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The relationship between ICT trade and China's OFDI development

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Abstract

Information and communication technology (ICT) is one of the important technologies that can promote global economic development. It has the characteristics of openness, globalization, and high efficiency, which makes it possible to greatly reduce the information acquisition cost and transaction cost of various enterprises in different countries in the world, and help each enterprise improve investment efficiency and expand investment. The impact of ICT on the global economy and trade now far exceeds people's expectations.

Based on the literature on gravity models, this paper uses the data of 2086 OFDI projects published by the Ministry of Commerce of China from 2012 to 2017 to aggregate 165 observations to perform regression analysis on the per capita GDP, ICT trade and other data of China and other 82 countries or regions. And summarize whether the bilateral ICT import and export trade will promote the number and amount of China's foreign investment.

On this basis, consider whether there is a relationship between development of ICT and China’s OFDI. The 4 hypotheses are put forward: 1. the increase in the per capita GDP of the investing country will promote the development of bilateral investment; 2. the increase in the distance between the two countries will reduce the traditional Investment links; 3. the increase in ICT goods imports and exports has a positive impact on OFDI; 4. the increase in Internet penetration in each country has a positive effect on the amount of China’s OFDI.
Keywords: ICT, trade, OFDI, gravity model.

Catalogue

1. Introduction

1.1 Research Background

In the situation of economic globalization, FDI are an important way for a country to participate in global economy. Since China implemented its policy of “Reform and opening up”, foreign trade has developed rapidly. It has attracted foreign investment through good resources and policy advantages. In the past two decades, China has continuously expanded its attractiveness for inward FDI (IFDI). Has become the world's second-largest country in attracting foreign capital inflows. Following China’s accession to the WTO in 2002, China’s overall national strength has continued to increase. While attracting foreign investment, it has vigorously promoted overseas investment. Therefore, OFDI has also continued to increase. In 2015, China achieved its first overseas direct investment (OFDI) to exceed the direct use of foreign capital (IFDI), thus transforming into a net capital exporting country. In 2012, to solve the problems of the low added value of manufacturing clusters and low quality of foreign investment, China's opening strategy changed, emphasizing "bringing in (IFDI)" and "going out (OFDI)" at the same time, which made China's OFDI It also developed rapidly.

The common development of OFDI and IFDI has also promoted China’s industrial upgrading, changes in market competition patterns, technological progress, and changes in international trade patterns. A major factor leading to these changes is the continuous progress of the ICT industry. The rapid development of information and communication technology has made geographic distance no longer a barrier to trade and investment, and the cost of information transmission and exchange has therefore decreased. While information and communication technology changes people's production methods, it also has a comprehensive impact on international politics, economy, culture, society, and other fields.

With the development of information and communication technology, information and communication technology and electronic communication products are rapidly spreading and popularizing in China. According to the National Bureau of Statistics of China: In 2015, there were only 37 million Internet broadband access users in China. In 2019, China’s Internet broadband access users have reached 449 million, which is achieved in 15 years. An increase of 1113.5%. At the same time, ICT is also widely used in the production and operation of enterprises. In 2019, Chinese enterprises used 32 computers for every 100 people on average. On average, 51 companies out of every 100 companies have their own websites, and 10.5% of them are involved in E-Business transaction activities.[1]

In China's latest manufacturing strategy, China has clearly listed the new generation of the ICT industry as the most important field in order to expand the network economy space and promote the development of the Internet and the integration of the economy and society. It can be foreseen that China's ICT industry will play an increasingly important role in leading China's economic development and technological progress.

At the same time, ICT eliminates the need for frequent cross-border visits for providers and recipients of trade and investment in various countries around the world. This enables enterprises to reduce transaction costs and simplify the transaction process, which greatly promotes the development of foreign investment. Its role is mainly reflected in:

1. The popularization of ICT has deepened specialized production. The popularity of ICT means that market transparency has increased. Enterprises need to continuously invest in high-level production factors and produce high-level new products to attract investment from all parties. Naturally, a more professional and international technology division situation has been formed, which has also increased the demand for international investment.
2. ICT has changed the structure of many industries. In the process of continuous improvement of ICT, enterprises have invested a lot of technology and knowledge elements, making the proportion of related investment in knowledge and technology-intensive industries continue to rise every year, and the proportion of investment in labor-intensive industries continues to decline.
3. The application of ICT shortens the transaction procedures and processes after the investment project is determined, thereby reducing the resource input in all aspects of the transaction

The ICT manufacturing industry itself has characteristics that are highly related to information technology. As the commercial use of 5G continues to deepen, the advantages of the ICT manufacturing industry will continue to expand and promote the maturity of the industrial chain. However, from the perspective of the division of labor in the global ICT manufacturing industry, China's ICT manufacturing industry is still in the downstream position of the global value chain, and its good industrial ecology has not yet been fully formed.

At the same time, countries around the world are constantly introducing policies to promote the development of the ICT industry, and the development of China's ICT manufacturing industry is also facing competition from other countries in the world. Foreign direct investment in various countries is developing rapidly. Obtaining advanced technical knowledge and management experience through strategic OFDI is an important way to promote technological innovation of ICT enterprises, and it is also an important way to realize the structural adjustment, transformation and upgrading of China's ICT manufacturing industry and the promotion of global value chain status.

International trade and foreign direct investment have always been the engines that promote the technological progress of Chinese enterprises. However, with the unpredictable changes in the global economic environment after the financial crisis, the growth rate of international trade has slowed, and the rising labor prices in China and the shortage of resources have increased foreign direct investment. The amount has been declining year by year, and the globalization dividend has gradually disappeared. To maintain their competitive advantage, multinational companies in developed countries have implemented "technology blockade and isolation" on Chinese companies in their foreign direct investment. Under the control of enterprises, the low-end technology acquired by China's ICT manufacturing industry is difficult to promote the transformation and upgrading of enterprises. From the perspective of global value chain, Chinese enterprises have not realized the natural upgrading of technology through international division of labor and industrial transfer. Instead, path dependence has occurred, leading to many difficulties in upgrading the global value chain of Chinese ICT companies. For example, one of the most familiar ICT products: iPhone, there was a saying "Designed by Apple in California" behind the Phone, and the assembly of the iPhone was contracted by Foxconn in China (2011). According to the information provided in capturing value in global networks: Apple's iPad and iPhone[2], Apple is not engaged in product production in the United States, but mainly engaged in product design, R&D and marketing. The production of real products is mainly concentrated in low-cost countries such as China. The United States takes 58.5% of the profit from a product, while China's large number of labor force engaged in production only gets 1.8% of the profit. The main reason for such a big gap between China and the United States lies in the different positions of the two countries in the global value chain. The United States participates in the high-end links such as product design, R & D and sales of the division of labor in the value chain, that is, the two ends of the "smoothing curve". Mastering the core and top technologies can create more value and be in a dominant position. China is mainly engaged in low-end links such as production and assembly, that is, the middle part of the "smile curve".

The main reason for this situation is that China is embedded in the global value chain by virtue of its rich and cheap labor force, large-scale market advantages. It is mainly engaged in the low-end links of the value chain such as low value-added product production and assembly, which will create less value. However, if China's ICT manufacturing industry wants to enhance its status in the global value chain, it must actively embed in the global value chain process. It cannot rely on the low-tech spillovers of developed countries to achieve technological growth. It should actively respond to the "going out" strategy and the "Belt and Road Initiative" Strategy.

1.2 Research Content and Method

Until today, in the relevant research on China's FDI, whether it is domestic research or foreign research, the main influence is from the perspective of FDI, taking into account their impact on the domestic economy[3] or the international economy (macro level) , such as the growth of China’s industry, the upgrading of the industrial structure[4], the impact of innovation[5], the domestic industrial value chain[6], and the existing distributed investment[7]. Therefore, this paper will focus on the promotion of ICT trade to China's OFDI, and whether the amount of ICT import and export between China and other destination countries is an important factor affecting China's foreign investment

This paper will use the 2012-2017 Chinese Ministry of Commerce's investment amount and destination country data of 2086 foreign investment projects as observations to analyze the annual status of ICT manufacturing goods import & export, the popularization of ICT in China and the destination country. Using the gravity model, the ICT industry's import and export volume, Internet penetration rate, etc., are used as variables to study their impact on Chinese companies' foreign investment. It is hoped to know whether specific enterprises can increase China's foreign investment through ICT import and export trade.

