

## Article

# The State of Grain Trade between China and Russia: Analysis of Growth Effect and Its Influencing Factors

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**Abstract:** As two influential countries in the global grain production and marketing system, China and Russia have increasingly strengthened their agricultural, economic, and trade cooperation. There are few papers that have considered trade relations from the perspective of the growth effect of grain exports, and it is necessary to fill this gap by systematically sorting the grain trade between the two countries and clarifying the growth effect and influencing factors in this paper. By comparing and analyzing the quantitative and structural characteristics of grain trade between China and Russia between 1996 and 2020, this study used the H–K marginal analysis method to explore the growth path and influencing factors of the export trade of grain products between China and Russia. The results show that the main driving force of the export growth of Russian and Chinese grain products is the price margin, which presents a growth pattern dominated by price and complemented by type and quantity. The empirical analysis of the gravity model shows that the size of the agricultural economy, grain productivity, trade cost, and economic shocks have significant impacts on bilateral trade. In view of this, the status of international agricultural cooperation between China and Russia will be further optimized if they can optimize trade policies to improve the quality of trade development, build cross-border cooperation parks to construct the layout of the whole industrial chain, strengthen infrastructure construction, and deepen and expand interconnectivity.



**Citation:** Fu, J.; Tong, G. The State of Grain Trade between China and Russia: Analysis of Growth Effect and Its Influencing Factors. *Agriculture* **2023**, *13*, 1407. <https://doi.org/10.3390/agriculture13071407>

Academic Editors: Ioan Sebastian Brumă and Steliana Rodino

Received: 17 May 2023  
Revised: 6 July 2023  
Accepted: 9 July 2023  
Published: 15 July 2023  
Corrected: 6 March 2024



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**Keywords:** China and Russia; grain trade; ternary margins; growth effects

## 1. Introduction

### 1.1. Research Background

Against the backdrop of the acceleration of unprecedented changes in the current century, the coexistence of strategic opportunities, risks, and challenges, and an increase in uncertain and unpredictable factors, Putin visited China in early 2022. The two countries signed a series of agricultural cooperation agreements, including “Supplementary Provisions to the Protocol on Phytosanitary Requirements for Russian Wheat Exported to China” and “Supplementary Provisions to the Protocol on Phytosanitary Requirements for Russian Barley Exported to China”, and other Russian bulk grain products, such as wheat and barley, have been allowed for exportation to China since then. In the global grain production and marketing system, Russia is a major producer and China is a major producer, consumer, and importer. The signing of the cooperation agreements between the two countries will have a profound impact on the global grain supply and demand relationship. Systematically sorting and judging the state of grain trade between the two countries, and clarifying the growth effects and influencing factors are of self-evident significance to the stability of the global grain industrial and supply chain and the optimization of the production and marketing system.

## 1.2. Related Research

### 1.2.1. Research on Agricultural Product Trade between China and Russia

The agricultural trade between China and Russia has always been a popular topic of study. The trade in agricultural products between China and Russia has a long history and has developed rapidly in recent years, mainly due to the strong complementarity and interoperability between China and Russia's agriculture in many aspects, such as factor endowment and agricultural production types. Through reviewing the literature, it was found that the existing research mainly focuses on specific aspects. First, in terms of research objects, the current research on Sino-Russian agricultural product trade mainly includes research on overall agricultural product trade (Tang, Bi, 2012) [1], agricultural trade under a certain category (Xu et al., 2021) [2], and trade of individual agricultural products (Zhu, Xinglong et al., 2020) [3]. Second, in terms of research content, the current research mainly focuses on the characteristics of Sino-Russian agricultural product trade. Tong Guangji et al. (2017) [4] believed that Sino-Russian agricultural product trade is dominated by inter-industry trade, supplemented by intra-industry trade. Zhang Guohua (2010) [5] used relative trade advantage indicators and concentration rate indicators for analysis and concluded that the products in agricultural trade between China and Russia are highly concentrated and highly complementary. Wang Rui et al. (2017) [6] used the stochastic frontier gravity model for analysis and concluded that the absolute value of the trade potential of agricultural products between China and Russia is large. Lastly, from the perspective of studying the problems of agricultural product trade between China and Russia, Yang Fengmin et al. (2015) [7] concluded that China-Russia agricultural product trade is mainly based on primary products, with low added value and lack of core competitiveness. Fang Lijun (2018) [8] argued that the trade structure of agricultural products between China and Russia is too concentrated and the competition is relatively fierce. Sun Hongyu et al. (2019) [9] used the VAR model for empirical analysis and concluded that green trade barriers have a significant inhibitory effect on the size of Sino-Russian agricultural product trade. Currently, scholars conducting research on agricultural product trade between China and Russia are focusing on a more macroscopic scale. In view of this, this article focuses on grain product trade between China and Russia, which not only enriches relevant research in this field, but also makes the research object more specific. Regarding the global grain trade pattern, Wang Jieyong (2021) [10] pointed out that the current global trade network is becoming increasingly complex. The network size is increasing, and connectivity and tightness are increasing. The trade network nodes are characterized by an unbalanced structure. Duan (2022) [11] believed that the trade system is crucial to global food security. Constructing a global food network using trade data revealed that the global food network has a distinct core-periphery structure. Constantin (2023) [12] analyzed the grain industry chain of some EU countries by constructing a sustainable competitiveness index and found that improving sustainable agricultural competitiveness requires adjusting trade patterns and policies according to each country's resource endowments. Ma (2022) [13] analyzed the evolution of international grain trade patterns using a complex network and entropy method, and found that the status of Asia, especially China, in the grain trade network is gradually improving, and that the international grain trade network shows a trend of multiple changes. Regarding Russia's grain trade, Russia has been transformed from a grain importer to an exporter and is one of the top five grain producers in the world with great grain export potential. Bu (2022) [14] believed that Russia has enormous potential for grain production, with a grain production potential of approximately 425 million tons. Maslova (2019) [15] pointed out that, in the Eurasian Economic Union, Russia's grain production is highly competitive within the Union region and even in the global market. The improvement in competitiveness between 2014 and 2016 was mainly due to the decrease in domestic production costs and the increase in output. Regarding China's grain trade, China's food security issue has always been a focus of studies, with its food consumption and imports ranking among the highest levels globally, making it the largest food consumer country in the world. Du (2022) [16] found that grain trade in the

Belt and Road region shows a mismatch between the direction of grain trade flows and actual demand. Ukraine and Russia are the largest grain exporters in the Belt and Road region, and China should seize the opportunity to strengthen cooperation. Duan (2021) [17] pointed out that there are differences in the dependence on different trading partners in China's current grain trade, that the grain trade shows vulnerability and high spatial and temporal heterogeneity among countries, and that the vulnerability areas are in North America and Northeast Asia with a likelihood of expanding.

