Agricultural trade pattern and potential in China and Russia

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Abstract. It makes use of the trade complementarity index, trade integration index and export concentration index to conduct an in-depth analysis of trade development process and the import and export structure of agricultural products between China with Russia from 2006 to 2017. The results show that degree of integration of China's agricultural trade with Russia continues to increase, and its trade structure is highly complementary. At the same time, the types of agricultural trade between them have increased significantly. The trade pattern of agricultural products is dominated by medium- and low-end primary agricultural products in China and Russia. The share of deep-processed agricultural products is relatively small, and the trade structure of agricultural products is monotonous, the bilateral trade potential has not yet been fully realized between China with Russia. Under the background of the “One Belt and One Road” initiative and the construction of China-Mongolia-Russia Economic Corridor, the trade potential between China and Russia will increase rapidly and the trade space will further expand.

1. Introduction
Many scholars have conducted some research on the strategies of the China-Mongolia-Russia Economic Corridor, mainly in three areas:

• Research on trade patterns and potential. Scholars mainly use trade integration index [1], trade specialization index [2], RCA index [3] and trade complementarity index [4] for statistics and calculations. It was found that China's fruit and vegetable products and vegetables have relatively comparative advantages. Russia and Mongolia have comparatively weak comparative advantages in fruit and vegetable products. Live animals, animal and vegetable oils and other products are weak in complementarity. At the same time, the two sides still lack the in-depth industrial cooperation, trade structure is relatively single, it is necessary to expand and deepen practical cooperation.

• Research on the factors affecting trade [5]. Some scholars have found that economic aggregates, border trade, and distance have a significant impact on China-Russia export trade [6].

• Geo-strategic significance and political structure. Domestic scholars from the strategic characteristics of the China-Mongolia-Russia Economic Corridor, the relevant theoretical basis of regional economic integration [7], the role and importance of China-Russian, China-Mongolian cooperation, the bilateral trade development process of China, Russia, and Mongolia, and the potential in regional economic and trade cooperation Study [8].
The results of the study helped promote the implementation of the “Belt and Road Initiative” and promoted the great potential for trade development between China, Russia, and Mongolia. Overall, the above studies have analyzed the economic and trade cooperation between China, Russia, and Mongolia from different perspectives [9]. However, most of the research focuses on China-Russian, China-Mongolian cooperative research [10], and detailed analysis of agricultural cooperation is relatively fragmentary. There are many researches on the development potential of agricultural products market [11], but most of the studies have no data analysis. At present, China, Mongolia, and Russia are considered as regions, and there is relatively little research on the analysis of China’s market demand and Russian-Mongolian exports.

Therefore, this study will use time-series data for the import and export of product types between regions. The trade integration index, trade complementarity index, and export concentration index were used to analyze the trade development process and evolution trends between China and Russia. Based on the spatial pattern and types of agricultural products, the international spatial pattern of trade between China and Russia, and the spatial pattern of import and export of key products are further analyzed, revealing the trade pattern between China and Russia. Finally, using the regression analysis method to predict the trade development trends of China, Russia in the next 30 years, so as to provide reference for the formulation of relevant Chinese plans and strategies.

2. Models and Methods

2.1. Data Sources and Processing
The data includes the import and export total volume of agricultural products, and the import and export volume of agricultural products by category in China and Russia in 2006-2017 and the import and export data of sub-categories for Russia in various provinces and regions in China in 2017. The total import and export volume of agricultural products from China and Russia is from UNCOMTRADE DATABASE, FAO data, and China Customs Statistical Yearbook for calculating trade complementarity index and export concentration index in 2006-2017. The import and export data of agricultural products of various provinces, regions and cities came from the China Customs Information Network and the General Administration of Customs of China in China and Russia in 2006-2017, which are used to analyze the status quo of trade patterns between China and Russia.

The agricultural products in this study mainly refer to primary products and processed products from planting, animal husbandry, and fishery. That is, plants, animals and their products obtained in agricultural activities include fruits and vegetables, flower seedlings, food crops, and aquatic products. The classification method adopted in the 1992 “Coordination of Trade Names and Coding System” (HSI 1992) includes agricultural products in Chapters 1-24, 41, 43, 44, 50, 51, 52 (table 1).