The research methods used in this paper are as follows:

1. Literature research method. Through extensive collection and reading of relevant domestic and foreign documents, this article initially clarifies the theoretical basis of FDI and their application in economics and uses this as a starting point to explore the relationship between OFDI and ICT trade in China and build on this basis. In addition, the selection of economic indicators and the use of modeling methods in this article will also cite relevant literature as references to improve the scientific and rigor of the research.

2. Statistical description. Based on collecting comprehensive relevant data, statistically describe the development status of its ICT industry development and other factor. Including the description of the average level such as the mean and median; the description of the degree of variation such as standard deviation, variance, and coefficient of variation, combined with the above statistical indicators in the form of graphs, to understand the trend of each variable intuitively and clearly.

3. Empirical analysis. This paper builds a gravity model based on the relevant data of China's ICT industry in the 2012-2017 years, uses stationarity test and multiple linear regression to conduct empirical analysis, and examines the development level, government level and internet level of the destination country and other variables.

2. Literature review on the relationship between ICT, trade and FDI

2.1 Literature review on ICT industry

2.1.1 The definition of ICT

The "ICT industry" discussed in this paper corresponds to Information and Communications Technology that appears in international definition.

In the "Statistical Yearbook of China's Electronic Information Industry", the electronic information industry is defined as follows: The electronic information industry is an industry that develops and produces electronic equipment and various electronic components, devices, instruments, and meters, and is a military-civilian industry. It is composed of production industries such as radio and television equipment, communication and navigation equipment, radar equipment, electronic computers, electronic components, electronic instruments, and other electronic special equipment. According to the statistical data collected by it, it can be seen that the scope of "electronic information products" includes: communication equipment products, radio and television equipment products, electronic computer products, household electronic appliances, electronic components products, and electronic special equipment products.[1]

Specifically, the ICT industry in this paper corresponds to "manufacture of computers, communication and other electronic equipment" (one of the China's industrial industries) and "information transmission, software and information technology" (one of the China's service industries).

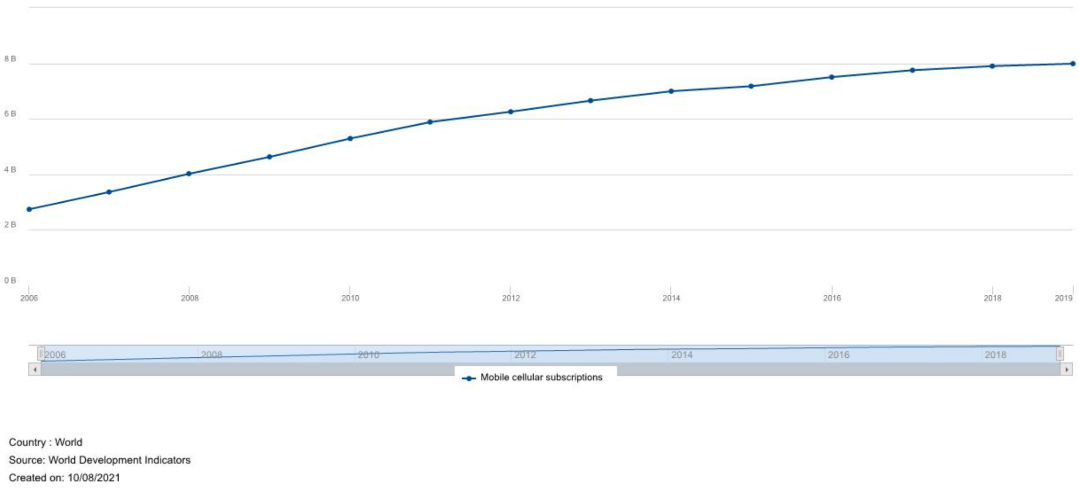
2.1.2 The development status of ICT industry

Information general technology is a new technology developed in the second half of the 20th century. Although its development time is relatively short, its development speed is amazing.

Although the US subprime mortgage crisis in 2007 caused international economic turmoil and a slight economic recession, the use of global information and communication technology services such as mobile phones and the Internet is still growing. As of the end of 2019, there were approximately 7.992 billion mobile phone users (chart 1).

Chart 1. World mobile cellular subscriptions

Source: world bank



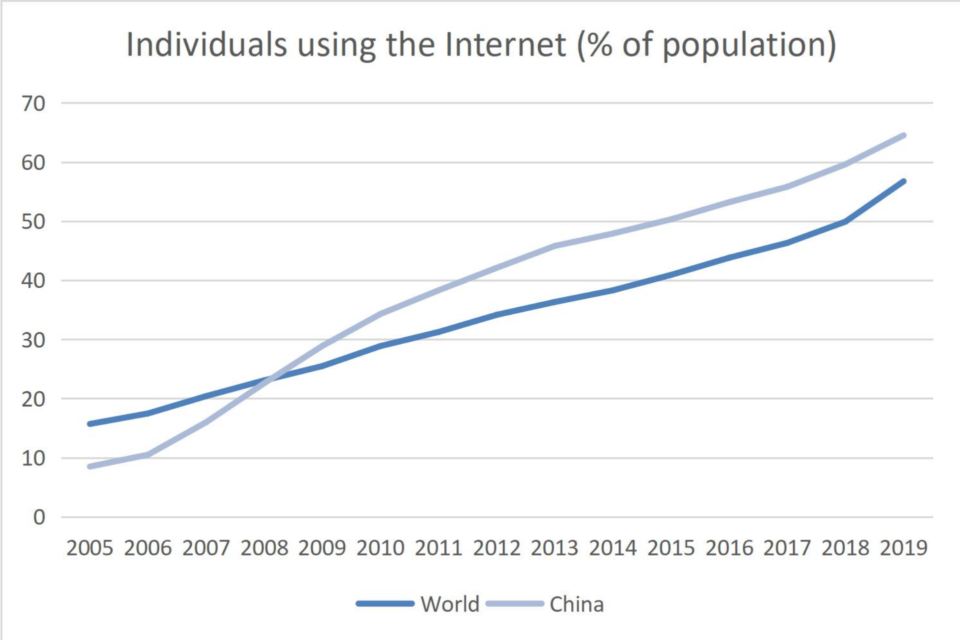
Compared with mobile phones, although the Internet has a slower development speed, its penetration rate is also increasing. In 2019, Internet users accounted for approximately 56.7% of the world's population.

An important challenge for increasing the number of people on the Internet is the limited fixed broadband access, which is now mainly limited to Internet users in developed countries and some developing countries. More than half of fixed broadband subscribers in developing economies are in China. In 2008, China surpassed the United States to become the world's largest fixed broadband market.

Chart 2 shows the overall trend of world Internet penetration and China's Internet penetration from 2005 to 2019. Their overall trend is to continue to rise. We can see that at the beginning, there was a huge difference in China's Internet penetration rate compared with the world in 2005, but with the economic development, it exceeded the world's Internet penetration rate for the first time in 2008. The penetration rate of the world's Internet in 2018-2019 is faster than that in previous years, because the ICT construction in developing countries is gradually improved, while the Internet penetration rate in China has experienced rapid growth, and the growth rate slowed down from 2013 to 2017.

Chart 2. Individuals using the Internet (% of global population)

Source: word bank and National Bureau of Statistics of China



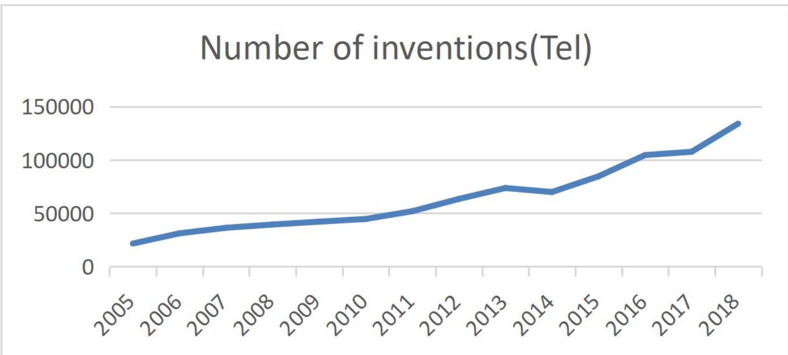
The popularization of the Internet is inseparable from China's investment in research and development in the ICT industry, and considerable progress in manufacturing and innovative technologies.

For example, China's self-developed digital program-controlled switches have reached an advanced level and are more in line with the requirements of China's telecommunications network. China has formed a complete optical communication industry and has become one of the few countries that can develop and produce a full range of optical communication industries. Like, switches, routers, and other broadband access equipment and a complete set of mobile communication systems can be developed and produced by themselves.

