A Study on the Impact of Technological Innovation Effect on Digital Finance in China

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Abstract: This paper uses provincial panel data from 2011-2020 and uses a fixed-effects model to study the impact of technological innovation on digital finance in China, both overall and across regions. The empirical results show that: first, the effect of technological innovation significantly improves the development of digital finance in China and provides a driver-type incentive effect on digital finance; second, there are differences in the impact of the development of digital finance on enterprise technological innovation in different regions. Based on the empirical analysis, this paper argues that the government and financial institutions should give full play to their roles and develop policy solutions related to technological innovation and digital finance to jointly promote the development of digital finance, and secondly, they should vigorously promote the technology innovation-driven development strategy and broaden the horizon of digital technology and financial development. The research in this paper enriches the research in the field of technological innovation effect and digital finance, which is important to promote the development of digital finance and help the economic quality growth.

1. Introduction

1.1 Background of the Selected Topic

In recent years, relying on the popularity of mobile Internet technology and the strong rise of emerging technologies such as big data and blockchain, China's digital economy has flourished. The financial sector has deepened the combination of finance and digital technology, and technological innovation has become an important driving force for the efficient development of the financial sector at present. Digital finance has emerged in response and has also gained rapid growth in recent years. At the end of 2021, the State Council issued the “14th Five-Year Plan for the Development of Digital Economy”, which scientifically drew a new blueprint for the development of China's digital economy during the 14th Five-Year Plan period, and clarified the guiding ideology, basic principles and development goals for promoting the healthy development of the digital economy. At the beginning of 2022, the digital transformation of the financial industry was further deepened with the issuance of two heavyweight guidance documents - the People's Bank of China's Financial Technology Development Plan (2022-2025) and the China Banking and Insurance Regulatory Commission's Guiding Opinions on the Digital Transformation of the Banking and Insurance Industry. have been issued to clarify further requirements and targets for the digital transformation of financial institutions. The Financial Technology Development Plan (2022-2025) states that it is necessary to deepen the digital transformation of the financial industry and fully release the potential of data elements in order to achieve the goals of improving service quality, strengthening financial supervision and achieving sustainable development. This undoubtedly reflects the importance of developing fintech from the policy aspect.

In the context of continuous technological innovation, the rapid development of information technology represented by big data, artificial intelligence, blockchain, etc., the new industry of digital finance can be continuously optimized and innovated with the help of big data and artificial

intelligence emerging technologies, which greatly break through the limitations of traditional finance, improve the efficiency of financial services and resource allocation, and optimize the financial structure, therefore, improving the level of science and technology and innovation capacity, promoting digital finance development is a necessary condition for building an innovative country.

1.2 Research Significance

With the arrival of the digital economy, the development of digital finance, which is a deep integration of finance and new technologies, is developing rapidly in China, breaking through the barriers of traditional financial services and playing an important driving role in high-quality economic development. The report of the 19th National Congress points out that innovation is the first driving force leading economic development and an important support to accelerate the transformation of economic development. In this context, it is of great practical significance and theoretical value how to improve technological innovation and better apply it to the development of digital finance, thus promoting the high-quality development of China's economy. Based on the panel data of 31 provinces in China from 2011 to 2020, this paper empirically examines the effect of the level of technological innovation on digital finance, with a view to providing reference and reference for further promoting technological innovation and digital finance development.

1.2.1 Theoretical Significance

At present, academic research on the impact of digital finance on technological innovation is more common, but the exploration of the impact of technological innovation on digital finance from the perspective of technological innovation is still in its initial stage. Therefore, based on the existing literature research, this paper changes the research perspective of the relationship between technological innovation and digital finance by cutting from the perspective of technological innovation, further enriching the interpretability of the theoretical relationship to reality, and providing a reference reference and expansion direction for the subsequent research.

