Financial Technology and the Economic Performance of High-tech Industries: A Comprehensive Research based on Econometric Model

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Abstract. High-tech industries play a pivotal role in driving the high-quality economic development of contemporary China. Financial technology, characterized by innovation as its core driver, offers indispensable support and strategic direction for the advancement of high-tech industries. Applying the Peking University Digital Financial Inclusion Index from 2011 to 2020, this paper explores the correlation effects of financial technology on the economic performance of high-tech industries (EPHI). The result reveals that: (1) digital finance enhances EPHI. (2) in terms of decomposition terms, both the coverage breadth and usage depth of digital finance have a significant positive impact on EPHI. (3) reginal heterogeneity studies show that digital finance increases EPHI in developed provinces more significantly. (4) technology innovation plays a part in mediating the process of digital finance to enhance EPHI. This paper adds new empirical evidence to the long-term government policy for the development of high-tech industries.

Keywords: Digital Finance; High-tech Industries; Firm Performance; Technological Innovation.

1. Introduction

In the process of promoting the high-quality development of the Chinese economy, the high-tech industry plays a crucial role in the ecosystem. Due to its reliance on technological research achievements, it possesses advantages in product manufacturing and services, such as minimal resource consumption and high added value. This facilitates structural transformation and upgrading of enterprises, providing new opportunities for the revitalization of traditional industries. Consequently, it becomes a significant driver of future national economic and social development.

Given the aforementioned significance, in recent years, the country has increased its investment in the research and development of the high-tech industry. According to data released by the National Bureau of Statistics, the total investment in research and experimental development in China reached 3.087 trillion yuan in 2022, a growth of 10.4% compared to the previous year. It has maintained double-digit growth for seven consecutive years since the "13th Five-Year Plan." However, the output level of technological product in the high-tech industry remain relatively low due to regional development imbalances, the impact of the COVID-19 pandemic and the lack of efficiency (Fan, 2020)[1]. Therefore, it is crucial and urgent to strengthen the output achievements of China's high-tech industry, identify the factors influencing its economic development, and continuously improve the production efficiency of it.

Financial technology is an essential component of constructing a digital China. As an innovative achievement China's financial sector, financial technology addresses issues such as the incomplete transmission mechanism and inefficient resource allocation in traditional financial industries. Through deep integration with modern technology, financial technology impacts the scale and efficiency of enterprises indirectly. Consequently, it propels the convergence and upgrading of industries.

In order to promote the development of high-tech enterprises, it is necessary to make full use of financial technology as a core element to make breakthroughs in technological transformation and equipment upgrading. A comprehensive clarification of the relationship between financial technology and EPHT can provide a deeper identification and understanding of the economic effectiveness of

financial technology in today's digital era, and provide a brand-new path for China's high-quality economic development.

Existing studies have mainly theoretical explored the impact of financial technology (Liu, 2019)[2] or the relationship between financial technology and economic development (Liu, 2021)[3]. However, there is relatively little literature on the study of financial technology on the development of high-tech industry. Therefore, this paper aims to make contribution in the following aspects: first, using the Peking University Digital Financial Inclusion Index and the economic performance of high-tech industries as indicators, this paper constructs an empirical analysis model to explore the promoting effect of financial technology on the development of high-tech industries. This paper is innovative in choosing the economic performance as an index of high-tech industry development. Second, different from many contemporary theoretical researches, this paper also explores the structural and regional heterogeneity of the model. Third, with technological innovation as a moderating factor, this paper aims to explore the mechanism of financial technology to promote the EPHT. This paper expands the research on financial technology and the development of high-tech industries, provides important insights for subsequent studies in terms of evaluation indicator, and offers important references for the formulation of government policies to promote high-tech industry development.

2. Literature Review and Theoretical Analysis

2.1 Impact of Financial Technology on Business Development

Research has shown that financial technology not only promotes the high-quality development of state-owned enterprises, but also provides important support and assistance for the development of non-state-owned enterprises (Wang, 2023)[4]. By gradually easing financing constraints, financial technology can provide effective financial support for underinvested enterprises (Wang, 2020)[5]. Moreover, with the rapid development of financial technology products, big data and blockchain can effectively solve the problem of information asymmetry therefore control the cost of enterprise information collection and exchange. Through the promotion of the bank credit scale, financial technology can also effectively weaken the enterprise motivation for risk avoidance(Li, 2023)[6].

