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Impact of China's Import and Export Trade on Innovation

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Abstract: Import and export trade is a very important economic indicator in a country's economic development, and science and technology innovation is a necessary journey for China to move from rapid economic development to high quality development. Import and export trade can lead to technology transfer, so changes in import and export trade can affect science and technology innovation to a certain extent, and innovation can also affect the production of products, thus affecting the import and export trade of a country. By collecting China's foreign trade and scientific and technological innovation input-output from 2003 to 2022, and comparing the trends of export products, scientific and technological innovation input-output, and trade dependence, the study found that due to its low position in the international value chain, China's R&D investment has relatively little impact on the value of export products. The structure of China's research and development investment is not reasonable, which leads to the slow growth of exports. China's import trade dependence is relatively high, which may give rise to risks. Accordingly, this paper advocates that China should attract foreign investment to promote innovation capabilities. Changing the structure of R&D investment to promote investment conversion rate. And expanding domestic demand to achieve sustainable economic growth.

Keywords: technological innovation, imports and exports, trade dependence, innovation investment

1. Introduction

1.1. Background

China has always relied on affordable labor and land resources, as well as a number of other measures, to accomplish rapid economic development. The demographic dividend has been gradually disappearing in recent years, and environmental resource constraints have caused China's economic growth to stagnate. A breakthrough in economic growth is urgently needed, as innovation is the primary force behind development and the primary safeguard for promoting high-quality economic development, and it is also the only way to solve China's development conundrum. In terms of import and export, China's total import and export has increased year after year, and has remained the world's top trading country for the sixth consecutive year. At the same time, China's innovation capacity and innovation

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scale have been significantly improved, and the number of patents granted as well as the personnel and financial investment in scientific research have guaranteed continuous growth. However, what is the relationship between science and technology innovation and imports and exports, and have the changes in innovation influenced the related changes in imports and exports? And does China's current innovation structure match and rationalize its import/export trade structure? Obviously, the study of these questions can reveal the problems in the structure of research investment and trade in China, and can suggest relevant recommendations for policy adjustments.

1.2. Related Research

Zhai documents China's Belt and Road Initiative (BRI) that seeks to increase communication between China and 70+ countries through the development of infrastructure and regional collaboration. Examining the economic development, Zhai's research offers insight into the host states' current environmental legal system as well as green development strategies used by China and BRI participants [1]. Connecting back to China's soft power approach as discussed by Khan & Fatima 2019, Nedophil similarly engages in how China utilizes green overseas finance through its Belt and Road Initiative (BRI) to further build soft power. Examining Chinese regulators and financial institutions, Nedophil asserts that insufficient soft power signals may lead to negative consequences while simultaneously harming green initiatives [2].

Zhou emphasizes how China's ambitious green building schemes are heavily dependent on top-down bureaucracy, are concentrated primarily in affluent cities, and are lavishly constructed through the lens of an ecological modernization philosophy. As Chinese ecological modernization necessitates coalition building for institutional design to be sufficient, such insights also suggest that programs may suffer from weak participation [3]. Ming et al. investigate how China's power generation is currently undergoing significant economic and social development, which has caused a rapid increase in CO_2 emissions, notably over the previous two decades. Researchers also give a general outline of how issues with technology and politics may also prevent the development of new energy sources [4].

Zhang and Bai examine the growth of new energy vehicles (NEVs) and point out that such initiatives are crucial for lowering pollution emissions, conserving fuel oil energy, and preserving the automobile and transportation sectors. Their research is intended to aid decision-makers and NEV participants in understanding the difficulties that such developments may encounter due to local protectionism, technological advancement, and subsidies fraud [5]. When analyzing the problem at hand, Zeng and colleagues use a four-stage semi-parametric DEA analysis framework to assess the investment effectiveness of the new energy industry in China. Overall, according to Zeng and colleagues, the new energy sector venture's investment efficiency is rather poor, but their research's analysis and findings have profound and important ramifications [6].

Li et al. examined the Chinese government's policies for promoting the creation and use of new energy vehicles through the macrocosmic, demonstration, subsidization, preferential tax, technical support, industry management, and infrastructure lenses while noting how consumer opinions influence such policies. In the end, they discover that the infrastructure and technical support policies are deficient [7]. Wang et al. measured new energy firms and divide them into four groups based on their innovation efficiency using innovation enterprises as a model to assess new energy enterprises' efficiency. Based on efficiency traits and using the non-radial DEA approach used to quantify such activities, strategies for improving innovation efficiency are suggested [8].