#### 1.2.2. Revision: Relevant Research on Growth Effects and Their Influencing Factors

Trade growth can bring about various effects, such as economic growth, environmental effects, and social effects (Peters, 2006; Ferreira, 2010) [18,19]. The view that open trade can promote economic growth has been verified and supported by many scholars (Dollar, 1992; Sachs, 1995; Edwards, 1998) [20–22]. However, some people have raised doubts about the growth effect of open trade, mainly on the measurement of open trade (Harison, 1999; Rodriguez, 2000) [23,24]. Konstantakopoulou (2016) [25] studied the relationship between exports and economic growth of southern eurozone countries during 1960–2014 using the border test method, and found that export-oriented policies can promote long-term economic growth of countries. Wang (2020) [26] studied nearly 25 years of data from 182 countries and found that trade growth also has an impact on the environment. As for the source of trade growth, classical trade theory has always believed that comparative advantage, i.e., the growth of existing products, is the source of trade growth. The new trade theory's assumption of economies of scale and product diversity preference makes extensive margin a new channel to explain trade growth [27]. First, regarding the study of the growth effect of agricultural exports, since Bing-Zhan Shih (2010) [28] pioneered the introduction of the quantity margin and price margin, the ternary marginal analysis method has been increasingly widely applied. Zhang et al. (2016) [29] argued that China's vegetable exports to ASEAN in recent years have followed a unique pattern of predominantly quantitative growth, supplemented by price growth and little change in export varieties. Zheng et al. (2018) [30] held that, in recent years, the main driving force for the growth of China's agricultural exports to Russia has been the quantity margin, while different growth stages of Russia's agricultural exports to China have different driving forces. Liu et al. (2019) [31] argued that the growth of China's agricultural trade with Vietnam is mainly due to the price margin, and that the quality of agricultural exports has not been improved. Second, current research on the influencing factors of the ternary margins has mainly been carried out by applying the expansion of the enterprise heterogeneous trade model and the gravity model to conduct empirical analysis. Amurgo-Pacheco and Piero (2008) [32] believed that the relative economic size of import sources has a significant positive impact on the extensive margin. Yang et al. (2016) [33] argued that the impact of the financial crisis on export growth mainly affects the price margin. Sun et al. (2018) [34] believed that the productivity of agricultural products of importing countries in bilateral trade has a significant positive impact on the intensive margin and extensive margin.

The food security crisis is becoming increasingly severe, and it has become the focus of the current global agricultural product market. China and Russia are both major global food producers and consumers, and bilateral cooperation to ensure food security is of great significance to the food market security of the two countries and the world at large. On the basis of the existing literature, the relevant studies on Sino-Russian agricultural trade focused on characteristic analysis, and there have been few detailed explorations of Sino-Russian grain trade. The marginal contributions of this study are discussed. Firstly, the research is more specific. Considering 24 types of food products under HS6 classification, this paper analyzes the scale, structure, and structural changes of grain product trade, and explores the evolution mode of bilateral grain product trade. Secondly, our research is rigorous, and our methods are scientific. To begin, the ternary marginal model is used to explore the reasons behind the trade growth, and explore the role played by the types,

quantities, and prices of grain trade. Subsequently, the gravity model is used to explore the influencing factors of marginal changes, and the breadth and depth of the study are relatively rare, which addresses the research gap more effectively.

## 2. Research Methods and Data Description

### 2.1. Research Methods

#### 2.1.1. H–K Measure Method

The H–K measure method proposed by Hummels and Klenow (2005) [35] was adopted to analyze the effect of the growth of bilateral grain product export trade between China and Russia. Hummels and Klenow divide a country's export growth into two parts: intensive margin and extensive margin. The definition of intensive margin is more uniform among domestic and foreign scholars, which refers to the expansion of product exports in terms of quantity. However, domestic and foreign scholars have different opinions on the definition of extensive margin. According to the research needs, the expansion margin was selected as the expansion of product export.

$$IM_{ej} = \frac{\sum_{i \in K_{ej}} P_{eji} X_{eji}}{\sum_{i \in K_{ej}} P_{wji} X_{wji}}, \quad (1)$$

$$EM_{ej} = \frac{\sum_{i \in K_{ej}} P_{wji} X_{wji}}{\sum_{i \in L} P_{wji} X_{wji}}, \quad (2)$$

where  $e$  represents the exporting country,  $j$  represents the importing country,  $i$  represents the grain products exported by the exporting country,  $L$  represents all grain products exported by the exporting country to the world, and  $K_{ej}$  represents all products exported by the exporting country to the importing country.  $P_{eji} X_{eji}$  represents the export value of products  $i$  exported by country  $e$  to country  $j$ , and  $P_{wji} X_{wji}$  represents the export value of products  $i$  exported by the world to country  $j$ .

$IM_{ej}$  represents the intensive marginal value of country  $e$ 's exports to country  $j$ . The larger the intensive marginal value is, the more of the same food product country  $e$  exports.  $EM_{ej}$  represents the extensive marginal value of country  $e$ 's exports to country  $j$ . The larger the extensive marginal value is, the more types of food products country  $e$  exports to country  $j$ .