2.2. Methods

2.2.1. TII of China's Agricultural Trade with Russia. Trade intensity index (TII) indicates the degree of trade dependence between two countries, the proportion of a country’s exports to a trading partner country to its total export volume and the total exports of that trading partner country to world total imports. The greater the value, the closer the trade links between the two countries and the stronger the dependence. The specific formula is:

\[ TII_{ij} = \frac{E_{ij}}{E_i} / \frac{I_j}{W} \]

In the formula, \( E_{ij} \) represents the export value of i to country j, \( E_i \) indicates the total export of i to the world, \( I_j \) indicates the total import of country j, and \( W \) indicates the total import of the world. The greater the TII, the closer the trade links between the two countries; the smaller the TII, the looser the trade links between the two countries.

2.2.2. TCI of China's Agricultural Trade with Russia. The trade complementarity index (TCI) measures the degree of complementarity of the trade structure between the two trading countries and
analyzes the export expansion potential of the two countries. This paper is widely used internationally to formulate a calculation method for international trade policies, as follows:

\[ TCI = 1 - \sum \left\{ \left( \frac{M_{ik}}{M_i} \right) - \left( \frac{X_{jk}}{X_j} \right) \right\} / 2 \]  

(1)

\[ C_{ij}^k = RCA_{xi}^k - RCA_{mj}^k \]  

(2)

\[ RCA_{xi}^k = \frac{M_{ik}^k}{M_i} / \frac{X_{Wj}^k}{X_W} \]  

(3)

\[ RCA_{mj}^k = \frac{X_{ik}^k}{X_i} / \frac{X_{Wj}^k}{X_W} \]  

(4)

In this formula, \( M_{ik}^k \) denotes the import value of agricultural products k in i countries, \( M_i \) denotes the import volume of agricultural products in i countries, \( M_{Xj}^k \) denotes the export value of agricultural products k in country j, and \( X_j \) denotes the export value of agricultural products in country j. This formula is used to indicate that the agricultural products exported in country j are exported to the world. Another country i imports k agricultural products from the world.

Table 1. Agricultural products in "Coordination of Trade Names and Coding System" (HSI 1992).

| HS01 | Live animals                   |
| HS02 | Meat and edible meat offal    |
| HS03 | Fish, crustaceans, mollusks, aquatic invertebrates   |
| HS04 | Dairy products, eggs, honey, edible animal product nes |
| HS05 | Products of animal origin, nes   |
| HS06 | Live trees, plants, bulbs, roots, cut flowers etc. |
| HS07 | Edible vegetables and certain roots and tubers |
| HS08 | Edible fruit, nuts, peel of citrus fruit, melons |
| HS09 | Coffee, tea, mate and spices   |
| HS10 | cereals                        |
| HS11 | Milling products, malt, starches, inulin, wheat glue |
| HS12 | Oil seed, oleagric fruits, grain, seed, fruit, etc, ne |
| HS13 | Lac, gums, resins, vegetable saps and extracts nes |
| HS14 | Vegetable plaiting materials, vegetable products nes |
| HS15 | Animal, vegetable fats and oils, cleavage products, et |
| HS16 | Meat, fish and seafood food preparations nes |
| HS17 | Sugars and sugar confectionery |
| HS18 | Cocoa and cocoa preparations  |
| HS19 | Cereal, flour, starch, milk preparations and products |
| HS20 | Vegetable, fruit, nut, etc food preparations |
| HS21 | Miscellaneous edible preparations |
| HS22 | Beverages, spirits and vinegar |
| HS23 | Residues, wastes of food industry, animal fodder |
| HS24 | Tobacco and manufactured tobacco substitutes |
| HS41 | Raw hides and skins (other than furskins) and leather |
| HS43 | Furskins and artificial fur, manufactures thereof |
| HS44 | Wood and articles of wood, wood charcoal |
| HS51 | Wool, animal hair, horsehair yarn and fabric thereof |
| HS52 | Cotton                        |

2.2.3 ECI of China's Agricultural Trade with Russia. The Export Concentration Index (ECI) measures the concentration of a country's export product categories. Calculated as follows:
ECI = \sqrt{\sum (X_i^k | X_i)^2}

In the formula: \(X_i^k\) is the export amount of \(k\) product in \(i\) country; \(X_i\) is the total export value of \(i\) country. ECI usually takes value between \(\frac{1}{\sqrt{n}}\) and 1. The smaller the ECI, the more scattered the structure of the agricultural export products of country \(i\); the bigger the ECI, the more concentrated the export agricultural product structure of country.