Zhang et al. assessed the mounting pressures on the Chinese government as a result of China's over-reliance on fossil fuels, which has made it the world's largest energy consumer and CO_2 emitter. China's energy demand is rising, reaching unprecedented levels as a result of economic growth and

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modern development. Both new energy structures and focused defenses are presented [9]. The evolution of China's renewable energy sector is examined historically and currently, and difficulties and potential solutions are discussed in order for China to meet its 2050 renewable energy targets. Citing China's rapid progress since the year 2000, stark percentages are revealed in which renewable energy goals may be reached by 2030, then by 2050 [10].

1.3. Objective

The objective of this essay is to examine the relationship between import and export trade and science and technology innovation in China, analyze the trends in foreign trade and innovation inputs and outputs, and identify the challenges and opportunities for China's economic development. The essay aims to provide recommendations for promoting innovation capabilities, changing the structure of R&D investment, and expanding domestic demand to achieve sustainable economic growth.

2. Current Situation

2.1. Current Situation of Technological Innovation in China

The investment of various forms of innovation resources, primarily includes the investment of R&D finances and the investment of R&D employees, is a crucial prerequisite needed for product development in high-tech businesses.

First of all, R&D investment, as shown in Figure 1, between 2003 and 2022, the amount of input expenditure in China's high-tech industry has been increasing, but the growth rate is generally on a downward trend, but its growth rate is maintained at more than 10%, maintaining a high growth rate. In 2022, China's R&D investment reached a new high of 3087 billion yuan, an increase of 10.42% year-on-year, and compared with 153.963 billion yuan in 2003, an increase of more than 20 times. The investment growth has fluctuated in recent years, but still maintains a high level of growth. R&D investment is an important guarantee for China to conduct technological R&D, so the continuous growth of investment ensures the increase of innovation.

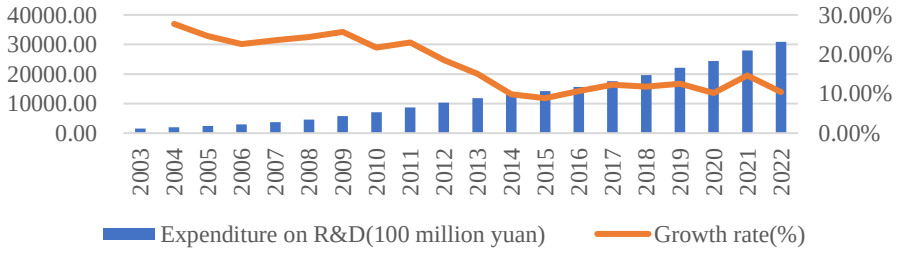

Figure 1: Expenditure on R&D(100 million yuan).

The quantity of researchers and developers is another crucial element in innovation. In order to accurately represent the R&D staff investment in the high technology industry, this article uses R&D personnel full time equivalent. The number of R&D employees in China's high-tech sector is still growing, as shown in Figure 2. 2021 R&D personnel full-time then full volume is 5.71 million person-years, which is more than five times higher than that in 2003. It can be seen that the growth of research personnel from 2013 to 2017 is relatively slow, which is mainly due to the decline in profits of high-tech industries from 2013 to 2017, which led to the loss of researchers thus reducing the growth rate. And the favorable policy conditions for high-tech industries in recent years have attracted more R&D researchers and their growth rate has been maintained at around 9%.

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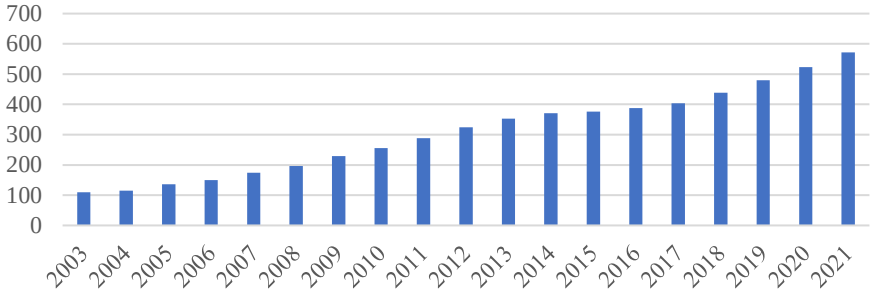

Figure 2: Full-time equivalent of R&D personnel (10000 man-year).