By further decomposition, the intensive margin can be decomposed into the price margin and quantity margin. The formula is as follows:

$$IM_{ej} = P_{ej} \times X_{ej}. \quad (3)$$

In Equation (3),  $P_{ej}$  is the price margin, and  $X_{ej}$  is the quantity margin. The price margin and quantity margin formulas are as follows:

$$P_{ej} = \prod_{i \in K_{ej}} \left( \frac{p_{eji}}{p_{wji}} \right)^{w_{eji}}. \quad (4)$$

$$X_{ej} = \prod_{i \in K_{ej}} \left( \frac{x_{eji}}{x_{wji}} \right)^{w_{eji}}. \quad (5)$$

The weight  $w_{eji}$  is expressed as

$$w_{eji} = \frac{\frac{s_{eji} - s_{wji}}{\ln s_{eji} - \ln s_{wji}}}{\sum_{i \in K_{ej}} \frac{s_{eji} - s_{wji}}{\ln s_{eji} - \ln s_{wji}}}, \quad (6)$$

$S_{eji}$  and  $S_{wji}$  respectively represent the share of the trade volume of the  $i$  grain product exported by the exporting country and the world to the importing country under the aggregate of all grain types exported by the exporting country to the importing country.

To sum up, the formula demonstrating that country  $e$ 's exports to country  $j$  account for the share of world exports to country  $j$  is as follows:

$$R_{ej} = IM_{ej} \times EM_{ej} = (P_{ej} \times X_{ej}) \times EM_{ej}. \quad (7)$$

We set the growth rate of  $R_{ej}$ ,  $EM_{ej}$ ,  $X_{ej}$ , and  $P_{ej}$  as  $GRej$ ,  $GRem$ ,  $GRx$ , and  $GRp$ , respectively.

$$GRej = GRem \times GRx \times GRp, \quad (8)$$

$GRej$  is the average annual growth rate of export share,  $GRem$  is the average annual growth rate of extensive margin,  $GRx$  is the average annual growth rate of quantity margin, and  $GRp$  is the average annual growth rate of price margin. The proportion of the growth rate of each indicator in the total export growth rate is the contribution rate of each indicator to the export growth.

### 2.1.2. Model Building

According to the Chaney (2008) [36] influencing factor model, the size of the agricultural economy, grain productivity, fixed trade costs, and economic shocks were selected as explanatory variables. Extensive margin, price margin, and quantity margin were taken as explained variables to construct the panel model, which is as follows:

$$Export = \beta_0 + \beta_1 AGDPR + \beta_2 PR + \beta_3 COST + \beta_4 WD + C. \quad (9)$$

The variables and data in Equation (9) were selected as described below.

#### Ternary Margins (Export)

The explained variable Export represents the ternary margins (extensive margin, price margin, and quantity margin) of bilateral grain exports between China and Russia. The ternary marginal values of bilateral grain exports between China and Russia between 1996 and 2020 calculated in the previous text are used here.

#### The Size of the Agricultural Economy (AGDPR)

The ratio of the agricultural added value of the importing country to the agricultural added value of the exporting country was used for calculation here. The data were sourced from the World Bank and were calculated at constant USD values in 2010.

#### Food Productivity (PR)

In general, the higher a country's grain productivity is, the greater its grain export capacity is. Thus, the ratio of agricultural per capita added value of food product-importing countries to agricultural per capita added value of exporting countries was used to measure this variable. The data were sourced from the World Bank and calculated on the basis of the constant value of USD in 2010.

#### Trade Cost (COST)

Drawing on the calculation of fixed trade costs by Qian (2010) [37], the formula for calculating bilateral trade costs is as follows:

$$\pi_{ej} = 1 - \left[ \frac{EXP_{ej} EXP_{je}}{s^2 (GDP_e - EXP_e) (GDP_j - EXP_j)} \right]^{\frac{1}{2p-1}}, \quad (10)$$

$GDP_e$  represents the total output of the exporting country, and the data were sourced from the World Bank.  $EXP_e$  and  $EXP_j$  represent the total amount of exports from the



exporting country and the total amount of exports from the importing country, respectively.  $EXP_{je}$  represents the total amount of exports from the exporting country to the importing country, and  $EXPe_j$  represents the total amount of exports from the importing country to the exporting country. The data were sourced from the United Nations Trade Database and calculated in constant 2010 USD.  $\rho$  is the elasticity of substitution, and  $S$  is the share of a country's or region's total output available for trade, set as  $\rho = 8$ ,  $S = 0.8$ .

#### Economic Shocks (WD)

International economic shocks have a great impact on trade. When the economic situation is stable, the size of international trade is relatively stable. Otherwise, the economic situation will have a negative impact on international trade. The international financial crisis in 2008 and 2009 and the economic sanctions imposed by Western countries on Russia in 2014 had a great impact on the bilateral trade between China and Russia. Therefore, the value of 2008, 2009, and 2014 was taken as 1, and the value of other years was 0.

#### 2.2. Data Description

On the basis of the statistical description of grain by the National Bureau of Statistics of China and the definition of grain products by Sun Zhilu et al. (2018) [38], the trade data of 24 grain products from 1996 to 2020 under the HS92 classification standard in the UN Comtrade database were selected. The selection of the sample interval was mainly based on the prediction that the cooperation between the two countries will continue, and that the impact of the COVID-19 pandemic in 2020 has not yet fully manifested.

### 3. Current Situation of Bilateral Grain Product Export Trade between China and Russia

#### 3.1. Export Trade Size of Bilateral Grain Products between China and Russia

From Table 1, it can be seen that Russia's total grain exports to China increased from USD 16.9911 million to USD 28.407 million during 1996–2020, an increase of 124.74%. China's total grain exports to Russia increased from USD 6,000,600 in 1996 to USD 23,149,900 in 2019, an increase of 285%. Meanwhile, the total export volume of grain products between China and Russia increased from USD 22,991,700 to USD 289,075,600 during the sample period, with an average annual growth rate of 11.12%. Russia's total trade in grain products exported to China accounted for about 90% of the total bilateral trade between the two countries. The first reason is that Russia has obvious advantages in agricultural natural resource endowment. Russia has an agricultural land area of 216 million hectares, including the world's largest black soil belt. The second is that, since the early 1990s, Russia has carried out large-scale agricultural reforms, adjusted the development path of agriculture, increased government support for agriculture, and expanded the area of grain cultivation, resulting in the rapid development of Russian agriculture. Third, in recent years, China–Russia relations have become increasingly close, having recently been upgraded to a new era of comprehensive strategic cooperative partnership, and the level of cooperation and exchange between the countries has continued to rise. Segmented by different trade phases, from 1999 to 2011, China has always been a surplus country in the bilateral grain export trade between China and Russia. The traditional pattern was broken in 2012, when Russia's total grain exports to China exceeded USD 20 million for the first time, mainly due to Russia's bumper grain production that year. From 2013 to 2018, Russia's grain exports to China fluctuated upward. Since 2015, Russia has become a surplus country in the bilateral grain export trade between China and Russia, and the surplus has shown an increasing trend year by year. This is mainly due to the “window period” of Russian agricultural exports to China in the context of the Ukrainian crisis and Western sanctions against Russia.

