

Article

Sino-US Cotton Trade Relations and Risk Analysis

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Abstract: The volume of cotton trade between China and the United States (th #2B2A62e #2B2A62US) has decisively impacted the world cotton trade market. Based on the cotton trade data between China and the US from 2012 to 2022, the relationship in trade between China and the US was analyzed multi-dimensionally. The basic situation of the Sino-US cotton trade was explored first through the analysis of historical data. Then, the sub-categories of Sino-US cotton were determined by using the trade integration and complementarity, and intra-industry trade index. Secondly, the potential risks to the Sino-US cotton trade relationship which are caused by changes in weather, policy, economy, market, and other factors were examined. Finally, suggestions were made to promote the development of the Sino-US cotton trade.

Keywords: Cotton trade, Trade relations, Risk analysis

1. Introduction

Cotton is an important commodity and is one of the world's important crops. It is also a strategic material related to the national economy and people's livelihood. Cotton is renewable, sustainable, and recyclable, and is an important raw material in the textile industry. Its production and trade influence the economic development of most countries and regions. With the development of the world's textile and garment industry, the demand for raw textile materials including cotton continues to increase. Cotton production and the cotton textile industry are interdependent and symbiotic, closely related to the livelihood of tens of millions of workers, the development of the industrial and agricultural industries, and economic development. The cotton industry affects the livelihood of employees in the cotton and its blended fabrics production industry and contributes to the stable development of the textile and garment industry in China and the United States (the US).

Since the 21st century, the global cotton industry has changed significantly. Cotton production areas have shown fluctuations in production, and supply and demand of the cotton market have changed dramatically. Since China acceded to the World Trade Organization (WTO), the supply and demand of China's cotton industry have been significantly adjusted. The production of cotton and its blended fabrics is important in China's textile industry as the export of cotton textiles has considerably contributed to China's total textile exports. By opening up the cotton market, China has become the world's largest cotton consumer and importer, a major exporter of cotton textiles playing an important role in the global cotton market. The US has always been an important participant in global cotton production and trade and has exported raw cotton and imported finished cotton products. Thanks to strong trade relationships with major cotton-consuming countries, the US has maintained its position as the world's largest cotton exporter for decades.

The US is the world's largest exporter of raw cotton, and China is the largest exporter of processed cotton products. Both countries have influenced the global cotton market for a long time. Affected by policy regulation and the Sino-US trade war, the cotton trade between China and the US has been in turmoil in the past decade, and the poor trade relations have negatively affected the cotton trade between them. In the early days of COVID-19, cotton was widely used around the world as an important raw material for medical supplies. After the pandemic, China's domestic textile and apparel consumer market has gradually recovered. However, the promulgation of the "Xinjiang cotton" ban in the US has damaged China's cotton trade.

The global cotton trade volume is huge with fierce competition. China's annual cotton consumption of cotton ranges from 7.3 to 9 million tons, accounting for about one-third of the global consumption. In 2022, China imported 1.1321 million tons of cotton from the US, accounting for 58.4% of China's total cotton imports and 32.8% of total global cotton imports. In that year, the US imported 25.3% of total cotton imports from China. In 2023, the US Department of Commerce estimated that the total global cotton consumption in 2023/24 would be 24.762 million tons, and the total domestic consumption of Chinese cotton would be 7.947 million tons, accounting for about 32% of global consumption. According to the General Administration of Customs, China's total exports of cotton, textiles, and apparel increased from USD 90.1 to USD 102.72 billion, accounting for more than 30% of the total exports. China exported USD 16.64 billion of cotton textile and apparel to the US in 2022.

Cotton trade between China and the US affects the global cotton industry. There are many factors affecting the relationship and various risks in the cotton trade between the two countries. Therefore, it is important to study the relationship and related risks in the cotton trade between China and the US. Based on the results, an optimized policy can be formulated to avoid damage from possible risks, stabilize the cotton trade, and optimize the cotton trade structure. By determining the risk factors from multiple

perspectives and understanding the complexity and dynamics of the Sino-US cotton trade, the supply and demand of the global cotton market can be viewed on the dynamics of the Sino-US cotton trade.

2. Literature Review

With the continuous advancement of the economy, investment and trade between countries have become closer. Yan and Huang (2021) **Error! Reference source not found.** verified the impact of China's cotton stock on global prices using indicators from 2010 to 2014. China, as a major cotton trading country, can stabilize global cotton prices to a certain extent by changing its policy. Taking the US-China trade war as an example, Cheng *et al.* (2023) used the Volatility Impulse Response Function (VIRF) to show that the US-China trade war impacted agricultural products, especially soybeans, coffee, cotton, corn, and wheat more than the global financial crisis, the new crown pneumonia epidemic, and related economic recessions, *etc.* Sabala and Devadoss (2020) analyzed the impact of a tariff increase on the global cotton market in the Sino-US trade war using the Spatial Equilibrium Model (SEM) and concluded that tariff countermeasures between China and the US adversely affected the market share of China and the US. The trade redistribution brought about by tariff countermeasures affected the production, consumption, and bilateral trade of other countries. These ripple effects changed the balance of the cotton market.

