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GRADUATION THESIS

on

**Research on Technical Barriers to Trade in International Trade and
Countermeasures**

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Institute of Economics and Administration
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ASSIGNMENT
FOR THE GRADUATION THESIS OF

Master's degree student Wang Xingyan, group 23ЭЭБам1, full-time mode of study

1The topic of the graduation thesis: “Research on Technical Barriers to Trade in International Trade and Countermeasures”

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2The deadline for the Master's degree student to complete the graduation thesis is 11.06.2025.

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Schedule for completing the graduation thesis

№ п/п	Content of the thesis	Deadline for completion	Due date, signature of the academic adviser
First year of study			
1	Substantiating of the research topic and methodology, subject and object of research	1.09.2023 – 31.10.2023	
2	Framing the scientific concept of research	1.11.2023 – 18.12.2023	
3	Collection of scientific literature for the thesis	19.12.2023 – 15.01.2024	
4	Substantiating the relevance, concept, and novelty of the research	16.01.2024 – 19.02.2024	
5	Framing of a detailed plan and layout of the research	20.02.2024 – 12.03.2024	
6	Studying new literature sources within the topic of the thesis	13.03.2024 – 26.03.2024	
7	Conducting theoretical research within the first chapter of the thesis	27.03.2024 – 30.04.2024	
8	Preparing the first chapter of the thesis	1.05.2024 – 30.06.2024	
Second year of study			
9	Conducting analytical research within the second chapter of the thesis	1.09.2024 – 22.10.2024	
10	Preparing the second chapter of the thesis	23.10.2024 – 24.12.2024	
11	Conducting analytical research within the third chapter of the thesis	25.12.2024 – 25.02.2025	
12	Preparing the third chapter of the thesis	26.02.2025 – 21.04.2025	
13	Preparing the introduction and conclusion	22.04.2025 – 12.05.2025	
14	Completing the graduation thesis	13.05.2025 – 26.05.2025	
15	Handing in the thesis for compliance control and antiplagiat	27.05.2025 – 9.06.2025	
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Summary

The graduation thesis comprises 77 pages, 4 chapters, 15 figures, 2 tables, 65 sources. INTERNATIONAL TRADE, HIGHT-TECH INDUSTRY, TECHNICAL TRADE BARRIES

The target of research is Study the impact of technical trade barriers in the high-tech industries of the main exporters of high-tech products in China on the export of high-tech products in China, and provide suggestions for the development of high-tech industries in China and other countries around the world.

The goal of work is to study cinsult literature, collect and analyse data, draw conclusions, and make suggestions.

The methodological framework of the paper is formed by the complex of theoretical and practical methods such as literature review, data analysis, comparative analysis.

The results of research include: Analyze China's trade data on high-tech products, find the causes and effects of technical trade barriers, and put forward suggestions on international trade in high-tech products.

The recommendations on disseminating and applying the results are as follows: Enterprises strengthen technical investment and self-management, and attach importance to sustainable development. The country continues to train professional talents. Increase policy and financial support, and continuously improve technological innovation capabilities. Establish a certification system and an information system. Strengthen trade cooperation and communication.

The theoretical relevance of the thesis is established by the mechanism of the impact of technical trade barriers and the main indicator system for measuring the level of technical trade barriers

The target of research can be further explored through the impact of technical trade barriers, international trade policies and geopolitics on the export of high-tech products

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Introduction

In recent years, with the rise of trade protectionism, technical trade barriers have a deeper and deeper impact on international trade. The high-tech industry is a leading and strategic industry in China, and it is of great practical significance to study the impact of technical trade barriers on China's export trade of high-tech products.

This article first reviews the literature from three aspects: the influencing factors of the export of high-tech products, the impact of technical trade barriers on international trade, and the impact of technical trade barriers on the export of high-tech products; then, starting from the theoretical level, it discusses the mechanism of the impact of technical trade barriers on the export of high-tech products. In theory, it is believed that the impact of technical trade barriers is dual and can hinder commodity exports through quantity and price inhibition, or promote commodity exports through coercion mechanisms; secondly, this article combs the development status of China's high-tech products from the perspective of the current situation of China's high-tech industry and the current situation of trade. The research results show that: the technical trade barriers of the high-tech industries of the importing country have a significant positive effect on the export of China's high-tech products.

The technical trade barriers have improved the transparency of product information. China can make full use of the information disclosure function of the technical trade barriers of the high-tech industries of the importing country to improve the quality of export products to meet the technical standards of the importing country, thereby promoting the export of high-tech products; By industry, the technical trade barriers of the high-tech

industries of the importing country have a significant effect on the export promotion of aerospace manufacturing, electronic and communication equipment manufacturing, computer and office equipment manufacturing, medical equipment and instrumentation manufacturing, but the promotion effect of the pharmaceutical manufacturing industry and the information chemical manufacturing industry is not significant.

This is due to the different development conditions of different industries and the different technological adaptability of Chinese companies to different industries.

Based on the above analysis, this article puts forward the following policy recommendations: at the enterprise level, enterprises should actively study international technical standards, improve their independent research and development capabilities, and strengthen their own management; at the government level, the government should continue to train relevant professionals, increase high-tech industry policies and financial support, establish advanced technical standards and information systems for technical trade barriers, and strengthen trade cooperation with other countries.

Chapter 1 A technical barriers to trade related concepts and theoretical basis

1.1 Factors affecting the export of high-tech products

According to the research content of this paper, this chapter mainly studies the previous literature from three aspects: the factors affecting the export of high-tech products in China, the impact of technical barriers to trade on international trade and the impact of technical barriers to trade on the export of high-tech products, and makes a summary and brief comment, which provides a theoretical and logical basis for the following research.

In view of the factors affecting the export of high-tech products, scholars have studied from different angles: some scholars believe that R&D investment has a significant impact on the export of high-tech products. The R&D investment of high-tech products can be divided into capital investment and personnel investment. Wei Long et al. (2005) found through empirical research that the influence of R&D capital investment and R&D personnel investment on the export of high-tech products is not significant [50, p. 3]; Qiu Shilei et al. (2017) built a VAR model based on the relevant time series data from 1985 to 2015 to study the influencing factors of China's high-tech products export. The research results show that R&D investment and human capital investment have a significant promotion effect on the competitiveness of high-tech products, and the promotion effect lasts for a long time, among which R&D investment has the strongest promotion effect, and the positive effect of human capital investment has a strong lag [37, p. 3].

Some scholars also think that the technical level and technological innovation ability of exporting countries have a significant impact on the export of high-tech products. Seyoum(2004) takes 60 countries as samples, and through multiple regression analysis,

takes foreign direct investment, scientific and technological level, investment of researchers, domestic demand level, domestic competition level and exchange rate as influencing factors, and draws the conclusion that scientific and technological level and investment of researchers have a strong influence on the export of high-tech products in a country [4, p. 15]; Fabio Montobbio (2005) research shows that a country's productivity level, scientific research ability and foreign direct investment have great influence on the export of high-tech products. At the same time, through the study of the export of high-tech products in developing countries, it is found that FDI has a significant impact on the export of products with medium technology level, while technological innovation has a significant impact on the export of products with high technology level [17, p. 14]; Huarong et al. (2015) believe that technology diffusion can promote the export of high-tech products and improve the quality and export competitiveness of export commodities by studying the innovation and dissemination of high-tech products [29, p. .3]; Zhao Gnomon et al. (2021) conducted regression analysis by collecting relevant panel data of high-tech industries in China, and studied the influence of innovation quantity and quality of high-tech industries on the export of high-tech products in China. After further analysis with panel Bayesian vector autoregressive model, it was found that the innovation quantity has a good positive effect on the export of high-tech products, while the interaction between innovation quality and high-tech products export is poor [65, p. 6 – 8].

In recent years, scholars tend to study the influence of economic policies on the export of high-tech products. Song Weiliang et al. (2016) conducted an empirical analysis based on the extended trade gravity model, using panel data of 64 countries from 2000 to 2014. The empirical results show that the intellectual property protection of importing countries

has an inhibitory effect on the export of high-tech products in China, and from the perspective of high-tech industry segmentation, the inhibitory effect on China's pharmaceutical manufacturing industry is the most obvious [42, p. 12]; Wei Ping et al. (2018) calculated the G-L index and Aquino index, selected the panel data of the United States and 35 countries from 2003 to 2015, and made an empirical analysis based on the trade gravity model. The research results show that the export control of high-tech products by the United States to China is not conducive to the development of high-tech products trade between the two countries [51, p. 9]; Liu Wei et al. (2019) based on the fictitious variable of American high-tech export control to China, studied the influence of export control on China's scientific and technological innovation under the background of Sino-US trade friction, and concluded that American high-tech export control to China inhibited the innovation and development of China's high-tech industries, and pointed out that China should speed up the technological innovation capability of high-tech industries to cope with the risks in international trade [32, p. 8]; Qu Lina et al. (2020) found through empirical research that the uncertainty of economic policy promotes the export price margin of high-tech products in China, and inhibits the expansion margin and quantity margin; In terms of countries, compared with middle-income countries, China's economic policy uncertainty has a more significant impact on high-income countries [38, p.13].

Scholars also investigated the influence of other related factors on the export of high-tech products. Chen Xiaohua et al. (2019) found through research that the mismatch of productive service resources has a negative impact on the export of high-tech products in developing countries [9, p. 11]; Dai Kuizao et al. (2019) found that the higher the level of vertical specialization, the higher the technical complexity of China's high-tech industries,

thus actively promoting the export of China's high-tech products [12, p. 10]; Zhang Yingying et al. (2020) conducted an empirical analysis based on the provincial panel data of China from 2003 to 2016, and found that the agglomeration of producer services has significantly promoted the export upgrading of high-tech products in China [64, p. 8]; Niu Hua and others (2020) think that trade liberalization has a significant role in promoting the export of high-tech products [33, p. 9].

To sum up, scholars at home and abroad have studied the factors influencing the export of high-tech products from the aspects of R&D investment, technical level and technological innovation ability, and economic policies, but scholars have not reached a unified conclusion, and there are also differences in the significant degree of influence of various factors on the export of high-tech products.

1.2 Impact of Technical Barriers to Trade on International Trade

In view of the impact of technical barriers to trade on international trade, scholars have investigated the industry, country and mechanism respectively.

First of all, the impact of technical barriers to trade on international trade is related to the industry. Yuan Li et al. (2012) used the available estimated values in previous international trade documents to explain the differences in relevant data sampling and methods and the changes in the impact of technical barriers to trade in a broad sense on international trade through meta-analysis. It is concluded that compared with other sectors, agriculture and food industry are more hindered by these obstacles. For agriculture and food trade, SPS regulations often hinder the export from developing countries to high-income countries. Not controlling the "multilateral resistance" barrier increases the possibility of

exaggerating the blocking effect of technical measures on trade. If the potential trade endogeneity is not considered, on the contrary, the research using direct maximum residue limits often finds more trade barrier effects and clearer policy implications than other measures [56, p. 12]; Zhang Xiue (2012) studied the influence of technical barriers to trade on the export trade of different industries in China through empirical analysis. The results showed that under the background of financial crisis, China encountered technical barriers to trade mainly in agricultural and food, mechanical and electrical instruments, chemical industries, etc. Through case analysis, it was found that the implementation of technical barriers to trade by the United States in China seriously hindered the development of China's export trade to the United States. However, different countries have different technical barriers to trade measures against China. At the same time, according to the situation of different provinces in China, technical barriers to trade have had a negative impact on the export trade of most provinces in China after the financial crisis [61, p. 3]; Wang Shaoyuan et al. (2016) studied the export of equipment manufacturing enterprises in China by constructing a two-stage gravity model, using the import coverage index to quantify the technical barriers to trade, and based on the panel data of 18 sample countries from 2004 to 2013, the research results showed that the technical barriers to trade inhibited the export of China enterprises to some extent from the perspective of the intensive margin of export enterprises, but from the perspective of the expansion margin of export enterprises, Technical Barriers to Trade (TBT) promotes the export of enterprises, which proves to a great extent that TBT has certain industry characteristics for the export of equipment manufacturing enterprises in China, and TBT can improve the transparency of product information and reduce market uncertainty [46, p. 9].

Secondly, the impact of technical barriers to trade on international trade is related to countries. Bao Xiaohua et al. (2014) used the relevant trade data of 105 countries in the world from 1995 to 2008, and made an empirical analysis based on the two-stage gravity model of HMR. They believed that the impact of technical barriers to trade on international trade flows was different between countries and industries: in terms of country differences, if the importing country is a developing country, the impact of technical barriers to trade on trade will be significantly promoted; if the importing country is a developed country, Then the impact of technical barriers to trade on trade shows a significant inhibitory effect. In terms of industry differences, the empirical results show that technical barriers to trade can inhibit the trade of agricultural products but promote the trade of manufactured goods, because if the cost of information disclosure is higher than the conformity cost, it may have a positive effect on trade flow [3, p. 17].

At the same time, technical barriers to trade have a dual effect on international trade. Zhang Xiaodi et al. (2004) found that the implementation of technical barriers to trade is relative by studying the impact of technical barriers to trade on China's agricultural exports. Because of the complexity of the causes of technical barriers to trade, it may be due to the protectionism of importing countries, or it may be due to the fact that importing countries respond to their consumers' needs through technical barriers to trade in order to protect their consumers. The impact of technical barriers to trade on the trade of exporting countries is twofold, that is, in the short term, it may reduce the trade flow of agricultural products, but in the long term, it may be due to the reversal mechanism of technical barriers to trade, prompting exporting countries to improve the quality of exported agricultural products to match the import demand of importing countries [60, p. 2]; Liu Bing et al. (2014)

investigated the influence of reducing technical barriers to trade on the change of economic effect through GTAP simulation method. The research results show that with the reduction of technical barriers to trade in RCEP region, China's GDP, welfare level and trade scale all showed a doubling trend [30, p. 8]; Grant et al. (2015) studied the impact of SPS regulations on the export of fresh fruits and vegetables in the United States. The results show that the implementation of SPS regulations usually has an inhibitory effect on trade, but as exporters become more familiar with the regulations, the inhibitory effect of SPS regulations will gradually decrease or even disappear [1]; Liu Shuangqin et al. (2016) conducted an empirical analysis based on the trade gravity model to explore the impact of American technical barriers to trade on China's export trade. The author thinks that the role of technical barriers to trade will usually appear after one year, so the technical barriers to trade are quantified through the delayed notification of American technical barriers to trade. The results show that American technical barriers to trade have obvious inhibitory effects on China's export trade, including quantitative inhibitory effects and price inhibitory effects [31, p. 8]; Song Yuchen et al. (2016) used time-varying parameter vector autoregressive model for empirical analysis, and found that in the short term, Japanese technical barriers to trade have a significant negative inhibitory effect on China's agricultural exports, but in the medium and long term, it will promote agricultural reverse mechanism [43, p. 7]; Zhang Yinghong et al. (2020) found that technical barriers to trade had a significant inhibitory effect on the export of agricultural products in China, based on the agricultural products export data of China from 2001 to 2007, and introduced the macro data of special trade concerns raised by China, and thought that special trade concerns would aggravate the negative impact of technical barriers to trade [63, p. 8].