1.2.2 Practical Significance

This paper adopts the empirical analysis method, based on the reading of relevant literature, and through the econometric model to study the effect of technological innovation on digital finance and the mechanism of its effect, which can help the relevant decision-making departments to introduce reasonable policies to improve the level of scientific and technological innovation, and improve the specific application measures of technological innovation in the field of digital finance in a targeted manner, which can provide decision-making reference for improving the level of scientific and technological innovation and promoting the development of digital finance It is also a guiding role and practical significance for improving the policies of science and technology innovation and digital finance development in China.

1.3 Research Content

Using data from 31 provinces in China from 2011 to 2020 as the research sample, this paper examines the promotion role and impact mechanism of technological innovation on digital finance through a panel's fixed-effects model. First, this paper selects four indicators to measure technological innovation from two perspectives of R&D input and technological output as the independent variables of this paper, and conducts regression analysis using time and region fixed-effects models to study their effects. Then, based on the regression analysis, robustness and endogeneity tests are conducted, and finally, conclusions and targeted recommendations are drawn.

2. Research Methodology

Based on the theoretical knowledge of statistics, quantitative economics and finance, this paper comprehensively and systematically investigates the effects of technological innovation on digital finance in China by using literature research method, qualitative analysis combined with quantitative analysis, and empirical analysis.

Literature research method: By reviewing and reading the literature written by domestic and foreign scholars, classifying, examining and analyzing articles and data tests and studying their results in depth, we study the relationship between technological innovation and numbers in depth on the basis of relatively mature theories and research methods. The literature is mainly from foreign language literature databases, web-based electronic materials such as Zhiwang, and books.

Qualitative analysis is combined with quantitative analysis. This paper uses qualitative analysis to define the concepts of digital finance and technological innovation, summarize the current situation of the development of digital finance and technological innovation, and generalize the laws of the development of digital finance in China. In terms of quantitative analysis, panel data of each province (municipality directly under the central government and autonomous region) and from 2011 to 2020 are used to determine relevant indicators, conduct descriptive statistical analysis on the level of technological innovation and other factors affecting digital finance in China, and use panel regression and other econometric methods to conduct empirical research and analysis to test the robustness and endogeneity of the model, and finally reveal the level of digital finance, technological innovation and other factors affecting digital finance in China. The model is then tested for robustness and endogeneity to reveal whether there are differences in digital finance, the level of technological innovation, and other factors affecting digital finance.

3. Data Sources and Descriptive Statistics

3.1 Data Source Pre-Processing

The data used in the article are mainly derived from three parts: first, the China Statistical Yearbook and the statistical yearbooks of each province; second, the statistical bulletin of national economic and social development of each province; and third, the Digital Inclusive Finance Index of Peking University published by the Digital Finance Research Center of Peking University. Taking data availability into account, this paper mainly selects panel data of 31 provinces (municipalities directly under the Central Government and autonomous regions) in China as the research samples to test the impact of technological innovation on digital finance, spanning the period of 2011-2020. The total index of digital inclusive finance is obtained from the Digital Inclusive Finance Index published by the Digital Finance Research Center of Peking University in previous years, the loan balance of financial institutions is obtained from the statistical yearbook of each province and the statistical bulletin of national economic and social development, and the remaining indicators are obtained from the China Statistical Yearbook.

In terms of data processing, due to the problems of large number of indicators and untimely data update, it is necessary to use Excel and other software to merge and pre-process some indicator data and provincial data.

3.2 Variable Description

3.2.1 Explanatory Variables

Digital Inclusive Finance Index (Dfin). As a product of the high integration of digital technology and financial market, the development of digital finance has broken through the barriers of traditional finance and has a significant role in advancing China's economic development. In response to the question of how to measure digital finance, domestic scholars have proposed different measurement methods. Guo Feng et al. (2020) from the Digital Finance Research Center of Peking University and the Ant Group Research Institute have jointly compiled a “Peking University Digital Inclusive Finance Index”, which covers 31 provinces (municipalities and autonomous regions) and 337 cities (regions and autonomous regions) above prefectural level in mainland China from three dimensions, including the breadth of digital finance coverage. The index includes digital financial inclusion indices of 31 provinces (municipalities directly under the central government and autonomous regions), 337 cities above the prefecture level (regions, autonomous regions, leagues, etc.), and about 2,800 counties (county-level cities, banners, municipal districts, etc.). In this paper, the digital financial index of each province (municipality directly under the

central government and autonomous region) is used as the explanatory variable.