In terms of the development of the cotton industry, Lu *et al.* (2018) analyzed the development status and dilemma of China's cotton industry and put forward countermeasures to enhance the competitiveness of China's cotton industry. Qin and Ning (2020) analyzed the development trends and policies of China's cotton industry since China's accession to the WTO and put forward policies to innovate China's cotton industry and solve the related problems. In the cotton trade pattern, Zhai and Yuan (2019) analyzed the characteristics and laws of the global cotton industry in the past 30 years and found that global cotton production fluctuated greatly due to the influence of cost, planting, and policies, and the cotton consumption and trade were changed with the transfer of the global textile industry. Liu *et al.* (2022) proposed that the trade adjustment of the importers and exporters of the world's cotton trade plays a decisive role in the stability of the global cotton trade, and trade partners of the cotton importing countries are important in the evolution of the trade pattern. Cheng and Feng (2017) believed that since the financial crisis, the world cotton trade has been fragmented and centralized, and the asymmetric status of "core" and "periphery" countries in the cotton trade has become prominent. On the Sino-US trade friction, Zhang *et al.* (2020) proposed that there are significant differences in the impact of trade frictions on the agricultural industry in China and the US with heterogeneity and the added value of the US in agricultural products has been greatly impacted. Wang *et al.* (2022) analyzed the characteristics of global cotton production and trade in the context of trade disputes and proposed that trade disputes in the medium and long term do not change the volatility of the cotton market, and the monopoly of major cotton exporters remains unchanged. Deng (2021) analyzed the reasons and impacts of the US' policy of restricting cotton in Xinjiang from the perspective of the global industrial chain and proposed corresponding policy suggestions for the development of China's cotton industry. Liu and Wang (2021) believed that there is a two-way fluctuation spillover effect between the futures and the spot market of cotton. The price fluctuations of cotton futures are affected by spot price fluctuations and related factors with a certain lag. Wang *et al.* (2021) studied the fluctuation characteristics and their relationship with the prices of Sino-US cotton futures and concluded that the Sino-US cotton futures show continuous fluctuations with a long-term stable equilibrium. The cotton futures prices in the US affected the Chinese cotton futures prices in one direction.

Existing literature mainly focuses on the development of the cotton industry, changes in trade patterns, cooperation and friction in trade, and cotton prices. Research on the cotton trade was carried out on the existence of cotton yarn, cotton fabrics, and other processed products, which cannot fully reflect the status of the cotton trade, especially between China and the US. Relations and risks in the cotton trade are rarely studied, too. Therefore, this study aims to explore the cotton trade relationship and risk impact between China and the US in multiple dimensions using a variety of research methods and measurement indexes.

3. Current Situation and Characteristics of Sino-US Cotton Trade

3.1. Data Source

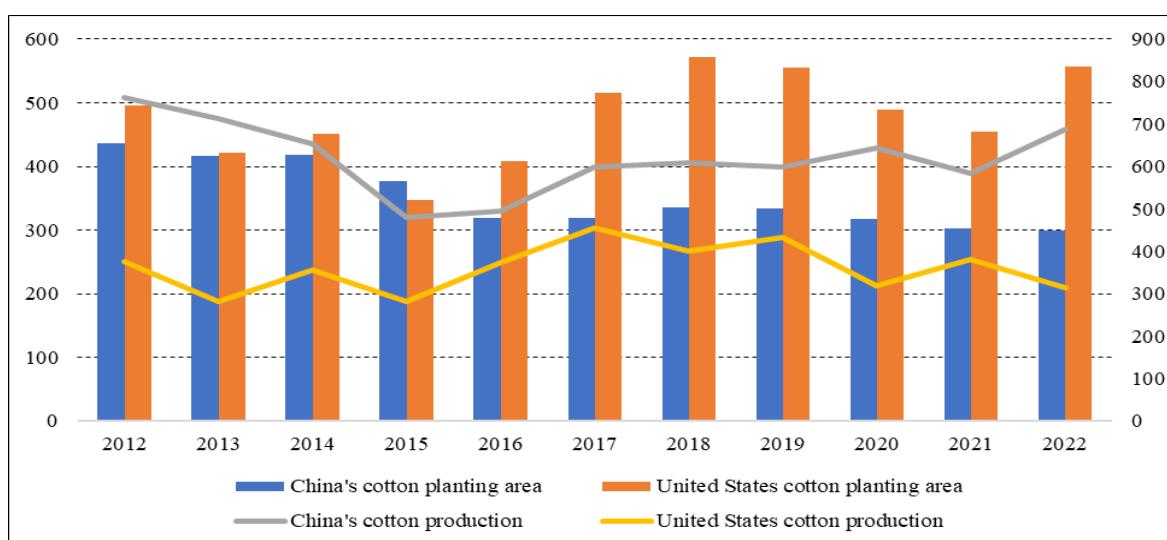
The data used in this study were derived from the United Nations Statistics Office (UN Comtrade Commodity Trade Database), the US Department of Agriculture (USDA), the General Administration of Customs of the People's Republic of China, the China Textile Industry Development Report and other publicly available statistics, reports, yearbooks and other resources. The Harmonized Commodity Description and Coding System (HS), the Standard International Trade Classification (SITC), and the Classification by Economic Category (BEC) were used for commodity classification in international trade (Zheng, 2010). Because the HS classification is complete and easy to understand, it was used to collect data on the cotton trade, raw materials, and products. In the HS code, Chapter 52 is assigned to raw cotton, carded cotton, cotton yarn, and cotton cloth according to the degree of processing of the product from raw materials to finished products.