The output of innovation is an important indicator of the level of innovation, this paper examines China's high-tech industry's innovation output using the number of patent applications that have been granted as an essential measure of the amount of innovation. Figure 3 shows that the number of patents granted in China as a whole is increasing. Only 182,226 patents were granted in 2003, but after 20 years, that number increased by more than 23 times, reaching 4,323,000 in 2022, with the highest number of patents granted in 2021 exceeding 4,600,000. The total number of patents awarded in 2014 was little less than in 2013, although after a year, there is once more a more noticeable rise. These figures show that the innovation production of the Chinese high-tech industry has increased and that the scale of innovation has increased significantly.

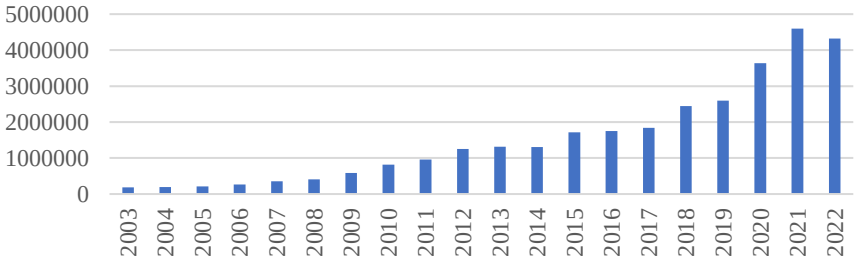

Figure 3: Number of patents application granted(item).

2.2. Current Situation of China's Import and Export Trade

As can be seen from Figure 4, China's import and export trade has surged since the reform and opening up, and the volume of imports and exports has increased even more dramatically since its accession to the WTO in 2001. in 2022, China's foreign trade imports and exports reached US$6,254,411 billion, maintaining its position as the world's top goods trading country for six consecutive years.

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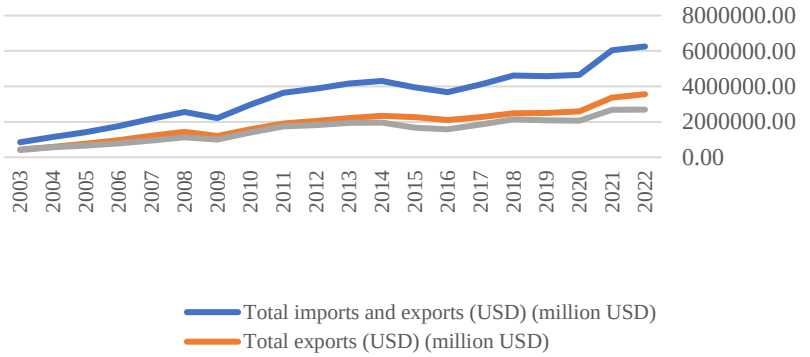

Figure 4: Total imports and exports in China.

In addition, high-tech goods only account for a small proportion of the commodity structure of import and export trade, and the trade structure is homogeneous. The manufacturing trade dominates the import and export trade, while the high-tech sector accounts for a relatively small proportion. In recent years, with the general improvement of the level of scientific and technological innovation, the proportion of high-tech products in China's import and export trade has increased, but on the whole is still low, the proportion of products containing such innovation in the import and export commodities is less than 35%, and in recent years the trade surplus of high-tech products has increased year by year, indicating that China is paying more and more attention to the research and development and high-tech products exports, as shown in Figure 5.

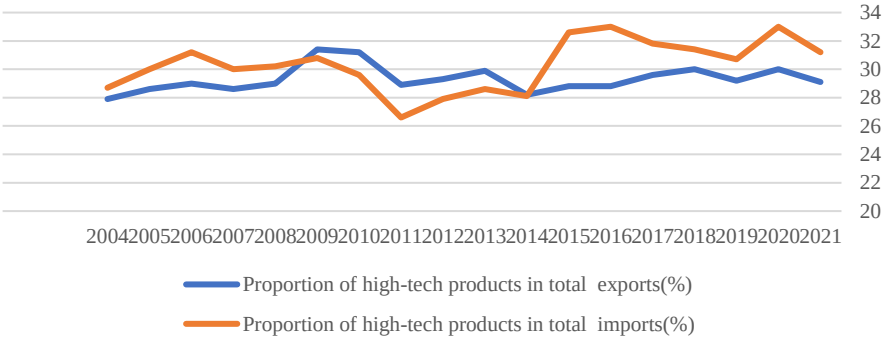

Figure 5: Proportion of high-tech products in trade(%).

