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## IMPACT OF OPENNESS ON THE DEVELOPMENT OF HIGH-TECH INDUSTRY IN CHINA

Y. C. Wang

*Southern Federal University, Rostov-on-Don, Russia*  
yuvan@sfedu.ru, ORCID: 0000-0002-5050-1028

**Abstract. The purpose of the research.** Although many scholars have done a lot of research on high-tech industries, most of them focus on the research on regional economic levels, government policies, scientific research funding, human capital, etc., but few of them involve the impact of openness on high-tech industries. Therefore, it is meaningful to make relevant research on the relationship between openness and the development of high-tech industries.

**The methodological basis.** The research is based on theoretical and empirical analysis. Initially, an analysis of the literature was carried out. After that, based on the panel data of thirty-one province (municipality) from 2010 to 2019, we mainly use empirical analysis methods by Stata 16.0 software to compare the mixed-effect model, random-effect model and fixed-effect model, to conduct the Hausman test, and use the fixed-effect model to analyze the relationship between openness and the development of high-tech industries, and make a comparative analysis by different regions, to put forward targeted development suggestions.

**Research result.** Openness is positively correlated with the development of high-tech industries, every 1 % increase in the level of openness, the output value of high-tech industries increases by 0.1095 %, this result is consistent with the hypothesis in this paper.

**The prospects of the research.** In this research, we only use the ratio of high-tech industry exports to GDP to measure the degree of openness, which is relatively simple and may be partial. How to comprehensively measure the degree of openness is also the direction of further research.

**Keywords:** openness, high-tech industry, development, China

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Научная статья

## ВЛИЯНИЕ ОТКРЫТОСТИ ЭКОНОМИКИ НА РАЗВИТИЕ ВЫСОКОТЕХНОЛОГИЧНОЙ ПРОМЫШЛЕННОСТИ В КИТАЕ

Ван Юйчань

*Южный федеральный университет, Ростов-на-Дону, Россия*  
yuvan@sfedu.ru, ORCID: 0000-0002-5050-1028

**Аннотация. Цель исследования.** Несмотря на многочисленные исследования в области развития высокотехнологичной промышленности, большинство из них сосредоточено на исследованиях региональных экономических уровней, государственной политики, финансирования научных исследований, человеческого капитала и т.д., но лишь немногие из них затрагивают влияние открытости на высокотехнологичные отрасли, что определяет цель данной работы — изучить взаимосвязь между открытостью экономики и развитием высокотехнологичных отраслей.

**Методологическая основа.** Исследование основано на теоретическом и эмпирическом анализе. Первоначально автором был проведен анализ литературы по теме работы. После этого на основе панельных данных 31 провинции (муниципалитета) за период с 2010 по 2019 год были использованы методы эмпирического анализа с помощью программного обеспечения Stata 16.0 для сравнения модели со смешанным эффектом, модели со случайным эффектом и модели с фиксированным эффектом для проведения теста Хаусмана и использования фиксированного модель-эффекта для анализа взаимосвязи между открытостью и развитием высокотехнологичных отраслей и проведения сравнительного анализа по различным регионам, чтобы выдвинуть целевые предложения по развитию.

**Результат исследования.** Исследование показало, что открытость экономики положительно коррелирует с развитием высокотехнологичных отраслей, с повышением уровня открытости на 1 % величина выпуска высокотехнологичных отраслей увеличивается на 0,1095 %, этот результат согласуется с гипотезой в данной работе.

**Перспективы исследования.** В этом исследовании используется отношение экспорта высокотехнологичной промышленности к ВВП для измерения степени открытости, что относительно просто и может быть частичным. То, как всесторонне измерить степень открытости, также является направлением дальнейших исследований.

**Ключевые слова:** открытость, высокотехнологичная промышленность, развитие, Китай

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**Introduction.** Since its birth, the high-tech industry has been hailed as the sunrise industry by countries all over the world, and various countries have actively taken various measures to encourage the development of high-tech industries. For decades, high-tech industries have become the main driving force for the economic growth of various countries, and a strong material basis for the development of human society towards modern civilization. The development scale and development level of high-tech industries have become an important factor to measure a country's economic vitality and growth ability, and it is a symbol of a country's comprehensive national strength. Technological innovation has a positive role in promoting the development of high-tech industries, but openness to the outside world is also one of the main channels

for international technology spillover [8]. With the continuous development of globalization, the economies of various countries will be more closely linked through investment and trade. Opening to the outside world can not only promote technological innovation in high-tech industries by importing and exporting high-tech products and conducting technical trade, but also indirectly drive the development of technology through the technological spillover effects, such as competition effect and demonstration effect, to improve continuously product quality and increase production efficiency.