2.2 Impact of Financial Technology on EPHT

It has been found that financial technology is closely related to the development of high-tech industries. According to Liu (2021)[7], technological innovation is the foundation of the development of high-tech industries. However, technological innovation requires a large amount of manpower, material and financial resources, and the process is long-period and high-risk. To meet this demand, financial technology plays an important role in pooling important production factors such as capital, talent and technology, which largely reduces the R&D risks of high-tech enterprises and promotes their technological innovation. Therefore, this paper proposes hypothesis 1:

Hypothesis 1: Financial technology can improve EPHT.

Financial technology includes three sub-dimensions of coverage breadth, usage depth and digitization level, which may have different degrees of impact on EPHT. Wu(2022)[8] has shown that coverage breadth and usage depth significantly inhibit the growth of total environmental productivity, while the effect of digitization level on total environmental productivity is not significant. In addition to this, Wang et al. (2020)[9], in their study of the impact of financial technology on the real economy, points out that coverage breadth and usage depth have a positive and significant impact on the development of the real economy in China, while digitization level had no significant impact. Based on the above analysis, this paper proposes hypothesis 2.

Hypothesis 2: There are structural differences between the three sub-dimensions of financial technology to promote EPHT.

At the same time, China is a vast country with significant differences in geographic location, cultural conditions, and economic resources among regions, resulting in imbalanced foundational elements for financial technology to develop. Studies have shown that the development of financial

technology shows a stepped quality from the southeast coast of China to the inland areas in the west (Guo et al., 2020)[10]. As a result, this paper puts forward hypothesis 3.

Hypothesis 3: There is regional heterogeneity for financial technology to promote EPHT due to provincial development level.

2.3 The Mechanism of the Influence of the Financial Technology on EPHT

On the one hand, Tang (2020)[11] has found that financial technology can provide companies with quality information that help them to quickly identify the optimal path for technological innovation and thus make rational and efficient decisions. In addition, financial technology can effectively promote technological innovation because it significantly improves the risk-taking level of firms (Zhang, 2023)[12]. Therefore, it can be inferred that firms that value technological innovation may have more inclination and dependence on financial technology.

On the other hand, technological innovation has an incentive effect on the development of high-tech industries. Pu (2023)[13] has found that the improvement of firms' innovation capability can improve the proficiency of employees and reduce production costs in the long run, which in turn increases the profits of high-tech enterprises. Technological innovation also can significantly affect the market value of firms through promoting digital transformation, improving production and operational efficiency, and increasing market profitability (Tao, 2023)[14].

Thus, it can be seen that financial technology may promote the development of high-tech industry to a greater extent under the moderating effect of technological innovation. Consequently, hypotheses 4 is formulated as follows:

Hypothesis 4: Corporate technology innovation positively moderates the driving effect of financial technology on EPHT.

The research framework of this study is shown in Fig. 1.

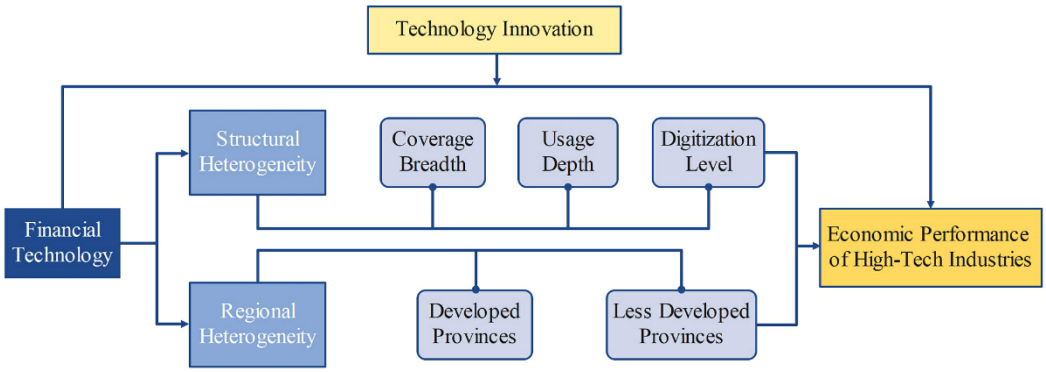

Fig 1. The research framework of finance technology and EPHT

3. Research Design

3.1 Model Construction

3.1.1 Benchmark Regression Model

To examine the impact of financial technology on China's high-tech industry, this paper will construct a panel fixed effects model as shown in equation (1):