#### 3.2. Structure of Bilateral Grain Product Export Trade between China and Russia

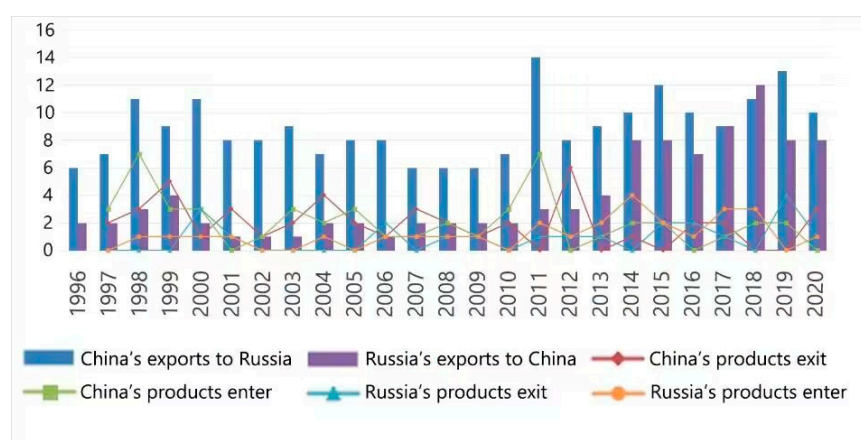
Between 1996 and 2016, the total number of types of grain products exported from China to Russia consistently far exceeded the total number of types of grain products exported from Russia to China (see Figure 1). However, since 2017, the gap between

the total exports of grain products from both sides has gradually narrowed. In 1996, the difference in the total number of types of grain products traded between Russia and China was 4, and, in 2011, the difference in the total number of types was 11. For 25 years, bilateral trade in grain products between Russia and China saw a certain number of old products exit and new products enter every year. However, in recent years, the number of new types of food products exported from Russia to China has steadily increased, in line with China's exports to Russia, trending toward excess.

**Table 1.** Trends in bilateral grain product export trade between Russia and China, 1996–2020 (unit: USD 10,000).

Year	China–Russia Value of Exports	Russia–China Value of Exports	Total Grain Trade between China and Russia	Grain Trade Balance between China and Russia	Surplus Country
1996	600.06	1699.11	2299.17	1099.05	Russia
1997	1561.63	1794.93	3356.56	233.30	Russia
1998	775.35	1422.20	2197.55	646.86	Russia
1999	5693.57	177.76	5871.33	5515.80	China
2000	5871.58	830.30	6701.88	5041.28	China
2001	1854.96	222.31	2077.27	1632.64	China
2002	5255.09	1.08	5256.17	5254.01	China
2003	7421.77	16.78	7438.54	7404.99	China
2004	4047.53	3.91	4051.45	4043.62	China
2005	4883.75	4.06	4887.80	4879.69	China
2006	6236.99	18.75	6255.74	6218.25	China
2007	1338.21	37.06	1375.27	1301.15	China
2008	2521.36	103.45	2624.81	2417.91	China
2009	2363.48	52.86	2416.33	2310.62	China
2010	2044.81	22.19	2067.00	2022.62	China
2011	3720.18	92.76	3812.95	3627.42	China
2012	2211.72	2335.01	4546.74	123.29	Russia
2013	2522.26	1809.86	4332.12	712.39	China
2014	4984.11	2676.09	7660.20	2308.02	China
2015	3445.02	13,092.54	16,537.57	9647.5204	Russia
2016	2336.34	13,229.08	15,565.41	10,892.739	Russia
2017	3607.96	14,453.78	18,061.74	10,845.823	Russia
2018	2615.56	26,353.86	28,969.42	23,738.295	Russia
2019	2314.99	23,585.90	25,900.88	21,270.907	Russia
2020	500.56	28,407.00	28,907.56	27,906.435	Russia

Note: Data from UN Trade Database.



**Figure 1.** Changes in the types of bilateral grain product trade between China and Russia from 1996 to 2020. Note: Data from UN Trade Database.

By subdividing the export trade structure of grain products between China and Russia, it can be seen from Table 2 that the export trade structure of grain products between the two countries is characterized by strong complementarity and high product concentration. From 1996 to 2020, China's export of grain products to Russia mainly focused on fresh cold non-seed potatoes, milled rice, and frozen common beans, accounting for more than 90% of China's total export of grain products to Russia. Among them, fresh cold non-seed potato has been ranked first since 2007. China's export of milled rice to Russia has shown a sharp decline since 2011 and has steadily increased in recent years. The proportion of frozen common beans has been on the rise since 2010. Russia's grain exports to China are mainly concentrated in soybeans, corn, and buckwheat, accounting for about 95% of the total grain exports to China. Among them, the proportion of soybeans has consistently ranked first. Although there have been fluctuations, it has always remained above 80%. There are two main reasons. One is that, due to the impact of soybean trade friction, China has actively expanded the source of soybean imports. The second is that the soybeans produced in Russia are non-GMO soybeans, which have excellent varieties and are highly favored by the market. Since 2013, the proportion of non-seed corn and buckwheat exported from Russia to China showed a trend of fluctuation decline, among which the share of non-seed corn dropped to 0.41% in 2017. In addition to these three types of products, since 2015, the share of Russian wheat products exported to China has increased year by year, and the export has shown a geometric growth.