In order to follow the trend of the times and promote mutual benefit among countries, in 2013, President Xi Jinping proposed «the Silk Road Economic Belt and the 21st-Century Maritime Silk Road», which is short of «the

Belt and Road» initiative. In the initiative, China will work with countries along the route to build jointly a new cooperation mechanism of political mutual trust, economic integration and cultural tolerance<sup>1</sup>. This initiative has won the approval and support from more and more countries. At the same time, it has also received positive responses from various regions in China. According to their own regional advantages, there are thirty-one provinces, autonomous regions and municipalities (not include Hong Kong, Macao and Taiwan), which have formulated corresponding development strategies, so as to promote actively the construction of the «the Belt and Road». The initiative of «the Belt and Road» is guided by the developed eastern coastal areas, strengthens the interaction and cooperation between the eastern, central and western regions<sup>2</sup>, leverages the development of the central and western regions, and gives full play to the comparative advantages of various regions to improve comprehensively the level of China's openness.

Since the reform and opening up in China, opening up has been a topic which is much talked about, and related researches are emerging one after another. However, it is worth noticing that most of these researches only focus on the degree of China's openness to other countries [15]. Relatively, there are few studies on the impact of the degree of openness between different regions on the economy and industry, and the standards for measuring the degree of openness are also different. Therefore, the relationship between openness and the development of high-tech industries is a subject worthy of in-depth study.

Although many scholars have done a lot of research on high-tech industries, most of them focus on the research on regional economic levels, government policies, scientific research funding, human capital, etc., but few of them involve the impact of openness on high-tech industries. Therefore, it is a relatively meaningful attempt to make relevant research on the relationship between openness and the development of high-

tech industries. In this research, we use panel data to analyze the impact of the openness on high-tech industries in the ten years from 2011 to 2019, to compare and analyze the impact of openness on high-tech industries in different regions, to provide some theoretical support and corresponding policy suggestions for the development of China's high-tech industry. Therefore, it has important theoretical value and practical significance for the research of openness and high-tech industrial technology.

**Literature review.** In the process of open innovation, if the openness is too low, the enterprise cannot fully absorb and utilize external resources. If the openness is too high, it cannot reasonably utilize external information and resources [2]. Therefore, in the research, we use the proportion of high-tech industry exports to GDP to measure the degree of openness. In the existing literature, there is no consensus on the impact of openness on high-tech industry. Some scholars believe that openness promotes the development of high-tech industry, while others believe that openness inhibits the development of high-tech industry.

Jou and Chen found that a concurrent process of intensifying the internal as well as external linkages has occurred in the Hsinchu Science-based Industrial Park. It indicates that not only is the regional advantage sustained sufficiently, but also the global industrial networks are expanded continuously to maintain the openness and dynamics of the region [9].

Harmse and Abuka believe that the competition and learning effects brought by openness are conducive to promoting the technological progress of South African manufacturing [6].

Sahbi Gabsi and Ali Chkir found that the degree of openness between developed and developing countries is conducive to the dissemination of technology and the development of productivity in developing countries [4].

Patricia Hofmann analyzed the impact of openness on technological progress and long-

1 Correct understanding of the «Belt and Road» [Electronic resource] // People.cn. URL: [https://baike.baidu.com/reference/13132427/7af3seJo6bCgIH9LGaYoPMapQPihzi0\\_jm18vsL7o8UggzToHkcjpfkFKccWPQ4qNgq8v\\_uRcxRAIUi4r\\_XRoA40cQ4nB8wzWnpTnY4nDlISypzcgylAJeQ](https://baike.baidu.com/reference/13132427/7af3seJo6bCgIH9LGaYoPMapQPihzi0_jm18vsL7o8UggzToHkcjpfkFKccWPQ4qNgq8v_uRcxRAIUi4r_XRoA40cQ4nB8wzWnpTnY4nDlISypzcgylAJeQ) [date accessed: 06.06.22].