$$Revenue_{it} = \alpha_0 + \alpha_1 DIF_{it} + \sum a_j Control_{jit} + \mu_i + v_t + \varepsilon_{it} \quad (1)$$

In the given model (1), $Revenue$ is the income from the main business, which represents EPHT, while DIF is the crucial coefficient associated with the digital finance index, and refers to financial technology. $Control$ serves as control variables, μ_i denotes the province dummy variable, v_t is the time dummy variable, and ε_{it} refers to the random error term.

3.1.2 Moderating Effect Model

To examine the moderating role of corporate technological innovation in the process of financial technology driving EPHT, this study establishes a moderation effect model, as depicted in equation (2).

$$Revenue_{it} = \alpha_0 + \alpha_1 DIF_{it} + \alpha_2 DIF_{it} \times Innovation_{it} + \sum a_j Control_{jit} + \mu_i + \nu_t + \varepsilon_{it} \quad (2)$$

Where, $Revenue$ is the dependent variable EPHT, DIF is the core explanatory variable financial technology. $Innovation$ acts as the moderating variable, and the control variables and their coefficients are included. Additionally, the fixed effects of provinces, fixed effects of years, and the random error term are considered.

3.2 Variable Selection

3.2.1 Explained Variable

Based on previous research (Cai, 2019)[15], this study adopts the main operating revenue, which reflects the fundamental information of a company's operating conditions, as an indicator of its operational performance, EPHT.

3.2.2 Explanatory Variable

This study utilizes the Digital Inclusive Finance Index (DIF) to assess the level of development in financial technology. Apart from *Index_Aggregate*, this study also examines three specific sub-indicators: *Coverage_Breadth*, *Usage_Depth*, and *Digitalization_Level* to further investigate the impact of financial technology on EPHT across different dimensions.

3.2.3 Control Variables

The development of the high-tech industry relies on technological advancements as its foundation, and its emergence and growth possess distinctive characteristics and patterns, making it susceptible to various and complex factors. This article refers to relevant research practices and selects the following controlled variables:

(1) *Regional economic development* ($Lpgdp$): The natural logarithm-transformed per capita regional GDP. Given the high costs, risks, and potential returns associated with the high-tech industry, its development necessitates a certain level of economic foundation. Regions with higher levels of economic development possess greater resources to propel the advancement of the high-tech industry.

(2) *Labor costs* ($Wage$): The natural logarithm-transformed average wage level of employed personnel. On the one hand, high labor costs may prompt the economy to transition from traditional industries to higher value-added and technology-intensive sectors, encouraging businesses to invest in more competitive and innovative areas, thereby driving the development of the high-tech industry. On the other hand, high labor costs may impose greater cost pressures on high-tech enterp rises, potentially inhibiting their economic performance.

(3) *Infrastructure construction* ($Density$): The natural logarithm-transformed railway density, calculated as the ratio of the total operational railway mileage to the land area of each province. Railway density reflects the coverage and development level of a region's railway network, indicating its transportation capacity, connectivity, investment, and technological support, among other aspects. Provinces with higher railway density may provide a stronger economic foundation and infrastructure support for the development of the high-tech industry.

(4) *Degree of openness to foreign trade* ($Open$): The natural logarithm-transformed ratio of total trade volume to regional GDP. The intensity of competition in the international trade market can influence the extent to which domestic enterprises are willing to invest resources in the development of the high-tech industry.

