



# Research on the Influence of R&D Investment on High-Tech Product Trade in China

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**Abstract.** At present, China's economy has gradually formed a new development pattern of "dual circulation economy". The high-tech industry is responsible for improving the capacity of independent innovation and plays a key role in achieving high-quality economic development and promoting the new development pattern of economy. It is known that technological innovation can improve product quality, enhance the international competitiveness of products and promote the development of international trade. Therefore, an in-depth study on the relationship between R&D investment and trade in high-tech products is of great practical significance to understand the role of R&D investment in technological innovation. This paper empirically investigates the relationship between R&D investment and trade in high-technology products based on provincial panel data of China from 2009 to 2018. The results of this paper show that R&D investment plays a positive role in China's trade of high-tech products. Accordingly, suggestions are provided such as increasing the intensity of R&D investment, investing in R&D investment purposefully, improving the welfare of employed people, also, increasing the added value of products and making rational use of the foreign investment.

**Keywords:** R&D investment · trade in high-tech products · technological innovation

## 1 Introduction and Background

At present, China has become the largest trading country in the world. The import and export of goods and services, foreign investment and introduction of foreign capital all play an important role in promoting China's economy. Especially as the core of national competitiveness, the production and trade of high-tech industry are of great importance to the national economy. In recent years, the country's support for high-tech industries has been increasing, and China's R&D funds for high-tech industries have continued to grow. China's high-tech products trade scale is also expanding, according to the National Bureau of Statistics, the high-tech products trade volume increased 16

times in 2020 than in 2000. It can be seen that China's high-tech industry has made outstanding achievements, but compared with the developed countries, there are still some problems in China's high-tech product trade, such as imbalance of export structure, less independent innovation, heavy dependence on foreign capital, low added value of products and so forth. Under the circumstances of dual circulation economy, it is meaningful to study the effect of R&D on high-tech products trade, discuss the research and development of high technology industry and the relationship between investment and economic benefit, moreover, how to use R&D to create maximum profits for foreign trade, which may promote the development of high technology products trade.

## 2 Literature Review

From the relevant literature, domestic and foreign scholars have conducted a lot of empirical and theoretical research on R&D investment and high-tech product export trade. Scholars have used different indicators and measurements to study different sample's data which leads to variability in the conclusions. According to the different research results, we make the following classification.

As for the relationship between R&D investment and high-tech product trade, Brauer-hjlm and Thulin (2010), who initially studied in this field and selected relevant data of 19 OECD countries from 1981 to 1999, showed that the export of high-tech products would increase by 3% for every 1% increase in R&D expenditure [1]. Sandu & Ciocanel (2014) claimed that R&D investment can promote the export of high-tech products to a certain extent [2]. Xiwei Li (2017) discussed the impact of R&D investment on the export value added of high-tech industry, and the results showed that R&D investment is conducive to improving the export value added of high-tech products in China [3]. Youqun Guo and Chengjuan Zheng (2007) showed that R&D investment plays an important role in the export of high-tech products [4]. Jian Chen and Zhao Chen (2006) studied the panel data of 31 provinces and concluded that R&D expenditure significantly promoted the export of high-tech products in China [5].

From the related researches on high-tech product trade, domestic and foreign scholars have constructed a variety of different indicators based on different methods and principles to measure the influencing factors of high-tech products. It is generally believed that human capital, foreign direct investment, R&D investment and technological innovation have positive promoting effects on the scale of high-tech export in China. Although these literatures have different emphases when considering the factors affecting the trade of high-tech products, they have variables in this paper for the selection of empirical control. From the perspective of the relationship between R&D investment and economic benefits, most domestic and overseas scholars believe that there is a significant positive correlation between R&D investment and innovation performance, but some empirical conclusions and research views are not consistent. This is due to the various kinds of influencing factors of innovation performance. The existing literature has not drawn a clear conclusion on how R&D investment specifically affects the trade of high-tech products, which is not helpful to clarify the total amount and use direction of R&D investment in China's high-tech industry.

Based on the above considerations, this paper will further analyze the role of research and development activities for high-tech products trade in combination with the actual situation. In this paper, wage level, economic scale, foreign direct investment and scientific and technological manpower input are selected as control variables.

### 3 Mechanism Analysis of the Influence of R&D Investment on High-Tech Product Trade

According to the theory of R&D investment factors, R&D investment is a production factor, and the more R&D investment a country has, the more conducive it will be to the transformation of high-tech product trade to high-tech content and high added value [6]. Previous research literature shows that R&D investment has a positive contribution in promoting the level of innovation output of firms [7], while technological innovation has a significant impact on high-tech trade in the following three aspects. Firstly, improve the product technology and the quality of existing goods, or invent new goods, increase the proportion of high-tech products trade. Secondly, optimize the structure of high-tech products trade. Thirdly, enhance the brand awareness and brand image [8].