Chen Qi et al. (2020) showed through data model research that the implementation of technical barriers to trade in importing countries had a more obvious negative impact on the export of China's high-tech industries in the short term, which led to a serious setback in China's export with the implementation of barriers in importing countries. At present, technical barriers to trade tend to be institutionalized by law and combined with intellectual property barriers. China's communication, computer and pharmaceutical industries are short of intellectual property reserves and sensitive to technical barriers to trade. It is easy for importing countries to take advantage of this trend to strengthen the concealment of technical barriers to trade and increase export repression of high-tech industrial products. On the one hand, there is a certain gap between the overall technical level of domestic high-tech industries and the international market, which leads to more severe competition between domestic and middle-and high-income countries in the high-tech product market with relatively low technical content; On the other hand, the speed of domestic technology upgrading is accelerating. In the high-end high-tech product market, the relationship between domestic and high-income countries has gradually changed from complementary to competitive, and the pressure from both sides has formed a "double-headed squeeze" effect on the export of domestic high-tech industries. Therefore, in the export market of middle-and high-income countries, the homogenization of products caused by technological imitation will make such countries implement more stringent technical barriers to trade and greatly curb exports [8, p. 54].

Wang Mengying (2020) think that under favorable foreign economic policies, the impact of the same technical barriers to trade on export volume will benefit from the positive strengthening of benign international trade conditions and trade promotion environment,

and the negative impact will be weakened; Under the unfavorable international trade environment and business environment brought by special trade restrictions, the export of China's information economy industry will be negatively strengthened by the same technical barriers to trade, and the negative impact will be strengthened; The favorable infrastructure deployment plan of exporting countries for information economy industry will weaken the negative impact of technical barriers to trade on industry exports. Moreover, the economic policies of exporting countries, trade restrictions of importing countries and infrastructure deployment plans of exporting countries will all affect the number or intensity of technical barriers to trade [45, p. 57].

To sum up, the impact of technical barriers to trade on international trade has industry differences. Compared with agricultural products industry, technical barriers to trade have a more obvious role in promoting high-tech products industry. Secondly, the impact of technical barriers to trade on international trade varies from country to country. Compared with developed countries, the technical barriers to trade implemented by developing countries as product importers promote trade, but as product exporters, they are more vulnerable to the negative impact of technical barriers to trade in importing countries. At the same time, scholars quantify the technical barriers to trade by selecting relevant indicators, and conduct empirical research by using different models, and think that the impact of technical barriers to trade on international trade has two aspects: positive promotion and negative inhibition.

1.3 The impact of technical barriers to trade on the export of products

According to the research content of this paper, we will focus on the research on the

influence of technical barriers to trade on the export of high-tech products by different scholars in recent years.

Cai Jingjing et al. (2017) investigated the impact of technical barriers to trade of importing countries on the export of high-tech products in China through the extended trade gravity model. The empirical data of high-tech industries in 22 trading partners of China from 2000 to 2015 are used. The cumulative notification number of technical barriers to trade in trading partners, the index of intellectual property protection and the bias effect of technical barriers to trade in importing countries on China's high-tech products exports are taken as the core explanatory variables, while other control variables include exchange rate and technological innovation ability. The results show that the technical barriers to trade or intellectual property protection of importing countries are negatively related to the export of high-tech products in China, but the inhibitory effect is not significant. However, if importing countries combine technical barriers to trade with intellectual property protection (partial effect), the export inhibition of high-tech products in China will be significantly improved; In addition, technical barriers to trade show industry differences in the export of high-tech products in China [7, p. 8].

Xu Wei et al. (2018) studied the pharmaceutical manufacturing industry in China from 2004 to 2016, and made an empirical analysis on relevant panel data by using the evolutionary game model, and concluded that the promotion of technical barriers to trade to technological innovation in exporting countries had a two-year lag period. At the same time, after a detailed study of China in different regions, it was found that the innovation promotion of technical barriers to trade was most obvious in central China [54, p. 6].

Cai Hongbo and others (2020) take the trading partner countries of free trade

agreements as the research object, and quantify the technical barriers to trade by using the natural language text processing method. They think that the higher the cooperation degree of technical barriers to trade, the more significant the promotion effect on the export growth of China's high-tech products, but it is limited to the overseas markets where high-tech products have entered; In addition, through the empirical analysis and comparison of the impact of technical barriers to trade between high-tech industries and low-tech industries, it is found that the export promotion of high-tech industries is stronger than that of low-tech industries [6, p. 11].

Fu Shaojun et al. (2020) based on the panel data of 45 major exporters of high-tech products in China, selected the notification volume of technical barriers to trade in all industries of importing countries as the core explanatory variable, and the market size, opening degree and monetary indicators of importing countries as the dependent variables, to investigate the impact of technical barriers to trade on the export of high-tech products in China. It is found that technical barriers to trade have a double effect: although technical barriers to trade inhibit the export of high-tech products in China as a whole, they lag behind for a period and then become a promotion [18, p. 10].

Xiong Yiqun and others (2024) believe that the impact of digital trade barriers on the quality of China's telecommunications export products is heterogeneous. Among the various classified indicators of digital trade barriers, infrastructure and connectivity digital trade barriers, payment system digital trade barriers, intellectual property digital trade barriers and other digital trade barriers have a positive role in promoting the quality of China's telecommunications export products; The coefficient of digital trade barriers in electronic transactions is negative but not significant. In terms of the per capita national income level

of export destination countries, digital trade barriers will inhibit the improvement of the quality of China's export products to high-income countries; The regression coefficient of the core explanatory variables in upper-middle income countries is positive but not significant. In terms of product quality, digital trade barriers are not conducive to upgrading the quality of high-quality communication products exported from China; The regression coefficient of the core explanatory variables of low-quality communication products exported from China is positive but not significant [52, p. 47].

Wang Yiqing et al. (2024) came to the conclusion that the impact of digital trade barriers on the quality of China's manufacturing export products is heterogeneous at the national, industrial and product levels. From the national level, digital trade barriers have made a significant contribution to the quality of manufacturing products exported from China to developing countries, but not to the quality of products exported to developed countries. From the industry level, digital trade barriers have different degrees of inhibition on the product quality of labor-intensive, capital-intensive and technology-intensive industries, but labor-intensive industries have the strongest inhibition, followed by capital-intensive industries and finally technology-intensive industries; From the product level, digital trade barriers mainly inhibit the quality improvement of products far from the world's leading edge, but have little inhibitory effect on the quality improvement of products close to the world's leading edge [48, p. 66].

To sum up, scholars have not reached a unanimous conclusion through empirical research. Some scholars have found that technical barriers to trade have a restraining effect on the export of high-tech products in China, while some scholars have come to the opposite conclusion that technical barriers to trade have a promoting effect on the export of high-

tech products in China, or the promoting effect will be realized in the future.

Through consulting a large number of documents, it is found that there are many factors that affect the export of high-tech products in China, including the investment in research and development of high-tech products, the technical level and technological innovation ability of exporting countries, and economic policies. This paper will focus on the impact of technical barriers to trade in economic policies on the export of high-tech products in China.

The impact of technical barriers to trade on export trade varies from industry to country. It is found that for different industries, due to product heterogeneity, technical barriers to trade generally inhibit the export of agricultural products in China and promote the export of manufacturing industries; For different countries, the technical barriers to trade implemented by developing countries as importers of products promote trade, but as exporters of products, they are more vulnerable to the negative impact of technical barriers to trade in importing countries. At the same time, technical barriers to trade have a dual impact on trade. If the exporting country fails to meet the requirements of the importing country's technical barriers to trade, it will directly have a quantitative inhibitory effect on the exporting country. If the exporting country adds the increased compliance cost to the price of export commodities, it will have a price suppression effect; If enterprises in exporting countries make rational use of the information disclosed by technical barriers to trade and carry out technological innovation to improve the quality of export products and meet the technical requirements of importing countries, it will promote trade. It is precisely because technical barriers to trade have a dual impact on international trade, and at the same time, scholars' conclusions on the impact of technical barriers to trade on the export of high-

tech products are not uniform in recent years, so it is of great practical significance to further explore the impact of technical barriers to trade on the export of high-tech products in China from the theoretical and empirical perspectives.

Chapter 2 Technical barriers to trade influence mechanism

2.1 Quantitative inhibition effect

With the wide use of technical barriers to trade in international trade, the impact of technical barriers to trade on international trade has gradually become the focus of research. Firstly, this chapter summarizes the technical barriers to trade, and expounds the definition, causes and development status of technical barriers to trade. Secondly, it focuses on how technical barriers to trade affect the export of high-tech products and explores the influence mechanism, which provides a theoretical and logical basis for the following research.

Technical Barriers to Trade (TBT) refers to a series of voluntary or compulsory technical measures taken by a country or a region to protect its social environment, product quality in its market, health and safety of its residents, and national or regional security. Technical barriers to trade will have a certain impact on the entry of goods and services from other countries or regions.

Technical barriers to trade are flexible. When implementing technical barriers to trade, importing countries can set targeted regulations for some countries, thus boycotting export products. At the same time, the technical standards issued by importing countries may be uncertain, which will make it difficult for exporting countries to grasp the export conditions. Improper use of technical barriers to trade is not conducive to the free circulation of world resources and the division of international trade, and at the same time hinders the technological exchanges and progress of all countries in the world.

Technical barriers to trade mainly include technical standards and regulations, conformity assessment procedures, information technology barriers and green technology

barriers. Among them, technical standards mainly refer to the production rules, guidelines or characteristic documents approved by recognized institutions or commonly used; Technical regulations mainly refer to the characteristic documents of related products that must be enforced; The conformity assessment procedure mainly refers to the certification that products meet technical regulations or standards by a third-party authorized institution recognized by both parties; Information technology barriers mainly refer to the obvious advantages of developed countries in e-commerce technology level and application degree, while some developing countries and underdeveloped countries may lead to opaque information and untimely information transmission when exporting, thus having a negative impact on exports; Green technology barriers to trade mainly refer to direct or indirect restrictive measures taken by importing countries to protect the environment.

As countries all over the world gradually realize that international standards and conformity assessment systems can promote the development of international trade by improving production efficiency, the international community hopes to encourage the development of international standards and conformity assessment systems. Therefore, through the Agreement on Technical Barriers to Trade, members are strongly encouraged to base their technical barriers to trade on international standards to facilitate trade, so as to ensure that these measures (technical regulations, technical standards, certification procedures, etc.) will not cause unnecessary obstacles to trade. Through its transparency provisions, the establishment of TBT agreement also aims to create a predictable trading environment. The establishment of relevant technical regulations, standards and inspection procedures in the WTO is mainly aimed at protecting the national security of all countries and the interests of consumers, and has legitimacy.

There are many reasons for technical barriers to trade, including (1) political factors: the government can often achieve national interests and political goals through technical barriers to trade, and restrict foreign competitive products from flowing into the domestic market on the grounds of public interests to protect the development of domestic industries. At the same time, with the growing opposition to free trade in some countries, technical barriers to trade have gradually evolved from agreements regulating commodity standards to means of trade protectionism, and many malicious and unreasonable technical barriers to trade have been derived; (2) Scientific and technological factors: With the deepening of international trade in recent years, the goods in the trade market have gradually changed from labor-intensive products to technology-intensive products. The rapid development of the world economy and the continuous improvement of the technical level of various countries have created conditions for the proposal of technical barriers to trade. Due to the different development speeds of countries, the technical level of countries is gradually widening, and importing countries can regulate the quality of products flowing into China through technical barriers to trade; (3) Social factors: Technical barriers to trade can create a predictable trading environment and regulate the trading commodity market. Due to the uneven technical standards and product quality in different countries, sanitary standards and other requirements are inconsistent. In order to protect the health and safety of domestic consumers, technical barriers to trade can well prevent unqualified goods from flowing into the domestic market, thus effectively protecting human health and social environment. For example, all countries in the world have formulated quarantine inspection regulations for imported goods, which can effectively prevent unqualified and unsafe food imports; At the same time, consumers' demand for goods has gradually shifted from attaching importance

to price to attaching importance to green, environmental protection and sustainable development, especially in developed countries.

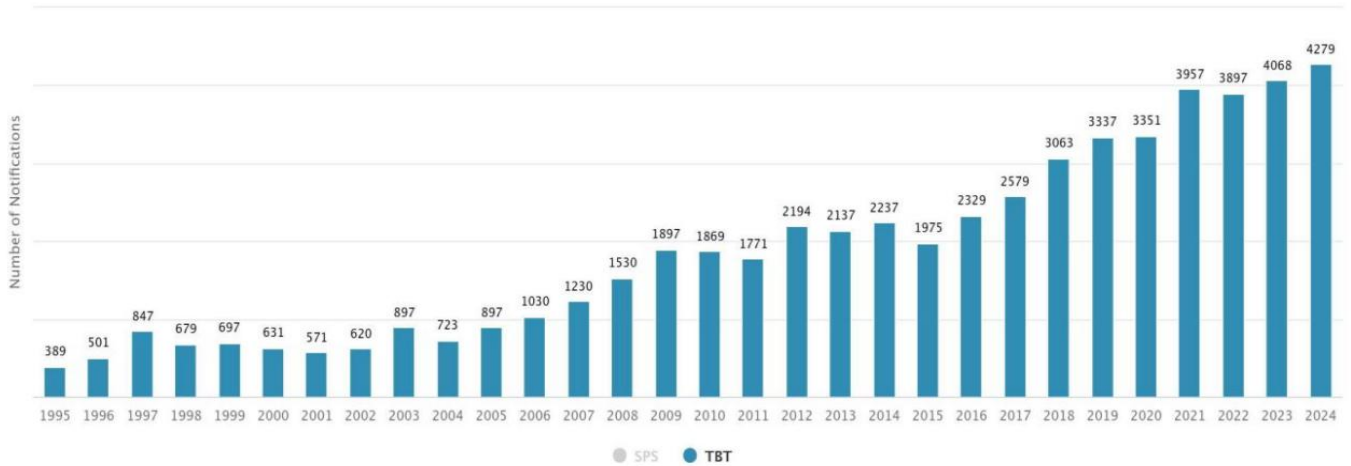


Figure 2.1 – Global Technical Barriers to Trade Notification from 1995 to 2024 [19]

As shown in Figure 2.1, from 1995 to 2024, the notification volume of global technical barriers to trade showed an overall upward trend, and technical barriers to trade gradually became the preferred means of trade protectionism in all countries of the world. From 2016 to 2021, the number of notifications of global technical barriers to trade continued to grow for six consecutive years, with the fastest growth rate in 2018, with a year-on-year increase of 23.3%. In 2019, the number of notifications of global technical barriers to trade reached 3,337, and the total number of notifications reached an all-time high. In 2022, the number of notifications of global technical barriers to trade increased negatively for the first time in the past seven years. The possible reason is that the outbreak of COVID-19 led to the global economic downturn, and international trade was facing severe challenges. At the same time, countries paid more attention to more serious issues such as epidemic prevention and control. From 2022 to 2024, the number of notifications of

global technical barriers to trade continued to grow, reaching a historical high of 4,279 by December 2024.

2.2 Price inhibition effect

Quantity inhibition effect, that is, technical barriers to trade restrict the inflow of substandard goods into the market through mandatory standard regulations, technical regulations, etc., and set up strict technical compliance review, which hinders the export of related goods in exporting countries to some extent, making exporting countries have to improve the quality of export goods in order to meet the relevant requirements of importing countries, thus increasing the conformity cost of export goods, which will hinder the export of goods in exporting countries in a short time. This conformity cost should have a restraining effect on the probability and flow of export of exporting countries.