3.2.4 Moderating Variables

In order to delve into the intrinsic mechanisms through which financial technology drives the economic performance of the high-tech industry, this study introduces the innovation development level of businesses in each region (*Innovation*) as a moderating variable, utilizing the number of patent applications and grants as the measuring tool for this parameter. When enterprises possess notable technological innovation advantages, the integration of financial technology with technical innovation in domains like research and development, product design, and market competition becomes more effective, thus facilitating the economic advancement of the high-tech industry.

3.3 Data Sources and Descriptive Statistics

This study's research data can be divided into two main parts. Firstly, for the core explanatory variables, the study utilizes the Peking University Digital Financial Inclusion Index and its corresponding three sub-dimensions to measure the level of financial technology development. Secondly, the data for the dependent variables, controlled variables, and moderating variables are sourced from the EPS database and the *China Statistical Yearbook*. After collecting and cleaning the data, this study selects panel data from 31 provinces in mainland China from 2011 to 2020 as the sample for analysis. Table 1 shows descriptive statistics.

Table 1. Descriptive statistics of variables

Variable	Obs	Mean	Std.dev.	Min	Max
Revenue	310	7.206	1.848	1.649	10.823
Index_Aggregate	310	5.212	0.677	2.786	6.068
Coverage_Breadth	310	5.060	0.844	0.673	5.984
Usage_Depth	310	5.195	0.651	1.911	6.192
Digitization_Level	310	5.510	0.677	2.026	6.136
Lpgdp	310	10.827	0.439	9.706	12.013
Wage	310	11.035	0.338	10.351	12.091
Density	310	5.235	1.001	1.404	6.956
Open	310	-1.820	0.967	-4.883	0.437
Innovation	310	9.964	1.620	4.796	13.473

4. Empirical Results Analysis

4.1 Baseline Regression Results

Table 2. Baseline regression results

Variables	(1) Without Control Variables	(2) With Control Variables
Index_Aggregate	0.719*** (4.740)	0.593***(4.339)
Lpgdp		1.563***(9.230)
Wage		-1.625***(-3.695)
Density		0.541***(2.731)
Open		0.0508(0.859)
Province and year FE	Yes	Yes
Constant	4.036***(7.382)	2.695(0.629)
R^2	0.551	0.674
Obs	310	310

Note: The values in parentheses are t-statistics, with *, **, and *** indicating significance at the 10%, 5%, and 1% levels, respectively. For consistency, the p-value retains only two decimal places, and the same below.

To examine the correlation among these factors, we conducted a regression analysis employing the Ordinary Least Squares (OLS) method for estimation. The results for the impact of financial technology on EPHT are presented in Table 2.

The results indicate that the aggregate index of financial technology has a positive and significant impact on EPHT, confirming *H1* of this study. Specifically, for 1% increase in the overall index of financial technology, EPHT increases by 59.3%, revealing the tremendous momentum that financial technology brings to the development of high-tech industries. As for control variables, economic development and the state of infrastructure can also enhance EPHT at an equivalent level of significance. However, the rising labor costs impose negative pressure on high-tech industries.

4.2 Heterogeneity Testing

4.2.1 Structural Heterogeneity

Financial technology exhibits structural differences in driving EPHT across the three sub-dimensions. This study conducts regression analyses with each of them respectively as independent variables. The results are presented in Table 3.

The results demonstrate that both *Coverage_Breadth* and *Usage_Depth* significantly enhance EPHT at the 1% level, with the coefficient of 0.230 and 0.529 respectively. This indicates that the impact of *Usage_Depth* on EPHT is significantly stronger than that of *Coverage_Breadth*, which is likely due to the resource dispersion associated with the *Coverage_Breadth*, while *Usage_Depth* enables the development of intelligent and personalized financial products to meet the specific needs of high-tech industries. However, *Digitalization_Level* does not exhibit a significant impact on EPHT. This may be attributed to the high costs associated with digital transformation. Consequently, the influence of financial technology on the EPHT plays structural differences, thus validating *H2*.

