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RESEARCH ON THE IMPACT OF OUTWARD DIRECT INVESTMENT ON THE DEVELOPMENT LEVEL OF DIGITAL ECONOMY

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Abstract: Under the background of the new development pattern of digital economy empowerment, based on the panel data of 31 provinces in China from 2010 to 2020, this paper uses the principal component method and the entropy weight method to measure the development level of digital economy in each region, and conducts an empirical study on the impact of outward direct investment in each province on the development of digital economy. It is found that OFDI has a restraining effect on the development level of digital economy as a whole, while outward FDI in the eastern, central and western regions also has a negative effect on the development level of digital economy in various regions, among which the inhibition effect is the most significant in the west, followed by the central region and the weakest in the east. Furthermore, by taking industrial structure upgrading as the mediating variable, when studying its mediating role in the influence of outward direct investment on the development level of digital economy, it is found that the advanced industrial structure plays a significant inhibitory role in it.
Keywords: Digital economy; OFDI

1. INTRODUCTION

OFDI is an important way for manufacturing enterprises to optimize resource allocation, enhance competitiveness and open up markets on a global scale, because it can make full use of resources, technologies and markets on a global scale, give play to its comparative advantages, and make up for its shortcomings in resources and capabilities, which is of great significance for a country to form an internationally competitive industrial chain.

New economic forms have become more and more diverse in recent years, and the digital economy is one of the most popular, richest and most significant in promoting the overall economy. In recent years, many countries have taken the digital economy as an important development goal and elevated it to the level of national economic development strategy, which shows its importance and development potential for economic development. These include China, the United States, Germany, France, the European Union (EU), the Organisation for Economic Co-operation and Development (OECD), Canada and India. Specifically, the United States has taken more and more frequent actions on the development of the digital economy in recent years, and has formulated various forms of development wars related to the digital economy in the past decade, including 5 at the national level. China also attaches great importance to the development of the digital economy, from the initial release of the "National Informatization Development Strategy Guidelines", to the later General Secretary Xi Jinping at the World Economic Forum 2017 Annual Conference, BRICS Leaders' Meeting, "Belt and Road Forum for International Cooperation" 2020 Central Economic Work Conference and other important meetings, have emphasized the development of the digital economy and made important instructions. On 12 June 2021, Singapore, Chile and New Zealand signed the Digital Economy Partnership Agreement (DEPA), and on 1 November 2021, China applied to join the Agreement. The implementation of the agreement reflects that trade and investment are presented in digital form, and a series of issues such as cross-border data flow, digital security, privacy and antitrust need to be solved. With the continuous improvement of digital infrastructure, the application scope of

digital technology represented by the Internet has also continued to expand, the degree of integration between digital technology and industry has deepened, and the development of digital economy has gradually become an important driving force for world economic progress.From an international point of view, in the post-financial crisis era, the United States, Europe, Japan and other major developed countries in the world have introduced relevant strategies and policies to actively develop the digital economy, believing that the digital economy is an effective way to cope with the financial crisis and promote national economic recovery, and the world has also emerged a wave of development of the digital economy. As a new factor of production, data will fully participate in all aspects of economic development, and the world economy is also in a period of technological revolution represented by digital technology. From a domestic point of view, China's digital economy has developed rapidly in recent years. According to the statistical report data of the China Academy of Information and Communications Technology, the scale of China's digital economy in 2020 will be close to 40 trillion yuan, accounting for nearly 40% of GDP, and the digital economy has become a key support for China's industrial restructuring and economic gear shifting.

In the context of China's steady economic development, the growth rate of China's FDI inflow tends to slow down, and as China's economy continues to improve, China's domestic market competition is becoming more and more intense, so many enterprises have turned their attention abroad. Since the reform and opening up, the inflow of FDI has made great contributions to China's economic development, and during that period, China's overall economic development model was driven by foreign investment, so there was more research on FDI and less research on OFDI. Since the beginning of this year, the development of OFDI in China has become more and more rapid, resulting in a series of studies, and more and more related research on OFDI.