Chart 3 is a trend of China's annual telecommunication technology patent acceptance volume from 2004 to 2018.

Chart 3. Telecommunications technology patent applications accepted（unit）

Source: China Statistical Yearbook



China's mobile phone industry is also increasing substantially. China has made considerable progress in its development capabilities in communication application software and network information software. The cumulative capital of China's ICT is gradually increasing, and its share of GDP is increasing. Through the calculation of inter-provincial ICT capital stock, it can be found that the capital accumulation of China's ICT hardware has gradually shifted from the eastern region to the central and western regions. The capital accumulation of China's ICT software is mainly in the economically developed provinces. Through the calculation of the ICT capital stock of 19 industries in China, it is found that the capital accumulation at the industry level in China is mainly concentrated in industries such as construction, manufacturing, finance, scientific research and technical services, and information on traditional industries such as agriculture, mining, accommodation, and catering. The degree of modernization is still low, and information technology needs to be further penetrated.

2.1.3 Literature review on ICT industry and trade

There is not much research on ICT and trade in China, and they mainly focus on the relationship between ICT development and economic growth. The development of ICT and foreign trade is still in its infancy for what concerns China.

Xu Qian (2004)[8] studied the relationship between telecom business revenue and GDP in 13 cities in Jiangsu Province in 2003. Through the establishment of a linear regression model and a double logarithmic regression model, she found that for every 100 million yuan increase in telecom business revenue, GDP increased by 4.011 billion yuan.; For everyone percentage point increase in telecom business revenue, GDP will increase by 0.97%.

Qin Hai, Li Hong sheng, Ding Zhen Huan (2006)[9] systematically expounded the relationship between ICT and economic growth based on international experience and Chinese practice, supplemented by empirical tests. The article first analyzes the impact mechanism of information and communication technology on economic growth, and then outlines the theoretical models and data processing methods used by economists in empirical research. Finally, based on the actual situation in China, a corresponding empirical analysis is carried out. In this article, the output value of the electronic information manufacturing industry is selected to replace the output value of the entire information and communication technology industry, and the error correction model is used for analysis. The conclusion is that the information and communication technology industry is one of the important driving forces for GDP growth, and the growth of the output value of the electronic information manufacturing industry will drive For GDP growth.

At same time many research have confirmed the positive effect of ICT capital deepening on productivity growth[10], and ICT investment has also been regarded as the main reason for the productivity gap between Europe and the United States since 1995[11]. However, the characteristics of these studies are: Based on the neoclassical growth theory, under strict assumptions such as a perfectly competitive market and constant returns to scale, they then analyze the contribution of information and communication technology capital to productivity, and do not consider the impact of information and communication technology. Spillover effects and shifts in the use of sectoral production functions[12]. With the continuous increase of R&D investment in enterprises, its role in promoting technological progress has become more and more obvious.

There are relatively more research literatures on the relationship between ICT and trade in the world than in China. In the past few years, some scholars have conducted empirical studies on the economies of different countries. From the beginning, it focused on the relationship between ICT and economic growth, and gradually developed to the relationship between ICT industry value and foreign trade.

Early scholars found that the price drop of ICT products will trigger a wave of ICT investment and trade, which allows ICT capital to replace other input factors and be widely used in the production process, thereby directly promoting productivity growth. Therefore, it is based on the growth accounting framework. To analyze the impact of ICT capital deepening on productivity. [11]

Caroline L. Freund (2000)[13], using Bolivia as an example, studied the relationship between the Internet and international trade using a trade gravity model, and concluded that in 1998 and 1999, every 10% increase in the number of Internet hosts would cause Bolivia the volume of foreign trade increased by 1%.

Roller and Waverman (2001)[14] used the data of 21 OECD countries for more than 20 years to study the supply and demand of GDP and telecommunications investment in OECD countries and concluded that there is a causal relationship between telecommunications infrastructure and GDP.

Freund and Weinhold (2002)[15] used US foreign trade data from 1995 to 1999 and used panel data methods to calculate the impact of Internet penetration on service trade exports and service trade imports. The conclusion is that for every 10% increase in Internet penetration, the export volume of service trade will increase by 1.7%, and the import volume will increase by 1.1%.

Benfratello, Razzolini and Sembenelli (2015)[16] takes small and medium-sized manufacturing industry in Italy as an example to study the relationship between ICT investment and offshore outsourcing. Generally speaking, ICT investment will reduce the cost of communication and coordination among multinational enterprises, so ICT investment should have a positive impact on offshore outsourcing. However, through the division of samples, this paper finds that for small and medium-sized manufacturing industries in Italy, the increase of complementarity in internal production stages or the increase of task complexity caused by ICT investment may reduce offshore production. This is because enterprises need to increase labor when dealing with unconventional problems or complex communication. For conventional problems or manual tasks, they will gradually replace labor with ICT investment, resulting in reduced demand for labor for daily work and reduced the tendency of manufacturing industry to transfer overseas. The conclusion is that ICT activity investment has a negative impact on the offshore tendency of small and medium-sized manufacturing in Italy.

From the above literature review, scholars from various countries are gradually enriching the research on the relationship between ICT and foreign trade and different industries and have achieved a series of research results. But at the same time, most of them focus on the study of the relationship with economic growth rather than the study of foreign investment. Therefore, based on summarizing previous studies, this article conducts research on ICT industry trade and international direct investment.

2.2 Literature review on OFDI theory

2.2.1 The theory of FDI

The theory of FDI mainly originated in the 1960s. The International Monetary Fund divided FDI into Inward Foreign Direct Investment (IFDI) and Outward Foreign Direct Investment (OFDI). In China IFDI is called: Overseas Direct Investment. It refers foreign investors investing in China through the establishment of foreign-invested enterprises, partnerships, joint exploration, and development of petroleum resources with Chinese investors, and the establishment of branches of foreign companies. Foreign investors can invest in cash, in kind, technology, etc., and can also use the profits obtained from foreign-invested enterprises for reinvestment). And Outward Foreign Direct Investment referred to as OFDI. In China it through the establishment of foreign invested enterprises, cooperative exploration, and development of petroleum resources with domestic investors and the establishment of branch organizations of foreign enterprises. Foreign investment can be made in forms of cash, physical investment, intangible assets and equity, in an addition with reinvestment of the foreign enterprises with the profits gained from the investment)[1].

2.2.2 The effect of OFDI on ICT industry

OFDI's role in promoting the ICT industry in investing countries is mainly as follows:

1. Grossman & Helpman (1991)[17] found the reverse technology spillover effect of OFDI between trading partners. In other words, the investment company aims to seek more mature technology, through greenfield investment, cross-border mergers and acquisitions, and cooperation with host country enterprises and R&D institutions to achieve comprehensive competitiveness in multiple fields such as product, R&D, management, and marketing. Through the feedback mechanism to promote the rapid development of related industries in the home country and promote the upgrade of the value chain of the foreign investment country. The reverse technology spillover effect is mainly demonstrated through the following channels:

a. Demonstration and Imitation: When a developing country invests in a technologically advanced country, the host country enterprise has a demonstration role in production technology, management technology, human resource training technology, etc., and the investing enterprise can imitate and learn from these technologies. These experiences will be passed on to domestic enterprises in the investing country through a feedback mechanism, thereby conducive to the upgrading of the industrial value chain of the investing country. At the same time, OFDI companies can set up R&D institutions in the host country or acquire local companies to obtain their R&D institutions, to imitate the technology of the host country companies or obtain core technologies from their demonstrations. At the same time, the technological achievements are passed to the parent company of the investing country through the feedback mechanism, and through the improvement of domestic enterprises, the versatility of the technology can spread and improve the acquired technology, to improve the domestic technology of the investing country and promote the upgrading of the ICT industry.

b. Upstream and downstream connections. Changes in downstream industries such as technological progress, quality improvement, and market expansion will drive the simultaneous development of upstream industries; at the same time, the upstream industry technology and management experience of raw materials and parts will be improved to promote the development of downstream industries. When a developing country invests in a developed country, multinational companies can obtain advanced technology from the host country, which promotes the technological advancement of the parent country's company and is conducive to the upgrading of the ICT industry. If a multinational company is a downstream enterprise of the industry, it can improve its production technology and management technology by working with the upstream enterprise of the host country. On the contrary, if the multinational company is the upstream enterprise of the industry, it can promote the technological progress and market expansion of the multinational company by cooperating with the downstream enterprise of the host country. Then, through the association with the home country enterprise, the acquired technology will be passed on to the home country company to promote domestic industrial upgrading. At the same time, if the upstream industrial enterprises with low technology content move labor-intensive industries to other developing countries through OFDI, it also means that the country can concentrate resources and human capital to technology-intensive industries. This transformation will undoubtedly promote the domestic industry shifts to high-end links.

c. Human capital: No matter which way the company invests abroad, it cannot be separated from the human resources of the host country. Therefore, the flow of human capital of OFDI is inevitable, and it is mainly reflected in two stages: the first stage is to hire local high-quality employees or directly utilize the human resources of the original enterprise in the way of mergers and acquisitions. This not only improves the R&D capabilities and value chain status of multinational companies, but also promotes the improvement of domestic human capital in multinational companies through foreign high-end talents. In the second stage, the cultivated high-end human capital is fed back to domestic enterprises, which in turn drives the increase of the human capital R&D capabilities of domestic enterprises, thereby promoting the upgrade of the value chain.

