The Role of Internet Information Technology in Economic Development

Based on the Threshold Test of Scientific and Technological Capabilities of 85 Economies

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Abstract. The application and popularization of Internet information technology has influenced the development and reform of all walks of life. Based on the panel data of 85 economies from 2004 to 2019, this paper constructs a two-way fixed effect model and a panel threshold model to empirically test the role of Internet information technology in economic development. The conclusions are as follows: firstly, Internet information technology plays an important role in economic development and can significantly promote economic development; Second, Internet information technology has a single threshold function based on scientific and technological ability in the process of influencing economic development, and with the improvement of scientific and technological ability, the promotion of Internet information technology to economic development is gradually enhanced. This study is helpful to deeply understand the role of Internet information technology in economic development, and bring some enlightenment for countries to promote the application of Internet information technology in social and economic life.

Keywords: Internet Information Technology · Economic Development · Scientific and Technological Ability · Threshold Effect

1 Introduction

The emergence and development of Internet information technology is a landmark change in human history. Since the beginning of the new century, Internet information technology has been involved in various fields, just like the industrial revolution, affecting the development and reform of all walks of life. With the development and popularization of Internet information technology, the way of information dissemination has been greatly improved, from newspapers and radio to television and internet, which has accelerated the speed and convenience of information dissemination. At a new historical starting point, trade frictions, the COVID-19 epidemic and the escalation of the Russian-Ukrainian conflict have brought more challenges and higher requirements to the development of all countries, and at the same time brought more opportunities. How to make good use of the intangible element of Internet information technology is very

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important for the development of all countries. In 2022, China's government work report emphasized the important development direction of "accelerating the development of industrial Internet and cultivating and expanding digital industries such as integrated circuits and artificial intelligence". This paper empirically explores the role of Internet information technology in the economic development of various countries by constructing benchmark regression model and panel threshold model, aiming at promoting the integration of Internet information technology with social and economic activities and accelerating the economic development of various countries.

2 Literature Review

Different scholars have studied the role of Internet information technology in social and economic development from different perspectives. Internet technology, which began in the 1990s, has influenced all aspects of economic life [12]. At present, information and communication technology is leading a new round of industrial transformation. With the technological progress of 5G, big data and intelligent manufacturing, Internet information technology has irreversibly become a new kinetic energy to promote national economic and social development [10]. Internet information technology can promote innovation [4, 14, 16]. Chen et al. found that in the Yangtze River Delta urban agglomeration in China, the cities with high Internet popularity have a higher marginal contribution to the innovation output, and therefore think that we should take the current digital economy development as an opportunity to promote the new generation of information infrastructure [3]. The popularity of the Internet has effectively broken the geographical limitations in the process of information dissemination [2]. In the digital age, it is very important to use the search function of the Internet to obtain external information. The development of Internet information technology is conducive to improving productivity, promoting innovation efficiency, reducing information costs, and ultimately improving the quality of enterprises' export products [8].

The development of Internet information technology has an important impact on economy and trade. Visser found through empirical tests that the access of broadband network has enhanced the intensive and extensive margins of international trade, and the penetration rate of the Internet is directly proportional to the types of differentiated products produced by a country [15]. The popularization of Internet information technology plays an important role in reducing market transaction costs and effectively promoting the prosperity of international trade, which is embodied in the fact that the Internet can improve the scale and institutions of international trade and promote new formats of international trade [5]. Swan et al. found that Internet information technology is helpful to promote the development of national economy and trade, and it has time effect and scale effect on trade [13]. Abeliansky pointed out that the quality of the Internet is more important than the per capita access to the Internet, and information and communication technology can significantly promote the development of trade and economy [1]. Pomfret found that the relationship between Internet and economy and trade was not significant in the early stage, and it began to be significant after 1997 [9]. Sun pointed out that the development of Internet and related technologies can increase the trade share of SMEs [11]. Gnangnon pointed out that the Internet can effectively enhance the diversification of service industry exports [6].