2 «The Belt and Road» finally delineates 18 provinces, Fujian and Xinjiang into core areas [Electronic resource] // People.cn. URL: [https://baike.baidu.com/reference/13132427/406cBPNjkQABaNKVoqSjAo0JbLZVZW0X1dmKpOFoQilGHgrXxNH5sUmVke1tXm4DNiIvDTIQ7DeD-MN9nnMFDyWjfdKKZ5KeXV7KdGZUTIIHn\\_-m3g](https://baike.baidu.com/reference/13132427/406cBPNjkQABaNKVoqSjAo0JbLZVZW0X1dmKpOFoQilGHgrXxNH5sUmVke1tXm4DNiIvDTIQ7DeD-MN9nnMFDyWjfdKKZ5KeXV7KdGZUTIIHn_-m3g) [date accessed: 06.07.22].

term economic growth, and the results show that openness leads to competition, which will have a negative impact on innovation and growth [7].

After studying the impact of openness on innovation, Antonio Navas believes that openness will promote innovation in sectors and improve production efficiency [13].

There are other scholars found that openness promoted the agglomeration and technological progress of high-tech industries [14]. Openness is not the main source of growth and progress in high-tech industries [11]. At present, in the development of China's high-tech industry, technology externalization acquisition in opening to the outside world has a great influence on the innovation performance of high-tech industry [16].

According to the «innovation-driven» growth theory proposed by Grossman and Helpman [5] and the trade spillover model proposed by Coe and Helpman [3], both of them affirm the impact of openness on innovation in high-tech industries. As one of the main channels of technology spillovers, openness will inevitably have a direct or indirect impact on a country's technological innovation, and the higher the degree of openness, the faster the flow of capital and commodities, and the more technology dissemination channels.

But some scholars put forward the opposite opinion. In general, openness is an important explanatory variable for the factors that influencing the development of high-tech industries, but we need to further verify its specific role in the development of high-tech industries.

### Model Construction and Data Explanation

#### *Research hypotheses and model building*

For an enterprise with a certain degree of openness, its innovative ideas and creativity may come from employees within the enterprise, or from information and resources outside the enterprise. By absorbing external knowledge and technology, it continuously enhances its own innovative practice ability, which is a simple path for enterprises to create value and profits. On the one hand, on the basis of continuous internal innovation attempts, the enterprise absorbs and utilizes advanced external technologies, shortens research and development time, reduces product research and development

costs, and improves innovation speed. Through openness and cooperation, enterprises can obtain complementary resources, share the costs and risks of innovation, reduce the uncertainty of technological innovation, shorten the innovation cycle, and improve innovation efficiency. On the other hand, the exchange of technology between enterprises and the outside has formed an invisible driving force, forcing enterprises to speed up technological innovation. Based on the above theoretical analysis, in this research, we mainly use empirical analysis methods by Stata 16.0 software. Empirical analysis can more directly, more scientifically and more accurately reveal the nature and internal laws of the research object, clarify the relationship between variables, and predict the development trend of things. We followed the research ideas of relevant scholars in the existing research, combined with ourself-understanding, and take the output value of high-tech industries as an indicator to measure the development of high-tech industries, and put forward an overall hypothesis, assuming that there is a significant positive correlation between openness and technological development of high-tech industries.

About openness, some scholars propose that it includes breadth (OpenB) and depth (OpenD). Breadth refers to the types and quantity of external resources used by enterprises for innovation activities in the process of open innovation, and depth refers to the importance of different innovation resources in enterprises' open innovation activities [10]. Due to the limitation of data, we do not conduct in-depth research on the degree of openness, we only take the output value of high-tech industries as an indicator to measure the development of high-tech industries, which is the explained variable. the degree of openness (the proportion of high-tech industry exports in the GDP of the current year) is taken as the explanatory variable. In order to facilitate the analysis of stata 16.0 software, the explanatory variables and the explained variables are given different symbols. The selection of specific variables and the explanation of indicators are shown in Table 1.

According to the above indicators, a linear regression model of the influencing factors of the high-tech industry is constructed:

$$Y = \alpha + \beta_0 X_1 + \varepsilon_{it} \quad (1)$$



### *Data sources and result analysis*

This paper mainly studies the impact of the openness of China's 31 provinces and municipalities (excluding Hong Kong, Macao and Taiwan) on the development of China's high-tech industries from 2011 to 2019. Therefore, China Statistical Yearbook, China High-tech Industry Statistical Yearbook, China Torch Statistical Yearbook, China Science and Technology Statistics Network are the main sources of research data.