2. OFDI’s crowding-out effect and optimal allocation of resources: The industries that want OFDI in the first place are those that will lose or have lost their comparative advantages and transfer their relevant production factors to the remaining industries. Industries with comparative advantages. OFDI can also transfer production to lower-cost countries or regions, so that the home country can have more energy and time to invest in higher-tech industries, which is conducive to the upgrade of the industrial value chain; at the same time, if the destination country of OFDI It is a developed country that makes the capital that has been idle and saved in the investment country operate better and promotes economic development. In short, OFDI can operate domestic surplus or idle capital and productivity, realize the optimal allocation of resources and capital, and promote industrial upgrading.

In the process of foreign investment, enterprises in developing countries cannot, like developed countries, only pursue profit maximization, because international investment in developing countries is aimed at improving the status of domestic industrial chains and achieving industrial upgrading. Therefore, OFDI will also have a restraining effect on the ICT industry of the investing country, which is mainly reflected in the following aspects:

1. The negative impact of international competition faced by foreign investment companies: developing countries encourage domestic companies to invest abroad for the purpose of achieving industrial upgrading and improving the position of domestic industries in the global value chain. Therefore, when choosing a destination country, we should not only consider tax havens to maximize profits, but should put the promotion of value chain upgrading in the first place. Destination countries should mainly consider the United States and European countries. However, investment in developed countries will inevitably face fiercer competition, which will create obstacles to industrial upgrading. Multinational

companies are facing a highly competitive international market. To gain a foothold in this market environment, they need a good business management model, marketing network, and core technology. However, multinational companies in developing countries do not all have these advantages, and it is difficult to win in the competition. In addition, the host country government protects local companies through various investment barriers and hinders the entry of foreign capital, which makes it very difficult for multinational companies to obtain markets in high-tech countries. It will eventually cause OFDI to fail, thus losing the upgrade channel through developed countries, which is not conducive to domestic industrial upgrading.

2. Hollowing effect of OFDI: For developing countries, technology-seeking OFDI generally has a large investment scale and a long return period, so its promotion of industrial upgrading is often difficult to show in the short term. In the case that the new industry has not yet acquired viability, the resource-seeking OFDI has transferred part of the industrial resources abroad, which has caused a short-term decline in the level of production and employment in the home country, and induced the loss of technology and taxation, resulting in the home country. The decline of industrial competitiveness is not conducive to industrial upgrading. At the same time, strategic-seeking OFDI requires more capital, which may result in a reduction in domestic investment in the investing country, thereby reducing the cost of domestic investment in R&D and brand design, thereby affecting the upgrade of the industrial value chain.

In some academic theories, developing countries without advantages should not choose OFDI. As far as the theory of foreign direct investment in developing countries is concerned, the theory of small-scale production technology holds that developing countries can only make OFDI in more backward developing countries and cannot invest in high-tech developed countries; The theory of technological change industrial upgrading believes that developing countries can obtain advanced technology through technological improvement and innovation through technological regeneration and changes, and make direct investment in high-tech developed countries. However, in the process of internationalization, enterprises in developing countries can only choose small-scale markets that have been ignored and abandoned by multinational companies in developed countries in terms of target markets and become "market followers" or "market deficiencies."

Lipsey [18] conducted a study on the domestic economic effects of OFDI in the United States. The results show that OFDI in the United States can promote domestic industrial restructuring, while improving domestic production efficiency, increasing national income, and expanding the domestic economy. The market is conducive to further attracting foreign direct investment (IFDI). At present, China's domestic research on the influence or role of China's foreign direct investment in China is still relatively small, but some scholars agree that the former has a promoting effect on the latter. Wang Zhiming [19] believes that China's "going out" strategy It will promote the improvement of the domestic market environment, which will drive the further development of foreign direct investment in China.

In summary, OFDI has both positive and negative effects on the ICT industry, and once the negative effects play a role, it will have a great hindrance to the development of the ICT industry. Therefore, while encouraging OFDI, developing countries must take into account the negative impact it brings and adopt policy measures to avoid it.

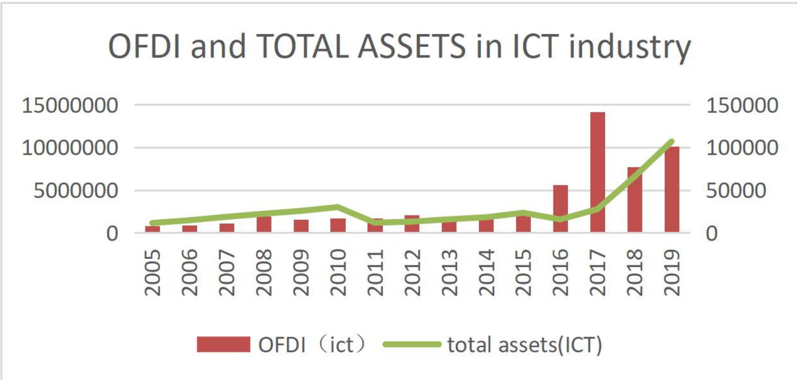
2.3 The development status of OFDI in China ICT industry

Since China's economic policy reform, China's overseas investment has gone through more than 40 years of development. In 1979, the State Council of China issued a law that clearly allowed domestic investors to set up enterprises abroad. This was the first time that China had set the permitting of foreign direct investment as a policy. However, China's OFDI only began to show a relatively strong growth trend after the 1990s. Large-scale overseas investment enables subsidiaries of ICT companies in host countries to use their geographical advantages to understand international market demand information, obtain advanced technology and management methods, and learn marketing models, thereby promoting the progress of the domestic ICT industry.

OFDI and capital stock in China's ICT industry from 2005 to 2019:

Chart 4. OFDI and capital stock in China's ICT industry

Source: National Bureau of Statistics of China



The amount of foreign direct investment and capital stock in China's ICT industry have some volatility, but overall, they have gradually increased, and the increase has been substantial since 2015.

From the perspective of the investment industry, in recent years, the structure of China's OFDI industry has shown a diversified structure, gradually evolving from the initial leasing service industry and mining industry to diversification and diversification. In 2012, China's investment in mining, manufacturing, and leasing services reached US$13.54 billion, US$8.67 billion, and US$26.74 billion, respectively, accounting for 15.4%, 9.8% and 30.5% of the total investment flow in the current period. In 2013, China's OFDI industry involved five major industries, manufacturing, wholesale and retail, mining, finance, and leasing services. The cumulative investment stock of these industries was US$548.6 billion, accounting for 83% of China's total OFDI stock.

3. Literature review on the gravity model

At present, the gravity model is extremely widely used in international trade empirical research. Because its form is similar to the universal gravitation formula, the gravity between two objects is determined by their mass and the distance between them. The gravity model was first proposed by Tinbergen (1962)[20] used for empirical testing of trade between countries. The volume of trade between the two countries depends on the economic scale and physical distance of the two parties. Among them, the economic scale of importing and exporting countries respectively reflects their potential demand and supply capabilities. The distance between the two countries is an important factor that constitutes the cost of trade between the two countries and is the most important obstacle to bilateral trade. The earliest form of its application in economics is as follows:

$$X_{ij} = A(Y_i Y_j)/\ D_{ij}$$

(Where X_{ij} represents the export value of country i to country j, A is a constant term, Y_i represents the GDP of country i, Y_j represents the GDP of country j, and D_{ij} represents the distance between the two countries) The natural logarithm of both sides of the equation can be taken Converted to linear form, as follows:

$$\ln(X_{ij}) = A + \alpha \ln Y_i + \beta \ln Y_j + \gamma \ln D_{ij} + \varepsilon_{ij}$$

(Where α , β , γ are the coefficient, ε_{ij} is random interference)

Ball (1966)[21] introduced the endogenous variable population and dummy variable trade agreements to expand the original standard model, and through empirical testing, it was found that the bilateral trade volume was negatively correlated with the population size. Later, scholars' expanded the trade gravity model with more explanatory variables, such as per capita income, bilateral exchange rates, language and culture, transportation cost factors, economic crisis, and so on. The scope of application of the gravity model is also more extensive, from the field of goods trade to cross-border population flow, FDI flow and other aspects.