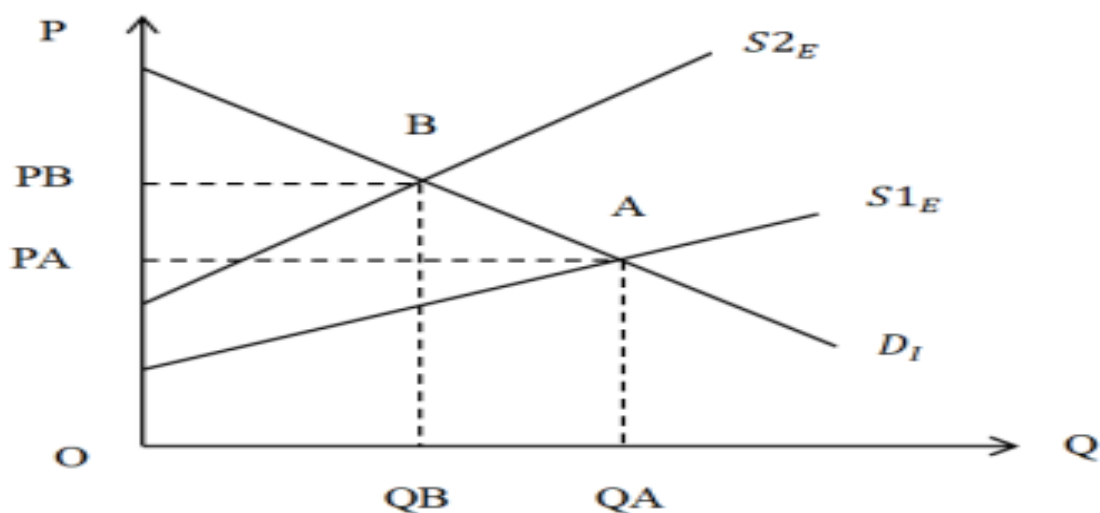


Figure 2.2 – Quantitative inhibition effect of technical barriers to trade
[25, p. 10].

As shown in Figure 2.2, $S1_E$ is the supply curve of the exporting country and D_I is the

demand curve of the importing country. Before the importing country implements technical barriers to trade, the importing country and the exporting country reach an equilibrium state at point A, the export price of the product is P_A , and the export value of the exporting country to the importing country is Q_A . When the importing country implements trade barriers, if the exporting country wants to continue exporting to the country, it must improve the relevant technical standards of the goods to meet the requirements of the importing country, that is, the conforming cost of the exported goods will increase, and the supply curve will move to S_{2E} to the left at this time. Assuming that the demand remains unchanged at this time, the two countries will reach a new equilibrium at point B, and the export price of products will increase to P_B and the export volume will also decrease to Q_B .

Technical barriers to trade implemented by importing countries may contain mandatory standards, while suppliers in exporting countries find it difficult to comply with mandatory standards, so they are prevented from entering the market, thus benefiting domestic producers.

If, due to the implementation of technical barriers to trade, the exporting country fails to meet the technical standards of the importing country in a short period of time, and the exporting country abandons its trade with the importing country, the trade volume between the two countries will be reduced to zero. Generally speaking, compared with enterprises with large business scale, strong economic strength and strong technological innovation ability, small and medium-sized enterprises with single production level, high dependence on foreign trade and weak technological innovation ability are more vulnerable to technical barriers to trade in importing countries.

Price inhibition effect, that is, with the increase of commodity export cost in exporting

countries, the profit of exporting countries will gradually decrease, at this time, the supply curve shifts to the left and the commodity export price increases; If, at the same time, the export country shifts the increase of production cost to the sales price of export commodities, when the export commodity price of the export country exceeds the price of the same commodity in the importing country, the export country's commodities will lose their competitiveness, which will lead to the decline of sales of enterprises in overseas markets and hinder exports.

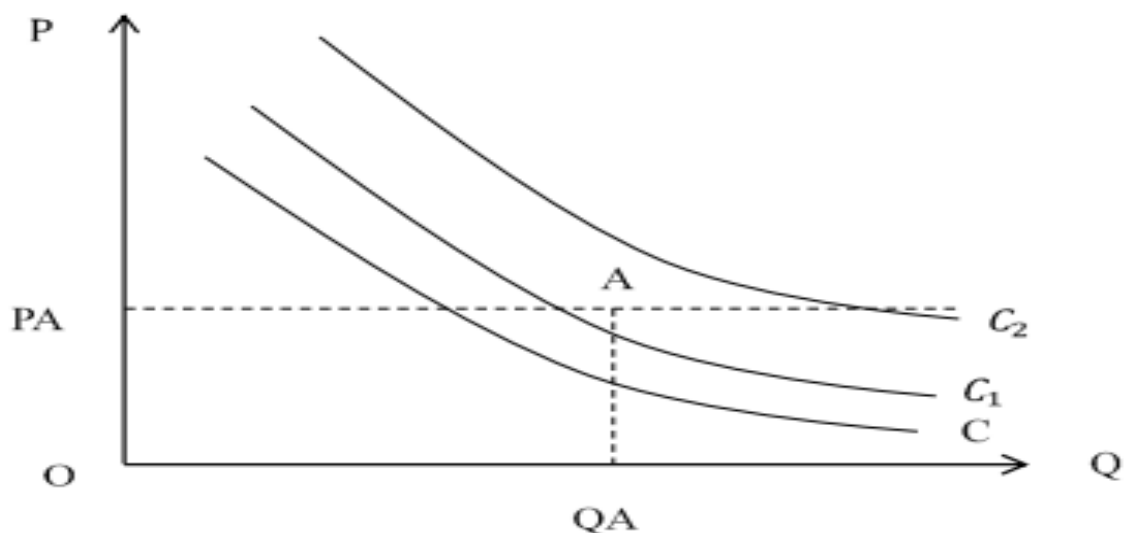


Figure 2.3 – Price Suppression Effect of Technical Barriers to Trade [25, p. 15].

As shown in Figure 2.3, when the importing country does not implement technical barriers to trade, the unit cost of export commodities is curve C, the price of export commodities in the exporting country is PA, the export volume is QA, and the net profit of export products is $PA - C$; When the importing country implements the technical barriers to trade, the exporting country produces the relevant conforming cost C' in order to improve the quality of goods to meet the standards, which makes the unit cost curve of export goods

move up. If $C+C'$ (curve C_1) $< PA$, the unit income of export goods will decrease C' . If $C+C'$ (curve C_2) $> PA$, the export goods will lose their competitiveness, thus inhibiting exports, or even [49, p. 12].

The quantity and price restraint effect of technical barriers to trade will jointly affect trade. From the dynamic process, the implementation of technical barriers to trade will lead to export obstacles in a short period of time, which will be affected by the quantity restraint effect. When the exporting countries carry out technological innovation according to the new technical standards, improve the quality of goods and cross the technical barriers to trade, the price restraint effect of technical barriers to trade will appear. When the technical barriers to trade at this time become universal technical standards, the countries with leading technical levels will implement new technical barriers to trade again. With the continuous innovation and development of technology, technical barriers to trade will continue round after round [58, p. 30].

Trade promotion effect. Posner (1961), an American economist, believes that technology is independent of labor and capital, and the gap between countries' technological development affects the international division of labor. Countries with strong technological level have comparative advantages in exporting technology-intensive products, but this gap in technological level will gradually narrow with the imitation of countries with backward technological level until the gap in technological level disappears. The technology gap theory explains that the importing country sets up technical barriers to trade to protect its own market because of the different technical levels between the importing country and the exporting country, so as to prevent the goods that do not meet the technical requirements from flowing into its own market. Although importing countries set obstacles to exporting

countries through technical barriers to trade, imitation time lag shows that the smaller the gap between the two countries' technical levels, the shorter the time lag required for them to reach the same technical level. If exporting countries make rational use of technical barriers to trade and improve the quality of their exports to meet relevant technical requirements, the possibility of trade between the two countries will be greatly increased.

Technical barriers to trade (TBT) have the function of information disclosure, which creates a predictable trading environment for international trade between the two countries, improves the transparency of product information, reduces the uncertainty of importing countries' markets, and makes export enterprises adopt higher technical standards to better respond to foreign consumers' preferences for environmental protection and high-quality products through the mandatory provisions of TBT, which plays a role in ensuring the quality of export products and increasing consumers' confidence. And in the long run, the implementation of technical barriers to trade only represents the temporary technical lead of the importing country. If the exporting country can make reasonable use of technical barriers to trade, it may stimulate the technical level of the exporting country to improve through the reverse mechanism, so as to make the products meet the relevant requirements of the importing country, thus gaining the trust of consumers in the importing country and stimulating the increase of demand, thus promoting trade flow.

In order to protect the domestic commodity market and intellectual property rights, the implementation of technical barriers to trade in importing countries is usually in the stage of commodity standardization, that is, the exporting countries have completed the process of learning technology, investment and production, and put the final products on the market. If the exporting countries take active actions at this time, make good use of the

information disclosure function when the technical barriers to trade are implemented, understand the relevant requirements and the latest market trends of the importing countries, actively learn and adopt advanced technologies to break through the technical barriers to trade of the importing countries, so that the products can meet the relevant technical standards of the importing countries, and at the same time have the opportunity to enhance the confidence of consumers in foreign markets, so as to promote exports.

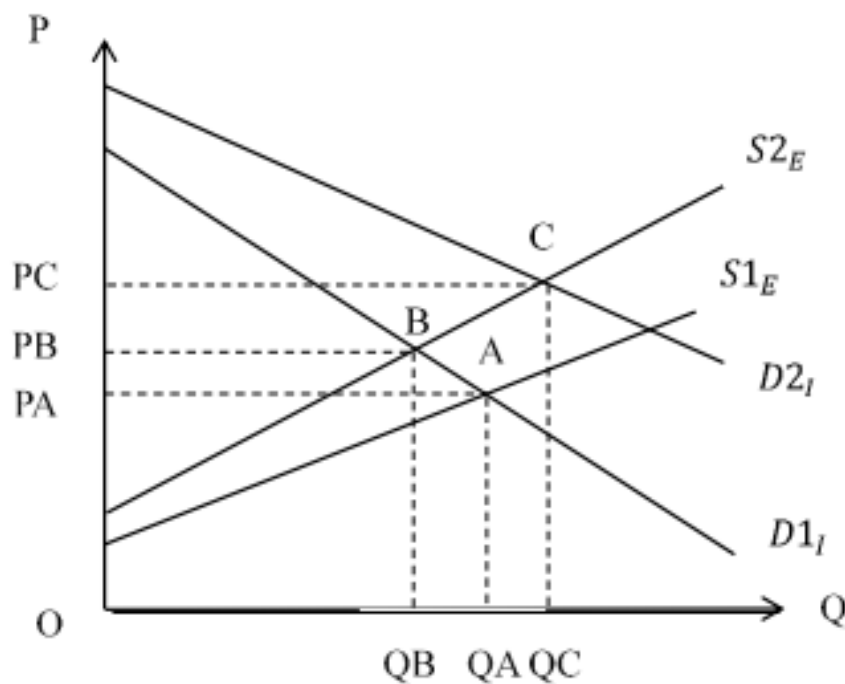


Figure 2.4 – Trade Promotion Effect of Technical Barriers to Trade [25, p. 18].

As shown in Figure 2.4, the initial equilibrium point between the importing country and the exporting country is the junction point A between $S1_E$ and $D1_I$, at which time the commodity price is PA. If the exporting countries make rational use of the information disclosure function of technical barriers to trade and regulate the export commodities, they will have the opportunity to trade with the importing countries. However, due to the increase in the conformity cost of commodities, the supply curve of exporting countries will shift

from $S1_E$ to $S2_E$, the price of commodities will rise to P_B , and the sales volume will decrease from Q_A to Q_B . Due to the implementation of technical barriers to trade, the quality of goods flowing in the importing country's market has improved, and higher technical standards have also increased consumer confidence and better met the needs of consumers. At the same time, the goods of exporting countries and the local goods of importing countries have gradually become heterogeneous, the enterprises that fail to meet the standards of importing countries have gradually been expelled, and the enterprises of exporting countries have gradually occupied more market share, and consumers' willingness to buy has become stronger. Therefore, the demand curve of importing countries has shifted from $D1_I$ to $D2_I$, and a new equilibrium has emerged between importing countries and exporting countries at point C, the commodity price increases to P_C , and the sales volume increases Q_C .

To sum up, the impact of technical barriers to trade on international trade flow may be uncertain. Technical barriers to trade have dual effects on trade. If the exporting country can't break through the technical barriers to trade in a short time, it will have a quantitative inhibitory effect on trade, which will lead to the exporting country's inability to export to the importing country; If the exporting country overcomes the impact and challenge brought by the technical barriers to trade of the importing country through technological upgrading and continues to export, but the price of the exported goods will increase and the competitiveness of the exported goods will be reduced, which will have a price suppression effect on trade.

Chapter 3 Analysis of the present situation of high-tech industries in China

3.1 Analysis of Technical Barriers to Trade

This chapter provides an overview and analysis of the current situation of technical trade barriers and the current situation of China's high-tech industry through a large number of data comparisons, discusses the reasons and effects of technical trade barriers faced by China's high-tech industry, and lays the foundation for the analysis later.

Evaluation of the overall situation of technical barriers to trade. While the trade of high-tech products is growing rapidly around the world, there are various restrictions on the trade policies of high-tech products formulated by various countries, which have caused serious impact on the global economy. How to evaluate the trade restrictions of high-tech products in various countries has become a hot topic for experts. At present, the main index systems to measure the level of technical barriers to trade include the digital service trade restriction index (DSTRI), the digital product trade restriction index (DTRI) and the global high-tech product trade promotion index. From the time dimension, DSTRI can cover the data from 2014 to 2022, showing the timeliness and richness of its data. In contrast, DTRI and the global high-tech products trade promotion index have limited years of public data, so it is slightly insufficient to evaluate the level of technical barriers to trade. In view of this, this paper chooses DSTRI index as the research basis to support the subsequent in-depth analysis. DSTRI was released by the OECD in 2019, and quantitatively evaluated the degree of technical barriers to trade in 46 economies, including 36 OECD countries and 10 non-OECD countries. By 2022, DSTRI has identified, catalogued and quantified the level of technical barriers to trade in 85 countries, including China. These barriers involve 22 service

industries, including telecom financial services, computer services, music and film services, logistics and legal services. The construction process of DSTRI index includes three core steps: scoring, weighting and summarizing. In the scoring stage, the binary system is adopted, and the case without trade restrictions is assigned to 0, and the case with restrictions is assigned to 1. At the same time, the scoring process also needs to comprehensively consider the specific regulatory and market characteristics, as well as the correlation and hierarchical structure between the indicators. For example, when there is no supplier with SignificantMarketPower (SMP), if the interconnection measures are still limited, the corresponding score is 1, otherwise it is 0. In the presence of significant market forces, if any measure is limited, the score is 1, and if there is no limit, the score is 0. After the scoring is completed, the weights are assigned according to the importance of the five sub-sectors of technical barriers to trade in high-tech products, and finally the technical barriers to trade index of each country is obtained through weighted summary. The DSTRI index creates a more diversified and competitive market environment for the development of digital trade by identifying and eliminating regulatory bottlenecks, which can help policy makers maximize the benefits of digital transformation.