2.3. Models
Based on agricultural trade data during 2006-2017, regression analysis was used to curve the growth of China's agricultural trade, and forecasted the trade volume of agricultural products in 2025, 2035, and 2050. By comparing several common fitting functions, a function with a good fitting effect (R2 maximum) is selected as a prediction model, table 2.

| Export—Import         | Forecast model              | R²     | F     | Forecast Value (Billion US) |
|-----------------------|-----------------------------|--------|-------|-----------------------------|
|                       |                             |        |       | In 2025 | In 2035 | In 2050 |
| China-Russia          | \(Y=0.1634t^2+3.078t+5.6729\) | 0.8309 | 125.0* | 40.75   | 114.02  | 285.1   |
| Russia-China          | \(Y=0.0554t^2-0.1175t+13.438\) | 0.7674 | 71.9** | 16.04   | 29.27   | 69.89   |

3. Results and Discussion

3.1. The China's agricultural trade with Russia.
China is the world’s most important agricultural trade country. It has close bilateral trade with Russia in the agricultural sector. The total trade volume of agricultural products between China and Russia increased rapidly. The growth of import trade was significantly higher than that of export trade (figure 1). The proportion of agricultural products imported by China from Russia has increased slightly in China's agricultural trade, indicating that China has a greater demand for agricultural products in Russia. It can be seen that the trade cooperation between China and Russia has increased significantly, and its share in China's agricultural trade has also increased.

![Figure 1. Agricultural product trade volume of China with Russia during 2006-2017.](image-url)
3.2. Agricultural products trade structure for China and Russia

There are major differences in China's export agricultural products trade with the Russia. China exports more labor-intensive primary agricultural products, and imports are mainly land-intensive. Russia are important trading partners of China. With the "One Belt and One Road” initiative, China and Russia will have a huge potential for the release of their agricultural product trade potential.

From the perspective of the exports of the China-Russia, the structure of China's export products is relatively concentrated, with labor-intensive agricultural products as the main factor, accounting for 42.37%; China's exports to Russia are relatively concentrated, and export categories have not changed much. It mainly exports grain (grain), fruits and horticultural products represented by vegetables and flowers (figure 2).

China's imports of agricultural products from the Russia are more concentrated, with land-intensive agricultural products accounting for 49.10% of the total. China's imports of agricultural products from Russia are still concentrated, and they mainly import resource-intensive products such as aquatic products, oilseeds, and nuts. After 2010, they added bulk agricultural products such as feed products, oil crops, soybeans, and corn. At present, Russia is the largest importer of aquatic products in China, and its imports account for about 30% of China's total imports of aquatic products. In the future, China will have a stable demand for Russian dairy products.

![Figure 2. Structure of trade agricultural products for China and Russia.](image)

3.3. International spatial pattern of agricultural trade for China and Russia

In 2017, the import market for Chinese agricultural products was dominated by Japan, Hong Kong, and the United States. Exports were mainly dominated by the United States, Brazil, and Australia, accounting for 37.61% of China's total exports of agricultural products and accounting for 45.34% of total imports. The relatively concentrated agricultural product trade market has increased the risk of China's agricultural product trade market, and has adversely affected China's effective use of international agricultural resources. The top three countries in Russian agricultural product exports are Turkey, South Korea and China, which account for a large amount of agricultural products for export; Brazil, Germany and Lithuania have the top three countries in import (figure 3). From the perspective of the international spatial pattern of Russian agricultural products imports, China's agricultural exports to Russia are facing fierce competition from other exporting countries. China's agricultural production costs have increased with the increase in labor costs and land rents, which shows that China's export of labor-intensive agricultural products to Russia needs to be adjusted, the types of exports should be diversified, and they will face more fierce competition at the same time.
3.4. Agricultural trade Provincial Spatial Pattern for China-Russia economic corridor