In the 1980s, scholars began to give it a theoretical basis, deriving and revising it theoretically. Anderson (1979)[22] believes that the simplest gravity model can be derived from the adjustment of the Cobb-Douglas production function. It is a single factor model (like the Keynesian trade model), that is, each country produces only one product without transportation costs and tariff. The proportion of income that the importing country spends on purchasing products from country i to the total income is b_i, and the same is true for other countries. Assuming that the equilibrium price is constant and equal to 1, then country j's imports of country i's products are:

$$M_{ij} = b_i Y_j$$

Where Y_j is the national income of country j. For country i, it is required that income equals sales, then:

$$Y_i = b_i(\sum_j Y_j)$$

This is the basic model of the gravity model that Anderson believes, and its assumptions are very harsh. Then Anderson relaxes his hypothesis, assuming that all countries produce two kinds of goods, one tradable product and one non-tradable product, and the share of a country's imports of tradable goods in its total income is a function of per capita income and total population, thus constructing Trade share expenditure model:

$$M_{ij} = \frac{\emptyset_i Y_i \emptyset_j Y_j}{\sum_i \sum_j M_{ij}}$$

Among them, $\emptyset_i$ and $\emptyset_j$ are the proportions of i and j respectively in the import expenditure of the two countries. Bergstrand (1985)[23] uses the general equilibrium model to derive the gravity model. Bergstrand assumes that a country produces only one product and incorporates price as exogenous variables into the trade equation through the supply and demand functions. On this premise, the equilibrium subsystem and partial equilibrium equations are constructed to derive the gravity model. If it is further assumed that production and consumption are completely replaceable, tariffs and transportation costs are zero, and goods can be fully arbitraged, the gravity model is simplified to:

$$M_{ij} = \frac{1}{2} Y_i^{1/2} Y_j^{1/2}.$$

Deardorff (1998)[24] believes that the gravity model can be derived from the Heckscher–Ohlin (H-O) model in international trade theory. When frictionless trade and consumer preferences are the same, its simplified form is consistent with that derived by Anderson (1979)[22] using the expenditure system method. Considering the different preferences of consumers in various countries, the introduced gravity model will be more complicated. After that, relax the assumptions, add trade costs to the trade between the two countries, and use the constant substitution utility function to express consumer preferences.

The form of the gravity model is:

$$M_{ij}^{fob} = \frac{Y_i Y_j}{Y_W} \frac{1}{t_{ij}} \left(\frac{\rho_{ij}^{1-\sigma}}{\sum_h \theta_h \rho_{ih}^{1-\sigma}}\right)$$

(Among them, σ is the elasticity of substitution between goods, t_{ij} is the average distance between all demanders and suppliers, θ_h is the ratio of national income of country h to the world's total income, and ρ represents the relative distance between individual demanders and suppliers.) But this gravity model cannot be used to test other theories and models.

In terms of trade distance, the initial trade distance refers to the physical geographic distance between the two countries. Later scholars believe that not only the physical geographic distance has an impact on the trade flows between the two countries, but also religious culture, historical factors, exchange rates, international economic environment, and trade policies. Equal distance and differences will also have an impact on trade between the two countries.

Frankel (1997)[25] added factors such as border proximity, language distance, per capita GDP and whether it belongs to the same trade alliance in the standard gravity model, which constitutes the complete form of the gravity model.

Rose (2000)[26] added three variables: colonial relations, exchange rate changes and common currency to Frankel's gravity model to construct an extended gravity model.

Yamarik and Ghosh (2005)[27] introduced 9 variables such as the interest rate of trading countries, the actual development level of both parties, the relative development level, and trade policy, etc., and proposed an extended model of the gravity model. In the real economy, the factors affecting the trade between the two economies are becoming more and more complex, and the continuous introduction of new exogenous variables makes the model analysis more accurate.

Anderson and Van Wincoop (2003)[28] develop a method that consistently and efficiently estimates a theoretical gravity equation, use the estimated general-equilibrium gravity model to conduct comparative statics exercises of the effect of trade barriers on trade flows, and apply the theoretical gravity model to resolve the "border puzzle."

The gravity models currently used by scholars are all new models established under the conditions of continuous relaxation of the original theoretical model assumptions. The progress and update of the model theory are consistent with the development of international trade theory, providing a more solid theoretical basis for studying the influence factors of regional and international trade flows.

4. Model specification

The research theme is the impact of ICT industry development and trade on China's OFDI. According to the foreign investment projects announced by the Ministry of Commerce of China, the manual sorting out and removing the sample data with incomplete variable observations, the research interval is 2012-2017, Using 6-year annual data, there are a total of 82 countries, and the number of observations is 165. The analysis tool is Stata17.0.

Based on the literature summary of the gravity model in the previous chapter, this paper uses the gravity model to study the flow of China's foreign investment. According to the availability of data, the following variables are introduced:

Investment amount: The amount of investment in the destination country of China each year is used as the first dependent variable.

Number of project investments: The number of projects that China invests in the destination country each year is used as the second dependent variable.

GDP per capita: In the basic gravity model, the GDP and population of bilateral countries are usually introduced as the most important control variables. At the same time, there are related literatures that use per capita GDP as a substitute, and these variables have been confirmed that they are positively correlated with trade flows. This paper also uses the annual per capita GDP of bilateral countries as an independent variable to verify its relationship with China's outward foreign direct investment.

Distance: In the basic gravity model, "distance" refers to the physical distance between two countries. Some paper extends the concept of "distance" to cultural distance and language distance etc. However, considering the availability of data, this paper uses the physical distance between, China (Beijing) and the capital of each destination country as the independent variable.

The bilaterally import and export of goods in the ICT industry: The import and export variables of ICT industry can largely reflect the development degree of ICT industry in a country. This paper uses the ICT goods import and export data of bilateral countries to determine the overall development of ICT Industry between China and destination countries in a certain year. The import and export of the ICT industry is divided into the import and export of information and communication software services (belonging to the service industry) and the import and export of information and communication equipment (belonging to the manufacturing industry). The ICT industry in most of the developing countries started relatively late, so there is a lack of data on the import and export of the ICT industry. In particular, the statistics of the import and export of ICT software services cannot meet the conditions of empirical analysis. Therefore, the ICT import and export analysis in this paper is only use the import and export data of the communication equipment manufacturing industry of bilateral countries.

Internet penetration rate: The development of ICT industry can also be reflected by the Internet penetration rate of a country. Because ICT technology not only needs high-end technology to realize profits, but also the popularization of basic communication technology and allowing individuals to use the Internet are important factors that will affect investment decisions. considering the availability of data, this article uses the Internet penetration rate of each country as the development level of the country's ICT software service industry. Use Internet penetration rate as an independent variable to measure its impact on investment in bilateral countries.

The degree of freedom international trade: The degree of free trade determines the products and quantity of international trade in this country every year. The import and export of ICT goods have also been affected. The different national laws and regulations cause the foreign trade and foreign direct investment of enterprises in the investing country to be affected by the policies of the bilateral countries. Compared with other paper, this paper introduces a new independent variable: the international free trade factor between countries, which is a measure of the degree of bilateral government's' control over national free trade. This data comes from Economic Freedom, which scores countries and regions around the world in many economic aspects, including free trade. This paper uses the product of the free trade index of China and the destination country as the measurement index of the degree of free trade of bilateral countries in investment projects.