3.2. Current Situation and Characteristics

As one of the important crops, cotton is globally cultivated. The Asian continent represented by China is the largest cotton production and consumption area, and North America, dominated by The US, is the second-largest cotton producer and largest exporter. Fluctuations in cotton production and trade between China and the US profoundly influence the global cotton market.

3.2.1. Scale of Cotton Production and Consumption

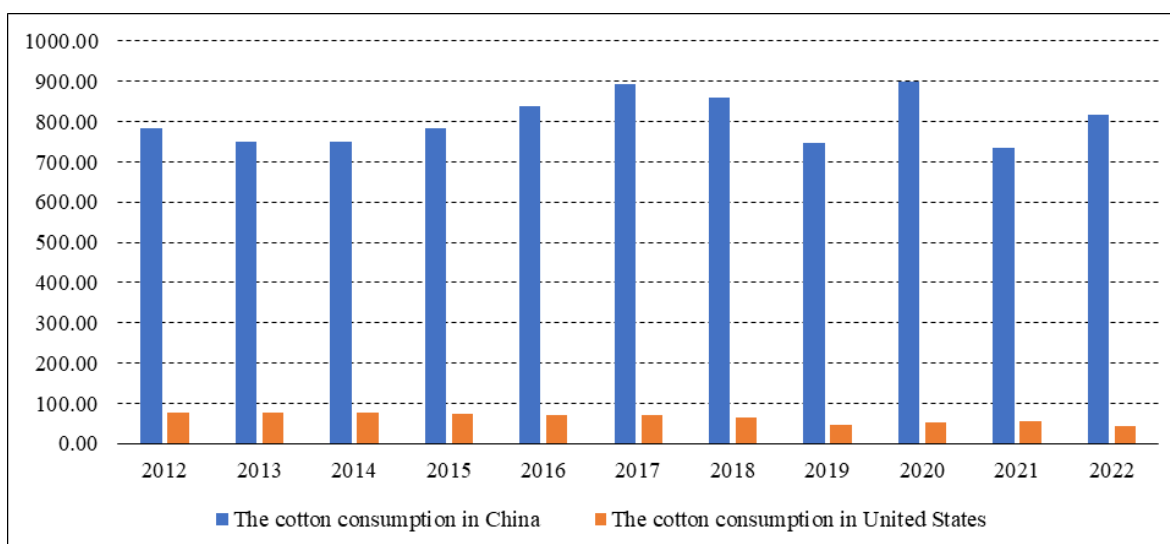
Since 2012, there have been significant differences in cotton planting in China and the US. Planting and harvesting of cotton in the two countries from 2012 to 2022 are shown in Fig. 1. The US showed a fluctuation in the cotton planting area and cotton production. In 2013, 2018, 2020, and 2022, La Niña caused a high temperature and drought in the US, and the cotton abandonment rate approached 30%. Affected by the adjustment of the global cotton trade structure and China's agricultural industry, China's cotton planting area decreased from 4.36 million ha in 2012 to 3 million ha in 2022 with the cotton planting area decreasing. However, with the progress of cotton equipment and cultivation technology, China's cotton production increased from 4.79 in 2015 to 6.68 million tons in 2022, with a growth rate of 39.5% (Fig. 1).



Source: the China Statistical Yearbook and USDA.

Figure 1. Cotton planting (in 1,000 hectares) and harvesting (in 10,000 tons) in China and the US.

With the continuous increase in the Chinese population and consumer preference for natural fibers, China's cotton consumption has increased significantly to become the world's largest cotton consumer since 1986. China's cotton consumption ranged from 7.3 to 9 million tons from 2012 to 2022. China's cotton consumption reached a peak of 8.9811 million tons in 2020. The cotton consumption in the US ranged from 762,000 tons in 2012 to 446,300 tons in 2022 with an overall decrease.



Source: Based on the China Statistical Yearbook and USDA.

Figure 2. Cotton consumption in China and The US (in 10,000 tons).

3.2.2. Cotton Trade between China and United States

Pure cotton, cotton yarn, and cotton fabric are traded between China and the US as shown in Table 1.

Table 1. Cotton trade sub-categories.

Class	HS code	Range
Pure cotton	5201	Uncarded cotton
	5202	Waste cotton
	5203	Combed cotton
Cotton	5204	Cotton sewing thread, whether or not for retail use
	5205	Cotton yarn (other than sewing thread) with a cotton content of 85% or more by weight, not intended for retail sale
	5206	Cotton yarn (other than sewing thread) containing less than 85% cotton by weight and not intended for retail sale
	5207	Cotton yarn (other than sewing thread) for retail sale
Cotton fabrics	5208	Cotton woven fabrics with a cotton content of 85% or more by weight, Weight per square meter ≤ 200 grams
	5209	Cotton woven fabrics with a cotton content of 85% or more by weight, Weight per square meter > 200 grams
	5210	Cotton woven fabrics, with a cotton content of less than 85% by weight, Mainly or only blended with chemical fibres, weight ≤ 200 grams per square meter
	5211	Cotton woven fabrics, with a cotton content of less than 85% by weight, Mainly or only blended with chemical fibres, weighing > 200 grams per square meter
	5212	Other cotton woven fabrics

Source: Based on the Harmonized Commodity Description and Coding System.