**Table 2.** Bilateral export volume and proportion of major grain products between China and Russia from 1996 to 2020 (unit: 10,000 tons, %). Due to space constraints, \*\*\* means that only partial ranking data of grain product trade are shown in the table. Please contact the author directly if necessary.

Trade Direction	Commodity Code	1996		***	2019			2020		
		Export Volume	Proportion		Commodity Code	Export Volume	Proportion	Commodity Code	Export Volume	Proportion
China–Russia exports	070190 Fresh and cold non-seed potatoes	1108.51	51.09	***	070190	3905.52	76.28	100630	2178.06	73.47
	100630 Milled rice	915.54	42.87	***	100630	968.22	18.91	070190	103.97	11.70
	100510 Seed corn	102.38	4.79	***	120100	86.22	1.68	071022 Frozen common beans	58.61	6.60
Russia–China exports	120100 Soybeans	6890.18	97.81	***	120100	71256.99	81.56	120100	69316.24	73.02
	100400 Oats	154.44	2.19	***	100590 Non-seed corn	6524.98	7.47	100590	13768.4	14.50
				***	100190 Other wheat and mixed wheat	5843.10	6.69	100110 Durum wheat	4244.76	4.47

Note: Data from UN Trade Database.

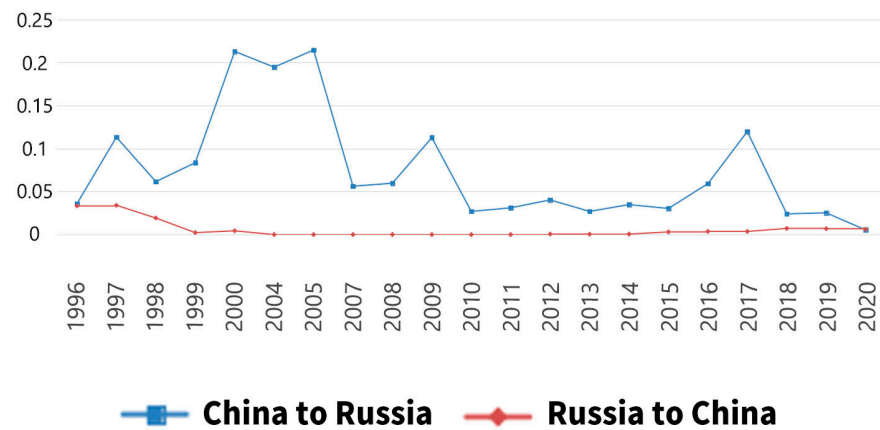
## 4. Marginal Decomposition of Bilateral Grain Product Export Trade between Russia and China

### 4.1. Overall Margin

#### 4.1.1. Intensive Margin

Figure 2 shows that from the overall perspective of China's grain exports to Russia, during the sample period, the intensive margin of China's export of grain products to Russia presented several obvious V-shaped fluctuations, with an overall downward trend. The intensive margin decreased by 38.9% from 0.036 in 1996 to 0.05 in 2020. The value of the intensive margin of Russian grain exports to China decreased from 0.033 in 1996 to a minimum value of 0.002 in 1999, remaining relatively stable thereafter. It can be seen that the intensive margin of China's export of grain products to Russia was far higher than that of Russia's export of grain products to China. This also indicates that the value of China's export of grain products to Russia was high, being vulnerable to external influences, with a large fluctuation range.

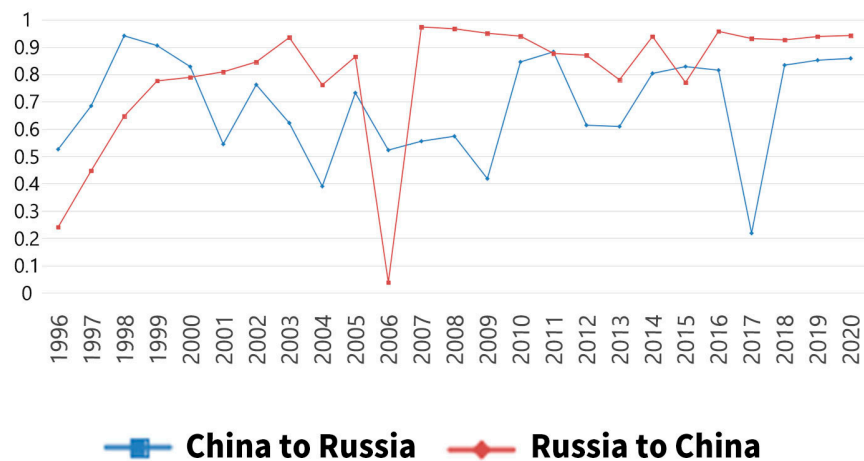




**Figure 2.** The intensive margin of bilateral export trade of grain products between China and Russia from 1996 to 2020. Note: Data from UN Trade Database. The intensive margin of grain products exported from Russia to China in 2001, 2002, 2003, and 2006 was 0; thus, these years were excluded.

#### 4.1.2. Extensive Margin

Figure 3 shows that the extensive margin of China's grain exports to Russia and Russia's grain exports to China both showed a fluctuating upward trend, with the extensive margin value of Russia's grain exports to China fluctuating more. Overall, the value of the extensive margin of China's grain exports to Russia increased from 0.526 in 1996 to 0.859 in 2020 during the sample period, an increase of 62.26%. The value of the extensive margin of Russian grain exports to China increased from 0.241 in 1996 to 0.943 in 2020, an increase of 291.29%, indicating that the variety of Russia's grain exports to China was constantly enriched and the export structure was gradually optimized.