In summary, through the study of OFDI and the development level of China's digital economy, the way to improve the development level of China's digital economy is discussed from a new perspective, and the relevant research on the development level of OFDI and the development level of digital economy is also enriched.

Based on the review of relevant literature, this paper establishes a benchmark regression model to test the significance of the impact of outward direct investment on the development level of digital economy at the provincial level, and to test whether this significance is heterogeneous between the eastern, central and western regions of China. On the basis of the benchmark model, the explanatory variables were replaced to test whether the impact of OFDI on the development level of digital economy was significant. Finally, the intermediary effect test is carried out to analyze the mediation effect of industrial structure advancement on the impact of outward direct investment on the development level of digital economy.

2. Literature review

2.1 OFDI Theory

The theory of foreign investment in developed countries mainly includes the theory of monopoly advantage, internalization theory, product life cycle theory, oligopoly determination theory, comparative advantage theory and international production compromise theory. Among them, the theory of monopoly advantage was first proposed by American scholar Hymer (1960) in "The International Operation of Domestic Enterprises: A Study of Outward Direct Investment", which holds that the main reason why multinational enterprises choose OFDI instead of other international production and operation is that enterprises can maximize the return of intangible assets by virtue of their monopoly advantages or unique advantages formed by their brands, product heterogeneity, sales skills, unique resources, and economies of scale and scope[1].

The assumption of market incompleteness in the theory of monopoly advantage is closer to reality, and the theory breaks through the limitations of explaining national companies in the theory of international trade in terms of the mobility of scarce resources and the international division of labor, and the explanatory power is stronger. But its limitations are also obvious. First, according to the theory, only TNCs with a monopoly advantage can make OFDI, while firms that lack a monopoly advantage are excluded. This is contrary to the fact that since the 80s of the 20th

century, enterprises in late-developing countries that do not have a monopoly advantage are also implementing OFDI. Second, the doctrine does not specify the applicable conditions for whether the product should be subject to technology transfer, trade or OFDI; The internalization theory is based on the limitations of the theory of monopoly advantage in interpreting OFDI, so some scholars have begun to interpret the motivation of OFDI from other perspectives. British scholars Buckley & Casson (1976) and Canadian scholar Rugman (1981) proposed internalization based on Coase's theory of transaction costs and market incompleteness. The theory points out that the market is not complete will induce high transaction costs, if enterprises cooperate with upstream enterprises in the raw materials and intermediate goods required for production, and can obtain them cheaply without using the external market to reach transactions, they can internalize the supply chain of the upstream industry to reduce transaction costs and maximize corporate profits. The essence of internalization theory is the practice and expansion of Coase's enterprise theory, which no longer simply emphasizes the monopoly advantage in enterprise operation, but focuses on the ability of enterprises to internalize their advantages with the help of OFDI, and also has strong explanatory power for the dynamic changes of multinational enterprises after the war. But the theory also has some flaws. For example, insufficient consideration of changes in the international economic environment: only partial explanations are given for the motivation of OFDI, and insufficient analysis of the location and layout of multinational enterprises; The product life cycle theory was proposed by Vernon (1996), who discovered that the production and sales process of products has a phased nature, which means that all regions or countries participate in the international division of labor according to existing resource endowments. This theory points out that product production can be divided into three stages: product innovation, maturity and standardization, and according to the phased characteristics of product production and combined with competitive conditions such as monopoly advantages and location factors, enterprises make decisions on international division of labor, and then form OFDI.Product life cycle theory has been relatively successful in explaining the motivation, timing and location of OFDI in developed countries such as the United States. However, there are also shortcomings: first, there is no reasonable explanation for the production of non-standardized products by multinational enterprises abroad; Second, the theory only examines the final product market, and does not explain the direct investment activities such as resource extraction and technology development. Third, this theory cannot give a reasonable interpretation of the outward FDI behavior of developing countries; The oligopoly determination theory is based on the hypothesis of oligopoly competition, proposed by Knickerbocker (1973), who believes that the OFDI behavior of individual enterprises will trigger the OFDI behavior of its rival enterprises[2].Although this theory points out the reasons for the OFDI behavior of competitors, it also analyzes the reasons for the initial OFDI behavior of enterprises, and in fact, the behavior of oligopolistic enterprises in OFDI should not only observe the behavior of competitors, but also examine its own factors. The theory of comparative advantage, also known as the marginal industrial expansion theory or the Kojima Kiyoshi hypothesis, was proposed by Kojima (1978) based on the H-O factor endowment theory. The theory states that the country will transfer or be at a comparative disadvantage to industries abroad, and these industries should be industries in which the host country has or is likely to have a comparative advantage. Investment and trade complement each other and are more conducive to promoting the economic and trade development of the two countries. This theory integrates the ideas of international trade and international direct investment, but it also has its own limitations in the subsequent evolution of the international economic environment and industrial development. The theory of production trade-off is more comprehensive than the above-mentioned theory of OFDI from developed countries, and is proposed by Dunning (1977) by integrating monopoly advantage theory, internalization theory and location theory, also known as the "OIL" mode[3]The theory also explains the conditions for the occurrence and transformation of three international production and business activities: trade, technology transfer and direct investment. However, there are also some flaws in the theory, such as equating the status of the three advantages without distinction between priority and priority, and the relationship between the three is not analyzed; It is not possible to give a rational analysis of the OFDI phenomenon in developing countries that lack the triple advantage.