Based on the trade restriction index of high-tech products published by OECD, this paper mainly analyzes the restriction levels of major countries in the world, as shown in Figure 1. From the national level, the level of technical barriers to trade in developed countries such as Australia, Britain and the United States is relatively stable, while the level of technical barriers to trade in developing countries such as China and India is increasing year by year. This may be because the developed countries, such as Britain and the United States, are developed in capital and information technology, and tend to build a free and open trade

market for high-tech products, and their trade level of high-tech products is relatively high. In contrast, developing countries are relatively backward in the development of digital industry, and often take stricter measures to protect local data security and digital industry, resulting in a higher degree of technical barriers to trade. In addition, as can be seen from the table, the average degree of trade restrictions on high-tech products in China is 0.269, with an overall increase of 67.39% and an average growth rate of 7.49% during the nine-year period. By 2022, China's DSTRI index will grow to 0.308, and it will continue to grow, indicating that the trade scale of high-tech products in China is increasing, while the technical barriers to trade are becoming more and more serious, and there are many restrictions on market access. Although China's high-tech product economy has been catching up rapidly in recent years and has made great achievements in the field of high-tech product trade, there is still much room for improvement compared with other technological powers in the world in terms of digital infrastructure construction quality, key technology research and human capital investment, market and regulatory environment optimization. Therefore, under the background of the increasingly open global economy, China should further optimize the market and regulatory environment, improve the policies and standards of high-tech products trade, and promote the export of high-tech products and digital products.

Evaluation of technical barriers to trade in different fields. Infrastructure connectivity. Infrastructure connectivity barrier means that due to various factors such as technology, policy, economy and culture, infrastructure cannot be effectively connected in the process of construction and operation, which further affects the coordinated development of regional economy. These barriers may be manifested as inconsistent technical standards, insufficient

policy coordination, insufficient capital investment and cultural differences. The high-quality construction of infrastructure plays an important role in the development of high-tech product trade, which can promote the development and innovation of digital technology, improve the efficiency and security of high-tech product trade, and reduce the search cost of high-tech product trading enterprises. However, infrastructure connectivity barriers will hinder the free circulation of goods and services, lead to rising trade costs and affect market efficiency. Especially in regional or transnational trade, barriers may hinder the originally realizable trade activities and limit the expansion of the market scale. In addition, when the connectivity of infrastructure is insufficient, the flow of production factors such as talents, technology and capital will also be restricted, which may lead to the reduction of resource allocation efficiency and affect the improvement of production efficiency and industrial upgrading.

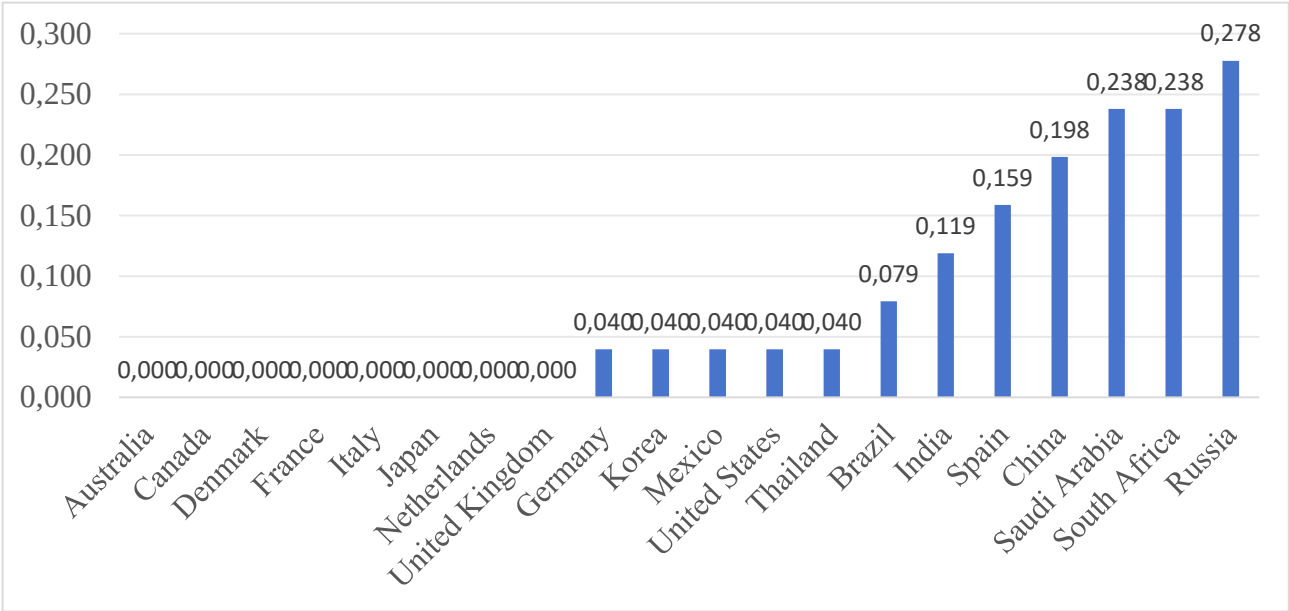


Figure 3.1 – DSTRI Index of Infrastructure and Connectivity in major countries in 2022 [27]

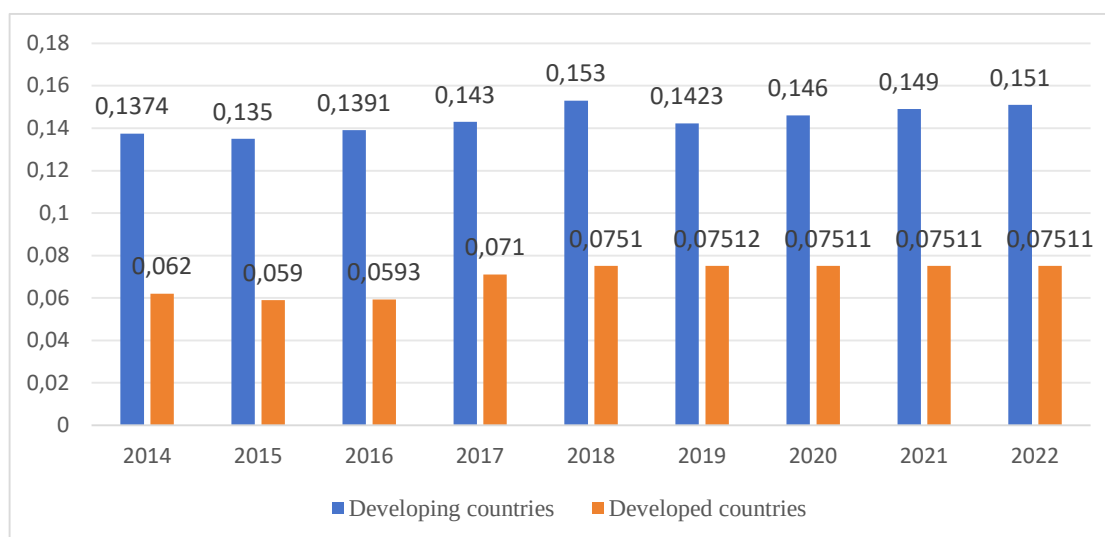


Figure 3.2 – DSTRI index of Infrastructure and Connectivity in developed and developing countries [36]

Figure 3.1 shows the technical barriers to trade index of major countries in the field of infrastructure connectivity in 2022. As can be seen from the figure, the technical barriers to trade index of these countries in this field is between 0 and 0.35 in 2022, of which the highest index is Russia, and the DSTRI index is 0.278; Followed by 0.238 in South Africa and Saudi Arabia, the lowest index is 8 countries such as Canada, and the limit in the field of infrastructure connectivity is 0. Figure 3.2 is the average index of technical barriers to trade in infrastructure connectivity in 85 countries divided into developed and developing countries published by OECD. By comparison, it can be found that the index of developing countries in this field is relatively high from 2014 to 2022, with the average index exceeding 0.12; The average value of technical barriers to trade index in developed countries is lower than 0.08. By analyzing these data, it can be found that developing countries are generally not perfect in Internet infrastructure and lack of security supervision. In order to protect their own data security, these countries tend to increase the level of data circulation restrictions. However, developed countries tend to reduce the restrictions on the cross-border circulation

of data in various countries because of their advanced technology and perfect digital infrastructure construction.

Electronic transactions. Electronic transaction barriers usually refer to various obstacles that make it difficult for both parties to conduct electronic transactions smoothly due to technical, legal, cultural and economic differences and restrictions in the process of electronic transactions. The popularization of electronic transactions can reduce transaction costs and prices, improve efficiency, and make transactions with high costs or difficult implementation feasible. At present, with the rapid expansion of the scale of international trade, tariffs and customs clearance procedures have greatly increased the cost of trade, and paperless electronic transactions can make exports more convenient. In addition, the tariff exemption of electronic transmission can also greatly reduce the market expansion cost of each enterprise, gain price advantage and optimize the export product structure. Electronic signature can ensure that the data in the transaction process will not be tampered with or forged, and improve the security of the transaction. Especially in cross-border transactions, electronic signature helps to prevent information leakage and fraud, thus enhancing the reliability of transactions.

As can be seen from the data in Figure 3.3, the technical barriers to trade index of all countries in this field is less than 0.045, in which the technical barriers to trade value of developed countries is generally between 0 and 0.025, while that of developing countries is between 0 and 0.045. In addition, South African, Indian, China and other developing countries have the highest barrier index in electronic transactions, reaching 0.042. With the emergence of new formats and modes of e-commerce, the difficulty of transaction and supervision is gradually increasing, which requires the government to issue a series of

policies to strictly license and manage e-commerce activities. Among them, China issued the Electronic Signature Law and the Personal Information Protection Law, which ensured the transaction security of cross-border electronic commerce.

However, judging from the current situation, there is still a gap in the field of electronic transactions in the trade of high-tech products in China. Although China has promulgated and implemented a series of policies to promote the opening of e-commerce, there may be technical differences between different e-commerce platforms and systems, which leads to the smooth flow of transaction data and information. Electronic transactions involve data privacy, network security, protection of consumers' rights and interests, etc., and sound laws, regulations and supervision mechanisms are needed to ensure fairness, transparency and security of transactions. At present, the laws and regulations in some key areas still need to be further refined and improved to meet the needs of the rapid development of trade in high-tech products. Therefore, in order to make up for these gaps, China needs to continue to strengthen technology research and development, improve laws and regulations, strengthen data protection and privacy security, and promote the healthy development of high-tech products trade and electronic transactions.

Payment system. As the core component of modern financial transactions, the efficiency and security of payment system directly affect the normal economic activities. The rise of trade in high-tech products has gradually transformed the traditional payment method into electronic payment method. Different from the traditional payment method, electronic payment is based on the Internet and uses advanced technology to complete information transmission through digital circulation, which is convenient, fast, efficient and economical. However, due to the inconsistency of technical standards and interfaces, as well

as the challenges of network security and data protection, the interconnection between different payment systems faces obstacles.

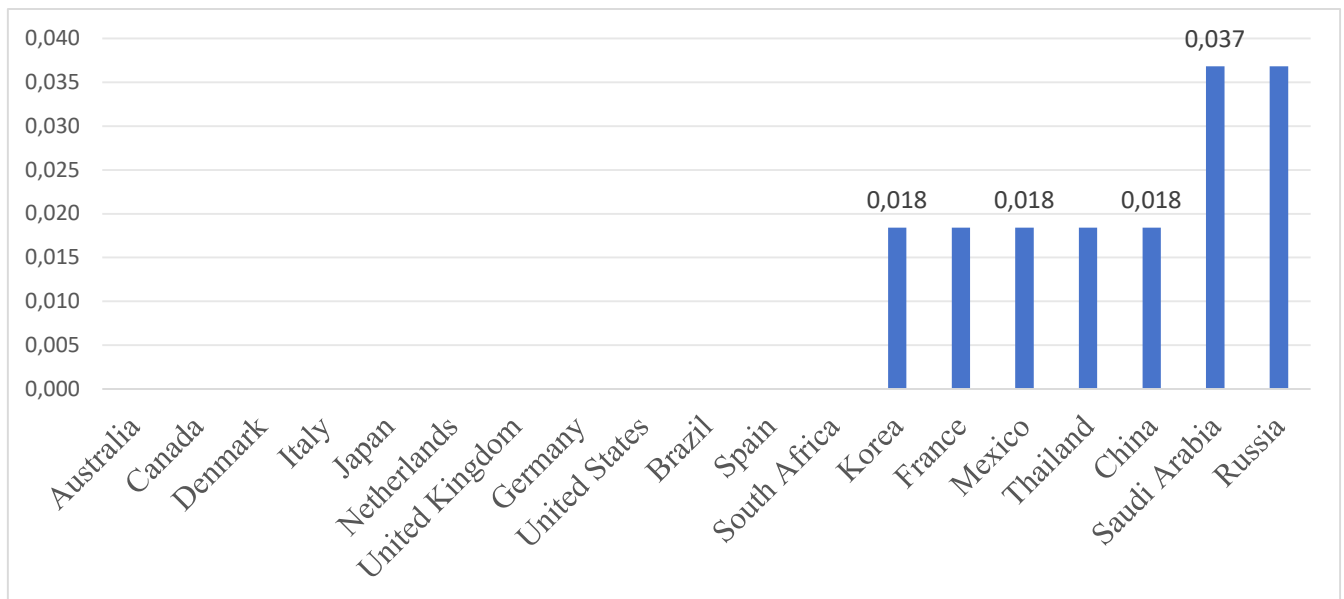


Figure 3.3 – DSTRI Index of payment Systems in major countries in 2022 [27]

Figure 3.3 shows the digital trade barriers in the field of payment system policies in major countries. It can be seen that the value of barriers in the field of payment system in various countries is generally low, mainly in the range of 0 to 0.04. This means that most countries have not set significant restrictions in the field of payment systems, and the degree of openness is relatively high. Among them, Russia and Saudi Arabia have the highest technical barriers to trade index in payment system, reaching 0.037; Developing countries such as China, Thailand and Mexico are still at a high level of barriers in the field of payment systems. Nowadays, although China gradually promotes the introduction of laws and regulations and management methods related to electronic payment every year, there are still imperfect supervision systems and hidden dangers in payment information security. Therefore, in the future development process, it is necessary to make rigid regulations on

consumer funds and information security in electronic payment, adhere to the principle of full opening in the field of electronic payment, implement national treatment before entry and negative list management system, and actively promote the opening up of this field by means of significantly relaxing market access.

(4) Intellectual property rights. The so-called intellectual property barrier refers to the fact that in the name of protecting intellectual property rights, it imposes import restrictions on goods containing intellectual property rights, or abuses its intellectual property advantages, which has a far-reaching impact on international trade. Such barriers are characterized by concealment, regionality and stages.