To sum up, most of the existing literatures focus on the linear influence of Internet information technology on economic development, while few pay attention to the nonlinear influence of Internet information technology on economic development. But in fact, different countries have different scientific and technological capabilities, and the impact of Internet information technology on the economic development of different countries will be different. In view of this, this paper attempts to supplement and expand the existing research. The possible marginal contributions of this paper are as follows: first, using the panel data of 85 economies from 2004 to 2019, using the two-way fixed effect model to empirically test the role of Internet information technology in the economic development of various countries; Secondly, using panel threshold technology, this paper empirically tests whether and what kind of threshold role scientific and technological capabilities play in the influence of Internet information technology on the economic development of various countries, and then discusses the dynamic nonlinear characteristics of Internet information technology on economic development.

3 Research Design

3.1 Model Setting

This paper constructs the following econometric model to reflect the impact of Internet information technology on social and economic development.

$$WI_{it} = \beta_0 + \beta_1 ICT_{it} + \beta_2 X_{it} + \mu_i + \varphi_t + \varepsilon_{it} \tag{1}$$

Among them, i represents the economy, t represents the year, and WIit is the explained variable, which represents the economic development level of i economy in t years. The larger the index value, the higher the economic development level. ICTit is the core explanatory variable, which indicates the t year Internet information level of i economy, and it is the core explanatory variable of this paper. The larger the index value, the higher the Internet information technology level, and Xit is the control variable, including capital formation level, government expenditure, education level, industrialization level and unemployment level, μi is used to control the regional fixed effect, φt is used to control the time fixed effect, and εit represents the error term.

The relationship between the level of Internet information technology and the level of economic development is not a simple linear relationship. Based on the panel threshold regression method proposed by Hansen7, this paper measures the nonlinear relationship between the impact of Internet information technology on economic development. Through the threshold effect test, it is divided into different intervals according to the scientific and technological ability, and empirically analyzes whether there will be a structural mutation in the process of Internet information technology affecting economic development, so as to verify whether the scientific and technological ability will affect the Internet information technology on economic development. Taking "economic development level" as the explained variable, "Internet information technology level" as the core explanatory variable and "scientific and technological ability" as the threshold variable, the following panel threshold model is constructed:

$$\begin{aligned} WI_{it} = {} & \alpha_0 + \alpha_1 ICT_{it} * I(q \le \gamma_1) + \alpha_2 ICT_{it} * I(\gamma_1 \le q \le \gamma_2) + \\ & + \alpha_n ICT_{it} * I(q \ge \gamma_n) + \alpha X_{it} + \mu_i + \varphi_t + \varepsilon_{it} \end{aligned} \tag{2}$$

Among them, X_{it} is the control variable mentioned above, and $I(q)$ is an indicative function. Only when the conditions of the indicative function are met can the value be 1, and when it is not met, the value is 0, $\gamma\ 1 \ldots\ \gamma\ n$ represents n thresholds to be estimated, and q is the scientific and technological capability of the threshold variable.

3.2 Variable Setting

Interpreted variable. The variable explained in this paper is the level of economic development (WI), which is represented by the annual per capita income of residents in each economy. The higher the per capita income level of residents, the higher the level of national economic development. The annual per capita income level of residents in each economy is obtained by reducing the consumer price index based on 2010.

Core explanatory variable. The core explanatory variable in this paper is the level of Internet information technology (ICT). The level of information technology is expressed by the proportion of information and communication technology service exports to the total service exports, in which information and communication technology service exports are mainly composed of information services consisting of computer data and news-related service transactions and computer and communication services consisting of telecommunications, postal services and express delivery services.

Threshold variable. Most scholars at home and abroad measure the index of scientific and technological ability from the aspects of investment in R&D funds and personnel or the number of patents output. Patents are the most direct results of scientific and technological innovation activities and have become the index used to measure scientific and technological ability in many documents. This paper selects the patent authorization index (lninno) as the proxy index of scientific and technological ability.