Research on the theory of OFDI from developing countries has increased sharply since the 80s of the 20th century, mainly including the theory of small-scale production, the theory of technological localization, the theory of

institutional adaptability, the theory of inward internationalization, the theory of LLL theory, the theory of country-specific advantages, and the theory of combination of investment-induced factors.

2.2 Review of Literature Related to Digital Economy

The concept of the "digital **economy**" was first proposed by Don Tapscott in 1996. With the continuous progress of information technology, Internet technology and a new generation of digital technology, the connotation of digital economy has evolved from narrow to broad. In 1998, the U.S. Department of Commerce (BEA) released the report "Emerging Digital Economy", pointing out that the "new economy" phenomenon of high economic growth, high employment rate and low inflation rate in the United States for 118 months in the 90s of the 20th century was derived from the widespread application of information technology. At this stage, the digital economy referred to by research institutions and scholars is essentially the ICT industry, that is, the digital economy in the narrow sense. After observing the application of Internet technology in the economy and society, BEA released a series of reports on "Emerging Digital Economy II" and "Digital Economy 2000" in 1999 and 2000, clearly pointing out that "the digital economy is a collection of information technology production industries, use industries and e-commerce". The OECD (2012) replaced the original Information Technology Outlook with the Internet Economy Outlook and detailed the socio-economic changes triggered by the Internet. At this time, the definition of the connotation of the digital economy still stays in the content of information technology industry, the rapid development of the Internet and e-commerce, etc., and has not yet involved the content of technology empowering traditional industries and data becoming a factor of production.

With the development of a new generation of digital technologies such as the Internet of Things and artificial intelligence and their deep integration and application in agriculture, manufacturing and service industries, the boundary scope of the digital economy has also changed greatly. Since 2014, the OECD has replaced the Internet Economy Outlook with a series of reports on the Digital Economy, which treats the digital economy as an information society and emphasizes that the impact of the digital economy is everywhere. BEA (2019) also clearly pointed out that the digital economy is constantly evolving, and its connotation and extension should be constantly updated with the innovative application of technology. Most scholars at home and abroad define the connotation of the digital economy no longer limited to the ICT industry or e-commerce in a narrow sense, but believe that the digital economy is a new economic activity or economic form based on digital technology in a broad sense. Different researchers have different perspectives when defining the digital economy. It can be summarized into the following three types:

First, from the perspective of phenomenon description, it emphasizes the new changes in economic activities triggered by the development of digital technology.（Kling and Lamb 1999）[4] believe that the digital economy is an economy in which the production, sales, and supply of products and services are directly dependent on digital technology;European Commission（ 2013）、British Computer Society（2014） and Rouse （ 2016）[5] It is also believed that the digital economy is a new economic form triggered by digital technology.Nathan and Rosso(2012）, Knickrehm (2016)[6] pointed out that the new economic output brought about by inputs such as digital technology and digital communication equipment is partly the digital economy.The British House of Commons (2016) views the digital economy as an economic form in which goods and services are traded digitally.