3.2.2 Explanatory Variables

The explanatory variable in this paper is the level of technological innovation. The existing literature mainly measures the level of technological innovation from two perspectives of R&D input or technological output; this paper integrates two perspectives of R&D input and technological innovation: for the perspective of R&D input, this paper selects two indicators of R&D expenditure and full-time equivalent of R&D personnel; for the perspective of technological innovation, this paper selects two indicators of total number of patent applications and total number of patents granted. In order to eliminate the influence of data fluctuation, the above four indicators are logarithmically processed.

R&D expenditure. R&D expenditure refers to the social research and experimental development expenditure, i.e., the actual expenditure of the whole society on basic research, applied research and experimental development. Xia Yi et al. (2021) [1] used R&D expenditure as an indicator of science and technology innovation to study the impact of science and technology innovation on economic growth in Sichuan province.

The full-time equivalent of R&D personnel. full-time equivalent of R&D personnel refers to the sum of the workload of R&D full-time personnel and the workload of part-time personnel converted by working hours. Similar to R&D expenditure, it compares science and technology manpower input from the input perspective.

Total number of patent applications. The total number of patent applications refers to the number of patent applications submitted by the State Intellectual Property Office, and the examination results are not considered. The total number of patent applications directly reflects the level of technological innovation, and does not need to consider the impact of factors such as long cycle time on technological innovation.

Total number of patents granted. The total number of patent grants, compared with the total number of patent applications, reflects the level of technological innovation more strictly and precisely. Yang Nan, Wang Yixian et al. (2021) [2] used the number of patents granted as the level of technological innovation from the output perspective.

3.2.3 Control Variables

In addition to the core explanatory variables that the level of technological innovation has an impact on digital finance, there are many other factors that can have an impact on digital finance, and if these influencing factors are ignored, it will inevitably lead to biased results. Therefore, this paper controls for this part of factors. In this paper, we choose gross regional product per capita (rgdp), trade openness (OPEN), level of traditional financial development (TF), urbanization (UR), industrial structure (STRU), and foreign direct investment (FDI) as the control variables in this paper.

Gross regional product per capita (rgdp):The development of finance cannot be separated from the economy, and the development of high-quality finance requires the support of good economic conditions. Generally speaking, regions with fast economic development have faster digital technology updates and high digital finance indices. In this paper, we use the gross regional product per capita to measure economic development.

Openness to trade (OPEN): With the formation of globalization pattern, regions produce more competitive enterprises and services based on their comparative advantages, and achieve win-win situation through trade activities between regions, which in turn promotes the development of digital finance. For this indicator, this paper uses the ratio of total import and export to its GDP to express.

Level of traditional financial development (TF): Digital finance is based on the development of traditional finance, and obviously, the development of traditional finance will directly affect the development of digital finance. In this paper, the ratio of loan balance of financial institutions to their GDP in each region is used to indicate the level of traditional financial development.

Urbanization (UR): The urbanization rate is equal to the proportion of urban population to the

total population in a region. The higher the urbanization level reflects that the level of urban development in the region is much higher than that in rural areas, and the rural population migrates more to the cities, and thus the higher the digital finance index. In this paper, the proportion of urban population to total population is used to reflect the level of urbanization.

Industrial structure (STRU): According to existing research, the greater the proportion of output value of secondary and tertiary industries to GDP, the better the industrial structure. In this paper, the sum of the value added of the secondary and tertiary industries as a proportion of the regional GDP is chosen to measure the industrial structure.