The composition and proportion of the cotton trade from 2012 to 2022 between the two countries are shown in Table 2. China’s imports from the US fluctuated, but the total imports from the US decreased every year. In the study period, China’s imports from the US showed a “U-shaped” trend. China imported 96.94% in 2012 and 83.1% of cotton in 2016 from the US. Since 2019, China’s cotton imports from the US accounted for more than 99% of the total cotton trade with the US. China’s imports of cotton yarn and cotton fabrics from the US showed a low proportion, of which the import value of cotton yarn decreased from USD 113 million in 2015 to USD 52,800 in 2022, and the proportion of imports of cotton fabrics was less than 1%. Cotton fabric is imported from China by the US, accounting for more than 85% of the total US imports. The proportion of cotton yarn ranked second, and the overall trend was fluctuating from 2.27% in 2012 to 9.53% in 2022. Pure cotton accounted for the lowest proportion of China’s cotton imports from the US, which was less than 0.1% as a whole, indicating that China’s pure cotton has no market in the US. China has been largely dependent on the US pure cotton, and the US imports cotton woven fabrics and cotton yarn from China.

Table 2. Composition of the US cotton trade with China, 2012–2022 (in USD millions).

Year	Export						Import							
	Total	Pure Cotton	%	Cotton	%	Cotton Fabrics	%	Total	Pure Cotton	%	Cotton	%	Cotton Fabrics	%
2012	3,519.40	3,411.69	96.94%	105.13	2.99%	2.58	0.07%	284.19	0.040	0.01%	6.45	2.27%	277.71	97.72%
2013	2,366.79	2,186.71	92.39%	176.90	7.47%	3.18	0.13%	283.63	0.020	0.01%	8.43	2.97%	275.17	97.02%
2014	1,224.98	1,115.35	91.05%	105.11	8.58%	4.52	0.37%	272.02	0.003	0.00%	9.05	3.33%	262.96	96.67%
2015	970.47	854.11	88.01%	113.47	11.69%	2.89	0.30%	285.88	0.100	0.04%	8.85	3.10%	276.92	96.87%
2016	663.94	551.74	83.10%	108.84	16.39%	3.35	0.50%	247.80	0.100	0.04%	12.36	4.99%	235.34	94.97%
2017	1,048.66	973.54	92.84%	71.16	6.79%	3.97	0.38%	236.10	0.150	0.06%	7.81	3.31%	228.15	96.63%
2018	948.67	921.30	97.11%	23.36	2.46%	4.01	0.42%	248.19	0.080	0.03%	8.64	3.48%	239.47	96.49%
2019	710.88	706.84	99.43%	1.04	0.15%	3.01	0.42%	155.11	0.040	0.02%	7.38	4.76%	147.70	95.22%
2020	1,823.72	1,821.65	99.89%	0.71	0.04%	1.36	0.07%	155.02	0.130	0.09%	9.63	6.21%	145.26	93.70%
2021	1,344.66	1,343.37	99.90%	0.13	0.01%	1.16	0.09%	86.19	0.040	0.05%	9.68	11.23%	76.47	88.72%
2022	2,907.56	2,903.81	99.87%	0.05	0.00%	3.70	0.13%	74.36	0.010	0.01%	7.09	9.53%	67.26	90.46%

Source: Based on the China Statistical Yearbook and USDA.

3.2.3. Relationship between China and the US in Cotton Trade

Table 3 shows the cotton trade between China and the US from 2012 to 2022. China’s cotton imports from the US showed a “W” shape with a large fluctuation. Since 2012, China’s cotton imports have declined from USD 3.79 billion in 2012 to USD 623 million in 2016 with a year-on-year decrease of 83.6%. China’s cotton exports to the US increased in 2017 and 2018 and decreased to USD 736 million in 2019. The export was affected by the Sino-US trade friction and the deterioration of the market environment. From 2012 to 2020, the US imported Chinese cotton stably, accounting for about 25% of its total imports. Affected by the “Xinjiang cotton” ban, the US’ total cotton imports from China decreased sharply to USD 98.88 million in 2022, accounting for only 9.63% of the US’ total imports. China’s imports from the US increased, reaching 32.83% of the total imports, far exceeding that in the previous years. The cotton trade between China and the US accounted for a high proportion of the global trade with a close, complex, and changeable trend.

Table 3. Cotton trade between China and the US (in USD millions).