The author uses panel data to study. The reason for choosing panel data is that panel data has the characteristics of both cross-sectional data and time series data, that is, it has cross-sectional dimensions (there are multiple observation samples in the same time period), and there is time sequence dimension (the same sample is observed over multiple time periods), so it has advantages for researching. Panel data is divided into long panel data and short panel data according to the relative length of the cross-sectional dimension and the time series dimension. In this paper, we use short panel data to study. The models used commonly for short panel data are include pooled regression model, fixed effect regression model, and random effect model [1].

In econometrics, the stationarity test of panel data is the primary problem of econometric analysis. The methods of model test for short panel data includes F test, LM test and Hausman test [12].

The F test is used to judge whether the fixed effect model is better than the mixed estimation model, and if the null hypothesis is rejected, the fixed effect model is selected.

The LM test is used to judge whether the random effect model is better than the mixed

estimation model. If the null hypothesis is rejected, then we will use the random effect.

The null hypothesis of the Hausman test is that the individual effects are not related to the explanatory variables, and the null hypothesis is rejected and a fixed-effects model is selected. Conversely, the null hypothesis is accepted and a random-effects model is selected. That is, the null hypotheses and alternative hypotheses of the Hausman test are:

- $H_0$ : Individual effects are independent of the regressors (random effects regression model);
- $H_1$ : Individual effects are correlated with regressors (fixed effects regression model).

Different types of inspections have different inspection purposes and inspection conclusions. In order to ensure the robustness of the data, we use the natural logarithm of the explained variables and explanatory variables, to analyze the data by the Stata16.0 software. The results are as follows (Table 2).

According to the analysis of the results of different types of tests, the panel data in this study is optimal using the fixed effect model. According to formula (1), the linear regression model of the influencing factors of high-tech industry is as follows:

$$Y = 0,1095\beta - 6,7390 + \varepsilon_{it} \quad (2)$$

At the national level, it can be seen that, the degree of openness and the output value of high-tech industries are significant at the level of 5%, and have a positive impact on the output value of high-tech industries. For every 1% increase in the level of openness, the output value of high-tech industries increases by 0,1095%, which verifies the previous hypothesis. Due to

Table 1  
Таблица 1

### **Variable design** **Переменная конструкция**

Variable category	Index	Variable name (unit)	Variable labels	Description and assignment
Explained variable	Output value	High-tech Industry output value	$Y$	High-tech main business income of each province (municipality) in each year
Explanatory variables	Openness	Openness degree (%)	$X$	High-tech industry exports as a share of GDP in each year

Table 2  
 Таблица 2

**The results of panel model**  
**Результаты панельной модели**

Item	POOL Model	FE Model	RE Model
$X$	0,1991(10,26**)	0,1095 (7,54**)	0,1191 (8,19**)
Intercept	-5,1972 (-7,73**)	-6,7390(-9,04**)	-6,0215 (-8,70**)
Sample size	310	310	310
Test	$F(11,298) = 603,23,$ $P = 0,0000$	$F(11,268) = 108,34,$ $P = 0,0000$	$X2(11) = 1938,89,$ $P = 0\ 0000$
Dependent variable	High-tech industry output value		
Note: ** is significant at the 95% confidence interval; In parentheses are the t value (POOL model and FE model) and z value (RE model). Data source: The analysis results of software Stata 16.0.			

Table 3  
 Таблица 3

**Division of China's economic regions**  
**Разделение экономических регионов Китая**

Region	Provinces (Municipalities)	Number of Provinces (Municipalities)
Eastern	Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan	10
Northeast	Liaoning, Jilin, Heilongjiang	3
Central	Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan	6
Western	Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	12

Table 4  
 Таблица 4

**Analysis results of different economic regions<sup>1</sup>**  
**Результаты анализа различных экономических регионов**

Item	Eastern	Northeast	Central	Western
$X$	0,2298 (9,21)	0,0758 (0,63)	0,1731 (4,67)	0,0566 (2,99)
Intercept	-3,3132	-9,6358	-6,3527	-8,1926 (-5,83)
Sample size	100	30	60	120

<sup>1</sup> Data source: The analysis results of software Stata 16.0.

the different development levels of provinces (municipalities), the degree of openness is also different or even quite different, so the regression of all data may not be able to accurately reflect the differences between regions. In view of this, according to the division of China's four major economic regions (eastern, central, western and northeast) (Table 3), the Stata16.0 software was used to analyze the data of the four regions again. The results are as follows (Table 4).