Control variables. In order to better measure the impact of Internet information technology on economic development and reduce related errors, this paper adds other control variables to constrain the model, and selects capital formation level, government expenditure, opening up level, education level, industrialization level and unemployment level as control variables. Specifically, (1) the level of capital formation (Capital): characterized by the ratio of total capital formation to GDP; (2) Government expenditure (Government): it is measured by the proportion of general government final consumption expenditure in GDP. General government final consumption expenditure is mainly composed of most of the national expenditure on security and national defense and the recurrent expenditure incurred by the government in purchasing goods and services; (3) Education level (Education): expressed by the proportion of total public expenditure on education to GDP, public expenditure on education is mainly composed of expenditures subsidized by the government in education management, educational institutions and private entities; (4) Industrialization level (Indle): the proportion of industrial added value to GDP is selected to measure; (5) Unemployment degree (Unemploy): expressed by the proportion of the total unemployed to the total domestic labor force.

3.3 Data Description

Based on the availability, continuity and comparability of data, this paper selects the panel data of 85 economies from 2004 to 2019 as the research object in Table 1. These

Table 1. Sample economies

Group	Economies
High-income economies	Chile, Estonia, Croatia, Hungary, Iceland, Israel, the Republic of Korea, Lithuania, Latvia, Panama, Poland, Romania, Seychelles, Trinidad and Tobago, Uruguay, France, Britain, Ireland, Belgium, Germany, Luxembourg, the Netherlands, Austria, Switzerland, Norway, Denmark, Finland, Italy, Sweden, Spain, Finland. Malta, Slovak Republic, USA, Canada, Japan, Singapore, Australia, New Zealand, Hongkong, China, Macau, China
Middle and high income economies	Albania, Argentina, Azerbaijan, Bulgaria, Belarus, Brazil, China, Colombia, Costa Rica, Dominican Republic, Georgia, Guatemala, Jordan, Kazakhstan, Moldova, Mexico, Mauritius, Malaysia, Peru, Russian Federation, Thailand, Saint Vincent and the Grenadines
Low-and middle-income economies	Bangladesh, Algeria, Arab Republic of Egypt, Honduras, Indonesia, India, Kyrgyzstan, Cambodia, Morocco, Philippines, Senegal, El Salvador, Swaziland, Tunisia, Ukraine and Uzbekistan.
Low-income economies	Togo, Uganda

economies contain most of the world's total population and economic output, which is representative and typical. Among them, the data of individual economies in a certain year are missing, and interpolation method is adopted to fill in. In order to eliminate the influence of measurement units and dimension differences on the research results, the variables expressed by absolute values are logarithmic. The data come from the World Bank database, the United Nations Industrial Development Organization database, the OECD database, the website of the United Nations Department of Economic and Social Affairs, the United Nations Trade Database, and the website of UNESCO. Table 2 shows the expressive statistical analysis results of the relevant variable indicators involved in the article.

4 Empirical Analysis

4.1 Benchmark Regression

First of all, the mixed regression model or fixed effect model is judged by F test, and the test result strongly rejects the original hypothesis, so the mixed regression model is excluded. Secondly, the Hausman test determines whether to choose the fixed effect model or the random effect model. The test results strongly reject the original hypothesis, and the result is to exclude the random effect model, which shows that the fixed effect model is the most scientific and reasonable, and the fixed effect model can try to avoid endogenous problems caused by unobservable factors that do not change with time.

Table 2. Descriptive Statistics of Variables

Variables	mean	sd	minimum	maximum	Sample size
WI	9.267	1.246	6.100	11.371	1360
ICT	0.080	0.083	−0.012	0.531	1360
lninno	6.019	2.808	0.001	12.899	1360
Capital	0.244	0.064	0.118	0.580	1360
Government	0.163	0.049	0.035	0.478	1360
Education	0.047	0.015	0.015	0.110	1360
Indle	0.263	0.088	0.037	0.661	1360
Unemploy	0.074	0.046	0.001	0.282	1360

In addition, in order to eliminate the negative impact of heteroscedasticity as much as possible, the robust standard deviation is used in the regression with fixed effect model. In Table 3, (1) and (2) are the regression results without and with control variables, respectively. It can be found that the regression coefficient of Internet information technology, a core explanatory variable, is always significantly positive at the significance level of 1% regardless of whether the control variables are added or not. This shows that a country (region) Internet information technology can significantly improve the level of economic development.