Year	The Us Imports from China	The Us Imports from The World	Percentage	China's Imports from the The Us	China's Imports from The World	Percentage
2012	288.29	1,188.65	24.25%	3,790.20	18,681.44	20.29%
2013	285.48	1,147.15	24.89%	2,618.65	17,229.07	15.20%
2014	275.92	1,126.27	24.50%	1,381.31	12,756.18	10.83%
2015	351.84	1,103.97	31.87%	1,103.01	10,254.13	10.76%
2016	261.76	973.61	26.89%	622.66	7,743.52	8.04%
2017	277.73	938.25	29.60%	1,072.85	8,614.96	12.45%
2018	321.05	961.09	33.41%	1,105.90	9,889.82	11.18%
2019	258.79	863.35	29.98%	735.63	9,227.51	7.97%
2020	212.11	906.75	23.39%	1,606.41	8,278.84	19.40%
2021	142.37	985.09	14.45%	1,590.85	10,534.60	15.10%
2022	98.88	1,026.62	9.63%	3,052.42	9,296.33	32.83%

Data source: Compiled and calculated according to the UN Comtrade database.

4. Sino-US Cotton Trade Relations Index

Trade cohesion index, trade complementarity index, and intra-industry trade index were used to analyze the cotton trade relationship between China and the US in multiple dimensions.

4.1. Trade Cohesion Index

The Trade Cohesion Index is a measure of the dependence of two countries on certain products. It is used to measure the proportion of a country's exports of a certain product to its trading partner in the country's total exports and the proportion of the total imports of the product in the total global imports of the trading partner. It is calculated as

$$TCD_{ij}^k = \frac{X_{ij}^k / X_i^k}{M_j^k / M_w^k} \tag{1}$$

where TCD_{ij}^k represents the trade cohesion index of country i and country j on k products, X_{ij}^k represents the total amount of k products exported by country i to country j , X_i^k represents the total export value of k products from country i , M_j^k represents the total import value of k products from country j , and M_w^k represents the total import value of k products in the world market. When $TCD_{ij}^k > 1$, the trade of k products between i and j is closely linked; When $TCD_{ij}^k < 1$, the trade links between i and j are loose; When $TCD_{ij}^k < TCD_{ji}^k$, country i is less dependent on country j for trade in products k than country j is less dependent on country i , and vice versa.

The trade of cotton products in sub-categories of the HS classification changes every year. China's dependence on the US' cotton in the sub-categories is higher than that of the US on China. Affected by China's policy reform, Sino-US friction, Xinjiang cotton restrictions, and other events, the index of cotton import and export between China and the US in 2014, 2018, 2019, and 2022 was low, and the trade ties became loose. Due to COVID-19 in 2020, the export of pure cotton for medical supplies has increased considerably. The combination index of pure cotton was higher than 1, showing a close trade relationship. In recent years, the trade of cotton yarn and cotton fabric was less than 1, indicating that the trade ties between the two countries were relatively loose. China's cotton yarn exported to the US increased showing an "M-shaped" fluctuation. China's import of US cotton yarn decreased due to the Sino-US trade frictions and countermeasures. US cotton yarn exported to China decreased considerably. Affected by the ban on "Xinjiang cotton" in the US, the trade of China's cotton fabrics with the US increased.

Table 4. China's cotton trade cohesion index with the US from 2012 to 2022.

Year	Pure Cotton Trade Cohesion (Export)	Pure Cotton Trade Cohesion (Import)	Cotton Trade Cohesion (Export)	Cotton Trade Cohesion (Import)	Cotton Fabrics Trade Cohesion (Export)	Cotton Fabrics Trade Cohesion (Import)
2012	0.91	1.14	0.26	0.25	0.64	0.06
2013	1.82	1.23	0.37	0.37	0.62	0.10
2014	0.07	1.09	0.43	0.22	0.58	0.14
2015	2.02	1.57	0.59	0.25	0.67	0.13
2016	3.25	1.27	0.84	0.29	0.59	0.20
2017	3.19	1.47	0.57	0.18	0.61	0.26
2018	0.78	0.97	0.57	0.06	0.64	0.25
2019	0.47	0.68	0.60	0.0031	0.44	0.24
2020	13.61	1.60	0.91	0.0034	0.40	0.23
2021	1.86	1.45	0.72	0.0004	0.20	0.16
2022	0.09	2.24	0.48	0.0002	0.19	0.64

Data source: Compiled and calculated according to the UN Comtrade database.

4.2. Trade Complementarity Index

The trade complementarity index is used to analyze the degree of the complementarity of the trade between two countries. It is calculated as the product of the trade comparative advantage of a certain product and the trade comparative disadvantage of the trading partner. It is a measure of the degree of compatibility and development of the trade relationship between two countries. The index is calculated as

$$TCI_i^k = RCA_{xi}^k \times RCA_{mj}^k \tag{2}$$

where $RCA_{xi}^k = (X_i^k X_i^a) / (X_w^k / X_w^a)$, $RCA_{mj}^k = (M_j^k M_j^a) / (M_w^k / M_w^a)$, TCI_i^k is the trade complementarity index of k products exported by country i and imported by country j and RCA_{xi}^k is the index of comparative advantage of country i in the export of k products. X_i^k is the total export value of k products of country i , X_i^a is the total export value of all products of country i , X_w^k is the total export value of all products in the world market, and X_w^a is the total export value in the world market. RCA_{mj}^k represents the indicative comparative advantage index of country j on imports of k products, M_j^k is the total imports of k products in country j , M_j^a is the total imports of all products in country j , M_w^k is the total imports of k products in the world market, and M_w^a is the total imports of all products in the world market. The larger TCI_i^k is, the greater the degree of complementarity between country i and j , and the smaller the vice versa. If $TCI_i^k > 1$, the trade of k products between the two countries is complementary; If $TCI_i^k < 1$, the trade complementarity of k products between the two countries is weak.