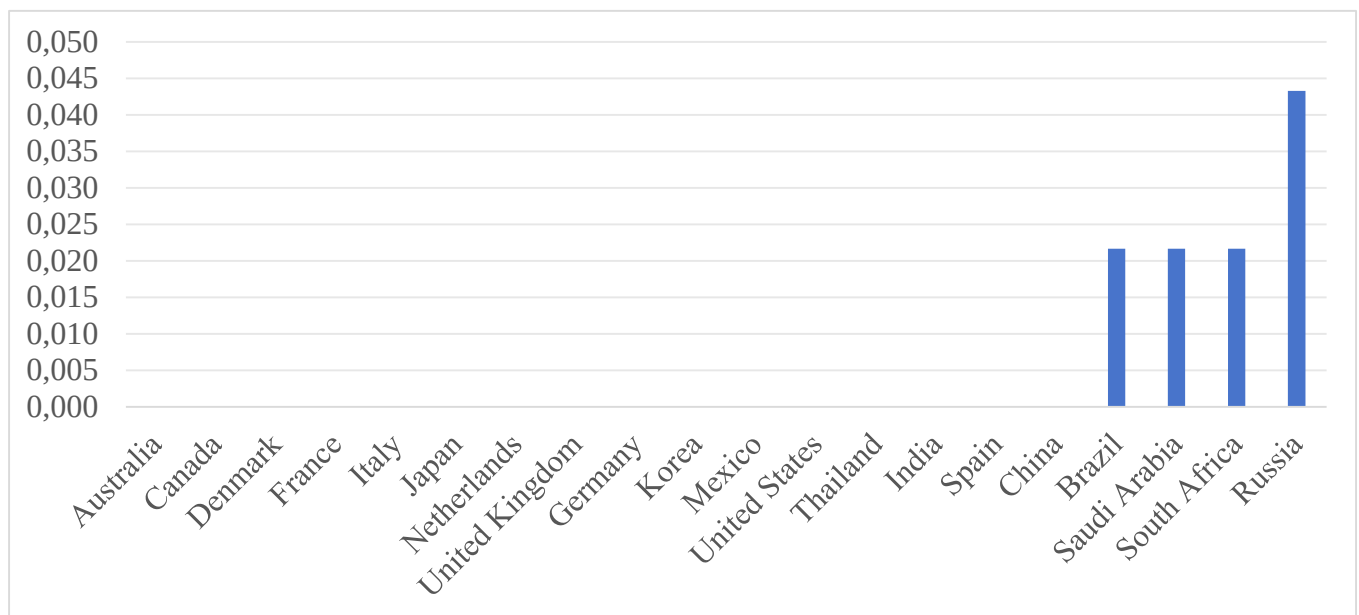


Figure 3.4 – The DSTRI Index of major countries in intellectual property rights in 2022 [27]

Figure 3.4 shows the trade restriction index of high-tech products in the field of intellectual property rights in major countries in 2022. It can be seen from the data that the

value of each country in this field is generally small, and the index value of more than half of the countries in this field is zero, which shows that these countries have not imposed access restrictions on foreign entrants due to the improvement of intellectual property rights. Among them, the country with the highest index is Russia, with a value of 0.043. In addition, in 2022, China's restrictions in the field of intellectual property rights will be zero, because intellectual property rights are the strategic resources for national development and the core elements of international competitiveness. China attaches great importance to intellectual property protection, and the legal system of intellectual property rights has been continuously improved and the protection efforts have been continuously enhanced. At the same time, in recent years, China's intellectual property services have become more open to the outside world, and international cooperation in intellectual property rights has continued to deepen. China has become a staunch defender, an important participant and an active builder of international rules on intellectual property rights.

Other barriers affecting the trade of high-tech products. In addition to the above four technical barriers to trade, there are various other barriers that affect the trade of high-tech products. First, it affects the performance requirements of cross-border digital trade. Some countries or regions may require foreign enterprises to use specific local software or encryption technology in their own markets, or require foreign enterprises to transfer key technologies when entering their own markets through regulations or policy means. Second, the restrictions on downloading and streaming media. Some countries may impose strict censorship and filtering systems on Internet content and restrict the access and downloading of foreign digital content, which not only affects the market access of digital content providers, but also limits consumers' right to choose. In addition, in some areas, due to

backward infrastructure or policy restrictions, Internet bandwidth may not be able to meet the needs of large-scale digital content transmission. Third, the restrictions on the regulatory standards and requirements of online advertising have led advertisers to adjust their content for different markets. Fourth, there is a lack of effective remedy mechanism for anti-competitive behaviors (including abuse of market dominance and unfair competition) on the Internet.

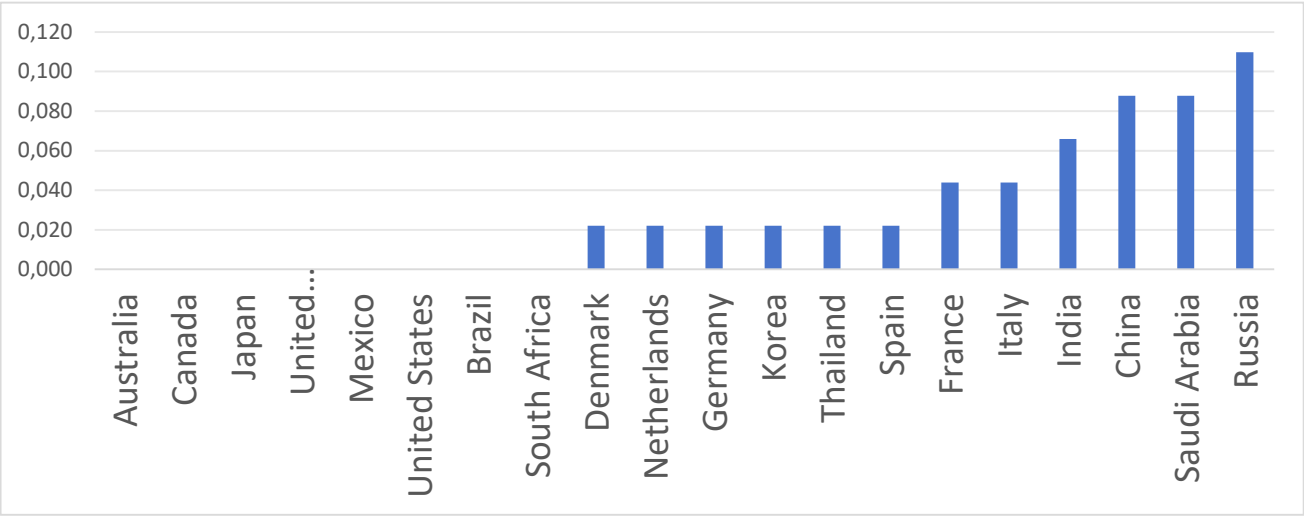


Figure 3.5 – The DSTRI index of other digital trade barriers in major countries in 2022 [27]

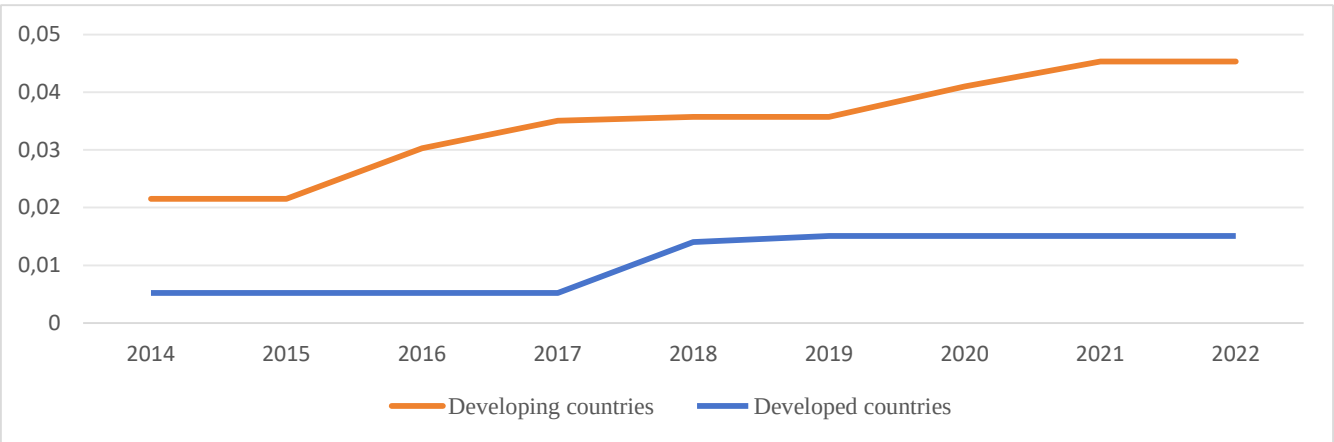


Figure 3.7 – The DSTRI index of developed and developing countries in other barriers from 2014 to 2022[36]

From Figures 3.5 and 3.6, it can be found that the value of barriers in this field is between 0 and 0.12, and the barriers in developing countries are relatively high compared with developed countries. In other technical barriers to trade, China's restriction value is relatively large, reaching 0.088. In addition, China has a wide range of restrictions in this field. For example, China stipulates in the Cyber Security Law that "this law shall apply to the construction, operation, maintenance and use of networks in People's Republic of China (PRC), as well as the supervision and management of network security." This means that the main body engaged in online publishing services must be in China, and there are certain restrictions for other foreign businessmen to enter online publishing services.

Restrictive measures of high-tech products trade in major countries. Influenced by many factors, such as political environment, economic development level, legal system and interest proposition, there are significant differences in technical barriers to trade measures among countries. For example, in terms of cross-border data flow, although the United States advocates the policy of free data flow, it has not completely liberalized the control measures for important domestic data; Russia and some countries in the European Union have imposed stricter supervision measures on data flow. This part mainly analyzes the specific measures taken by the United States, the European Union and China on technical barriers to trade.

The United States. The digital industry in the United States has a solid foundation and has a leading edge in the fields of high-tech product trade and information technology. In terms of cross-border data flow, the United States has identified the free flow of cross-border data as a core clause in the trade rules of high-tech products. In the "Three-country Agreement between the United States, Mexico and Canada", the United States clearly stated

that the State party should not be restricted or forced to implement the data localization policy on the grounds of national security. In terms of intellectual property protection, the United States not only actively promotes the internationalization of domestic high-standard intellectual property protection norms at the legal level, but also takes measures to monopolize and restrict the development of high-tech industries in emerging economies. As the world's leading software service provider, the United States firmly opposes any form of compulsory technology transfer, and has set up a series of trade rules, explicitly prohibiting other countries from making unreasonable demands on enterprises in terms of technology transfer, production processes and other property rights information, so as to ensure the autonomy of enterprises and the fairness of market competition. In terms of personal information protection, the United States has not yet issued a unified privacy protection law, but relies on industry self-discipline and state-level legislation to safeguard personal privacy, and advocates reducing unnecessary interference caused by personal information protection regulations. In terms of digital service tax, the United States conducted a "Section 301" survey on digital service tax implemented or to be implemented in many countries such as Britain, Italy and Brazil to assess its compliance and potential impact.

In principle, the EU supports the cross-border flow of personal data and remains relatively open to the flow of data within the EU to non-EU countries. However, the European Union insists on implementing high standards of privacy protection rules in the network environment, emphasizing that data flow must be carried out under the premise of strict privacy protection. If privacy protection cannot be effectively guaranteed, the cross-border flow of data will be prohibited. In terms of intellectual property protection, the

European Union has formulated a comprehensive intellectual property protection plan mainly based on the exception clauses in the Agreement on Trade-related Aspects of Intellectual Property Rights, which covers patents, trademarks, geographical indications and copyrights, and aims to intensify efforts to crack down on piracy and counterfeit goods and ensure the legality and security of intellectual property rights. In addition, the EU attaches great importance to the protection of source code, and makes it clear that it will not take the acquisition or transfer of software source code as a prerequisite for the market access of digital services, so as to maintain fair competition and innovation vitality in the digital market. In the field of personal information protection, the EU adopted the General Data Protection Regulations in 2016, which was officially implemented in 2018. The adoption of this regulation marks that the European Union has reached an unprecedented height in the protection of personal information and its supervision, and is known as the most stringent data protection bill in history. This regulation sets a new standard for the protection of personal data and privacy information of EU citizens, further strengthens the protection of personal information and its supervision mechanism, and gives data subjects the right to know and access personal data. In the digital service tax policy, the European Union has taken precise and targeted measures, only taxing the income generated by specific digital services with user participation as the core value creation mode, rather than collecting taxes on the overall profits of enterprises in a general way. The implementation of this tax policy will help to distribute the tax burden of the digital economy more fairly and promote the healthy development of the digital economy.

China actively promotes the development of high-tech products trade and constantly improves relevant policies, regulations and institutional systems. In recent years, the

governance framework of cross-border data flow in China has been formed day by day, and the regulations and standards related to cross-border data flow have been continuously introduced. In order to ensure national data security, protect personal information rights and interests, and further standardize and promote the orderly and free flow of data according to law, China's cross-border data circulation rules system is constantly improving. For example, the Cyber Security Law of the People's Republic of China clearly stipulates that the cross-border transmission of personal information must obtain the explicit consent of the subject of personal information in advance, and the overseas recipient must strictly abide by the laws and regulations of China. As a big data country in emerging countries, although China has promulgated the Data Security Law (Draft) on data cross-border, which has established basic norms and principles for data governance, compared with the all-round data strategy and top-level design promoted by the United States and Europe, there is still a certain gap in the construction of cross-border data flow rules system in China. In terms of intellectual property protection, in order to strengthen the protection and management of intellectual property rights, stimulate the vitality of innovation, and promote the construction of a new development pattern, China has promulgated a series of policies and laws, such as the Patent Law and the Trademark Law, and defined the requirements for the application, examination, authorization, protection and management of patents and trademarks. The implementation of these policies and laws has further strengthened the protection of intellectual property rights and promoted the high-quality economic development.

3.2 Development Status of China High-tech Industry

High-tech industry research and experimental development activities' investment is

an important power source for the development and innovation of high-tech products, including R&D funds and R&D personnel.