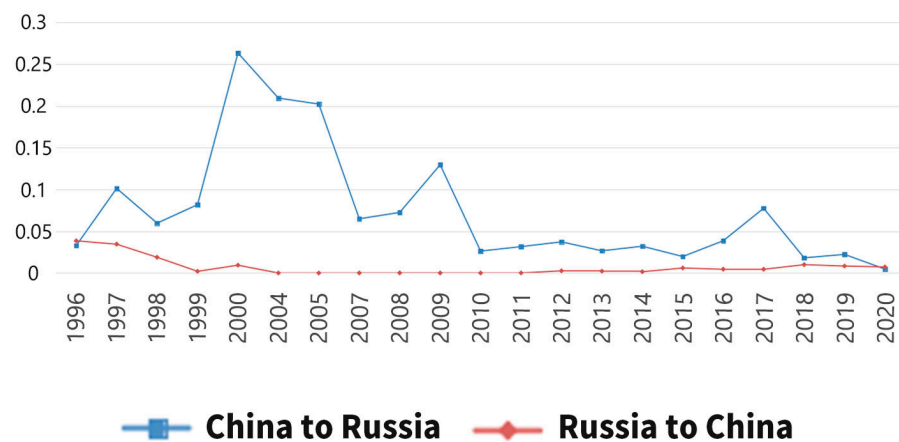


**Figure 3.** Extensive margin of bilateral grain product export trade between China and Russia from 1996 to 2020. Note: Data from UN Trade Database.

#### 4.1.3. Quantity Margin

The quantity margin of China's grain exports to Russia first rose and then fell. The quantity margin of Russia's grain exports to China fluctuated greatly and showed a downward trend in general (see Figure 4). The value of the quantity margin of China's grain exports to Russia decreased from 0.032 in 1996 to 0.004 in 2020. The value of the quantity margin of Russia's grain exports to China decreased from 0.038 in 1996 to 0.007 in 2020. The value of the quantity margin of China's grain exports to Russia was greater than that of Russia to China, indicating that Russia had a relatively strong demand for grain products from China. The quantity margin of bilateral grain product trade between China and Russia fluctuated greatly, mainly due to the fact that the quantity margin elasticity of enterprises'

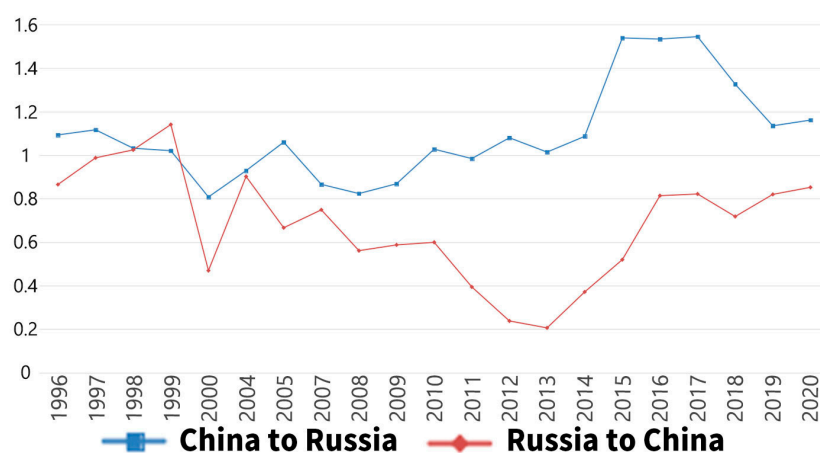
exports is highly susceptible to the economic development conditions of both the exporting and the importing countries, as well as external factors.



**Figure 4.** Quantity margin of bilateral grain product export trade between China and Russia from 1996 to 2020. Note: Data from UN Trade Database.

#### 4.1.4. Price Margin

As seen in Figure 5, the price margin of China's grain products exported to Russia fluctuated upward, from 1.093 in 1996 to 1.161 in 2020. Since 2007, the price margin of China's grain products exported to Russia have increased, mainly stemming from China's increased investment in grain production. However, the increase in agricultural costs has led to a rise in product prices, resulting in an inversion of domestic and international grain prices. Since 2017, China has gradually increased subsidies to agriculture and stabilized the prices of food products. The price margin of Russia's grain exports to China decreased from 0.865 in 1996 to 0.852 in 2020, mainly due to the fact that Russia has given more policy support to agriculture in recent years, resulting in its lower prices of grain products than that of China. However, Russia's agriculture is mainly based on extensive management, which also leads to greater price fluctuations in its grain products.



**Figure 5.** Price margin of bilateral grain product export trade between China and Russia from 1996 to 2020. Note: Data from UN Trade Database.

#### 4.2. Phase Analysis

According to the analysis of ternary margins of bilateral grain product export trade between China and Russia, the contribution rate of ternary margins to bilateral grain product export growth was further analyzed. In order to avoid a distortion of the growth rate due to too large a span of selection years, three time nodes, namely, China's accession to the WTO in 2001, the world financial crisis in 2008, and the Ukraine crisis in 2014, were

selected, and the changing trend of contribution rate of the ternary margins to the growth of grain product trade between China and Russian was studied in four stages.

Table 3 shows that the growth of China's export of grain products to Russia was a result of the growth in the quantity of exports in the existing grain product categories and the increase in new grain product categories, where the main driving force was the price margin, followed by the extensive margin, with the lowest contribution of the quantity margin. By stages, from 1996 to 2001, the contribution rate of intensive margin and extensive margin of China's grain exports to Russia was 97.27% and 2.73%, respectively, with the quantity margin showing negative growth. Since China's accession to the WTO in 2001, it has gradually reduced trade barriers in accordance with its commitments. China has increased its export of grain products to Russia, with a substantial increase in quantity margin. From 2009 to 2014, affected by the world financial crisis, the quantity and types of grain products exported by China to Russia declined sharply. From 2015 to 2020, China's export of grain products to Russia still mainly depended on the increase in product quantity. The expansion level of product categories was low and needed to be continuously improved. In general, China's export of grain products to Russia is mainly manifested by the increase in intensive margin, especially the price margin. This indicates that the growth of China's export to Russia during the sample period was characterized by the trade volume growth at the expense of price, and the quality of grain products still needed to be improved.

**Table 3.** Marginal contribution rate of bilateral grain product export growth between China and Russia from 1996 to 2020.