External trade dependence reflects the degree of dependence of the country's economic growth on import and export trade. Import dependence reflects the openness of a country's market to the outside world, while export dependence reflects the dependence of a country's economy on foreign trade. In Figure 6, it can be seen that China's import and export trade dependence has been gradually decreasing in the previous years, indicating that China is gradually expanding its domestic production. The dependence on import trade has been stable recently, showing that China's openness to the outside world has been stable at this level; however, the dependence on export trade has increased recently, showing that China will place more importance on export trade after 2020 and that the growth rate of export trade has outpaced the growth rate of GDP.

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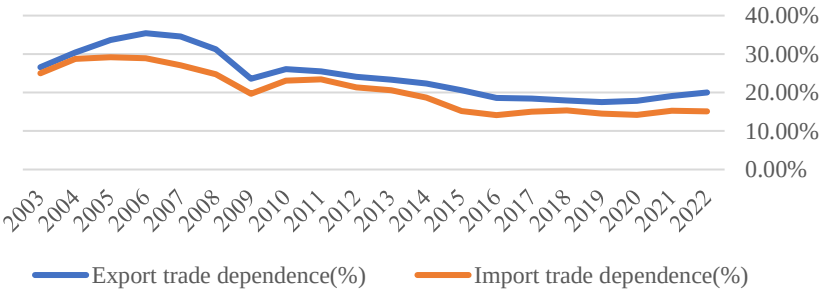

Figure 6: Trade dependence (%).

Since there is a huge gap between countries and provinces in each region, the national import and export situation is not representative of each province, so the total import and export volume by internal destination and source of goods for provincial regions is used and the following table is derived.

Figure 7 shows that the amount of foreign trade is higher in the eastern coastal cities, with Guangdong accounting for the largest share of import and export volume and showing a clear upward trend in recent years. The other coastal cities' growth rates of import and export trade volume are also more apparent. The development tendency of import and export trade has also been seen in several inland regions in recent years, with an increase in both imports and exports.

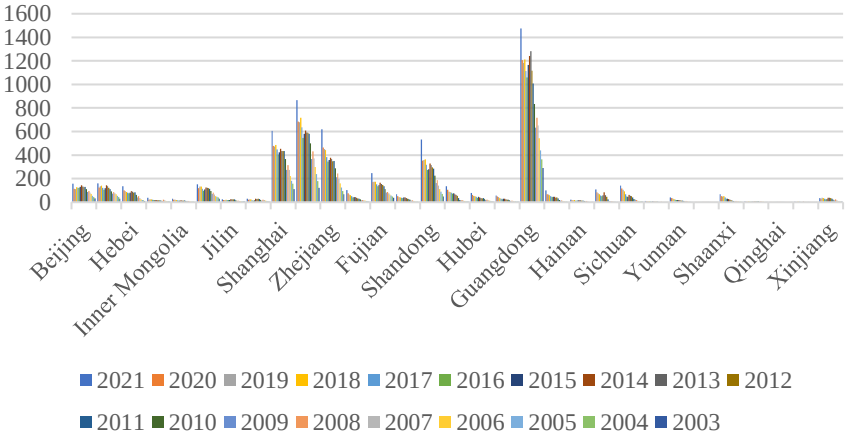

Figure 7: Import and export of provinces in China(unit: billion USD).

3. Correlation Analysis

An analysis of the current state of China's exports and imports and innovation shows that R&D investment in innovation is not proportional to the growth of exports.

3.1. Low Added Value of Exported Products Leads to Insufficient Innovation

According to the endogenous growth theory, the increase of technology innovation-related investments can improve a country's production technology, which can improve product quality and promote product upgrading, thus increasing the value added of export products and greatly enhancing the export volume. Investment in R&D increases the stock of knowledge in society as a whole and promotes the progress of science and technology. After investing in R&D, enterprises can acquire new technologies, knowledge and capabilities, and employ R&D personnel to improve the R&D capability of the company. By using these new technologies, knowledge, capabilities and hired R&D

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personnel, companies can produce high quality and improve product quality by further developing new products to meet market demand, improving products and enhancing product differentiation; on the other hand, mass production is carried out in various ways to increase productivity, such as improving production lines to reduce average costs. Thus, R&D investment will contribute directly to upgrading product quality and indirectly to upgrading product quality through increasing product productivity.