The trade complementarity index of the sub-categories of cotton between China and the US from 2012 to 2022 is shown in Table 5. The trade complementarity between China and the US decreased as China and the US emphasized the trade complementarity in different cotton categories. China's cotton and cotton yarn exported to the US showed a low trade complementarity. China's cotton fabric exported to the US was complementary with a small fluctuation in a year, indicating that China's cotton fabric exports were related to trade development. The trade complementarity index of the US cotton fabric exports to China was small ranging from 0.17 in 2012 to 0.03 in 2022. However, the trade complementarity of pure cotton and cotton yarn from the US to China was higher than 1, showing strong trade complementarity and a strong competitive advantage of the US pure cotton. Since 2012, the cotton trade complementarity index between China and the US declined every year due to the adjustment of the cotton trade structure. This declined the comparative advantage and disadvantage index of cotton trade between the two countries, which in turn affected the trade complementarity index.

Table 5. Cotton trade complementarity index between China and the US from 2012 to 2022.

year	Pure cotton trade complementarity (Export)	Pure cotton trade complementarity (Import)	Cotton trade complementarity (Export)	Cotton trade complementarity (Import)	Cotton fabrics trade complementarity (Export)	Cotton fabrics trade complementarity (Import)
2012	0.0002	18.35	0.14	4.00	1.07	0.17
2013	0.0001	12.36	0.10	3.50	0.95	0.11
2014	0.0002	8.55	0.10	3.93	0.93	0.12
2015	0.0003	6.22	0.07	4.22	0.85	0.09
2016	0.0002	5.12	0.08	4.08	0.93	0.08
2017	0.0002	6.17	0.08	4.33	1.05	0.08
2018	0.0004	7.37	0.09	3.93	1.08	0.09
2019	0.0003	7.74	0.07	3.62	0.95	0.07
2020	0.00004	9.16	0.06	2.64	1.13	0.04
2021	0.0001	5.62	0.05	2.31	0.98	0.04
2022	0.0002	6.76	0.06	1.90	0.87	0.03

Data source: Compiled and calculated according to the UN Comtrade database.

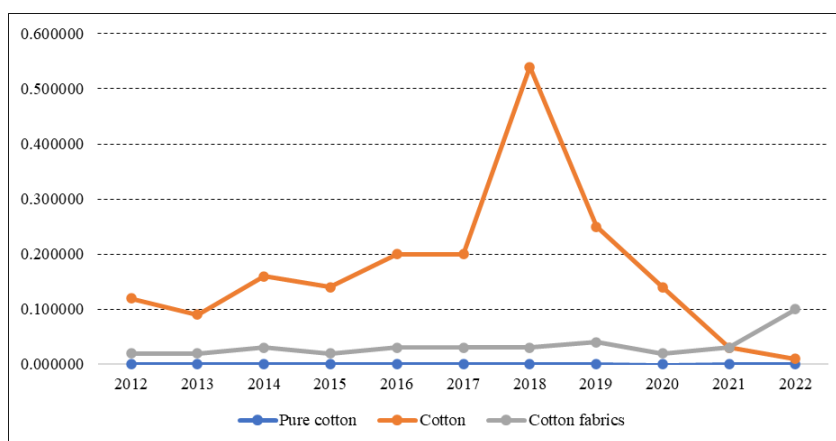
4.3. Intra-industry Trade Index

Intra-industry trade refers to the import and export trade between two countries in the same industry on similar products and their intermediate products. It is used to measure the degree of intra-industry trade in an industry as an indicator of a complementary trade demand. In this study, the Grubel-Lloyd's (G-L) index was used to measure the intra-industry trade of cotton between China and the US. The index is calculated as

$$GL_{ij}^k = 1 - \frac{|X_{ij}^k - M_{ij}^k|}{|X_{ij}^k + M_{ij}^k|} \quad (3)$$

where GL_{ij}^k is the intra-industry trade index of country i on k products, X_{ij}^k is the total amount of k products exported by country i to country j , and M_{ij}^k is the total amount of k products imported by country i from country j . The value of GL_{ij}^k falls between 0 and 1. The closer the intra-industry trade index is to 0, the closer the trade index is to the inter-industry trade, and the closer the index is to 1, the higher the degree of intra-industry trade between the two countries. The lower the degree of intra-industry trade, the stronger the complementarity of trade between the two countries on the commodity; On the contrary, it means that the two countries are more competitive in trade on the commodity.