Foreign direct investment (FDI): the continuous inflow of FDI inevitably provides funds for regional development, in addition, it can also influence digital financial development through the path of absorbing advanced technology and knowledge sharing. In this paper, with reference to existing studies, to eliminate the influence of exchange rate and other factors, the actual FDI amount is converted into RMB and then divided by the regional GDP to measure it.

3.3 Descriptive Statistics

Table 1 Variables and Meanings

Variable type	Variable name	Variable symbol	Variable definition
Explained variables	Total Digital Inclusive Finance Index	Dfin	Peking University Total Digital Inclusive Finance Index
Explanatory variables	R&D funding	X1	Costs for internal R&D activities are taken as natural logarithm
	R&D personnel full time equivalent	X2	The sum of full-time personnel plus part-time personnel converted to full-time personnel based on workload is taken as the natural logarithm
	Total number of patent applications	X3	The total number of patents filed by enterprises in the year is taken as the natural logarithm
	Total number of patents granted	X4	The total number of patents granted in the year is taken as the natural logarithm
Control variables	Per capita gross regional product	rgdp	GDP per region / number of people per region
	Trade Opening	OPEN	Total import and export /GDP
	Traditional Financial Development	TF	Loan balance of financial institutions by region /GDP
	Urbanization	UR	Urban population/total population
	Industrial Structure	STRU	Value added of secondary and tertiary industries /GDP
	Foreign Direct Investment	FDI	(Actual foreign direct investment in each city * exchange rate of the year)/ GDP

Table 2 Descriptive Statistics of Variables

Variable	Sample size	Mean	SD	Max	Min
y	310	216.235	97.03	431.928	16.22
X1	310	14.129	1.703	17.034	7.401
X2	310	10.43	1.707	13.459	3.091
X3	310	10.573	1.59	13.782	5.136
X4	310	9.964	1.62	13.473	4.796
rgdp	310	5.545	2.735	16.489	0.075
FDI	310	0.493	1.958	34.22	0.05
OPEN	310	268.105	455.301	2396.98	0
UR	310	0.579	0.132	0.89	0.23
TF	310	1.473	1.029	17.48	0.66

The variables and their meanings are shown in Table 1. According to Table 2, the mean value of the explanatory variable digital finance index Y is 216.235, the standard deviation is 97.03, and the maximum value is 431.928, indicating that the level of digital finance in each province achieves leapfrog development in 2011-2020, and the uneven development of digital finance in each province is more serious, with large differences and significant regional differentiation characteristics. For the explanatory variables, i.e., the four indicators reflecting the level of technological innovation: R&D expenditure, full-time equivalents of R&D personnel, total number of patent applications, and total number of patents granted, the analysis finds that the maximum and minimum values differ greatly, and the standard deviation values are large, indicating that for each province (municipality directly under the Central Government and autonomous region), the R&D expenditure, full-time equivalents of R&D personnel, total number of patent applications, and total number of patents granted all have The differences are large.

4. Results of the Empirical Analysis

4.1 Benchmark Model

To estimate the impact of technological innovation on digital finance, a benchmark econometric model is adopted in this paper and the regression model is set as follows:

$$Y = \mu_t + \nu_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + X_i + \varepsilon_{it}$$

Where Y is the explanatory variable of this study, measuring the level of digital financial development, expressed using the total digital financial inclusion index. (j=1,2,3,4) is the explanatory variable of this study, which measures the level of technological innovation. represents R&D expenditure (million yuan), represents R&D personnel full-time equivalent (10,000 person-years), represents total number of patent applications (one), and represents total number of patents granted (one). The control variables are: regional GDP per capita (rgdp), trade openness (OPEN), traditional financial development (TF), urbanization (UR), industrial structure (structure), foreign direct investment (FDI), and individual fixed effects and time fixed effects, respectively, and random error terms, where denotes province and year.