However, the fact is that the increase in R&D investment has not led to a simultaneous increase in export value, and even a decrease in some years, probably because China's current position in the "vertical division of labor" in the global value chain is still weak and the value added of exported products is low, while most of the R&D investment projects are high technology products, which have less impact on the impact on low value-added products is relatively small. A study found that, in terms of subdivision, despite the rapid increase in the share of China's exports of computers and communication equipment, however, compared with Japan and Germany, the domestic high-value share of our computer, electronics, optical equipment and electronic machinery and equipment industries is still in a weak position.

3.2. Uneven Proportion of Investment Leads to Insufficient Innovation

Three categories of R&D spending can be identified: basic research, applied research, and experimental development. Basic research is one of them. It is an experimental or theoretical investigation done to learn the characteristics and rules of motion of objective objects as well as to produce new ideas and theories. Finding potential applications for basic research findings or investigating novel approaches or applications that should be used to accomplish preset objectives are both examples of applied research. Conversely, experimental development makes use of already-acquired knowledge from fundamental research, applied research, and real-world experience to create new goods, materials, and gadgets, establish new business models, and enhance the aforementioned work that has already been formed and created. Therefore, basic research is not only a prerequisite and catalyst for applied research, but also a source of independent innovation in China's industrial core technology. The low proportion of China's expenditure on basic research may be the main reason for limiting the significant growth of exports. Compared with developed countries, China invests more in research and development in applied disciplines, while investing less in basic disciplines. However, investment in applied research has not led to an increase in the number of exported products. This is because the relatively low proportion of investment in basic scientific research is not conducive to the vitality and sustainability of technological innovation, and the development of applied technology mostly only involves improving the original product process to reduce costs, the export impact on existing products is significant, while the influence of exports on new items is little. The proportion of some low value-added products exported from China is steadily declining, while the proportion of high-tech products exported from China is gradually rising. While the cost of low-end items has reduced and their exports are getting close to saturation, there is little correlation between the investment in applied scientific research and the export growth rate of high-tech products. This demonstrates that the amount spent on scientific research has not significantly affected the number of exports. Another reason is the protection of intellectual property rights. In the process of imitation innovation, the increasing threshold for intellectual property protection leads to an increase in the cost of innovation generated by application investment, which has a negative impact on exports.

As a result, despite China's growing proportion of R&D spending, it still invests much less heavily in R&D than major manufacturing nations like the United States, Japan, and Germany. What's more, the majority of China's R&D spending is going toward manufacturing and applying process improvement. Basic research only made up 6.3% of all research spending in 2022, compared to 15% in the

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US and UK and 20% in France and Italy. This implies that the expansion of high-tech product exports may potentially be hampered by transitional investments in application technology.

3.3. Possible Impact of Trade Dependence on China

Trade dependence refers to the extent to which a country or region relies on international trade to meet its economic needs. When a country or region heavily depends on exports to sustain its economic growth and development, it is said to be trade dependent. Conversely, when a country heavily depends on imports to meet its domestic consumption needs, it is also considered trade dependent.

Trade dependence can be beneficial as it allows countries to specialize in the production of goods and services that they are comparatively more efficient at producing, and trade them with other countries for goods and services that they are less efficient at producing. However, excessive trade dependence can also leave a country vulnerable to external shocks, such as changes in global demand or supply disruptions. Additionally, it can limit a country's ability to diversify its economy and increase its resilience to economic downturns.

From the previous data, it is obvious that China had a relatively high import dependence, especially on high technology goods. This could lead to possible consequences.

First of all, there will be economic risks. As one of the world's largest trading nations, China is vulnerable to global economic downturns, trade wars, and reductions in demand from its trading partners. This could cause significant economic impacts and risks, particularly if exports contribute significantly to GDP growth. Secondly, it can cause single-industry structure. Over-reliance on certain export products could lead to a single-industry structure in China's economy, making it difficult to adapt to market changes and develop new industries. Additionally, due to rising labor and land costs, low-value-added industries may face challenges such as relocation. Thirdly, political risks can be possible. Excessive trade dependence could also bring political risks. For example, if China depends on certain countries' markets, these countries may leverage their market advantages to pressure China and influence its policy choices and economic sovereignty. Fourthly, this may lead to environmental pollution. Excessive trade dependence could lead to environmental pollution. Some export industries, such as mining and steel, may consume natural resources and energy excessively, causing environmental damage and pollution. Finally, a specific problem could be amplified in China: social inequality. Excessive trade dependence may lead to social inequality. Some regions or industries may benefit more from trade, while others may face negative impacts, resulting in unequal distribution of income and opportunities.