Second, from the perspective of feature generalization, it emphasizes the difference between the digital economy and the traditional economy in terms of driving forces and production factors. A typical representative is the definition of digital economy at the G20 Hangzhou Summit, that is, "digital economy refers to a series of economic activities with the use of digital knowledge and information as key production factors, modern information networks as important carriers, and effective use of information and communication technologies as important driving forces for efficiency improvement and economic structure optimization". Similarly, the Chinese Academy of Information and Communications Technology (2020) defines the digital economy, which believes that the digital economy is "a new economic form with digital knowledge and information as the key production factors, digital technology as the core

driving force, modern information network as an important carrier, and the deep integration of digital technology and the real economy, continuously improving the level of digitalization, networking and intelligence, and accelerating the reconstruction of economic development and governance models". This definition comprehensively covers the basic elements, technical attributes, development carriers, etc. of the digital economy.

The third is to emphasize the accounting scope of the digital economy from the perspective of structural decomposition.Bukht and Heeks (2018) [7] and the United Nations UNCTAD (2019) both point out that the digital economy consists of digital sectors, digital economy and digital economy; The UK Bureau of Statistics (2015) believes that the digital economy is a combination of hardware, software and telecommunications infrastructure, as well as e-commerce; BEA (2019) proposes that the digital economy should consist of three components: digital infrastructure, e-commerce and digital services; The China Academy of Information and Communications Technology (2017) divides the digital economy into digital industrialization, industrial digitalization, digital governance and data value. The National Bureau of Statistics (2021) defines the scope of digital economy accounting as digital industrialization and industrial digitalization.

In society, the United Nations and European think tank Bruegel and other institutions[8] have used the GDP standard of the ICT industry to screen and determine the approximate scope applicable to digital economy accounting in the real economy industry, and then measure the scale of the digital economy. This method has great advantages in determining the accounting scope and measuring the method, but this process only starts from the core perspective, and at the same time leads to the defect of small accounting scope, resulting in a small accounting result, accounting for only 0.06 of GDP. To this end, the United States and Australia from another perspective: national accounts, put forward different forecasting schemes, borrowing from the United States [9] measurement method, in the selection of digital products when using the supply table, the operability of this initiative has been greatly improved, although the United States and Australia continue to optimize in this regard, actively explore, but always have certain limitations, the United States and Australia Analysis Bureau emphasized that this method still has many limitations in terms of scope, It cannot be used to account for the content of the digital economy such as peer-to-peer transactions and some emerging digital products, and if it is studied from a production perspective, this method cannot be used, and must be translated into the final demand for import and export for corresponding measurement. In the report "Digital Economy Estimates" released by the International Monetary Fund (IMF) [10], the digital sector is defined in order to measure the size of the digital economy in each country, and the return results are supplemented to avoid omissions. This method is more strictly defined, the accounting scope has been optimized, and the scale of the digital economy has been measured from a narrow level. However, the IMF's measurement of the digital economy is still incomplete, and certain conditions are limited when supplementing the relevant with the results of regression.

By combing the above literature, the traditional statistical accounting methods have shortcomings in the measurement of digital economy, and various research institutions and researchers have successively used different accounting ideas and statistical methods to estimate the digital economy from multiple dimensions through the construction of differentiated index systems. In 2015, the OECD's major economies in the world compiled a set of digital economy measurement systems, and the digital economy development index system constructed included 38 comparable indicators, and conducted a more comprehensive research and analysis when selecting indicators. The following year, in 2016, Eurostat compiled and measured the Digital Economy and Social Index reflecting the degree and process of the development of the EU's digital economy, which includes five aspects: broadband access, Internet applications, human capital, digital technology utilization and digital services, covering a total of 30 secondary indicators. In 2019, the U.S. Bureau of Economic Analysis used supply tables to measure the value added and total output brought by the U.S. digital economy on a well-defined basis.Abdulkarim A. Oloyede (2023) et al. take into account the impact of government and telecommunications regulators in digital economy indicators [11]; Mohd Junaid Akhtar (2023) et al. [12]; Madinatou Yeh Bunje (2022) et al. discussed the impact of digital economy on the foreign trade of African countries from the perspective of international trade[13]. ;Effective governance by governments such as Muhammad Shahbaz (2022) can enhance the impact of the development of the digital economy on the global energy transition[14] ; Ibrahim Niankara