The definition of each variable in the gravity model is as follows (table 1):

Table 1 Description variable

	Symbol	Variable meaning
Explained variable	lnOFDI	value of OFDI from China in country h in year t
	lnCount	count of projects from China in each country j in year t
Explanatory variables	lnGc	China's GDP per capita in year t
	lnGh	GDP per capita of host country h in year t
	lnD	Distance between the capitals of country h and China
	lnGOV	Index of the degree of "Freedom to trade internationally" between the country h and China in year t
	lnImports	the index of China's ICT goods imports (% total goods imports) in country h in year t
	lnExports	the index of China's ICT goods exports (% total goods imports) in country h in year t
	lnInternet	Internet penetration rate, represent by the index of Individuals using the Internet (% of population) in country h t in year t

Model 1

$$lnOFDI_{i,h,t} = \alpha_0 + \beta_1 lnGc_{i,t} + \beta_2 lnGh_{h,t} + \beta_3 lnD_{i,h,t} + \beta_4 lnGOV_{i,h,t} + \beta_5 lnImports_{h,t} + \beta_6 lnExports_{h,t} + \beta_7 lnInternet_{h,t} + \varepsilon_{i,h,t}$$

Model 2

$$lnCount_{i,h,t} = \alpha_0 + \beta_1 lnGc_{i,t} + \beta_2 lnGh_{h,t} + \beta_3 lnD_{i,h,t} + \beta_4 lnGOV_{i,h,t} + \beta_5 lnImports_{h,t} + \beta_6 lnExports_{h,t} + \beta_7 lnInternet_{h,t} + \varepsilon_{i,h,t}$$

Where index *i* refers to China, h to the partner country, and t refers to the year. α_0 refers to the constant term, β_i refers to the regression coefficient of each variable, and $\varepsilon_{i,h,t}$ refers to the random disturbance term. The above two equations are the two models that need to be verified in this paper.

5. Data description: the MofCom Database and the other data sources

5.1 Data source

The OFDI data of the empirical analysis part of this paper comes from the foreign investment projects disclosed by the Ministry of Commerce of China since 2012 in investment project information database. As of August 2021, there are a total of 2,988 OFDI projects recorded since May 2012. The contents of the project records include the investment destination country, investment time, and investment method, investment industry, investment amount. However, some of the items are missing or incorrect in content. After screening, 2086 items from 2012 to 2017 are selected as the panel data source.

According to the 2086 projects of China's foreign direct investment from 2012 to 2017 announced by the Ministry of Commerce of China, it shows that the countries and regions involved in OFDI have diversified. In 2012, China's foreign investment projects were distributed in 46 countries and regions around the world, and by 2017, it will be further expanded to 82 countries or regions. According to the amount of investment, the main countries and regions of China's foreign investment are ranked by Saudi Arabia, Vietnam, United States, Malaysia and Nigeria, and the proportion of investment is nearly 63%. It can be seen from this that, as a developing country whose foreign investment is aimed at realizing industrial upgrading, it has not concentrated the target countries mainly in Africa, Latin America, and other regions. At the same time, it has also carried out a large amount of investment in the United States and European countries.

Ranking of the top ten destination countries for OFDI in China (Table 2):

Table 2. Top 10 destination countries

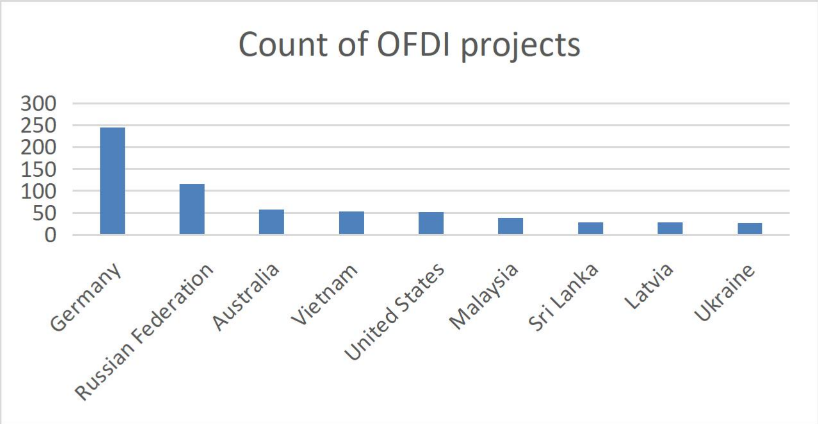
Source: Ministry of Commerce of China

Countries	OFDI (10 thousand dollars)
Saudi Arabia	7238629
Vietnam	6956364
United States	3398485
Malaysia	3226145
Nigeria	2933176
Korea, Rep.	2212510
Russian Federation	2020128
Germany	1737912
Indonesia	1618514
Italy	662600

In terms of the number of investment projects, European countries are the most important investment destinations.

Chart 5 Count of OFDI projects in China

Source: Ministry of Commerce of China



The empirical analysis part of the data on the per capita GDP of bilateral countries, ICT industry import and export, and Internet penetration rate are from the World Bank (World Development Indicators).

The indicator to measure the degree of economic freedom of a country comes from

Economic Freedom. This research project uses third-party data sources to determine that the free trade index of each country or region is fair and transparent. 1. Freedom of personal choice; 2. Freedom of market competition; 3. Freedom of market entry and exit.

The following is the ranking of the top 20 free trade countries and regions (Table 3):

Table 3. TOP 20 free trade countries and regions

Source: Economic Freedom

Countries and regions	Freedom to trade internationally
Hong Kong SAR, China	9.579493955
Singapore	9.335951955
Netherlands	8.899106261
United Arab Emirates	8.768821844
Belgium	8.743978939
Germany	8.725778977
Luxembourg	8.706234971
United Kingdom	8.684137273
Denmark	8.671569263
New Zealand	8.669202448
Panama	8.661775769
Ireland	8.589763586
Georgia	8.573574003
Latvia	8.532375435
Estonia	8.531304241
Sweden	8.456837219
United States	8.406543113
Finland	8.399054776
Canada	8.374684677
Italy	8.368136398

The physical distance between Beijing, China and the capitals of various countries are all from the National Bureau of Statistics of China and the China Statistical Yearbook.

5.2 Descriptive Statistics

In order to estimate the credibility of the results, White's module is used to test the heteroscedasticity.[29] and sequence correlation. At the same time, the Bootstrap sampling method[30] and the robustness test of the 1% and 99% tail reduction method are used to deal with the values, and finally the robustness of the model is determined.

Table 4 Summary statistics

	N	Mean	Std. Dev.	min	Median	max
lnOFDI	165	8.442	2.726	0.9	8.44	15.78
lnCount	165	1.724	0.932	0	1.548	4.547
lnGc	165	10.766	0.101	10.625	10.762	10.947
lnGh	165	11.537	2.183	5.739	10.911	18.281
lnD	165	8.891	0.513	6.863	8.937	9.866
lnGOV	165	3.725	0.195	2.681	3.777	4.001
lnImports	165	5.147	0.521	3.828	5.124	6.541
lnExports	165	4.66	0.977	3.294	4.555	7.103
lnInternet	165	7.814	0.765	3.768	8.059	8.581

Among them, Mean is the average value of the sample, Std. Dev is the sample standard deviation, representing the degree of dispersion of the data, Min is the minimum value of the sample, Max is the maximum value of the sample, and Median is the median value. (The number of observations is 165, the number of countries is 82, and the total time interval is 6 years, 2012-2017)

5.3 Correlation analysis

Table 5 Correlation Coefficient

	lnOFDI	lnCount	lnGc	lnGh	lnD	lnGOV	lnImports	lnExports	lnInternet
lnOFDI	1								
lnCount	0.674***	1							
lnGc	0.278***	0.357***	1						
lnGh	0.317***	0.280***	-0.030	1					
lnD	-0.415***	-0.369***	-0.001	-0.463***	1				
lnGOV	0.171**	0.105	0.087	-0.255***	0.133*	1			
lnImports	0.583***	0.434***	0.257***	0.157**	-0.259***	0.290***	1		
lnExports	0.557***	0.306***	0.010	0.148*	-0.392***	0.347***	0.735***	1	
lnInternet	0.289***	0.286***	0.378***	-0.153**	0.124	0.468***	0.273***	0.115	1

Lower-triangular cells report Pearson's correlation coefficients, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The results show that Var (lnGc, lnGh, lnGOV) with Var(lnOFDI) is positive and significant at the 1% level.

The correlation of Var (lnGOV) with Var(lnOFDI) is positive and significant at the 5% level.

The correlation of Var (lnD) with Var(lnOFDI) is negative and significant at the 1% level.

The correlation of Var (lnGc, lnGh, lnImports, lnExports, lnInternet) with Var(lnCount) is positive and significant at the 1% level.

The correlation of Var (lnD) with Var(lnCount) is negative and significant at the 1% level.

On the whole, there are some variables that are significantly related to the explained variables in the overall independent variables and control variables. Therefore, a regression model can be established to further study the interdependence between them.