4. Suggestion

From the previous chapter, it can be concluded that China's current position in the international division of labor is still at a relatively low level, the value added of its export products is not high, and after the demographic dividend disappears, these low value added products will be moved to lower cost countries and regions for production. Therefore, China needs to improve its position in the international division of labor value chain, and export products as close to the middle and high end as possible. Undoubtedly, in terms of technology, technology transfer and spillover absorption are important ways for developing countries to quickly catch up with developed countries. However, it needs to be clear that it is far from enough to achieve economic catch-up simply by relying on technology transfer and spillover from abroad. In the end, multinational companies carry out relevant industrial chain transfer to extend the life of technology and to maximize profits. In this way, enterprises will maintain technology monopoly in the early stage of new technologies. The intensity of technology transfer and technology spillover absorption by technology enterprises will directly affect

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the export competitiveness of China's export products, especially high technology products. Therefore, China should actively attract foreign direct investment with high technology level, and really realize the secondary innovation based on digestion and absorption, and then use it for itself, and at the same time introduce the basic facilities and environment for high-tech leading projects, actively participate in the international community in the field of science and technology exchanges and cooperation, encourage and attract foreign enterprises to establish science and technology research and development centers in China, and also make use of the technology transfer and technology spillover of multinational companies. On the basis of technology transfer and technology spillover from multinational companies, we should make full use of domestic and foreign technological innovation resources, promote the improvement of enterprises' independent R&D and technological innovation capabilities, form their own brand advantages, improve the technological content of products, and transform the growth of China's export trade.

In addition, China's basic research investment is relatively small. Basic research is the foundation and prerequisite for the development of applied research and experimentation, and is an important part of promoting the upgrading of Chinese product quality. China should direct its investment and attention on basic research to lay the foundation for applied research and experimental development, and promote efficient transformation of R&D investment. Moreover, due to the high cost of IPR protection, there is an urgent need for China to change its technological innovation model from imitation innovation to independent innovation, and to encourage independent innovation through policy incentives and institutional design, so that technological innovation and IPR protection system can form a positive feedback with each other.

In addition, the Chinese government has recognized the risks of excessive trade dependence and has actively promoted the implementation of the "dual circulation" development strategy in recent years to strengthen support for domestic demand and technological innovation, reduce dependence on foreign trade, and achieve more sustainable and robust economic growth.

According to the related researches, here are some specific solutions given by the Chinese government. The government stimulate the growth of the domestic market demand by increasing residents' income, expanding public expenditure, and encouraging consumption. Also, it is increasing support for high-tech industries such as artificial intelligence and 5G to enhance the technological level and industrial competitiveness. The government try to support companies to improve product quality and added value through technological innovation and cost reduction to increase their international market competitiveness. Last but no least, China promotes the formation of an open world economy by actively participating in the formulation of international trade rules, expanding openness, and promoting inter connectivity.

These measures aim to strengthen the internal circulation and reduce dependence on foreign trade by expanding domestic demand, enhancing technological level and industrial competitiveness, thus achieving sustainable and stable economic growth.

5. Conclusion

By analyzing China's trade and science and technology innovation from 2003-2022 and comparing the trends of export value data and science and technology innovation input as well as the trends of trade dependence, this paper draws the following conclusions: (1) The increase in R&D investment has not led to an increase in export value, which is due to China's low position in the international division of labor and its low market share for high technology products. (2) China's research investment structure is unreasonable, with less investment in basic research, a weak disciplinary base, and many innovations relying on imitation, leading to slow growth in exports and also resulting in high costs due to factors such as intellectual property rights. (3) China's import dependence is relatively

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high, especially on high-tech products, which may result in a single industrial structure, industry relocation, political risks, environmental pollution, social inequality, etc.

The above findings provide policy insights to cope with China's current transformation of import and export trade, balanced innovation orientation, strengthening domestic demand and reducing trade dependence: (1) Improving its position in the international division of labor value chain, attracting foreign investment, utilizing technological innovation resources, and promoting independent R&D and innovation capacity, (2) Emphasizing investment in basic research and promoting efficient transformation of R&D investment, (3) Expanding domestic demand, strengthening internal circulation and reduce dependence on foreign trade, thus allowing sustained economic growth.

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