Trade Direction	Phase	Contribution Rate %				
		R	IM	EM	P	X
China exports to Russia	1996–2001	100.00	97.27	2.73	122.28	−25.02
	2002–2008	100.00	84.97	15.03	80	4.97
	2009–2014	100.00	225.69	−125.69	268.75	−43.06
	2015–2020	100.00	102.11	−2.11	85.43	16.67
Russia exports to China	1996–2001	100.00	241.43	−141.43	168.57	72.86
	2002–2008	100.00	89.85	10.15	110.05	−20.2
	2009–2014	100.00	100.44	−0.44	116.3	−15.86
	2015–2020	100.00	77.18	22.82	21.25	55.93

The growth of Russia's export of grain products to China mainly depended on price margin, followed by quantity margin, and the contribution rate of the extensive margin was the lowest. From 1996 to 2001, the growth of Russian exports to China depended on the price margin. From 2002 to 2008, due to the increasingly close trade cooperation between China and Russia, the types of grain products exported from Russia to China kept growing, and the contribution rate of the extensive margin achieved rapid growth. From 2009 to 2014, Russia's exports to China showed a downward trend. From 2015 to 2020, Russia's export of grain products to China was enriched, and the quantity of products during these periods rose. Overall, in the early period, Russia's export growth to China mainly depended on the intensive margin, especially the price margin, while, in the later period, the contribution of extensive margin to export growth continued to rise, indicating that the types of grain products exported by Russia to China gradually diversified.

## 5. Factors Influencing the Ternary Margin Value of Bilateral Grain Product Exports between China and Russia

Using STATA15, a cross-sectional fixed effect model was selected for regression analysis of the above panel data, and the analysis results are presented below (see Table 4).

On the whole, the size of the agricultural economy and grain productivity have an impact on the quantity margin, price margin, and extensive margin of bilateral grain product exports between China and Russia. Trade costs have an effect on the price margin

and insignificant effects on the quantity and extensive margins. Meanwhile, economic shocks have a significant effect on the price margin.

**Table 4.** Regression analysis results of influencing factors on the ternary marginal export of grain products from China and Russia.

Explanatory Variable	Quantity Margin	Price Margin	Extensive Margin
Agricultural economic size	−0.029 *** (−2.937)	0.166 ** (2.504)	0.114 ** (2.532)
Grain productivity	0.365 *** (2.742)	−2.677 *** (−2.887)	−1.383 ** (−2.254)
Trade cost	0.125 (1.135)	4.47 * (1.939)	0.37 (0.364)
Economic shock	0.008 (1.523)	−0.259 *** (−3.11)	0.013 (0.394)
Constant term	−0.213 ** (−1.968)	0.763 (0.847)	1.295 * (1.959)
Observation number	50	50	50
R <sup>2</sup>	0.464	0.723	0.726
F	4.977 ***	15.038 ***	15.210 ***

Note: The values in parentheses are t-values. \*, \*\*, \*\*\* indicate significance at the 1%, 5%, and 10% levels, respectively; *p*-values are all less than 0.01.

### 5.1. Factors Influencing the Quantity Margin of Bilateral Grain Product Exports between China and Russia

Firstly, the impact of agricultural economic size on the quantity margin of bilateral grain product exports between China and Russia is significant at the level of 1%. As the agricultural economic size of the importing country increases by 1 unit, the quantity margin decreases by 0.029 units. Second, grain productivity has a positive effect on the quantity margin and is significant at the level of 5%. This indicates that, when the grain productivity of the exporting country increase by 1 unit in the grain trade between China and Russia, the quantity margin of exported grain products increases by 0.365 units. Referring to Qian et al. [37], it can be speculated that the positive effect of the improvement of grain production efficiency on the export of grain products may be related to various favorable policies introduced by the government. Lastly, trade costs and economic shocks have a positive effect on quantity margin, but not significantly.

### 5.2. Factors Influencing the Price Margin of Bilateral Grain Product Exports between China and Russia

Firstly, the impact of agricultural economic size on the price margin of bilateral grain product exports between China and Russia is significant at the level of 5%, which indicates that, when the agricultural economic size of the importing country increases by 1 unit, the price margin increases by 0.166 units. Secondly, the impact of grain productivity on the price margin is significant at the level of 10%. When the grain productivity increases by 1 unit, the value of price margin decreases by 2.677 units. This indicates that the grain productivity of the export destination country has a negative effect on the price margin of bilateral grain product trade between China and Russia. The higher the productivity of the export destination country is, the stricter price restrictions are on the products entering the market, which is more unfavorable for the increase in exports. Thirdly, the impact of trade costs on the price margin is significantly positive at the 1% level. This may be related to trade controls between China and Russia. The impact of economic shocks on the price margin is significant at the 10% level, indicating that Western economic sanctions on Russia have contributed to the increasingly close trade development between China and Russia.

### 5.3. Factors Influencing the Extensive Margin of Bilateral Grain Product Exports between China and Russia

First, the effect of agricultural economic size on the extensive margin is significantly positive at the 5% level, indicating that the increase of agricultural economic size in importing countries has a positive impact on the export of new food products, which is in line with the expectation of the traditional gravity model. Second, the effect of grain productivity on the extensive margin is negative at the level of 5%. The effects of economic shocks and

trade costs on the extensive margin are positive, but not significant, indicating that the effects of economic shocks and trade costs on the export of new products are not significant.

## 6. Conclusions and Implications

### 6.1. Conclusions

A ternary marginal analysis was implemented with the data of bilateral grain product export trade between China and Russia from 1996 to 2020 in this paper. The influencing factors of bilateral grain product export trade between China and Russia were determined, and some conclusions were drawn on the basis of the calculation of ternary margins. First, from the perspective of overall scale, the total amount of bilateral grain product export trade between China and Russia has increased rapidly. The growth rate of grain product exports from Russia to China is greater than that of China to Russia, and the deficit of China's grain product exports to Russia has normalized, especially after the sanctions imposed on Russia in 2014. In terms of trade structure, the bilateral grain product exports of China and Russia are highly complementary, but the range of export products is relatively concentrated. Second, from the results of marginal analysis, the main driver for the growth of bilateral grain product exports between China and Russia is the price margin, which presents a growth pattern mainly based on price, supplemented by type and quantity. Third, from the analysis of influencing factors, the size of the agricultural economy, grain productivity, trade costs, and economic shocks all have various influences on the ternary margins of bilateral grain product exports between China and Russia. The size of the importing country's agricultural economy has a positive effect on export prices and export variety, but a negative effect on export price. The influence of grain productivity on export price and export variety is significantly negative, while that on export quantity is significantly positive. Trade costs and economic shocks also have a significant impact on export prices, with trade costs having a positive impact on export prices and economic shocks having a negative impact on export prices. With the implementation of the Belt and Road Initiative and the increasingly close relationship between China and Russia, the total export volume of grain products between China and Russia is increasing year by year, which also shows the necessity of maintaining good relations between China and Russia, continuing to promote the "the Belt and Road" initiative and building a community of shared future for mankind.