(2023) et al. examine the impact of B2P electronic payroll and G2P digital benefits on formal financial inclusion in the global open economy[15]; Christian Bergqvist (2023) et al. studied the impact of market changes on the development of the digital economy[16].

To sum up, research in the field of digital economy emerged in the 90s of the 20th century, and the research time was not long but attracted great attention. At present, the research mainly focuses on the definition, impact, rules and management of digital economy and national management, digital economy measurement, etc., with the continuous expansion of the scale of digital economy, the research has entered a period of rapid development, although no normative discussion of the digital economy has been formed, but the basic nature has reached a broad consensus, and many practical ideas have been formed on the measurement of the digital economy. The research on OFDI theory has been relatively mature, and the OFDI of micro-entities in various industries has also been explored to a certain extent. However, with the development of the digital economy, the traditional OFDI theory is facing many new factor changes. On the whole, there are still few studies on the impact of OFDI on the digital economy, and even less on inter-provincial OFDI. Under the background that the measurement and mechanism of OFDI affecting the digital economy still need to be further enriched and improved, this paper takes 31 provinces in China as the research object to explore the impact of OFDI on the development level of digital economy in China, which is also a supplement to this field.

Combined with the internal upgrading theory of the theoretical analysis part, it can be seen that OFDI can rapidly expand the accumulation of capital, technology and human capital in the industry, and then produce the compensation effect of core resources, which is conducive to the optimal allocation of production factors in the industry on a global scale. Moreover, in the process of OFDI, reverse technology spillover effects may also occur, stimulating technological progress in the industry and the realization of industrial structure upgrading. Based on the above analysis, this paper argues that OFDI will directly affect the realization of the advanced industrial structure, that is, the focus of the industrial structure will be promoted to the tertiary industry with a higher industrial level coefficient. However, the advanced industrial structure can reallocate production factors such as labor force and capital among industries, so that the tertiary industry can develop rapidly, to a certain extent, weaken the digital development of the primary and secondary industries, and then have an impact on the development level of digital economy in various regions.

3. RESEARCH DESIGN

3.1 Measurement Model Setting

Firstly, in order to test the specific impact of China's OFDI on the development level of digital economy, this paper constructs the following benchmark measurement model:

$$digit_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \alpha_2 X_{it} + \lambda_i + u_{it} \quad (1)$$

Among them, i represents 31 provinces and regions in China; t represents time; digit represents the level of digital economy development indicators; OFDI indicates the level of OFDI; X represents other control variables; Indicates a fixed effect; Represents a random perturbation term.

3.2 Description of Variables

3.2.1 The variable being explained.

The explanatory variables in this paper are the development level of digital economy in each province of China, and four indicators are used with reference to relevant research: the number of Internet broadband access users among 100 people, the proportion of computer service and software industry employees in urban units, the total per capita telecommunications business and the number of mobile phone users in 100 people, and then use the principal component method and the entropy weight method to measure the development level of digital economy in Chinese provinces.

3.2.2 Core explanatory variables.

The core explanatory variable in this paper is the level of OFDI, measured using provincial OFDI flows.

3.2.3 Control variables.

In order to analyze the impact of economic development on the digital economy more comprehensively, refer to the existing literature on the development level of digital economy, and select the per capita education years (EDU), per capita GDP (pgdp), market-oriented index (market), patent application authorization (patent), openness (open), fixed asset investment to GDP ratio (asset), urban population *to* total population ratio (POP).