From the analysis results in Table 4, it can be seen that different regions have different degrees of openness, and the impact on the development of high-tech industries is significant within the 95 % confidence interval. The previous hypothesis is verified again. Regardless of whether it is in the east or the central and western regions, opening up is conducive to the development of high-tech industries in various regions. Therefore, under the opportunity of the «the Belt and Road» initiative, all regions should seize the opportunity and actively participate in the construction of the «the Belt and Road». It is necessary to strengthen cooperation with neighboring countries along the route and improve the overall openness level of China. It is also necessary to strengthen the interaction and cooperation between the eastern, central and western regions in China, and the eastern region lead and promote to the common development of the central and western regions, and bring greater benefits to the central and western regions.

However, in each economic region, the impact of openness on high-tech industry is different. The influence coefficients of eastern, central, northeastern and western are 0,2298, 0,1731, 0,0758, and 0,0566, respectively. It shows that, in the eastern region, every 1 % increase in openness degree will increase the output value of high-tech industries more than the central, western and northeastern regions. Openness degree can increase the output value of high-tech industries, and the eastern region with a higher openness degree has a greater technology spillover effect on high-tech industries than other regions.

**Conclusion and discussion.** Based on the data of Chinese high-tech industrial enterprises from 2010 to 2019, we analyze the direct impact of openness on the development of high-tech industries, and the following conclusions were drawn.

Under the trend of economic globalization, the economic development of a country is inevitably affected by the development of the world economy. In the regression results, the degree of openness has a significant positive impact on the output value of high-tech industries within the 95 % confidence interval. For every 1 % increase in the level of openness, the output value of high-tech industries increases by 0,1095 %. We believe that, it is because the development of high-tech industries is more international, the products of high-tech industries have a higher degree of international recognition, and the corresponding high-tech industry products have a wider market range. There is a higher level of openness, it is more frequent economic and technological exchanges between the country and other countries. This will narrow the gap between the development level of high-tech industries of a country and the development level of the world. At the same time, a higher level of openness also means that the country enjoys a wider world market, thereby promoting the development of its high-tech industry.

Through the empirical research, it is proved that openness is beneficial to the development of high-tech industries. Therefore, under the «the Belt and Road» initiative, China should insist on opening to the outside world, and should continue to expand and deepen its openness. With the help of the multilateral mechanisms and regional cooperation platforms, China should establish actively economic cooperation partnerships with other countries around the world, strengthen technical exchanges to build jointly the «the Belt and Road», so that production factors such as capital and labor can flow freely among countries, markets of various countries can be deeply integrated, so as to achieve peaceful development, mutual benefit and win-win situation. In China, different economic zones have obvious differences in openness due to different levels of development. Although the country has implemented the strategy of the rise of the central region, the development of the western region, and revitalizing the northeast industrial base, however, compared with the eastern region, there is still a big gap in the level of science and technology and the level of openness. Therefore, for the three regions, it is not only to implement the strategy of bringing in, but also the strategy of going out, so as to

further improve the driving effect of openness on the development of high-tech industries.

It needs to strengthen the breadth and depth of opening to the outside world for the development of high-tech industry. The degree of openness profoundly affects the economic development of a country or region. It was opened earlier in the eastern, and its development is better than that of the central and western regions. Therefore, to improve the development level of China's overall high-tech industry, other regions need to learn from the development experience of the eastern region to improve the degree of opening to the outside world. The degree of opening to the outside world has been improved, and the amount of foreign investment attracted will also increase. Moreover, by further expanding the level of opening to the outside world, high-tech industries can participate in the division of labor in the global value chain, and through foreign trade cooperation, they can obtain the spillover of technology and knowledge, and improve the development level of high-tech industries.

In this research, we only use the ratio of high-tech industry exports to GDP to measure the degree of openness, which is relatively simple and may be partial. How to comprehensively measure the degree of openness is also the direction of further research.

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## ИНФОРМАЦИЯ ОБ АВТОРАХ



**Y.C. Wang** — 3rd year Postgraduate Student, Faculty of Economics, Southern Federal University.  
105/42 Bolshaya Sadovaya st., Rostov-on-Don, Russia

**Ван Юйчань** — аспирант 3-го курса экономического факультета Южного федерального университета.  
Россия, г. Ростов-на-Дону, ул. Б. Садовая, 105/42