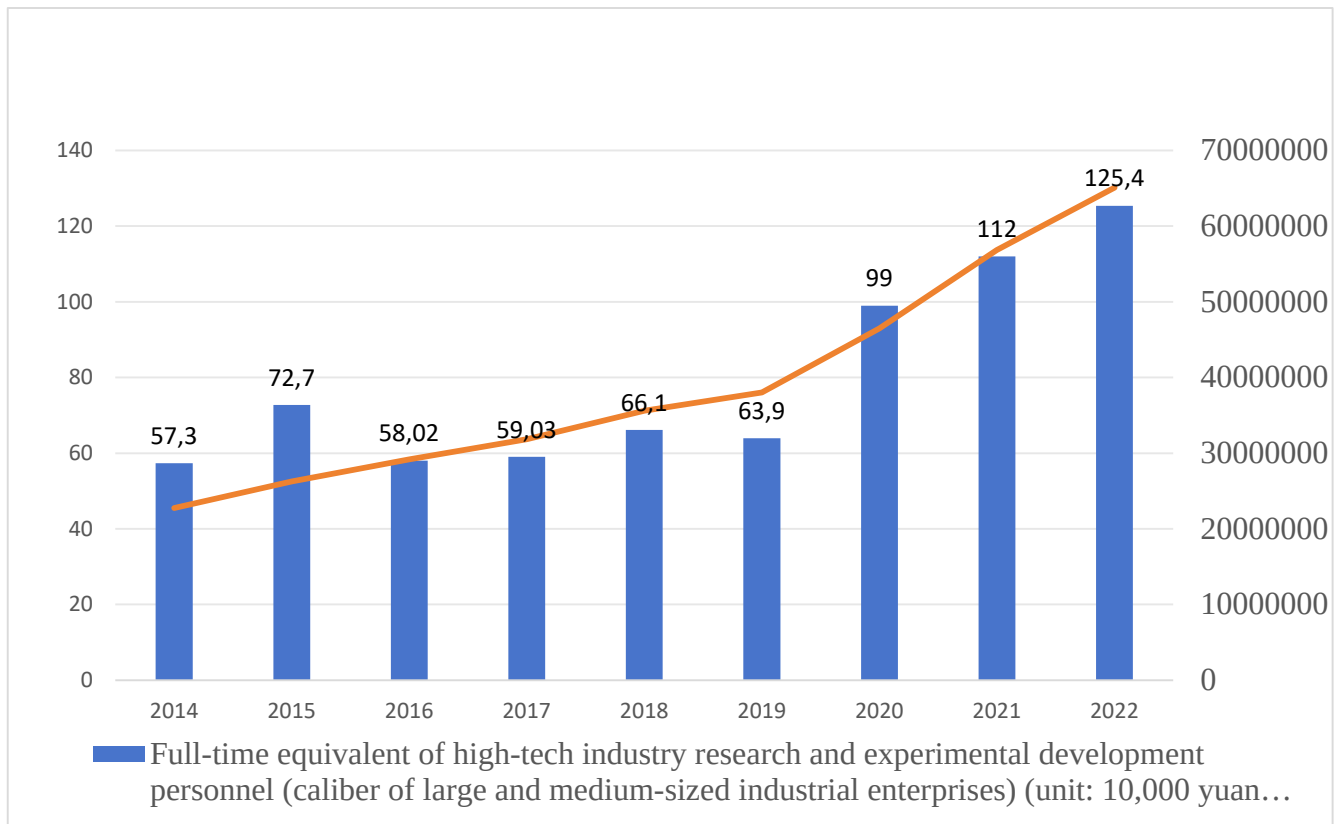


Figure 3.7 –Research and experimental development activities of high-tech industries in 2014–2022 [41]

Compared with the investment of funds, human capital, as a higher-level factor, can directly participate in the product development process and more intuitively affect the quality of high-tech products. The increase of R&D investment can promote the development of high-tech industries, improve the quality of high-tech products, and then improve the export competitiveness of high-tech products.

As shown in Figure 3.8, China's investment in research and experimental development of high-tech industries is on the rise, indicating that the R&D activities of high-tech industries in China have been continuously strengthened. In 2022, the expenditure on research and experimental development of high-tech industries in China reached

650,773.04 million yuan, and the full-time equivalent of research and experimental development personnel of high-tech industries reached 1,254,000 person-years, indicating that the investment in high-tech industries in China was increasing.

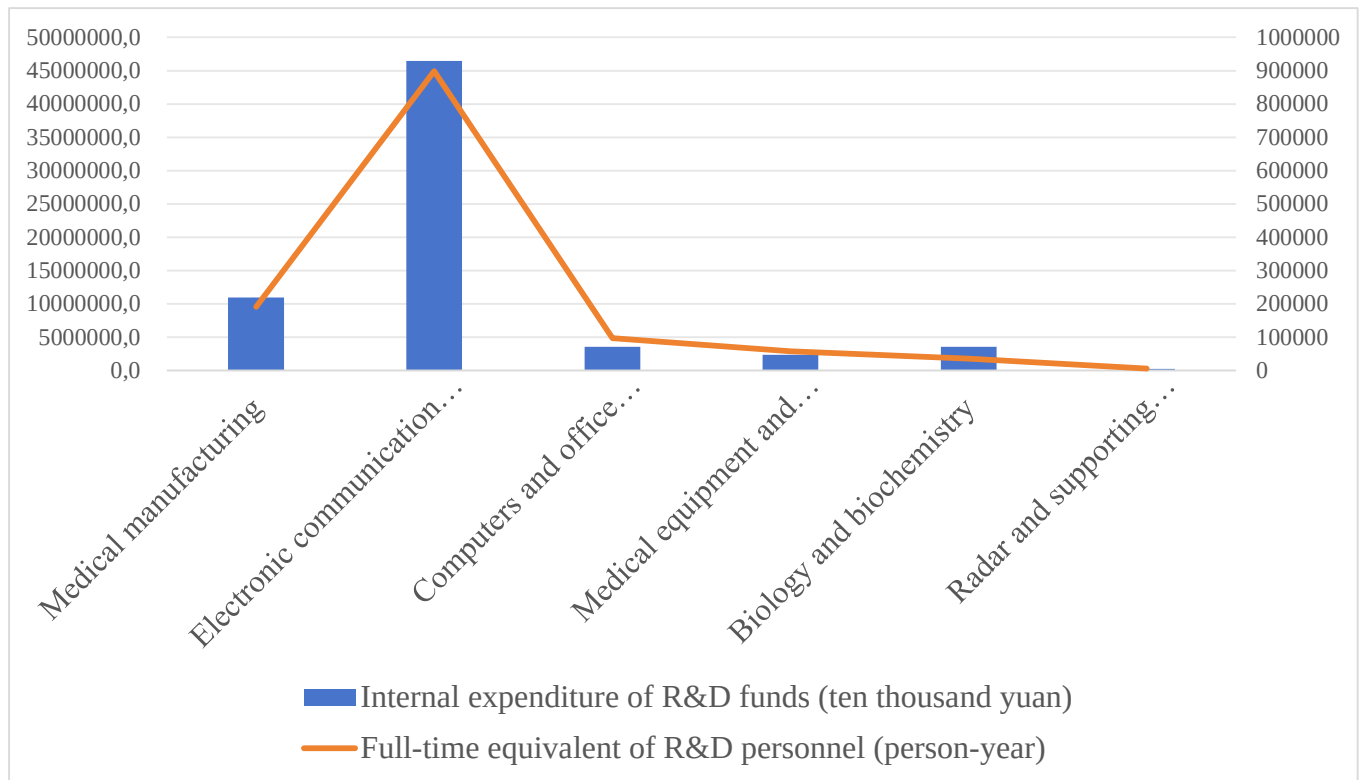


Figure 3.8 – Research and Development of High-tech Industries by Industry in 2023

[39, p. 40]

In terms of industries, as shown in Figure 3.2, China electronics and communication equipment manufacturing industry invested the most in R&D. In 2023, the internal expenditure of R&D funds reached 464,538.038 million yuan, and the full-time equivalent of R&D personnel reached 898,892.6 person-years, followed by pharmaceutical manufacturing industry. The investment of radar and supporting equipment manufacturing industry is the lowest, with the internal expenditure of R&D funds of 2,595.442 million yuan

and the full-time equivalent of R&D personnel of 5,792.8 person-years. It shows that there is a big gap in R&D investment in different industries in China.

High-tech industrial patents. According to the technology gap theory, countries with advanced technology have comparative advantages in technology, and technological innovation is crucial to the development of a country's high-tech industry. Technological innovation is also an important source of power for the sustained and upward development of China's high-tech products. If we only rely on the introduction of foreign technology, China's high-tech industry cannot develop in essence, and China cannot take the initiative in technology research and development. Technological innovation can reduce product prices by improving production efficiency, or satisfy consumers' preferences by increasing product added value, which makes China's high-tech products more competitive internationally. At the same time, technological upgrading can promote the optimization of China's export commodity structure, and gradually share more profits in the international division of labor.

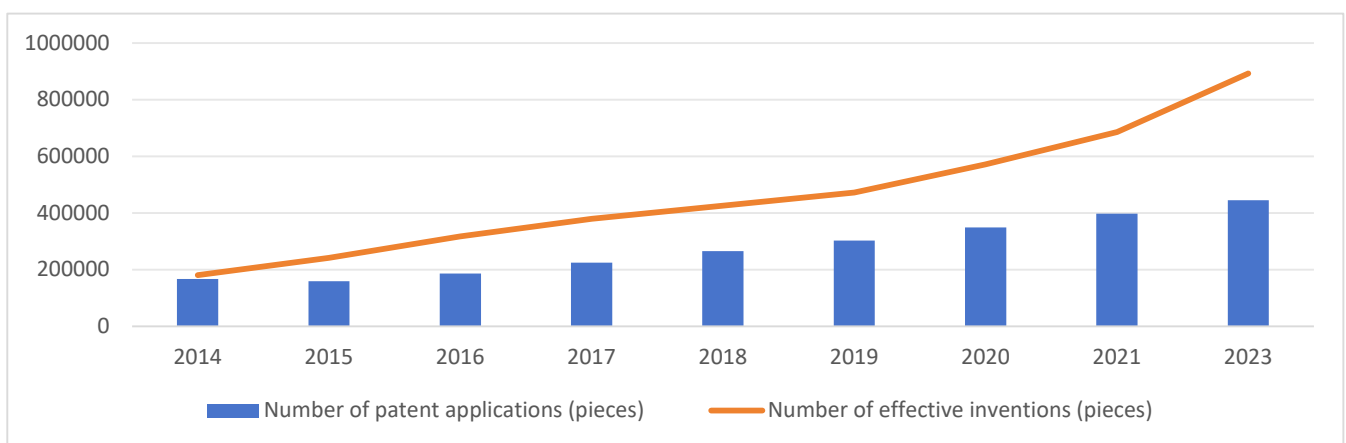


Figure 3.9 – Patent Situation of High-tech Industry in 2014–2023 [35]

As shown in Figure 3.3, in recent years, with the continuous strengthening of R&D activities, the number of patent applications for high-tech industries in China and the number of effective invention patents for high-tech industries have increased substantially

3.3 China High-tech Industry Trade Status

Import and export volume of high-tech products. As shown in Figure 3.10, the export of high-tech products in China is in a fluctuating growth state, and the financial crisis in 2008 led to a decrease of about 9.3% in 2009. However, since then, the export volume of China has been increasing, and the overall scale has been increasing. In 2022, the export volume was 1.57 times that of 2012.

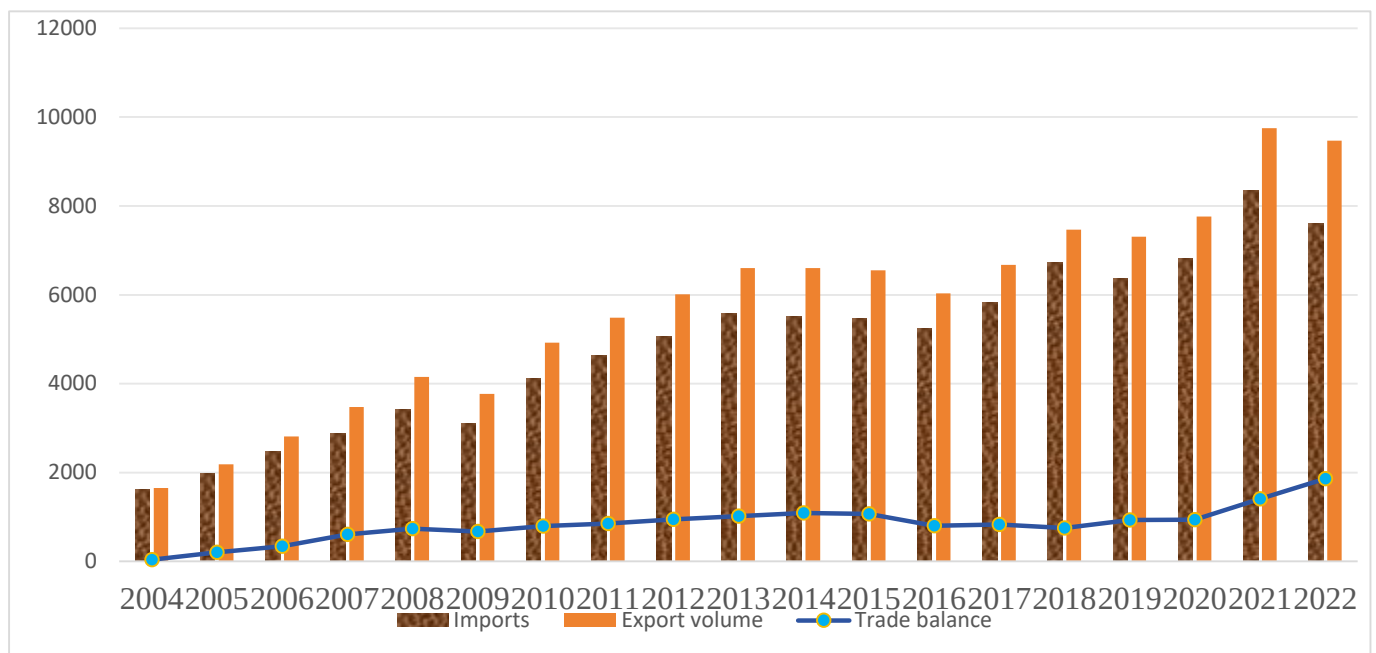


Figure 3.11 – Import and export volume of high-tech products in 2013–2022(USD 100 million) [26]

In 2015, the export volume of high-tech products in China declined slightly. In 2017, it began to reverse the gradual decline in 2015. In 2021, the export volume increased

significantly, reaching 974.9 billion US dollars, and fell back in 2022, with the export volume reaching 946.7 billion US dollars. From 2004 to 2022, China's trade in high-tech products have been in a state of surplus, which has also made great contributions to China's trade surplus.

Table 3.1 – Export Value of High-tech Products by Field in 2020, 2021 and 2023 [compiled by the author on: 14,15,16]

Technical field	Export volume (ten thousand yuan)		
age	2020	2021	2023
total	248802768	292251793	277967894
Pharmaceutical manufacturing industry	8891752	20550162	9001593
Electronic and communication equipment manufacturing industry	185325379	206186292	218867798
Computer and office equipment manufacturing industry	46433286	56978366	41849710
Medical equipment and instrument manufacturing industry	7398780	7771204	7742840
Information chemical manufacturing industry	357696	297090	179152

High-tech products export industry structure. The field of computer communication technology started earlier in China. According to the data in Table 3.1, in recent years, the

export sub-sectors of China's high-tech products are mainly concentrated in the field of electronic and communication equipment manufacturing. In 2023, the export of computer, communication and electronic technology accounted for 78.84% of the total export of high-tech products, which still dominated the overall export structure, with the export value reaching 218,867,798 yuan. The export volume of computer and office equipment manufacturing industry ranks second, with US\$ 418,497.1 billion, which is lower than that in 2021, accounting for 15.06% of the total export volume of high-tech products. In 2021, the export of pharmaceutical manufacturing industry reached 205,501.62-million-yuan, accounting for 7.03% of the total export of high-tech products, an increase of 131% compared with 2020, which was probably affected by the international COVID-19 epidemic. The export of high-tech products in China mainly depends on the development of electronic and communication equipment manufacturing industry. If this industry is impacted, the overall export of high-tech products in China will face great risks. Therefore, China should strengthen the coordinated development of various high-tech products to reduce risks.