5.4 Multicollinearity test

Table 6 Multicollinearity test

Variable	VIF	1/VIF
lnExports	2.910	0.344
lnImports	2.640	0.379
lnGOV	1.620	0.616
lnInternet	1.560	0.643
lnD	1.550	0.646
lnGh	1.370	0.731
lnGc	1.300	0.772
Mean VIF	1.850	

The problem of collinearity, when multicollinearity exists, will affect the estimation of the model's results, making the results unreliable. Multicollinearity test uses the method of variance inflation factor. VIF stands for variance inflation factor. When the maximum value of VIF is greater than 10, it indicates that there may be serious multicollinearity issues affecting the estimates. When all VIF are less than 10, there is no multiple in the model. Here we can judge based on the results that the VIF of all variables does not reach 10 and above, so it can be concluded that multicollinearity does not substantially affect the estimates.

6. Results: presentation and discussion

6.1 Model test (Heteroscedasticity)

Homoscedasticity is to ensure that the regression parameter estimator has good statistical properties. An important assumption of the classic linear regression model: the random error term in the overall regression function meets homoscedasticity. When the assumption of homoscedasticity cannot be satisfied, OLS is no longer BLUE (best linear unbiased estimate). The White heteroscedasticity method used in this paper.[29]

Table 7 Test of Model

Model	Test type	Ho: Null Hypothesis	p-value
1	White's test for homoskedasticity	Ho: homoskedasticity	Prob > chi2 = 39.67
	Wooldridge test for autocorrelation	H0: no first order autocorrelation	Prob > F = 8.271***
2	White's test for homoskedasticity	Ho: homoskedasticity	Prob > chi2 = 28.52
	Wooldridge test for autocorrelation	H0: no first order autocorrelation	Prob > F = 13.987***

White's test null hypothesis is that the model satisfies the condition of homoscedasticity. The chi2 statistic of model 1 is 39.67, and its concomitant probability is 0.2694>0.05, that is, the null hypothesis of homoscedasticity cannot be rejected at the 5% level, so it shows that the condition of homoscedasticity is satisfied; the chi2 statistic of model 2 is 28.52, which the concomitant probability is 0.7724>0.05, that is, the null hypothesis of homoscedasticity cannot be rejected at the 5% level, so it shows that the condition of homoscedasticity is satisfied.

6.2 Model results

Table 8 Model results

	(1)	(2)	(3)	(4)
VARIABLES	lnOFDI	lnOFDI	lnCount	lnCount
	(Classic-1)	(Model-1)	(Classic-2)	(Model-2)
lnGc	7.6633***	4.1306**	3.3441***	2.0720***
	(1.6964)	(1.9432)	(0.6148)	(0.7227)
lnGh	0.2124**	0.2321***	0.0649**	0.0679***
	(0.1004)	(0.0857)	(0.0293)	(0.0255)
lnD	-1.7817***	-0.9715**	-0.5418***	-0.4902***
	(0.4411)	(0.4125)	(0.1241)	(0.1352)
lnGOV		-0.3869		0.0673

		(0.9379)		(0.3400)
lnImports		1.0726**		0.4585***
		(0.5197)		(0.1726)
lnExports		0.8132**		-0.0387
		(0.3285)		(0.1045)
lnInternet		0.7330***		0.2283**
		(0.2517)		(0.0920)
Constant	-60.6722***	-43.6642**	-30.2112***	-21.2240***
	(19.3632)	(20.8050)	(6.8254)	(7.7607)
Observations	165	165	165	165
R-squared	0.2719	0.5139	0.2817	0.3780
Adj R-sq	0.258	0.492	0.268	0.350
F value	24.07***	34.23***	28.32***	16.51***

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The classic results of Model 1 show that, controlling other variables unchanged, the coefficient of lnGc is 7.6633, which is significant at the 1% level, indicating that lnGc has a significant promoting effect on lnOFDI, the coefficient of lnGh is 0.2124, which is significant at the 5% level, indicating that lnGh It has a significant promoting effect on lnOFDI; the coefficient of lnD is -1.7817, which is significant at the 1% level, indicating that lnD has a significant inhibitory effect on lnOFDI. (This conclusion is consistent with the complete formal conclusion of Model 1) **At the same time, this result is consistent with the application results of gravity models in other literature. The per capita GDP of bilateral countries has a positive impact on the amount of OFDI, while the physical distance between two countries has a negative impact on the amount of OFDI. The further away the destination country, the smaller the amount of investment will be.**

The results of model 1 show that when other variables are controlled unchanged, the coefficient of lnGc is 4.1306, which is significant at the 5% level, indicating that lnGc has a significant promoting effect on lnOFDI. For every 1% increase of lnGc, lnOFDI will increase by 4.13%.

The coefficient of lnGh is 0.2321, which is significant at 1%, indicating that lnGh has a significant promoting effect on lnOFDI. Every 1% increase in lnGh will increase lnOFDI by 0.23%;

The coefficient of LND is -0.9715, which is significant at 1%, indicating that LND has a significant inhibitory effect on lnOFDI. Every 1% increase in LND will reduce lnOFDI by 0.97%;

The coefficient of lnImports is 1.0726, which is significant at the level of 5%, indicating that lnImports can significantly promote lnOFDI. Every 1% increase in lnImports will increase lnOFDI by 1.07%;

The coefficient of lnExports is 0.8132, which is significant at the level of 5%, indicating that lnExports can significantly promote lnOFDI. Every 1% increase in lnExports will increase lnOFDI by 0.8%;

The coefficient of lnInternet is 0.7330, which is significant at the level of 1%, indicating that lnInternet has a significant role in promoting lnOFDI. Every 1% increase of lnInternet will increase lnOFDI by 0.73%. **In the complete model, we can see that the import and export of goods in the ICT industry will significantly affect the amount of OFDI, and the Internet penetration rate of bilateral countries also has a significant promoting effect, which is higher than the inhibitory effect of distance between bilateral countries in absolute value, indicating that the development of electronic communication can offset the disadvantage brought by physical distance. Surprisingly, the international free trade coefficient of bilateral countries does not have statistical significance on the amount of OFDI when other variables are controlled unchanged.**

Turning to the gravity models predicting the number of projects, the basic gravity model in column (3) shows that, controlling other variables unchanged, the coefficients of lnGc and lnGh are significantly positive. Among them, the coefficient of lnGc is significant at the 1% level, and the coefficient of lnGh is significant at the 5% level, indicating that lnGc and lnGh are significant for lnCount the coefficient of lnD is significantly negative at the 1% level, indicating that lnD has a significant negative impact on lnCount. (This conclusion is consistent with the complete formal conclusion of Model 2.

The results of model 2 show that when other variables remain unchanged, the coefficient of lnGc is 2.0720, which is significant at the 1% level, indicating that lnGc has a significant promoting effect on lnCount. For every 1% increase of lnGc, lnCount will increase by 2.0720 units.

The coefficient of lnGh is 0.0679, which is significant at the level of 1%, indicating that lnGh has a significant promoting effect on lnCount. Every 1% increase in lnGh will increase lnCount by 0.068%.

The coefficient of lnD is -0.4902, which is significant at 1%, indicating that lnD has a significant inhibitory effect on lnCount. Every 1% increase in LND will reduce lnCount by 0.49%.

The coefficient of lnImports is 0.4585, which is significant at the level of 1%, indicating that lnImports can significantly promote lnCount. Every 1% increase in lnImports will increase lnCount by 0.46%.

The coefficient of lnInternet is 0.2283, which is significant at the level of 5%, indicating that lnInternet has a significant role in promoting lnCount. Every 1% increase in lnInternet will increase lnCount by 0.23%.

In model 2, we can see that, like the statistical results in other literature, the per capita GDP of bilateral countries has a significant positive correlation with the number of investments in the destination country, while the physical distance between the two countries has a significant negative correlation. The goods import and Internet penetration of ICT industry also have a significant positive impact on the number of investments, The index of bilateral countries on international free trade is still not significant, but the difference from model 1 is that the number of exports of goods in ICT industry does not have a significant impact on the number of foreign investments.