4.2 Baseline Regression Results

In this paper, the panel data of 31 provinces (autonomous regions and municipalities directly under the central government) in China from 2011 to 2020 are used to determine whether the above-mentioned model is set up using a fixed-effects model or a random-effects model through a Hausman test model before conducting the baseline regression estimation. In most of the current studies, the fixed-effects model is more commonly used, but for the rigor of the argument, a rigorous Hausman test is conducted on the data to determine which model to use for the empirical study. The original hypothesis can be set as ": individual effects are not correlated with other explanatory variables, i.e.: the random effects model is the correct model", and the Hausman test is conducted, and the results show that the original hypothesis is rejected based on the results showing that the p-value is 0, which passes the 1% level of significance test. Rejecting the original hypothesis that rejects the individual effect is not correlated with the explanatory variables, so the fixed effect model is used in this paper. Table 3 reports the regression results of the impact of technological innovation on digital finance in each province (municipality and autonomous region).

Table 3 Regression Results of the Impact of Technological Innovation on Digital Finance

	y
X1	39.72***
	(2.94)
X2	-23.27**
	(-2.47)
X3	31.48***
	(2.86)
X4	19.37*
	(1.76)
rgdp	7.596***
	(3.06)
FDI	-0.617
	(-0.68)
OPEN	-0.0517***
	(-6.80)
UR	979.2***
	(9.80)
TF	1.436
	(0.78)
structure	-255.1*
	(-1.67)
_cons	-995.3***
	(-6.45)

Note: The observed values are n=310, ***, ** , * indicate significant at 1%, 5%, 10% significance level respectively.

From the estimation results in Table 3, the coefficient estimates of the explanatory variables (X1, X2 and X3) are 39.72, 31.48, and 19.37, respectively, and pass the significance level tests of 1%,

1%, and 10%, respectively, which indicate that R&D funding, total patent applications, and total patents granted can significantly contribute to the development of digital finance. The coefficient estimates of 39.72 and 19.37 indicate that, in comparison, R&D expenditure has the most significant effect on the development of digital finance, and the total number of patents granted has the least significant effect on the development of digital finance.

However, the coefficient of the explanatory variable is estimated at -23.27 and passes the 5% significance level test, which indicates that the full-time equivalent of R&D personnel has a depressing effect on digital finance development. This may be due to the following: on the one hand: according to Lucas' endogenous growth model, the externalities of innovation will make the private returns to investment in scientific and technological human capital lower than the social returns due to the positive externalities and spillover effects of technological innovation activities or human capital. The positive externality of R&D personnel full-time equivalent is an indicator used to measure the investment in scientific and technological manpower, which makes the private return lower than the external return, which is not conducive to the long-term development of innovative enterprises and thus inhibits the development of digital finance. On the other hand, due to the strong guiding role of the government, the government plays a dominant role in the resource allocation of S&T human capital investment. [3] However, due to the constraints of market failure and other factors, public sector decisions may not be in line with market development, resulting in the investment of science and technology human capital that is not in line with the need for optimal market choice. This will result in the input of science and technology human capital not achieving the expected results, i.e., the input is not proportional to the output, which in turn acts as a disincentive for digital finance. [4]

4.3 Multicollinearity Test

In general, when the number of explanatory variables in a model is large, a high degree of correlation between variables may occur, i.e., multicollinearity. To test for multicollinearity among the variables, the VIF value test is its common detection method. Table 4 reports the results of the multicollinearity test for each explanatory variable. The results show that the average VIF (variance inflation factor) value among the explanatory variables is 27.31, and the problem of multicollinearity exists, but it is not serious, and for the purpose of causality inference, this paper considers that the multicollinearity test is passed.

Table 4 Multicollinearity Test

Variable	VIF	1/VIF
X4	76.200	0.013
X3	72.360	0.014
X1	57.930	0.017
X2	48.430	0.021
UR	6.040	0.165
rgdp	5.620	0.178
structure	2.470	0.405
OPEN	1.610	0.620
TF	1.270	0.785
FDI	1.110	0.903
Mean VIF	27.310	

4.4 Endogeneity Test

In the above estimation, although this paper controls for other variables affecting digital finance, the impact of technological innovation on digital finance is likely to be endogenous due to some unobservable factors, leading to biased results. On the one hand, there may be a reverse causality between technological innovation and digital finance, i.e., technological innovation drives the development of digital finance, while digital finance also promotes the improvement of technological innovation. On the other hand, although this paper controls for other variables affecting digital finance, the factors affecting digital finance are multifaceted, so the above model is

likely to have omitted factors, which will lead to bias in the results.