3.4 The causes and effects of technical barriers to trade faced by high-tech

The reasons why China's electronic information industry faces technical barriers. External factors. For a long time, China's cheap labor cost has attracted the global manufacturing industry to enter, and developed countries have begun to enter China and choose to invest and build factories. In this way, it can help China's economic construction and launch the brand of "Made in China" at the same time. But for this reason, in the view of developed countries such as Europe and America, the price advantage of high-tech products produced in China is obvious. If it enters the domestic market, it will definitely

directly affect the development of its electronic industry. Taking this as a starting point, many countries choose to further restrict the export of China's high-tech products through technical barriers to trade. Countries in Europe and America mainly use their own technology to continuously improve the import standards of high-tech products. Some countries choose to impose technical barriers on China in the name of protecting intellectual property rights and protecting the environment. When the technical regulations and standards are getting higher and higher, it will inevitably further restrict the export of high-tech products in China. Especially with intellectual property rights, the export cost of China has been greatly increased, the profit rate of high-tech products has been reduced, and the market competitive advantage of domestic high-tech products has been further affected.

Internal factors. The technical level of high-tech products in China is not high, and most enterprises don't care about product research and development. Usually, they don't choose to invest their limited capital resources in scientific and technological innovation. Compared with Europe, America and other countries and regions, the technical level of China's electronic information industry needs to be improved. At the same time, most enterprises in China don't have enough innovation consciousness to blindly pursue and emphasize low-price promotion. Under the extensive economic concept that didn't talk about strategy before, enterprises only pay attention to the scale of production, but ignore the marginal effect of production, lack the idea of investing in technology research and development, and don't pay attention to internal training. In the long run, it will inevitably limit the improvement of enterprise's innovation ability. Electronic information enterprises have not conducted in-depth and detailed research on the relevant technical standards and policies and systems in the importing countries' markets, and have not actively participated in the formulation of

international technical standards, so they have been in a passive state. Under the attack of real technical barriers, they often appear weak, usually accept it in its entirety and retreat step by step. They do not take the initiative to take up legal weapons and international regulations to protect their legitimate rights and interests, and their ability to respond to lawsuits is also very low, which leads to greater damage to their interests.

China's electronic information industry faces the influence of technical barriers Negative influence. Setting up technical barriers will seriously affect the cost and price of high-tech products in China, and the international competitive advantage will be less and less, which has seriously affected normal trade exchanges. Technical barriers to trade have had a great impact on many aspects of the electronic industry, such as entrusted processing, procurement, packaging, etc., and combined with different measures to affect the export of China products, including environmental measures, technical regulations, etc. In order to ensure that China's products can gain enough market share and the export growth continues to increase, China's electronic export enterprises can only continue to increase production costs, invest more time and energy, and the profits that enterprises should get are getting less and less, and the previous cost and price advantages will not exist. In addition, some countries will restrict the evaluation institutions that China enterprises can choose when exporting high-tech products, which will make the related enterprises have to spend a lot of money to complete the systematic evaluation process, which will make it difficult to effectively control the maintenance costs of enterprises and even miss the best trade time. Under the background of economic globalization, the confrontation between countries is becoming increasingly anxious, and the previous trade barriers and protective measures have gradually withdrawn from the historical stage. At present, the most popular technical

barriers to trade are one of the main reasons for the current trade frictions in the international market. Technical barriers to trade directly increase the export cost, and the response of electronic information industry is very obvious. Positive influence. On the one hand, technical barriers to trade have limited the phased achievements of China's electronics industry; on the other hand, the profound thinking of more subjects has forced enterprises and industries to improve their overall technical level. They can no longer stay in the original traditional processing and assembly, but should focus on independent research and development, intellectual property rights, patent breakthroughs and production innovation, so that China's high-tech products can perfectly meet international regulations. Relevant enterprises should be in line with international standards, constantly improve the quality of China's high-tech products, continuously enhance their competitive thinking and raise their legal awareness. In addition, we should increase investment in human resources and actively introduce talents with strong comprehensive quality, especially legal talents. Fully guarantee the steady improvement of enterprises' ability to respond to lawsuits and improve their ability to use legal weapons to safeguard their legitimate rights and interests.

To sum up, in terms of the development status of high-tech industries in China, in recent years, China's investment in high-tech industries has shown an upward trend, indicating that the R&D investment activities of high-tech industries in China have been continuously enhanced, but the investment in different sub-sectors is quite different; The number of patent applications and effective invention patents for high-tech industries in China also showed a good increase trend, indicating that the innovation capability of high-tech industries in China is constantly improving.

Technical Barriers to Trade (TBT) has gradually become an inevitable problem for

countries in international trade. This paper studies and analyzes the influence of TBT on the export of high-tech products in China by collecting the relevant data of major exporting countries and regions of China. Based on the analysis, this paper draws a conclusion, and puts forward some policy suggestions on how to reasonably avoid and make use of technical barriers to trade in the export of high-tech products in China at the enterprise and government levels.

Through reading the relevant literature in the past, it is found that there are many factors affecting the export of high-tech products, including R&D investment,

Technological innovation, etc. In recent years, scholars have focused on how economic policy factors affect the export of high-tech products. Theoretically, TBT has a dual effect on the export of high-tech products: the quantitative inhibition effect is that if the exporting country fails to meet the relevant technical requirements of the importing country, it will lead to the exporting country giving up trade and the transaction volume between the two countries will be reduced to zero; The price restraint function is that if the exporting country improves the quality of goods to meet the technical requirements, it will lead to an increase in the cost of goods, which will lead to an increase in the price of export goods and a decrease in the competitiveness of goods; The role of trade promotion is that exporting countries provide technical guidance and promotion to their own goods through the disclosure of technical barriers to trade, meet the technical standards of importing countries, enhance the confidence of consumers in importing countries, and thus promote exports.

By studying the present situation of China's high-tech industries, it is found that China's high-tech industries have developed rapidly, and the investment in high-tech

industries is considerable. The number of patent applications and effective invention patents in China's high-tech industries have also increased rapidly, which reflects the enhancement of China's innovation ability. The fluctuation of China's high-tech products exports has increased, and the export areas are mainly concentrated in some developed countries and regions. The export development trend is good, but it still faces problems such as unbalanced export industry structure, concentrated export sources and processing trade as the main export mode. In addition, the export of high-tech products in China accounts for a high proportion of manufacturing exports, but the export competitiveness of products in different high-tech industries is quite different, and aerospace technology still faces the problem of export competitiveness disadvantage. The specific conclusions are as follows:

1 The technical barriers to trade in high-tech industries implemented by China's major high-tech products exporting countries and regions have promoted the export of high-tech products in China. Technical barriers to trade have the function of information disclosure, which to some extent reflects the technical requirements of related products in importing countries and points out the direction of technical improvement for enterprises in exporting countries. At the same time, China's high-tech industrial export enterprises have good technical adaptability, which can effectively use the technical barriers to trade issued by importing countries, manage export products, strengthen technological innovation, and improve relevant technical standards to adapt to national technical barriers to trade standards and related procedures. Technical Barriers to Trade only means that the importing country is currently in a leading position in technology. With the gradual improvement of China's high-tech industrial system and the gradual expansion of skilled workers and labor force in recent years, it has provided a relatively solid foundation for high-tech industries. At the

same time, because the existing standards related to high-tech industries are more rigorous and standardized, China's adjustment time for technical barriers to trade in importing countries is relatively short, so that it can quickly raise the standards of export products to break through the technical barriers to trade in importing countries, enhance the competitiveness of China's high-tech products exports, and promote the export of high-tech products.

2 The per capita GDP of importing countries is positively related to the export of high-tech products in China. The per capita GDP of importing countries reflects the economic scale of importing countries. The higher the per capita GDP, the higher the consumption power of consumers and the stronger the demand for high-tech products, which will promote the export of high-tech products in China. The per capita GDP of China has a positive impact on the export of high-tech products in China. The higher the per capita GDP of China, the stronger the supply capacity of high-tech products, which is more conducive to export.

3 The real effective exchange rate index of RMB is negatively correlated with the export of high-tech products in China. An increase in the real effective exchange rate index of RMB means an increase in the relative value of RMB, while a decrease means a relative depreciation of RMB. The real effective exchange rate not only takes into account the changes in the currencies of a country's major trading partners, but also excludes the inflation factor, which can more truly reflect the external value of RMB. When the real effective exchange rate of RMB falls, it means that the devaluation of RMB is greater than that of its major trading partners, and the international competitiveness of China's commodities is relatively improved, which hinders imports and promotes exports.

4 The trade distance adjusted by the international oil price has no significant effect on the export of high-tech products in China. In recent years, with the continuous development of globalization, scholars generally believe that distance has become less important in the application of international trade, which may be due to the diversification of transportation modes brought about by the development of science and technology, and at the same time, the transportation cost brought by trade distance has decreased by a certain proportion compared with before; In addition, despite the rising oil price, due to the development of science and technology, the efficiency of fuel use in all countries has been greatly improved, or a series of renewable resources have affected the use of crude oil, thus affecting the sensitivity of the two countries to trade distance. The above reasons may lead to the result that the influence of trade distance on the export of high-tech products in China is not significant, which is also in line with the development trend under the background of economic globalization.

5 The input of high-tech products from China has no significant effect on the export of high-tech products from China. This may be due to the inability to monitor and measure the quality and ability of R&D personnel. Although the full-time equivalent of R&D personnel in China has been on the rise, the effective use of personnel in the research and development of high-tech products need further investigation. China's labor force has always had the advantage of low cost, but this advantage is difficult to use for high-tech products, which need human capital with higher knowledge and skills, so its influence on the export of high-tech products is not obvious.

In terms of industries, technical barriers to trade have different promotion effects on different industries, which is due to the different development levels and technological

adaptability of different high-tech products industries in China.

First of all, TBT plays a significant role in promoting the export of aerospace manufacturing, electronic and communication equipment manufacturing, computer and office equipment manufacturing, medical equipment and instrumentation manufacturing. The main reason is that China's aerospace equipment technology itself has a strong technical foundation, which belongs to the key development projects in China and has the advantages of industrial innovation. When encountering technical trade barriers, it can make timely adjustments and improve the technology; China's electronic and communication equipment manufacturing industry, computer and office equipment manufacturing industry have developed well, and the industries are relatively mature. In 2023, its export volume accounted for 78.84 % of the total export of high-tech products, which has export advantages, and the technical complexity of this field in all high-tech industries is low, and the relevant technical regulations are more perfect; At the same time, China's medical equipment and instrument manufacturing industry has a good momentum. With the increasing demand for drug quality in China, the medical equipment and instrument manufacturing industry has also gained opportunities for vigorous development. After years of development, China's scientific instrument research and development technology has gradually matured, and more and more attention has been paid to the introduction and absorption of foreign advanced technologies and continuous innovation, which has led to the technical barriers to trade playing a significant role in promoting these four industries.

Secondly, technical barriers to trade do not promote pharmaceutical manufacturing and information chemical manufacturing significantly. The main reasons are that the pharmaceutical manufacturing industry requires higher technical level, China

pharmaceutical industry started late, and there is still a certain gap compared with the mature markets of developed countries in the world. Moreover, the research and development of innovative products requires a lot of resources, and the requirements for production equipment and technological processes are extremely strict, and the production cycle is long. There is still much room for improvement in the transformation stage of China pharmaceutical manufacturing industry.

In recent years, with the rise of trade protectionism and the global economic downturn, the number of technical barriers to trade in various countries has gradually increased, which poses a great challenge to the export of high-tech products in China. On the other hand, strictly controlling the technical standards of export products is of positive significance for protecting China's resources, environment and human health, and is also conducive to promoting the sustainable development of China's economy and promoting the export of high-tech products in China. Based on the above analysis and conclusions, this paper puts forward the following policy suggestions.

Enterprise level. First, enterprises should actively study international technical standards and obtain international standard certification. With the rapid development of high-tech industry in China, many countries point their contradictions at China while building technical barriers to trade, hoping to restrict the R&D and innovation of high-tech products in China through some targeted laws and regulations. Due to the endless changes of technical barriers to trade in various countries, consumers' market preferences in different countries are also different. Enterprises should constantly improve the export quality of high-tech products to meet or even exceed international standards in order to cope with the implementation of technical barriers to trade in various countries. Enterprises establish

comparative advantages through core competitiveness, thus promoting the development and export of high-tech products, which is also conducive to the sustainable development of enterprises.

Second, strengthen technology investment and improve the independent research and development ability of enterprises. Enterprises should learn from the advanced technical information in the international market, strengthen technological innovation and get rid of dependence on foreign technology. Especially in the field of high-tech industries, the entry threshold for enterprises is relatively high. By building their own brands and strengthening their core competitiveness, enterprises can make their own products unrepeatable, thus occupying their own position in the international market.

Third, strengthen enterprise's own management and attach importance to sustainable development. Enterprises should constantly improve their own technical level and management system, strive for green environmental protection and sustainable development, and ensure that the quality of their own products reaches the standard when exporting. In addition to the relevant hard technical standards, health standards and environmental protection standards cannot be ignored by enterprises in China. In addition, enterprises should constantly improve the modern management system, enhance their management ability, explore scientific management methods, constantly give play to their own competitive advantages in the management process, and improve product quality and corporate image, so as to better cope with technical barriers to trade.

Government level. First, continue to pay more attention to the regulations on international technical barriers to trade, and constantly cultivate relevant professionals in high-tech industries, laws, technical barriers to trade research and other fields. Judging from

the existing trend, the number of notifications of technical barriers to trade in various countries is increasing. The notifications of technical barriers to trade not only reflect the needs of consumers in the international market, but also reflect the competitive field in the international market. China should actively adapt to the changes in international market demand, study the technical barriers to trade implemented by various countries with a positive attitude, and make rational use of WTO rules to limit its disadvantages and reduce its damage to the export of high-tech products in China. Legally safeguard the rights and interests of China, at the same time actively use relevant information, vigorously promote the establishment of technical standards for high-tech products in China, realize the sustainable development of society and economy, and promote the improvement of the quality of high-tech products in China. To deal with the technical barriers to trade in various countries, such as high professionalism and long-time span, it is beneficial for the relevant departments to fully grasp the technical barriers to trade by cultivating relevant professionals and establishing professional service teams, so as to keep abreast of the latest international trends and make reasonable responses in practical work.

Second, increase policy and financial support for high-tech industries, and constantly improve the technological innovation capability of high-tech industries in China. China should make full use of the incentive effect of technical barriers to trade implemented by importing countries on China's technological innovation, improve its technological innovation ability, encourage enterprises to carry out technological innovation by formulating preferential policies and providing multi-channel financial support, reduce the cost of enterprise innovation, continuously push China's high-tech industries to climb upstream of the global value chain, and improve China's position in the international

division of labor, so as to better promote China's stable economic growth.

In addition, the implementation of relevant preferential policies and financial support for the export of high-tech industries at the national level is conducive to stimulating the independent innovation ability of enterprises, expanding the trade and development of high-tech industries in China, improving the export quality and competitiveness of high-tech products, creating the image of independent high-tech products in China, and further promoting the structural optimization of China's export trade.