Figure 3 shows the intra-industry trade index of China-US sub-category cotton products from 2012 to 2022. The trade of pure cotton and cotton fabrics was stable, belonging to the level of inter-industry trade with a high degree of vertical division of labor. The intra-industry trade index of cotton yarn fluctuated showing an intra-industry trade in 2018, but the intra-industry trade index of cotton yarn except for 2018 was lower than 0.5. From 2012 to 2016, the intra-industry trade index of cotton yarn increased from 0.12 to 0.54, indicating that the trade of cotton yarn was dominated by inter-industry trade and gradually changed to the intra-industry trade. Since 2019, the intra-industry trade index of cotton yarn has decreased, and the cotton yarn trade between China and the US was the inter-industry trade. The cotton trade between China and the US was dominated by inter-industry trade, and the competitiveness between China and the US was weakened, while the complementarity was strengthened, and the trade potential became larger.



Data source: Compiled and calculated according to the UN Comtrade database.

Figure 3. Intra-industry trade index of U.S.-China cotton trade.

Such results showed that the Sino-US cotton trade relationship was close, complex, and changeable and the closeness of the Sino-US cotton trade relationship was affected by global political and economic patterns and the fluctuation of the international market, which are potential risks and challenges.

5. Risk Analysis

Based on the above analysis results, natural, policy, economic, and market factors were analyzed.

5.1. Weather

The growth and development, yield, and quality of cotton are closely related to climate. El Niño and La Niña cause extreme weather and global climate anomalies and affect the utilization of water resources. Extreme weather events cause fluctuations in cotton yields. If China and the US experience extreme weather in the growing season of cotton, lower cotton yields or loss of quality occur. In the US, La Niña strengthened in 2022, although the area of cotton farming was increased. High temperatures and drought caused a record-high rate of abandonment of cotton farming, and the output decreased by 16.2%. The reduction in cotton production disrupted the price of cotton and affected the trade flow of raw cotton between China and the US. The low quality of cotton affected textile products and its competitiveness in the global market as well as the Sino-US cotton trade. To respond to weather risks, China and the US need to take risk management measures such as purchasing insurance and building reserves, which increase the cost of the cotton trade. Changes in cotton production, quality, and price caused by weather affected the China-US cotton trade relationship.

5.2. Trade Policy

The policy restricted the relationship between China and the US cotton trade, which was embodied in trade reform and frictions. The cotton trade between China and the US in 2016 and 2019 decreased significantly, and in 2022, China's trade with the US showed decreased exports and increased imports. Since the implementation of China's cotton policy reform in 2014, China's cotton prices have decreased, coupled with China's huge cotton stocks. In 2016, to "destock" and solve the problem of high cotton prices in national reserves, China issued additional cotton import quotas except for the import quotas promised by joining the WTO and meeting the needs of textile cotton distribution. In 2018, affected by the Sino-US trade friction, China implemented countermeasures against the US, imposing an additional 25% tariff on raw cotton from the US. In 2019, due to the impact of the countermeasures, the cotton trade between China and the US decreased sharply by 30%. In 2022, the US imposed a ban on cotton and cotton products from China's Xinjiang region. To maintain the export of cotton textile products, China's textile industry imported a large amount of cotton from the US for processing. The adjustment and change in trade policies between China and the US and the instability of trade relations negatively affected the cotton trade relations between China and the US.

5.3. Economic Cycle

Fluctuations in the economic cycle affected the cotton trade. Since the subprime mortgage crisis, the anti-globalization trend in economics and politics became prevalent, highlighted by "black swan events" in 2016 and accelerated by COVID-19 in 2020 (Dong and Yuan, 2022). Sino-US trade frictions, COVID-19, and geopolitical conflicts interrupted global industrial and supply chains, which slowed the world economy. The global economic recession has brought about the rise of trade protectionism, and the US measures such as raising tariffs and implementing non-tariff barriers strengthened the protection of US cotton, thereby restricting the import of Chinese cotton and hindering the Sino-US cotton trade. COVID-19 influenced the supply chain due to the closure of enterprises and the disruption of logistics and transportation. This affected the supply and delivery of cotton and the cost and reliability of the China-US cotton trade. At the same time, the economic recess diverged monetary policies between China and the US. The US Federal Bank adopted monetary tightening policies, which increased the value of the US dollar, depreciated the RMB, and increased the exchange rate. The fluctuation of the Sino-US exchange rate exacerbated trade costs and risks and affected the Sino-US cotton trade. The adverse fluctuations of the economic cycle inhibited the Sino-US cotton trade, which in turn risked the Sino-US cotton trade relationship.

5.4. Market Pressure

The deterioration of global trade affected the global cotton market, which played a non-negligible role in the Sino-US cotton trade relationship. The economic downturn decreased the demand of the global cotton market, weakened the willingness and ability to consume and import cotton, and compressed the Sino-US cotton trade. The global cotton industry is constantly changing, and the expense of the cotton trade affects the selling price of cotton. Affected by COVID-19 and Sino-US trade frictions, the labor, transportation, and tariff increased sharply. The cotton textile industry was transferred from China to low-cost countries such as Southeast Asia, and China's cotton textile exports decreased. The export of China is not optimistic, which affects the use of raw cotton in China's textile industry. China and the US have difficulties such as rising costs and constraints on cotton production. Decreasing market demand and increasing production costs put cotton producers in China and the US under stress. This forces them to reduce or stop cotton farming which disturbs the cotton industry in China and the US. These market risk affect the competitiveness and trade volume of cotton between the two countries, which is not conducive to the stable development of cotton trade between China and the US.