3.2.4 Mediation variables.

In this paper, the industrial structure upgrading variable is selected as the mediating effect variable, and the industrial structure upgrading variable is decomposed into two indicators: industrial structure rationalization (TL) and industrial structure advanced (TS).

3.3 Data Sources and Descriptive Statistics

This paper selects the balanced panel data of 31 provinces in China from 2010 to 2020 for analysis, among which the indicators of digital economy development level are from the China Urban Statistical Yearbook. Outward FDI flows are from the Statistical Bulletin of China's Outward Direct Investment; The number of years of schooling per capita is calculated by the National Bureau of Statistics data; GDP per capita data is derived from local statistical bureaus of each province; The market-oriented index is derived from the "China Marketization Index Report by Province"; The data on the number of patent applications granted are from the State Intellectual Property Office; Data on openness to the outside world comes from the National Bureau of Statistics; The data on the ratio of fixed asset investment to GDP comes from the regional statistical yearbook; The data on the ratio of urban population to total population comes from the China Urban Statistical Yearbook; The calculation data of industrial structure rationalization and industrial structure advanced are from the China Statistical Yearbook. The descriptive statistics for each indicator are shown in the table 1:

Table 1 Descriptive Statistics of Variables

variable	variable code	observations	mean	standard deviation	minimum	maximum
digital economy development（Principal component method）	digit1	310	0.600	0.066	0.492	0.892
digital economy development（Entropy weight law）	digit2	310	0.371	0.174	0.077	0.982
OFDI flows	ofdi	310	242422.703	406269.270	2.000	2396772.000
years of schooling per capita	edu	310	9.136	1.079	4.666	12.107
GDP per capita	pgdp	310	53227.345	26875.339	16024.00	164158.000
market-oriented index	market	310	7.722	2.183	-0.160	12.107
number of patent applications granted	patent	310	56727.571	88508.135	121.000	70725.000
degree of openness to the outside world	open	310	0.269	0.287	0.008	1.464
investment in fixed assets as a percentage of GDP	asset	310	0.852	0.292	0.211	1.597
the ratio of urban population to total population	pop	310	0.581	0.131	0.227	0.896
rationalization of industrial structure	tl	310	0.227	0.201	0.008	1.042
the industrial structure is advanced	ts	310	1.335	0.720	0.527	5.244

4. EMPIRICAL RESULTS AND ANALYSIS

4.1 Benchmark Regression Results

The following table shows the fixed effect estimation results of 31 provinces in China, combined with the estimation results of model (1) and model (2), it can be found that when the control variables are not added, the outward FDI flow has a significant positive effect on the development level of the digital economy at the significance level of 1%, but when other control variables are added, the effect of OFDI on the development level of the digital economy becomes negative, and this estimate results preliminarily confirm that OFDI has an impact on the development of the digital economy. As shown in Table 2.

Table 2 Baseline Regression Estimation Results

variable	（1）	（2）
ofdi	5.77e-08***	-5.42e-09*
	(4.82)	(-1.96)
education		0.000809
		(0.11)
pgdp		0.00000194***
		(7.91)
market		0.00107
		(0.36)
patent		6.44e-08**
		(2.45)
open		-0.0137
		(-0.67)
asset		-0.0265***
		(-4.42)
population		0.600***
		(9.75)
_cons	0.586***	0.156**
	(201.78)	(2.34)
N	310	279
R2	0.08	0.94
adj. R2	0.07	0.94

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

From the estimation results of the control variables, the regression coefficient of per capita GDP is significantly positive at the level of 1%, indicating that higher living standards can promote the development of digital economy. The regression coefficient of the number of patent applications granted was significantly positive at the level of 5%, indicating that the improvement of R&D intensity in various provinces can promote the development of local digital economy. The regression coefficient of the ratio of fixed asset investment to GDP is significantly negative at the level of 1%, indicating that investment in fixed assets may hinder investment in industrial digitalization, which in turn hinders the development of the digital economy. The regression coefficient of urban population as a proportion of total population is significantly positive at the level of 1%, indicating that as the rural population shifts to urban areas, it will promote the local economy, and then promote the development of the local digital economy. In addition, the per capita number of years of education and the degree of marketization have a positive impact on the development of the digital economy, while the degree of openness has a negative impact on the development of the digital economy, but it has not passed the significance test, the reason may be that the level of human capital of local residents has not been effectively utilized, and the government has not played its due role in the development of the digital economy, resulting in the marketization index failing the significance test, and the increase in the degree of openness may lead to the dependence of the region on foreign investment. As a result, the development of the region's digital economy is hindered.