First, the panel fixed effects themselves address the endogeneity of the omitted variables. In addition, the instrumental variables approach is used to further reduce the interference of endogeneity. In this paper, drawing on the ground approach of Sun Churin (2015), the one-period lagged variables of the core explanatory variables are used as instrumental variables to circumvent endogeneity.

Table 5 Endogeneity Test Results

	(1)	(2)	(3)	(4)
	y	y	y	y
X1	32.58**	31.69**	21.42**	18.19*
	(2.52)	(2.10)	(1.97)	(1.65)
X2	-84.25***	-86.90***	-77.27***	-74.77***
	(-7.25)	(-5.93)	(-7.68)	(-7.45)
X3	2.738	7.545	21.64	-18.45
	(0.22)	(0.59)	(1.19)	(-0.96)
X4	63.54***	62.37***	49.08***	89.31***
	(5.06)	(4.96)	(2.83)	(4.42)
rgdp	3.330*	2.842	3.005	2.301
	(1.65)	(1.38)	(1.46)	(1.10)
FDI	-0.253	-0.649	-0.591	-0.618
	(-0.22)	(-0.56)	(-0.51)	(-0.53)
OPEN	-0.0815***	-0.0815***	-0.0835***	-0.0849***
	(-11.78)	(-11.16)	(-12.22)	(-12.42)
UR	205.1***	226.7***	239.5***	238.5***
	(4.47)	(4.66)	(5.14)	(5.17)
TF	2.122	1.476	1.810	1.158
	(0.88)	(0.62)	(0.76)	(0.48)
structure	21.89	19.96	6.326	32.37
	(0.29)	(0.25)	(0.08)	(0.41)
_cons	-155.3**	-161.3*	-129.2*	-104.1
	(-2.01)	(-1.87)	(-1.68)	(-1.36)
N	279	279	279	279

Note: ***, ** , * denote significant at 1%, 5%, and 10% significance levels, respectively, and the values in parentheses are t-statistics.

Based on the endogeneity issue consideration, columns (1)-(4) are regressed with the lagged one-period variables of X1, X2, X3, and X4 as the instrumental variables in turn. From the regression results, it can be seen that for columns (1)-(4) all satisfy the following conclusions: the regression coefficients of R&D funding and total patent grant are still greater than zero and pass the significance test, indicating that both R&D funding and total patent grant significantly promote the development of digital finance, and this test result is consistent with the significance and sign direction of the regression coefficients mentioned above. full time R&D personnel The regression coefficients of full-time equivalents of R&D personnel are still smaller than zero and pass the significance test, indicating that full-time equivalents of R&D personnel have a suppressive effect on digital finance, which is consistent with the above regression findings. However, although the regression coefficient of total patent applications does not pass the significance test, since total patent applications is the core indicator of technological innovation from the perspective of output and plays a decisive role in this study, the indicator of total patent applications is still retained in this paper.

4.5 Robustness Test

The common methods for robustness testing include split-sample regression, variable replacement, and exclusion of special samples. In this paper, we adopt the combination of split-sample regression method and special sample exclusion method, i.e., we adopt the robustness test of data exclusion sub-sample: firstly, we divide 31 provinces (autonomous regions and municipalities directly under the central government) into eastern, central and western provinces

according to the official criteria, and then we exclude one province from the eastern, central and western regions respectively, and after comparison and analysis, we finally choose to exclude Fujian Province from the eastern region, Inner Mongolia Autonomous Region from the central region and Ningxia Hui Autonomous Region from the western region. After comparing and analyzing the data, the eastern region excluding Fujian Province, the central region excluding Inner Mongolia Autonomous Region, and the western region excluding Ningxia Hui Autonomous Region were selected.