Third, establish advanced technical standards and a unified and standardized certification system, and establish an information system for technical barriers to trade. China should perfect and formulate its own technical standards according to the existing mature international standards. In the long run, the technical barriers to trade commonly used in some developed countries in the world will still become the new international technical standards. We should learn from international standards, unify domestic policies, increase investment in standard construction, and establish domestic technical standards that match the new international technical standards and are suitable for the development of China in combination with the reality of China. At the same time, strengthening the construction of domestic technical standards can promote the improvement of domestic product quality, enhance consumer confidence, contribute to the sustainable development of China's economy, environment and society, and promote the optimization of the export trade environment of China's high-tech products. Information asymmetry may cause some enterprises to face many obstacles when exporting. Many small and medium-sized enterprises may not understand the latest international market access standards, be not good at using professional websites to make inquiries, or not understand some process operations

when exporting, so it is difficult to take timely measures to deal with technical barriers to trade. The government should organize professional departments to be responsible for the research of relevant laws and regulations, establish an early warning mechanism for technical barriers to trade, build a special website for technical barriers to trade information, and timely transmit the latest international laws and standards to relevant enterprises so that enterprises can take timely countermeasures.

Fourth, strengthen trade cooperation between China and other countries, and carry out technical barriers to trade communication in high-tech fields. Good trade relations can effectively reduce the implementation of malicious technical barriers to trade in China by other countries, and at the same time can effectively promote the smooth development of trade between the two countries. High-tech products have strong heterogeneity, and the information disclosed by technical barriers to trade has a profound impact on products. In the future, cooperation between China and other countries in standard building and mutual recognition of rules should be continuously strengthened. Relevant responsible persons of the two countries should communicate and negotiate on technical barriers to trade regularly, actively create mutually beneficial and win-win bilateral relations, conduct friendly consultation and coordination on unreasonable technical barriers to trade, and reduce the trade costs caused by unreasonable technical barriers to trade.

Conclusion

Technical barriers to trade have gradually become an inevitable problem in international trade. By collecting data and analyzing the current situation of technical barriers to trade in China, the development of high-tech industries and trade restrictions, the reasons and effects of technical barriers to trade faced by high-tech industries in China, this paper draws the following conclusions.

China's high-tech industry has developed rapidly, and the investment in high-tech industry is considerable. The number of patent applications and effective invention patents in China's high-tech industry has also increased rapidly, which reflects the enhancement of China's innovation ability. The fluctuation of China's high-tech products exports has increased, and the export areas are mainly concentrated in some developed countries and regions. The export development trend is good, but it still faces problems such as unbalanced export industry structure, concentrated export sources and processing trade as the main export mode. In addition, the export of high-tech products in China accounts for a high proportion of manufacturing exports, but the export competitiveness of products in different high-tech industries is quite different, and aerospace technology still faces the problem of export competitiveness disadvantage.

In terms of industries, technical barriers to trade have different promotion effects on different industries, which is due to the different development levels and technological adaptability of different high-tech products industries in China.

First of all, TBT plays a significant role in promoting the export of aerospace manufacturing, electronic and communication equipment manufacturing, computer and

office equipment manufacturing, medical equipment and instrumentation manufacturing. The main reason is that China's aerospace equipment technology itself has a strong technical foundation, which belongs to the key development projects in China and has the advantages of industrial innovation. When encountering technical trade barriers, it can make timely adjustments and improve the technology; China's electronic and communication equipment manufacturing industry, computer and office equipment manufacturing industry have developed well, and the industries are relatively mature. In 2023, its export volume accounted for 78.84 % of the total export of high-tech products, which has export advantages, and the technical complexity of this field in all high-tech industries is low, and the relevant technical regulations are more perfect; At the same time, China's medical equipment and instrument manufacturing industry has a good momentum. With the increasing demand for drug quality in China, the medical equipment and instrument manufacturing industry has also gained opportunities for vigorous development. After years of development, China's scientific instrument research and development technology has gradually matured, and more and more attention has been paid to the introduction and absorption of foreign advanced technologies and continuous innovation, which has led to the technical barriers to trade playing a significant role in promoting these four industries.

Secondly, technical barriers to trade do not promote pharmaceutical manufacturing and information chemical manufacturing significantly. The main reasons are that the pharmaceutical manufacturing industry requires higher technical level, China pharmaceutical industry started late, and there is still a certain gap compared with the mature markets of developed countries in the world. Moreover, the research and development of innovative products requires a lot of resources, and the requirements for production

equipment and technological processes are extremely strict, and the production cycle is long. There is still much room for improvement in the transformation stage of China pharmaceutical manufacturing industry.

In view of these problems, the following solutions are proposed. At the enterprise level, enterprises should actively study international technical standards and obtain international standard certification. Strengthen technical input and improve the independent research and development ability of enterprises. Strengthen enterprise's own management and attach importance to sustainable development. At the national level, we will continue to pay more attention to the regulations on international technical barriers to trade, and constantly train relevant professionals in high-tech industries, laws and technical barriers to trade research. Increase the policy and financial support for high-tech industries, and constantly improve the technological innovation capability of high-tech industries in China. Establish advanced technical standards and a unified and standardized certification system, and establish an information system for technical barriers to trade. Strengthen trade cooperation between China and other countries, and carry out technical barriers to trade communication in high-tech fields.

Reference List

1 Agricultural Economics. Findings from Virginia Tech Broaden Understanding of Agricultural Economics. Assessing the Impact of SPS Regulations on US Fresh Fruit and Vegetable Exports // Agriculture Week. 2015. № 7. P. 846–849.

2 Angelie L. Study on the Impact of Technical Barriers to Trade on China's Foreign Direct Investment. University of international business and economics. 2023. № 13. P.15–16.

3 Bao X., Zhu D. Differentiated effect of technical barriers to trade: international experience and its enlightenment to China // World Economy. 2015. № 11. P.71–89.

4 Belay S. The role of factor conditions in high–technology exports: An empirical examination // Journal of High Technology Management Research. 2004. № 15. P.145–162.

5 Cai B. Research on the impact of technological innovation on the export competitiveness of China's high–tech products. Harbin University of Commerce. 2017. 66 p.

6 Cai H., Zhu Y. The impact of technical trade measures in free trade agreements on China's export trade // Economic Horizon. 2020. № 9. P. 77–89.

7 Cai J., He H., Li S. Technical barriers to trade and the export of high–tech products in China—an empirical analysis based on the extended trade gravity model // Industrial Technology Economy. 2017. № 10. P. 45–54.

8 Chen Q. Analysis of the impact of technical barriers to trade on China's exports of different technology industries. Zhongnan University of Economics and Law. 2020. 67 p.

9 Chen X., Huang X., Liu H. Analysis of the impact of mismatch in producer service

resources on the export of high-tech products // Statistical research. 2019. № 1. P. 65–76.

10 Chen X. The impact of digital trade barriers on global value chain climbing and its mechanism analysis. Dongbei university of finance and economics. 2023. 63 p.

11 Chu Z. Empirical analysis of export competitiveness of high-tech products in China // International Economic and Trade Exploration. 2011. № 11. P.10–16.

12 Dai K., Fang J. The impact of vertical specialization on the complexity of export technology and its mechanism–based on the empirical evidence of high-tech industries in China // Journal of Zhongnan University of Economics and Law. 2019. № 4. P.100–113.

13 Du L., Xie H. Theoretical and empirical research on the export restrictions of American high-tech products to China // International trade issues. 2010. № 10. P.9–16.

14 Export Value of High-tech Products by Field in 2020, 2021 and 2023. URL: <https://www.stats.gov.cn/sj/ndsj/2021/indexch.htm> (access date: 17.04.2025)

17 Fabio M. The impact of technology and structural change on export performance in nine developing countries // World Development. 2022. № 4. P.527–547.

18 Fu S. Chen Z. Study on the Impact of Technical Barriers to Trade on the Export of High-tech Products in China–An Empirical Analysis Based on the Data of 45 Countries // International Business Accounting. 2020. № 11. P. 61–80.

19 Global Technical Barriers to Trade Notification from 1995 to 2024.URL: <https://export.highcharts.com> (access date: 18.04.2025)

20 Guo J., Yang Y. Economic growth, technological innovation and the export complexity of China's high-tech manufacturing industry // International trade issues. 2020. № 45. P. 2–3.

21 Guo M., Guo J. Wei P. The impact of technological innovation on the export

competitiveness of China's high-tech industries // Journal of capital university of economics and business. 2018. № 3. P. 21–29.

22 Hang C. An empirical study of the technical barriers to trade on the export of electronic information products in China. Shanghai international studies university. 2021. 55 p.

23 Huang X., Yang G. Research on the status of international division of labor of high-tech industries in China: a transnational analysis based on non-competitive input-occupation-output model // World Economy. 2010. № 5. P. 82–100.

24 Hu W., Chen X., Chen Z. China electronic information industry manufacturing regional development differences and spatial pattern evolution // Regional Economic Review. 2018. № 1. P. 36–47.

25 Hu Y. research on the influence of technical barriers to trade in developed countries on China's high-tech industry export trade. Hunan university. 2023. 59 p.

26 Import and export volume of high-tech products in 2013–2022 (USD 100 million). URL: <https://data.stats.gov.cn/adv.htm?m=advquery&cn=C01>. (access date: 21.04.2025).

28 Jiao X. Study on the export competitiveness of high-tech products in China. University of international business and economics. 2018. 56P.

29 Kun-Huang H., Tiffany H., Wenhsiang L. Innovation and diffusion of high-tech products, services, and systems // Journal of Business Research. 2015. № 4. P. 1–4.

30 Liu Bi., Chen S. Research on the economic effects of reducing technical barriers to trade under the RCEP framework—an empirical analysis based on GTAP model // International Trade Issues. 2014. № 6. P. 91–98.

31 Liu S., Li Z. The impact of American technical barriers to trade on China's export

trade—an empirical study based on the trade gravity model // Industrial Technology Economy. 2016. № 4. P. 74–82.

32 Liu W., Zhang X. Analysis of the impact of US high-tech export restrictions on China's scientific and technological innovation—based on the background of Sino-US trade friction // Industrial Technology Economy. 2019. № 9. P. 35–43.

33 Niu H., Cui M., Zeng Y. R&D investment, trade liberalization and high-tech products export from the perspective of network—also on the dynamic characteristics of high-tech products trade network // Statistics and Information Forum. 2020. № 7. P. 66–76.

34 Pan W. Analysis of the impact of technical barriers to trade on China's foreign trade development and countermeasures // Modern Economic Information. 2019. № 9. P. 160–176.

35 Patent Situation of High-tech Industry in 2014–2023. URL: <https://data.stats.gov.cn/easyquery.htm?cn=C01&zbs=A0N0T01&sj=2023> (access date: 17.04.2025).

36 Peng h. Research on the influence of digital trade barriers on the export product structure of China's manufacturing industry. Jiangxi university of finance and economics. 2024. 63 p.

37 Qiu S., Wu Z., Dong H. Empirical analysis of the influencing factors of China's high-tech products export—based on time series variable VAR model // Science and Technology Management Research. 2017. № 11. P. 105–111.

38 Qu Li., Liu J. The impact of economic policy uncertainty on China's export ternary margin—evidence from high-tech products // International Economic and Trade Exploration. 2020. № 5. P. 35–50.

39 Research and Development of High-tech Industries by Industry in 2023. URL:

<https://data.stats.gov.cn/easyquery.htm?cn=C01&zb= A0N0R03&sj=2023> (access date: 17.04.2025).

40 Research and Development of High-tech Industries by Industry in 2023. URL: <https://data.stats.gov.cn/easyquery.htm?cn=C01&zb= A0N0R03&sj=2023> (access date: 17.04.2025).

41 Research and experimental development activities of high-tech industries in 2014–2022. URL: <https://data.stats.gov.cn/adv.htm?m= advquery&cn=C01> (access date: 11.04.2025).

42 Song W., Wang Y. The impact of intellectual property protection in importing countries on the export of high-tech products in China—based on the expansion of the trade gravity model // Macroeconomic Research. 2016. № 9. P. 162–175.

43 Song Y., Zang Y. Japanese technical barriers to trade and the dynamic effects of China's agricultural exports // Exploration of economic issues. 2016. № 3. P.156–163.

44 Wang j. Research on the impact of green trade barriers on the complexity of export technology. Zhejiang university. 2024. 65 p.

45 Wang M. Study on the Impact of Technical Barriers to Trade on the Export Trade of China's Information Economy. Beijing University of Posts and Telecommunications. 2020. 72 p.

46 Wang S., Li G. Empirical analysis of the dual marginal impact of TBT on the export of China equipment manufacturing enterprises—based on the two-stage gravity model // Macroeconomic Research. 2016. № 8. P. 74–115.

47 Wang S. Research on the impact of patent barriers on China's high-tech products export. University of international business and economics. 2019. 58 p.

48 Wang Y. Study on the influence of digital trade barriers on the quality of China's manufacturing export products. Northwest Normal University. 2024. 75 p.

49 Wang Y. The development trend of technical barriers to trade in EU and its impact on China's exports. Foreign Affairs University. 2021. 62 p.

50 Wei L. Li Lijuan. Empirical analysis of the impact of technological innovation on the export of high-tech products in China // International Trade Issues. 2005. № 12. P. 32–40.

51 Wei P., Zhang C. US export control of high-tech products to China and its impact on trade between the two countries // Industrial Technology Economy. 2018. № 1. P. 76–85.

52 Xiong Y. Research on the impact of digital trade barriers on the quality of China's telecommunications export products. Jiangxi normal university. 2024. 63 p.

53 Xu N. The impact of American technical barriers to trade on technological innovation of China enterprises. Jinan University. 2020. 55 p.

54 Xu W., Bu H. Game analysis of technical trade barriers and innovation decision-making of exporting countries // Discussion on modern economy. 2019. № 6. P. 79–85.

55 Yin Y. Analysis of the impact of EU technical barriers to trade on China's exports of mechanical and electrical products. Sichuan University. 2023. 114 p.

56 Yuan L., John C. B. A meta-analysis of estimates of the impact of technical barriers to trade // Journal of Policy Modeling. 2012. № 34. P. 497–511.

57 Zeng A. Study on the Impact of Technical Barriers to Trade on the Dual Margins of China's Mechanical and Electrical Products Export. Southwestern University of Finance and Economics. 2020. 67 p.

58 Zhan R. Study on the impact of technical barriers to trade on the sustainability of enterprise innovation. Guangdong University of Foreign Studies. 2024. 70 p.

59 Zhang S. Wen K. The impact of US technical barriers to trade on China's exports—also on the essence of Sino–US trade friction // International Economic Cooperation. 2019. № 4. P. 82–94.

60 Zhang X., Li X. The Double Effects of Technical Barriers to Trade on Agricultural Products Export Trade // Economic Research Reference. 2004. № 71. P. 37–38.

61 Zhang X., Li S. Technical barriers to trade on China's export trade and countermeasures // Contemporary Economic Research. 2012. № 11. P. 88–92.

62 Zhang Y. Study on the Impact of Technical Barriers to Trade on the Export of China's High–tech Products. capital university of economics and business. 2021. 59 p.

63 Zhang Y., Zhu J. Technical barriers to trade and China's agricultural exports—based on the perspective of special trade concerns // World Agriculture. 2020. № 9. P. 4–12.

64 Zhang Y., Bai D., Gao Y. Did producer services cluster promote the export upgrading of high–tech industries in China? // Economic Jingwei. 2020. № 5. P. 72–80.

65 Zhao G., Yu L., Dai H. The quantity and quality of innovation and the export of high–tech industries // China Management Science. 2021. № 2. P. 61–68.