Surprisingly, in the initial assumption of this paper, the degree of government control over national free trade will have a negative impact on China's foreign investment. However, according to the results, whether in model 1 or model 2, the impact of international free trade of bilateral countries on China's OFDI is not significant. This paper holds that there may be two aspects that will cause errors to the data results: On the one hand, the free trade index of different countries on the economic freedom website may be not completely accurate. Although the data used to evaluate the degree of international free trade comes from third-party data, The source data used to measure the degree of free trade of different countries may be biased, because considering that the statistical data of many developing countries are incomplete., which leads to unreasonable data. On the other hand, the data on investment projects published on the website of China's Ministry of Commerce may not be representative. In order to ensure the authenticity and official nature of investment projects, each information of investment projects will undergo strict political review. Therefore, most of the recorded investment projects come from the background of state-owned enterprises. This paper holds that when a country's free trade policy has an impact on OFDI investment, the degree of impact on private investment tendency and state-owned enterprise investment tendency may be different. This may lead to the fact that the degree of free trade assessed by third-party institutions may not be relevant to the investment project information used in this paper. Therefore, these projects cannot directly replace all China's foreign investment data.

6.3 Robust test

In order to obtain more accurate and reliable results, this article uses two robustness test methods to test the original model's robustness, 1. Bootstrap sampling method estimation method, 2. Winsorize model estimation method after extreme value processing.

Table 9 Result

	(1)	(2)	(3)	(4)

VARIABLES	lnOFDI (Bootstrap -1)	lnOFDI (Bootstrap -2)	lnOFDI (Winsorize-1)	lnOFDI (Winsorize- 2)
lnGc	4.1306**	2.0720***	3.9148**	1.9934***
	(1.9749)	(0.6953)	(1.7022)	(0.6553)
lnGh	0.2321***	0.0679***	0.2331***	0.0660**
	(0.0847)	(0.0247)	(0.0827)	(0.0318)
lnD	-0.9715**	-0.4902***	-0.8852**	-0.4703***
	(0.4133)	(0.1359)	(0.3611)	(0.1390)
lnGOV	-0.3869	0.0673	-0.7959	-0.1312
	(0.9588)	(0.3825)	(1.1131)	(0.4285)
lnImports	1.0726**	0.4585***	1.0760**	0.4458**
	(0.5020)	(0.1667)	(0.4691)	(0.1806)
lnExports	0.8132***	-0.0387	0.8135***	-0.0276
	(0.2999)	(0.1018)	(0.2622)	(0.1009)
lnInternet	0.7330***	0.2283**	0.8686***	0.2864***
	(0.2683)	(0.0997)	(0.2744)	(0.1056)
Constant	-43.6642**	-21.2240***	-41.6828**	-20.2382***
	(21.0308)	(7.3823)	(18.5459)	(7.1401)
Observations	165	165	165	165
R-squared	0.5139	0.3780	0.5172	0.3859
Adj R-sq	0.492	0.350	0.496	0.358
F value / Wald chi2	235.6***	122.9***	24.02***	14.09***

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The idea of the bootstrap method in the table is carry out multiple samples with return in the samples (the sampling times set in this paper is 500 times, and the seed parameter is set to 1000) to observe whether the coefficient size, positive and negative direction and significance of the core explanatory variable have changed significantly in the two cases. If there is no significant change, it shows that the model is robust.

Under the condition that other factors remain unchanged, the results of this table show that when other variables remain unchanged, the coefficients of lnGc and lnImports of model 1 are positive and significant at the 5% level, the coefficients of lnGh, lnExports and lnInternet are positive and significant at the 1% level, and the coefficients of lnD are negative and significant at the 5% level; The coefficients of lnGc, lnGh and lnImports of model 2 are positive and significant at the 1% level, the coefficients of lnInternet are positive and significant at the 5% level, and the coefficients of LND are negative and significant at the 1% level. The conclusions of the above two models are basically consistent with the original model, the coefficients are the same, and the significance level is consistent with the 5% condition. Therefore, it shows that the original model is robust.

The last two columns are the estimated results after Winsorize processing. The idea of robustness test is to use Winsorize to shrink the 1% and 99% data before and after to avoid the influence of extreme values on the results. If the model is significant after processing the extreme values The situation is consistent with the original model, indicating that the conclusions of the model are robust (although the data is macro data at the national level, there may still be statistical anomalies or outliers). While keeping other factors constant, the results of this table show that, controlling other variables unchanged, the coefficients of lnGc and lnImports of Model 1 are positive and significant at the 5% level, and the coefficients of lnGh, lnExports, and lnInternet are positive. And it is significant at the 1% level, and the coefficient of lnD is negative, and significantly negative at the 5% level; the coefficients of lnGc and lnInternet of Model 2 are positive and significant at the 1% level, and the coefficients of lnGh and lnImports are positive, and in the 5% level is significant, the lnD coefficient is negative, and the 1% level is significantly negative. The conclusions of the above two models are basically the same as the original model, and the coefficients are slightly different, which shows that the original model is robust.

7. Conclusions

This paper holds that the trade development of ICT industry and the popularization of telecommunications technology can reduce the cost of international foreign investment, and on this premise, build a model to evaluate the impact of ICT industry on China's OFDI.

This paper selects the foreign investment projects published by the Ministry of Commerce of China and the economic development indicators of the world bank from 2012 to 2017 as the data sources, sorts out 165 observations through these data, measures the degree of interactive development on the basis of verifying the development relationship between China's OFDI and ICT import and export of bilateral countries, and then constructs a gravity model for empirical analysis. The impact of indicators such as "Internet penetration" and "degree of international free trade" on China's OFDI is further introduced. The main conclusions are as follows:

1. Per capita GDP has a significant positive impact on China's OFDI. The gravity model used in this paper introduces the per capita GDP of the traditional gravity model as the control variable. The results of empirical analysis are consistent with those in other literature: when other variables are controlled unchanged, the per capita GDP of China and the destination country will have a positive impact on the investment amount and investment times of China OFDI. Another feature is that the impact of China's per capita GDP growth on OFDI is greater than that of the destination country's per capita GDP growth on China's OFDI. In general, the higher China's per capita GDP, the greater the motivation of Chinese enterprises to invest abroad. At the same time, the higher the per capita GDP of the destination country, the more Chinese enterprises will attract investment.

2. Physical distance will have a significant negative impact on Chinese OFDI. In this model, the physical distance of the traditional gravity model is also introduced as the control variable. The results of empirical analysis are consistent with those in other literature: when other variables are controlled unchanged, the farther the physical distance from the capital of the destination country to Beijing, the less China's investment in the destination country will be. This is due to the inevitable costs brought by physical distance, such as communication cost, transaction cost and transportation cost of physical goods. The increase of these costs will reduce profits and reduce the investment power of Chinese enterprises.

3. The impact of goods import trade volume of ICT industry on China's OFDI is greater than that of goods export trade volume. In the empirical analysis, when China's ICT goods import from the destination country increases, the amount of investment projects and the number of investment projects increase (significantly at the level of 1%), while each increase in ICT goods export only increases the amount of investment projects, and has no significant

correlation with the number of investment projects. From this, the increase of ICT Industry Import and export trade in bilateral countries will have a positive impact on China's foreign investment. But the China's ICT industry import is a more effective factor driving China's foreign investment

4. Internet penetration has had a significant positive impact on China's OFDI. In order to comprehensively measure the development of ICT, this paper not only introduces the independent variable of ICT goods import and export in the gravity model, but also introduces the index of Internet penetration in bilateral countries, that is, the proportion of people using Internet services in the total population in China and destination countries every year. Through the test results of empirical analysis, it can be seen that the impact of the Internet on China's OFDI is significant, and its impact is greater than that of the per capita GDP of the destination country on China's OFDI, that is, for the purpose, the convenience of information communication is the more important factor. From the negative impact of physical distance, the development of ICT can reduce the blocking effect of distance on bilateral investment

Generally speaking, the development and trade of ICT industry have a positive impact on China's foreign investment, because the development of ICT provides a relatively complete investment environment and operation mechanism for international investment, realizes the transnational transmission of resources and information sharing, and effectively reduces the economic losses caused by the uncertainty of international trade and the asymmetry of information, It realizes the effective allocation of resources in the international market. ICT not only promotes the integration of international economy, but also improves the connection between national markets and international markets.

At the same time, ICT has produced a new "e-commerce model", which makes e-money the main payment method of international trade and the main means for trade and investment in most countries. Using e-commerce, the supply and demand sides can communicate directly and immediately. Investors can find the required information on the Internet, negotiate and sign electronic contracts directly on the Internet, and remotely control production and implementation management. E-commerce enables most of the trade process to be completed through the network. The direct contact between supply and demand reduces the intermediate links, reduces transaction costs and improves economic efficiency.

The above conclusions fully affirm the positive impact of ICT development and trade on China's foreign investment.

8. Bibliography

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