4.2 Robustness Test

In the previous benchmark regression, the measure of digital economy development indicators is the principal

component analysis method used, this paper uses the entropy weight method to re-measure the development level of digital economy development in each province, and is used to carry out robustness test, robustness test regression results are shown in the following table 3:

Table 3 Robustness Test Regression Results

variable	robustness test
ofdi	-2.23e-08**
	(-2.41)
education	0.0141
	(0.77)
pgdp	0.00000571***
	(10.02)
market	0.00690
	(0.81)
patent	0.000000292***
	(4.16)
open	-0.0323
	(-0.64)
asset	-0.0603***
	(-4.48)
population	1.819***
	(11.83)
_cons	-1.128***
	(-6.92)
N	279
R2	0.94
adj. R2	0.94

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

4.3 Heterogeneity Testing

Different regions and different provinces in China have different resource endowment characteristics, therefore, the influence of digital economy development level by OFDI may vary from region to region. Regarding the division of geographical locations, this paper analyzes the heterogeneity of 31 sample provinces according to the location division methods of central, eastern and western regions, and discusses the impact of OFDI on the development of digital economy. As shown in Table 4.

Table 4 Regression Results of Eastern, Central and Western Heterogeneity Tests

variable	eastern	central	western
ofdi	-4.46e-09	-5.70e-08*	-4.79e-08**
	(-1.33)	(-2.21)	(-2.48)
education	0.0237	0.00851	-0.0121*
	(1.55)	(0.59)	-1.99
pgdp	0.00000177***	0.000000834*	0.00000210***
	(8.06)	(2.33)	(3.43)
market	0.00257	-0.00144	-0.000187
	(0.41)	(-0.44)	(-0.05)
patent	6.71e-08**	0.000000262	0.000000383
	(2.44)	(0.88)	(1.47)
open	-0.00675	-0.184***	0.0458**
	(-0.35)	(-10.39)	(2.61)
asset	-0.0271***	-0.0192	-0.0288***
	(-3.76)	(-1.36)	(-3.60)
population	0.517***	0.841***	0.632**

	(6.67)	(8.36)	(3.08)
_cons	-0.0999 (-0.71)	0.0498 (0.51)	0.305*** (5.07)
N	99	72	108
R2	0.94	0.96	0.96
adj. R2	0.93	0.96	0.96

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

According to the regression results of the heterogeneity test in the above table, it can be seen that outward FDI in the eastern, central and western regions will have a restraining effect on the development level of local digital economy, but the regression coefficient of outward direct investment in the eastern region has not passed the significance test, which may be because the eastern region is more developed in industry and less affected by OFDI. The effect of other control variables is similar to that of benchmark regression.

4.4 Intermediary Effect Test

This paper uses industrial structure rationalization and industrial structure advancement as alternative indicators for industrial structure optimization, and discusses and studies the intermediary role of industrial structure optimization in the development of digital economy in regions affected by OFDI, among which the mediating effect model of industrial structure rationalization is:

$$digit_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \alpha_2 X_{it} + \lambda_i + u_{it} \quad (2)$$

$$tl_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \lambda_i + u_{it} \quad (3)$$

$$digit_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \alpha_2 tl_{it} + \alpha_3 X_{it} + \lambda_i + u_{it} \quad (4)$$

The mediating effect model of advanced industrial structure is:

$$digit_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \alpha_2 X_{it} + \lambda_i + u_{it} \quad (5)$$

$$ts_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \lambda_i + u_{it} \quad (6)$$

$$digit_{it} = \alpha_0 + \alpha_1 ofdi_{it} + \alpha_2 ts_{it} + \alpha_3 X_{it} + \lambda_i + u_{it} \quad (7)$$