Tab.6 Robustness test results

	(1)
	y
X1	45.80**
	(3.32)
X2	-27.28**
	(-2.81)
X3	28.59*
	(2.45)
X4	24.85*
	(2.18)
rgdp	7.093**
	(2.79)
FDI	-0.759
	(-0.83)
OPEN	-0.0522***
	(-6.72)
UR	969.4***
	(9.39)
TF	0.901
	(0.48)
structure	-277.5
	(-1.75)
_cons	-1035.2***
	(-6.57)
N	280

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively, and the values in parentheses are t-statistics.

As can be seen from Table 6, the regression coefficients of R&D funding, total patent applications, and total patents granted are still greater than zero and pass the significance test, indicating that R&D funding, total patent applications, and total patents granted have significant positive effects on the development of digital finance, and the regression coefficients of full-time equivalents of R&D personnel are still less than zero and pass the significance test, indicating that full-time equivalents of R&D personnel have This test result is consistent with the significance and sign direction of the above regression coefficients. The regression results in Table 6 are still consistent with those in Table 3, indicating the robustness of the empirical results in Table 3.

5. Conclusions and Policy Recommendations

5.1 Research Conclusion

This paper constructs a fixed-effects model with the panel data of 31 provinces (municipalities directly under the Central Government and autonomous regions) in China from 2011 to 2020 as a sample for empirical research, focusing on the impact of technological innovation on the level of digital finance development, and finally obtains the following conclusions.

First, technological innovation plays a significant positive role in the development of digital finance. In general, technological innovation and digital finance are closely linked, and technological innovation acts on finance and promotes the development of digital finance.

Second, in terms of each indicator measuring the level of technological innovation, R&D

funding, total patent applications, and total patents granted have a significantly positive effect on the level of digital finance development, while R&D personnel full-time equivalent has a suppressive effect on digital finance development. This is mainly due to the positive externalities of technology human capital and the fact that the investment in technology human capital does not necessarily meet the need for optimal market choice. In addition, R&D funding has a greater contribution to the development of digital finance than total patent applications and total patents granted. This suggests that increased R&D investment may be more likely to promote the development of digital finance compared to technological output.

5.2 Policy Recommendations

Based on the main findings of the study, this paper puts forward the following policy recommendations for technological innovation to better serve the development of digital finance in China.

First, actively promote the transformation of technological innovation results. Guide the transformation of technological innovation results into real productivity, which in turn will play a boosting role in the development of digital finance. Strengthen policy leadership and cooperation, increase policy implementation, and government departments should actively promote policy implementation and refine relevant guidelines to ensure that the work is put into practice. In addition, improve the evaluation mechanism of scientific and technological achievements, break down the barriers to the transformation of innovative achievements, stimulate the vitality of researchers, and further promote the transformation of scientific and technological achievements.[5]

Second, continuously improve the efficiency of technology resource allocation. The public sector should start from the market itself, determine the intensity of science and technology investment that corresponds to the level of market development and the related standards, and realize the demand of science and technology capital investment to meet the optimal market choice. Not only that, in response to the problem of high input and low output of some innovation research, resource allocation efficiency should be improved to reduce ineffective inputs and maximize benefits.

Thirdly, to realize the positive driving effect of technological innovation on digital finance. Vigorously develop the role of technological innovation in improving and advancing the financial system and financial system at the macro level. Accelerate the development and layout of the Internet, big data and other emerging technologies to lay a good technical foundation for the development of digital finance. Deepen the application of artificial intelligence, big data and other emerging technologies in government supervision and service platforms, and promote the transformation of financial services into technology.

Fourth, establish a sound digital financial regulatory system. Regulators can leverage digital technology to improve the digital financial regulatory system and ensure the healthy development of digital finance within a safe zone. Of course, it is also necessary to avoid excessive regulation causing obstacles to development, and should creatively find suitable methods to achieve regulatory purposes.

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