4.2 Threshold Regression

Based on the threshold model (2), it is necessary to check whether there is a threshold model. Using "bookstrap" to construct asymptotic distribution to test the significance of single threshold, double threshold and triple threshold, and then make threshold regression through the obtained real threshold value to analyze the threshold effect of Internet information technology on economic development. The results show that scientific and technological ability plays a single threshold effect in the influence of Internet information technology on economic development, and the threshold value is 10.8559. The test results are shown in Table 4.

According to the number and value of the above threshold values, a single threshold model of the influence of Internet information technology on economic development based on scientific and technological capabilities is constructed in Table 5. It can be found that the regression coefficient of internet information technology to economic development is significantly positive regardless of whether the scientific and technological ability reaches the threshold value. With the scientific and technological capability crossing the threshold, the influence coefficient of Internet information technology on economic development increases.

Table 3. Benchmark Regression Results

Variable	(1)	(2)
ICT	1.374***	1.133***
	(0.351)	(0.340)
Capital		0.0156
		(0.241)
Government		−0.618
		(0.394)
Education		2.453*
		(1.397)
Indle		−0.644
		(0.426)
Unemploy		−2.101***
		(0.292)
_cons	9.157***	9.483***
	(0.0281)	(0.185)
N	1360	1360
R^2	0.089	0.229

Note: The figures in brackets are standard errors, and ***, ** and * mean significant at the level of 1%, 5% and 10% respectively, the same below

Table 4. Threshold Existence Test

Threshold model	P value	threshold value	BS times	95% confidence interval
Single threshold	0.0100	10.8559**	500	(10.7721, 11.0672)
Double threshold	0.1620	11.8919	500	(11.8722, 11.8992)
Triple threshold	0.9740	11.9801	500	(11.8802, 11.9987)

5 Conclusions and Recommendations

5.1 Conclusions of the Study

The popularization and development of Internet information technology has a great influence on the world today. Based on the panel data of 85 economies from 2004 to 2019, this paper empirically tests the linear and nonlinear effects of Internet information technology on economic development by using two-way fixed panel model and threshold panel model. The conclusions of this paper are as follows: Firstly, Internet information technology plays an important role in economic development and can significantly improve

Table 5. Threshold Regression Results

variable	WI
ICT*I ($q \leq \gamma 1$)	0.945***
	(0.114)
ICT*I ($q \geq \gamma 1$)	6.163***
	(0.471)
Capital	−0.0521
	(0.0921)
Government	−0.661***
	(0.227)
Education	2.188***
	(0.565)
Indle	−0.549***
	(0.126)
Unemploy	−2.119***
	(0.160)
_cons	9.495***
	(0.0606)
N	1360
R^2	0.296

the level of economic development; Secondly, there is a single threshold effect based on scientific and technological capabilities in the process of influencing the economic development of various countries, and with the improvement of scientific and technological capabilities, the positive impact of Internet information technology on economic development has a dynamic nonlinear feature from weak to strong.

5.2 Policy Implications

In order to better promote the development of Internet information technology, strengthen the application of Internet information technology in social and economic life, and promote economic development, this paper puts forward the following policy suggestions:

First, increase investment in the construction of new information infrastructure. The state should increase capital investment, formulate new information infrastructure construction plans, and strengthen the infrastructure construction of Internet information technology and digital economy;

Second, formulate support and preferential policies and measures for Internet development. Introduce policies to support the development of the Internet, promote institutions, research institutes and enterprises to engage in basic research on Internet information, make breakthroughs in theory, and then promote the transformation from theory to application, so as to strive for more innovative results in the application of Internet information;

Third, increase the popularity of Internet information and digital economy. According to the needs of enterprises and individuals, lectures on the basic knowledge of Internet information technology and digital economy will be held regularly to better popularize relevant knowledge, so as to promote the public's understanding of Internet information technology and digital economy, strengthen their attention, and stimulate the public's application and innovation.

By strengthening the capital investment, relevant policy support and popularization of internet information and digital economy, we hope to promote the development of national internet information technology and digital economy and better serve the social and economic development.

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