-Kazakhstan trade levels in 2020–2020 under different indicators.

5. Conclusion

Xinjiang is a crucial region for the development of the western region and the Belt and Road Initiative. It exports its agricultural resources to numerous foreign countries. This paper examines the foreign trade issues in Xinjiang within the context of China's new development pattern. This paper analyzes the current state of Sino-Kazakhstani trade, specifically the current state of agricultural product trade. Using the gravity model and fuzzy algorithm, the growth potential of Xinjiang's agricultural international trade is also analyzed. Finally, countermeasures are proposed for the mode of development of international trade in Xinjiang. In the future, we will not only be limited to Xinjiang trade, but will instead predict the trend of trade between China and other

countries in the world, and we will study the application of deep learning in cross-border trade.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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