Sufficient R&D investment is an effective means to improve the quality of technological innovation in high-tech industries. High-quality patent output provides a solid foundation for secondary innovation in high-tech industries, promotes the trade of high-tech products and brings greater economic benefits. From the perspective of trade structure, processing trade is the main way of China's high-tech products trade. The reason for the low level of trade structure and the low value added of export lies in the strong dependence on foreign technology, insufficient research and development. The producers may increase R&D investment in the domestic high technology products, make full use of foreign investors' direct investment in capital and technology, leverage technological innovation, increase the added value of products, maximize the integration and utilization of resources so as to promote the economic development of high-tech industries. As for the brand, if a country or region wants to be in an invincible position, it must rely on the brand. Therefore, high-tech enterprises are likely to adapt to the trend of industrial development, constantly adjust their development strategies, increase the R&D investment of new technologies and new products and build industry-leading brands by improving product quality and technological innovation, so as to establish their product characteristics and brand advantages.

## 4 The Empirical Analysis of the Impact of R&D Investment on High-Tech Product Trade in China

### 4.1 Model Specification

In this paper, the total trade volume of high-tech products is taken as the explained variable, R&D investment in high-tech industry is taken as the core explanatory variable. And the wage level, economic scale, foreign direct investment and scientific and technological manpower input are introduced as control variables to establish the following model:

$$TL_{it} = a_0 + a_1RD_{it} + a_2WAGE_{it} + a_3GDP_{it} + a_4FDI_{it} + a_5RE_{it} + \varepsilon_{it} \quad (1)$$

**Table 1.** Variable definition table

Variable type	Name of the variable	Abbreviations	Variable meaning	The data source
The explained variable	Trade volume of high-tech products	TL	Total trade volume of high-tech products	EPS database
Explanatory variables	Research and development investment	RD	Internal RD expenditure of high-tech industry	EPS database
	Wage level	WAGE	Total salaries of employees in enterprises of high-tech industry	National Bureau of Statistics
	Economic scale	GDP	Gross domestic product	EPS database
	Foreign direct investment	FDI	Actual amount of foreign capital used	National Bureau of Statistics
	Science and technology manpower input	RE	High-tech industry R&D personnel full-time equivalent	EPS database

In the above equation,  $i$  represents the section unit of each province, and  $t$  represents the year.  $TL_{it}$  represents the total trade volume of high-tech products.  $RD_{it}$  represents the R&D investment in high-tech industries.  $WAGE_{it}$  represents the wage level.  $GDP_{it}$  represents the economic scale.  $FDI_{it}$  represents the foreign direct investment.  $RE_{it}$  represents the input of scientific and technological manpower in high-tech industries.  $\varepsilon_{it}$  represents the error term.

For the balance and availability of panel data, Hong Kong, Macao and Taiwan were not selected as research samples in the empirical model. Considering inflation and other factors, taking 2009 as the base period, the GDP deflator was used to deflate the total trade volume of high-tech products, R&D investment, wage level, economic scale and foreign direct investment respectively as shown in Table 1. All variables in the table are taken as logarithms.

## 4.2 The Empirical Test

### 4.2.1 Descriptive Statistics

Before the empirical analysis, descriptive statistics on the total trade volume of high-tech products, R&D input of high-tech industries, total wage in high-tech industry, economic scale, foreign direct investment and scientific and technological manpower input are shown in Table 2.

**Table 2.** Descriptive statistics

variable	N	mean	sd	min	max	unit
TL	310	$1.94 \times 10^{11}$	$4.39 \times 10^{11}$	$4.78 \times 10^7$	$2.44 \times 10^{12}$	Yuan(RMB)
RD	310	$5.71 \times 10^5$	$1.14 \times 10^5$	$1.66 \times 10^2$	$8.42 \times 10^6$	Yuan(RMB)
FDI	310	$7.34 \times 10^9$	$1.2 \times 10^{10}$	$3.38 \times 10^7$	$9.52 \times 10^{10}$	Yuan(RMB)
GDP	310	$1.73 \times 10^8$	$1.42 \times 10^8$	$4.41 \times 10^6$	$7.28 \times 10^8$	Yuan(RMB)
WAGE	310	$2.43 \times 10^7$	$2.19 \times 10^7$	$9.50 \times 10^6$	$1.33 \times 10^8$	Yuan(RMB)
RE	310	$7.48 \times 10^4$	$1.04 \times 10^5$	$1.91 \times 10^1$	$6.22 \times 10^5$	

**4.2.2 Empirical Results**

In order to test the relationship between R&D investment and high-tech product trade, all models in this paper adopt fixed effects for regression. All variables in the table are taken as logarithms.