### 6.2. Implications

On the basis of the conclusions above, combined with the current development of the trade in grain products between China and Russia, the efforts of China and Russia to optimize the state of bilateral trade in grain products can focus on four aspects.

#### 6.2.1. Optimizing the Trade Policies of Both Countries and Improving the Quality of Trade Development

Good trade policies are an important foundation for promoting high-quality development of bilateral trade between China and Russia. A regular meeting mechanism between the agricultural authorities of China's and Russia's provincial and municipal governments should be established so as to jointly provide convenience for enterprises' bilateral trades and services. Through full exchanges and coordination, the consensus of departmental meetings, and making overall plans, the foundation of cooperation led by the heads of the two countries would be consolidated, and the political and diplomatic relations between governments would be further strengthened. The two sides would jointly facilitate bilateral trade and services for enterprises, as well as promote the formulation and implementation of reciprocal trade policies. It is recommended that the General Administration of Customs take the lead, and the counterpart departments of China and Russia formulate technical trade measures, including mutual recognition of technical standards for inspection and quarantine, appropriately increasing the number of Chinese labor quotas, shortening the time for processing labor permits, relaxing the transit deposit and operating time limits



for large- and medium-sized equipment, and accelerating the flow of food products and factors, which are able to improve the efficiency and facilitation of trade clearance and reduce grey clearance.

#### 6.2.2. Building Cross-Border Cooperative Parks and Creating the Whole Industrial Chain Layout

Cooperation is a process of continuous exploration and innovation, and cross-border cooperation parks can play a leading and exemplary role. First of all, through cross-border industrial parks, cooperative elements with comparative advantages between the two sides can be fully utilized, and products can bypass trade barriers entering the other side's market without trade frictions directly. Secondly, by jointly building and operating specialized parks, such as science and technology parks, economic and trade cooperation zones, and cross-border agricultural industrial parks, production factors could be integrated. Subsequently, research and development, production, and marketing systems with comparative advantages would be established, so as to achieve the effect of collaborative development, joint construction of the market, and utilization of the market. Industrial cooperation platforms to promote centralized layout and cluster development would be built, thus optimizing the industrial layout and configuration, creating regional agricultural industry synergy, so as to form a cluster effect, and improving the agricultural industry to support capacity and comprehensive production capacity.

Thirdly, during the construction of a park, importance should be attached to the improvement of soft power to promote the localization of the construction and operation of the cooperative zone. Moreover, emphasis should be placed on environmental protection and sustainable development, safeguarding the legitimate rights and interests of laborers, guiding enterprises to consciously assume corresponding responsibilities and obligations, and establishing new images of participating cooperative enterprises to enhance the competitiveness of the enterprises.

#### 6.2.3. Building a Financial Service System and Supporting the Development of Cooperative Enterprises

Adequate financial support is not only an important prerequisite for the development of cooperation, but also a necessary condition for promoting the continuous deepening of cooperation. In order to provide support for participating enterprises, the construction of the financial service system for Sino-Russian cooperation should be strengthened, and various commercial banks in developing and designing financial products that support foreign agricultural cooperation should be supported. Commercial banks could also be encouraged to provide preferential treatment in the applications for projects such as deep processing of agricultural products and for special funds for financing guarantees for small- and medium-sized enterprises, providing equal treatment for domestic and foreign agricultural enterprises. In addition, financial institutions are encouraged to increase policy-based guarantees, adjust the loan application threshold and mortgage loan requirements of cooperative enterprises appropriately, and support the development and innovation of foreign agricultural cooperative enterprises. This can expand the types and coverage of cooperative investment insurance, help cooperative enterprises avoid investment risks, and explore the ways to solve the financing difficulties of cooperative enterprises by means of implementing investment and management throughout the entire industry chain, and comprehensively enhancing their value.

#### 6.2.4. Strengthening Infrastructure Construction and Achieving Interconnectivity in Agricultural Cooperation between China and Russia

Firstly, the interconnection construction of transportation and other infrastructure should be strengthened, fully utilizing the land transportation corridor formed in the adjacent areas of China and Russia, and exploring the development of more convenient and accessible sea logistics transportation routes through the "Binhai No.1" and "Binhai No.2" transportation corridors to reduce transportation costs, improve transportation

level, and reduce transportation costs. Secondly, the remodeling and upgrading of the functions of customs clearance ports and corridors should be accelerated by building professional supporting ports for grain import and promoting the construction of a “hub” through infrastructure construction. Thirdly, customs clearance, turnover, and storage capabilities should be comprehensively improved by promoting the normalization of cross-border transportation of goods, accelerating the overall transformation of railways and highways at ports, and building modern grain storage bases. Lastly, the resources of railway container stations and inland ports should be integrated, and large domestic and foreign logistics enterprises actively introduced. The construction of logistics parks should be accelerated, and the comprehensive logistics capacity of important nodes improved to build an international logistics chain with long transport distance, large capacity, low cost, and high speed, thus ensuring stable, fast, and smooth flow of elements.

**Author Contributions:** Conceptualization, J.F. and G.T.; methodology, J.F.; software, G.T.; validation, J.F. and G.T.; formal analysis, J.F.; investigation, G.T.; resources, J.F.; data curation, G.T.; writing—original draft preparation, J.F.; writing—review and editing, J.F. and G.T.; visualization, J.F.; supervision, G.T.; project administration, G.T.; funding acquisition, G.T. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Heilongjiang Province Philosophy and Social Sciences Research Planning Project “Promoting Sino–Russian Agricultural Cooperation Research Based on Institutional Innovation of China (Heilongjiang) Pilot Free Trade Zone”, grant number 22JYH064.

**Institutional Review Board Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Conflicts of Interest:** The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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