6. Conclusions and Recommendations

By analyzing the cotton trade between China and the US from 2012 to 2022 using qualitative and quantitative methods, the following conclusions were drawn in this study.

Recently, China's cotton planting area has been declining, but the output has increased. The changes in cotton planting area and yield are the same in the US, but cotton output has declined due to extreme weather. China's cotton consumption fluctuated between 7.3 and 9 million tons, but the overall cotton consumption in the US decreased. The cotton trade between China and the US was characterized by large volume and high fluctuations. China imported raw pure cotton from the US, while the US imported processed cotton fabric products. This is in line with the current situation of China's export of processing products in the cotton market, and the US export of raw cotton and and import of manufactured goods.

Global situation, national policies, and COVID-19 impacted the Sino-US cotton trade relationship. The relationship in the raw cotton trade was close, but that in the cotton yarn and cotton fabric trade was loose. China's import of the US cotton and cotton yarn and the US import of cotton fabrics from China were highly complementary. The cotton trade between China and the US was dominated by inter-industry trade, and the Sino-US cotton trade was diversified by inter-industry trade. Weather risk impacted the yield and quality of cotton in China and the US, and the global price of cotton. Changes in trade relations brought about by trade frictions changed the trade policies of the two countries, which affected the trade. The global economic environment restrained the Sino-US cotton trade. Changes in the supply and demand and cost differences in the global cotton market influenced the competitiveness and volume of the China-US cotton trade. These risks harmed the Sino-US cotton trade relationship, which in turn

affected the stability of the global cotton market with hidden dangers to the safety of the global economy. Based on this, the following suggestions were made for the development of the China-US cotton trade.

As the impact of weather risks on the China-US cotton trade cannot be ignored, China and the US must enhance risk management and cooperation to address the challenges to cotton production. China and the US need to improve the accuracy and timeliness of meteorological forecasts by establishing a meteorological monitoring system. Chinese and US cotton enterprises and farmers must be assisted in arranging planting plans, optimizing planting layouts, and adjusting sowing and harvesting times. Improving the emergency management system and establishing a sound emergency plan and response mechanism helps the cotton industry cope with sudden meteorological disasters, pests, and diseases. The construction of meteorological monitoring and emergency response system can reduce the risk of extreme weather events and sudden disasters in cotton production, ensure the stability and safety of cotton production, improve the risk resistance and stability of the cotton industry in China and the US, and enable the sustainable development of trade.

China's long-term trade deficit with US cotton means that China's cotton industry is dependent on US cotton with industrial trade risks. To reduce the risk of dependence, China must cooperate with other cotton-producing countries and establish diversified import channels. By exploring new sources of cotton supply, supply risks can be hedged to ensure the stability of cotton supply, and avoid production disruptions caused by natural disasters, political turmoil, or other problems. In addition, import diversification can increase the competitiveness of the cotton market, and when the market price fluctuates, Chinese and US cotton enterprises can flexibly adjust their import channels to reduce the business risk caused by price fluctuations. In addition, by establishing cotton trade relations with other countries, high-quality cotton resources can be secured to enrich product lines, improve quality, and differentiate cotton products. It is necessary to develop the cotton industry through cooperation with other countries to reduce the impact of protectionism, trade frictions, or geopolitical conflicts.

In economic recovery, to ensure the stable development of the cotton industry, China and the US must appropriately encourage financial institutions to increase financial credit, provide preferential loans and financing support, and convenient and efficient financial services. It is required to help enterprises expand production scale, improve technology, update equipment, and enhance the supply capacity of the entire industry to meet the needs of the development of the cotton industry. At the same time, China and the US must restructure the cotton industry to optimize the industrial supply structure and strengthen the cooperation and coordination of upstream and downstream enterprises in the cotton industry chain. The cotton supply chain and industrial chain must have competitiveness and anti-risk ability. Through the establishment of a cotton industry supply chain management platform, information can be shared and resources are allocated optimally. It is needed to strengthen the docking of cotton production and marketing, reduce logistics costs, and improve the operational efficiency of the entire industry to cope with the trade pressure brought about by anti-globalization and economic recession.

To mitigate the impact of external factors such as market contraction, it is particularly important to enhance global competitiveness. Affected by multiple factors such as logistics obstruction and supply chain disruption, the cost of cotton trade has increased, which affects the price competitiveness in the global market. Advanced planting technology and management methods can effectively improve the quality and total yield of cotton, thereby adding value to cotton and vitalizing the cotton industry. Scientific and technological innovation is important to transform and upgrade the cotton industry. The automation of the cotton production process is required to reduce labor input and the pressure on production costs. By optimizing production processes and introducing energy-saving technologies, the US-China cotton industry can achieve a win-win situation of economic and environmental benefits while reducing energy consumption and environmental pollution. In addition, innovative technology needs to be employed for the optimization and upgrading of the cotton industry structure to allow the cotton industry in China and the US to be high-end, intelligent, and green and increase the added value and global competitiveness of the entire cotton industry.

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