There are significant spatial differences in the pattern of import and export trade between China's provinces and Russia. Judging from the inter-provincial spatial distribution, China's Inner Mongolia, Xinjiang, Shanxi, Heilongjiang, Jilin, Shandong, Jiangxi, Chongqing, Gansu, Shaanxi, Henan, Ningxia provinces and regions and Russia's Far East region to carry out agricultural trade (figure 4), with border trade as the mainstay. China and Russia import and export trade is mainly concentrated in Heilongjiang and eastern coastal provinces. There are major differences in the participants and spatial patterns of China-Russia import and export trade. In 2017, China's total imports from Russia accounted for 35.1% of Heilongjiang's total, accounting for one-third of its total trade volume; of Russia's export trade, Heilongjiang's share was only 9.1%, while Zhejiang, Jiangsu, and Guangdong accounted for approximately 50% of the total. It can be seen that in China's import trade of Russian agricultural products, border trade plays an important role; in the export trade of Russian agricultural products, the eastern coastal areas with a relatively large economic aggregate play an important role.

![Figure 3](image)

**Figure 3.** Top ten national of agricultural products trade in China and Russia.

The above results confirm to some extent the existing research results that the economic aggregate and border trade have a significant impact on the trade volume between China and Russia. China–Russian trade accounts for a large share, Russia's total economic volume and total trade volume are relatively large, and the economic impact has a relatively wide geographical range.

3.5. Agricultural trade potential for China and Russia

The trade volume will show an upward trend in the next 30 years between China and Russia (table 2). In 2025, China’s trade volume with Russia’s agricultural products will reach $56.79 billion; in 2035, it is expected to reach $143.29 billion. The strength of agricultural economic and trade ties between
China and Russia will continue to deepen. The trade space will further expand between China and Russia with the advancement of the “Silk Road Economic Belt” and the “Chinese-Mongolia-Russia Economic Corridor”.

![Figure 4. Provincial distribution of China’s trade with Russia in 2017.](image)

In the specific agricultural product structure, the types of agricultural products imported by China from Russia will increase in the future, and vegetables and fruits will continue to be used. The structure of China’s export agricultural products will show a trend of advanced. Seeing from the inter-provincial spatial distribution, China’s Inner Mongolia, Xinjiang, Shanxi, Heilongjiang, Jilin, Shandong, Jiangxi, Chongqing, Gansu, Shaanxi, Henan, Ningxia and other provinces and regions have more trade with Russia.

4. Conclusion
Chinese trade links are getting closer with Russia. Russian agricultural products have become more and more important in China’s agricultural products.

China’s agricultural exports to Russia are facing fierce competition from other exporting countries. China’s export of labor-intensive agricultural products to Russia needs to be adjusted, the types of exports should be diversified. China’s Inner Mongolia, Xinjiang, Shanxi, Heilongjiang, Jilin, Shandong, Jiangxi, Chongqing, Gansu, Henan, Ningxia and other provinces and regions have more trade with Russia.

The types of agricultural products imported will increase by China from Russia in the future, and vegetables and fruits will continue to be used. The structure of China’s export agricultural products will show a trend of advanced.

Three countries have different resources and endowments with different advantages. Agricultural products have strong mutual complementarity, high degree of integration, and great potential for trade cooperation. With the comprehensive advancement of the “Silk Road Economic Belt”, three countries trade cooperation will continue to expand, and the space and potential will remain enormous for future.
Optimize trade structure and innovate industrial cooperation. Agricultural industrial parks will be actively build along the economic corridors, promote industrial clusters and platforms through investments, and promote three countries agricultural trade. It will optimize structure of agricultural products and expand the types of agricultural trade.

With the “One Belt and One Road” initiative and the advancement of the China-Mongolia-Russia Economic Corridor, China and Russia will have a huge potential for the release of their agricultural product trade potential. Tap the potential of China’s import trade cooperation and promote the balanced development of bilateral trade cooperation.

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