The regression estimation results are shown in the following table 5, 6, 7 and 8:

Table 5 Test Results of Rationalization of Industrial Structure (1)

variable	rationalization of industrial structure (1)
ofdi	-3.07e-08 (-1.12)
_cons	0.235*** (35.27)
N	310
R2	0.01
adj. R2	0.00

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 6 Test Results of Industrial Structure Rationalization (2)

variable	rationalization of industrial structure （2）
tl	-0.0944* (-2.04)
ofdi	-6.61e-09*** (-2.78)
education	-0.000245

	(-0.03)
pgdp	0.00000195***
	(10.02)
market	0.000239
	(0.09)
patent	7.08e-08**
	(2.59)
open	-0.0135
	(-0.67)
asset	-0.0273***
	(-4.59)
population	0.532***
	(9.96)
_cons	0.234***
	(3.31)
N	279
R2	0.95
adj. R2	0.94

Table 7 Test Results of Advanced Industrial Structure(1)

variable	the industrial structure is advanced (1)
ofdi	0.000000355***
	(6.65)
_cons	1.249***
	(96.50)
N	310
R2	0.13
adj. R2	0.13

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

Table 8 Test Results of Advanced Industrial Structure (2)

variable	the industrial structure is advanced （2）
ts	-0.0944*
	(-2.04)
ofdi	-6.61e-09***
	(-2.78)
education	-0.000245
	(-0.03)
pgdp	0.00000195***
	(10.02)
market	0.000239
	(0.09)
patent	7.08e-08**
	(2.59)
open	-0.0135
	(-0.67)
asset	-0.0273***
	(-4.59)
population	0.532***
	(9.96)
_cons	0.234***
	(3.31)
N	279
R2	0.95
adj. R2	0.94

t statistics in parentheses
* p < 0.1, ** p < 0.05, *** p < 0.01

According to Table 5, the negative impact of OFDI on the rationalization of industrial structure is not significant. According to Table 7, it can be seen that the increase in OFDI has a significant positive impact on the advanced industrial structure, and according to Table 8, it can be seen that the advanced industrial structure has a negative impact on the development level of the digital economy in various provinces, and has passed the significance test at the level of

10%, the reason may be that the focus of China's industrial structure is on manufacturing, processing industry and other industries, and the advanced industrial structure is to measure the ratio of the output value of the tertiary industry to the total output value of the primary, secondary and tertiary industries. Therefore, the advanced evolution of industrial structure is not conducive to the improvement of the development level of digital economy.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

In order to better adapt to the general trend of digital economy development and promote the improvement of China's digital economy development level, this paper takes the outward direct investment flow of various provinces in China as the starting point, firstly measures the development level of digital economy by using the principal component method and the entropy weight method respectively, and secondly, based on China's interprovincial panel data, empirically studies the impact and utility of OFDI on the development of digital economy in China's provinces. Finally, taking industrial structure optimization as the mediating variable, the mediating role of industrial structure optimization in the influence of OFDI on the development level of digital economy is discussed, and the following main conclusions are finally obtained: (1) On the whole, OFDI has a significant inhibitory effect on the development of local digital economy; (2) Although outward FDI in the eastern region has a negative impact on the development of the digital economy, it is not significant, while the outward direct investment activities in the central and western regions will significantly inhibit the development level of the local digital economy. (3) The advanced industrial structure of the tertiary industry will increase with the increase of foreign direct investment, but it is not conducive to the development of the digital economy from China's main economic industries.

Based on the above research conclusions, in order to better promote the development of China's digital economy and achieve the high-quality development of China's economy, the following countermeasures and suggestions are put forward: (1) In the process of development of each province, more attention should be paid to the cultivation of talents, and the human capital of each region should be fully utilized; (2) The play of government functions should be paid more attention, market relations should be regulated, and resources can be effectively utilized; (3) While paying attention to the tertiary industry, China should also grasp the development of the primary and secondary industries, integrate digitalization into all aspects, and achieve a second leap in high-quality economic development.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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