The baseline regression results are shown in Table 3, and the R square coefficient of the above model is 0.863, indicating a good overall goodness of fit. The core explanatory variable of the model has a significant promoting effect on high-tech product trade. The specific explanatory variables are analyzed as follows:

**Table 3.** Results of baseline regression

Variables	Model (1) Total Trade in High-tech Products (lnTL)
Constant term	-3.442 ( 0.130)
R&D	0.312*** (0.000)
WAGE	0.455*** ( 0.005)
GDP	-0.242 ( 0.281)
FDI	0.999*** (0.000)
RE	-0.098 (0.437)
R-squared	0.863
Number of obs	310

Note: The standard errors corresponding to variables are in the brackets. \*, \*\* and \*\*\* respectively indicate that they pass the significance test at the level of 10%, 5% and 1%

First, R&D investment in high-tech industries passes the significance test of 1%, indicating that the total trade volume of high-tech products increases with the rise of R&D investment. Increased investment in research and development can boost technological innovation, reduce the risk of relying on imports of core devices, increase market demand and expand the scale of the foreign trade. The regression results show that when the R&D investment increases by 1%, the trade volume of high-tech products will increase by 0.312%, which indicates that R&D investment has significant social return attribute.

Second, the wage level passes the the significance test of 1% and has a positive impact on the trade volume of high-tech products. Every 1 percentage increase of the wage level will promote the trade volume of high-tech products to increase by 0.455 percentage, indicating that the increase of the wage level has a promoting effect on the trade volume of high-tech products. The increase of wage level is conducive to the improvement of work efficiency and output, thus driving the development of high-tech industry and the growth of trade volume of high-tech products.

Third, foreign direct investment passes the significance test of 1%. Previous literature shows that foreign direct investment is accompanied by technology spillover effect, thus driving the development of domestic industries. According to the regression results it can be seen that foreign direct investment has positive promoting effect to the high-tech products trade, for every 1% increase in foreign direct investment, high technology products trade volume will increase by 0.999%. It also reflects that our high-tech product trade relies too much on foreign capital, which accords with the reality that the high-tech industry is still restricted from abroad in some fields.

Fourth, economic scale and scientific manpower input fail to pass the significance test. On one hand, the higher the level of economic development, the stronger the export supply capacity of high-tech products. As shown in Table 3, regression result of economic scale is not significant, indicating that China's high-tech products are sensitive to the potential demand scale of trading countries and the economic scale of the destination country is also an important factor affecting China's high-tech product trade. On the other hand, it takes a relatively long process of research and transformation for the input and development personnel to generate economic benefits. Although the impact of the input and development personnel on the trade volume of high-tech industry is not significant in the short term, the importance of scientific and technological manpower input cannot be ignored. To some extents, the regression results also show the deficiency of the transformation of R&D to output in high-tech industry.

## 5 Conclusions and Suggestions

This paper firstly analyzes the influence path of R&D input on China's high-tech product trade from the theoretical level, and then conducts modeling based on the panel data of 31 provincial levels from 2009 to 2018, except for Hong Kong, Macao and Taiwan, to explore the influence of China's R&D input on high-tech product trade and draws the following conclusions: R&D input has a positive impact on high-tech product trade. The paper provides the following suggestions for future research.

First, it is essential to increase the intensity of R&D investment and focus on both quantity and quality. Innovation is the vitality of high-tech industry, R&D investment is

an important material basis for innovation. Only by increasing investment in the high-tech industry, providing good infrastructure guarantee for the high-tech industry and ensuring the support of human resources, capital and other factors, can the sustainable development of the trade of high-tech products be promoted.

Second, invest in R&D investment purposefully. On the basis of accurate analysis of the current situation, find out the entry point of R&D investment. Try to grasp the development of market under the guidance of consumers' demand so that the research and development investment of each unit can play a maximum role and improve its economic benefits.

Third, improve the welfare of employees. To vigorously improve the welfare of workers employed in high-tech industries is a key link to promote the development of high-tech industries. At present, the essence of economic transition development in our country is the transition from high input with low output to high quality. As the high-tech industry has the characteristics of knowledge - intensive, technology - intensive, it puts forward high requirements for people engaged in this occupation. The development of trade in high-tech products must be supported by a strong contingent of skilled workers, and the economic and social benefits of workers in high-tech industries must be enhanced to fully mobilize their enthusiasm for work and maximize their potential.

Fourth, increase the added value of products and make rational use of the foreign investment. Encourage state-owned enterprises, collective enterprises and private enterprises to increase the investment in scientific research as well as added value of their products and improve the technological content of their products. Actively support local enterprises to establish cooperative relationships with colleges and universities and scientific research institutions and rationally utilize domestic R&D talents and resources. Simultaneously realize the organic combination of R&D and output and improve the technical level and innovation ability. Unswervingly pursue the strategy of "going global" and develop the international market to realize the integration of global resources. Make full use of foreign investment and actively learn from foreign advanced technology, expand the spillover effect of technology to improve the R&D and innovation ability of local enterprises.

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