Table 3. Structural heterogeneity testing results

Variables	(1) *Index_Aggregate*	(2) *Coverage_Breadth*	(3) *Usage_Depth*	(4) *Digitization_Level*
DIF	0.593***(4.339)	0.230***(4.116)	0.529***(5.136)	-0.383***(-4.126)
Control	Yes	Yes	Yes	Yes
Province FE Year FE	Yes Yes	Yes Yes	Yes Yes	Yes Yes
Constant	2.695(0.629)	4.415(1.009)	-0.238(-0.057)	2.383(0.555)
R^2	0.674	0.672	0.683	0.672
Obs	310	310	310	310

4.2.2 Regional Heterogeneity

To examine the regional differences in EPHT driven by financial technology, this study defines the development levels of each province. Drawing upon existing literature (Li, 2023)[16], the average per capita GDP of each province for the period 2011 to 2020 is ranked from highest to lowest, and the province that corresponds to the median value is chosen as the threshold for classification. Specifically, provinces with a GDP above the median are classified as developed provinces, while those below are categorized as underdeveloped provinces. The regression results based on this classification can be found in Table 4.

Through regional analysis, it becomes evident that financial technology significantly drives EPHT in developed provinces, with a coefficient of 0.543 and a significance level of 5%. However, the counterpart in underdeveloped provinces shows no significant impact on EPHT. This is probably because developed provinces have more robust innovation ecosystem, greater investment in research and development, and supportive technology policies. Hence, the influence of financial technology on EPHT exhibits regional variations, confirming *H3*.

Table 4. Regional heterogeneity testing results

Variables	(1) Developed Provinces	(2) Underdeveloped Provinces
Index_ Aggregate	0.543**(2.157)	0.320(1.284)
Control	Yes	Yes
Province and year FE	Yes	Yes
Constant	-14.24(-1.254)	10.71**(2.278)
R^2	0.568	0.770
Obs	150	160

4.3 Robustness Test

The present study employed three different approaches to examine the robustness of the regression results.

4.3.1. Alternative Variable Approach

To effectively evaluate the validity and robustness of the model, this paper conducts a test to alleviate the potential endogeneity issues. Considering the delayed impact of financial technology development and the potential reverse causality between financial technology and EPHT, this study replaces the core explanatory variable with its lagged counterpart. The regression results, as presented in Table 5 (1), demonstrate that the impact of financial technology on the EPHT is statistically significant at the 1% level, indicating a certain level of robustness in these findings.

4.3.2. Instrumental Variable Approach

Considering other endogeneity issues such as missing variables, this study draws insights from the research conducted by Tang (2020) and Xie (2023)[17]. It employs the number of internet ports, as released by the National Bureau of Statistics, as an instrumental variable to conduct a 2SLS regression for measuring the development of digital finance.

On the one hand, the number of internet ports serves as a reflection of the extent of internet penetration, encompassing a more macroscopic concept. As individual enterprises, their economic performance is unlikely to influence the level of internet penetration. On the other hand, the widespread adoption of the internet provides digital finance with broader application scenarios and underlying infrastructure, establishing a direct positive correlation between the two factors. Hence, the number of internet ports is considered a suitable instrumental variable.

The results from regression (2) in Table 5 indicate that the Cragg F-statistic is 28.696, surpassing the critical value of 16.38 at a significance level of 10%. Consequently, the null hypothesis regarding weak instrumental variables is rejected. Furthermore, the p-value of 0.000 demonstrates the significance of the results, which lends robustness to this conclusion.

4.3.3. Sample Exclusion Approach

Table 5. Robustness test results

	(1) Alternative variable approach	(2) Instrumental variable approach	(3) Sample exclusion approach
Index_Aggregate	0.630***(4.601)	1.907***(4.065)	0.556***(3.451)
Control	Yes	Yes	Yes
Province and year FE	Yes	Yes	Yes
Constant	3.230(0.697)	8.139(1.543)	5.611(1.225)
Cragg		28.770	
R^2	0.600	0.979	0.675
Obs	279	310	270

Considering the unique status of direct-administered municipalities nationwide, these cities are typically regarded as centers of technological development and receive special support policies compared to ordinary cities. Therefore, this study further excludes samples from direct-administered municipalities and estimates equation (1) based on the adjusted sample. The results, with a coefficient of 0.556 and a significance level of 1% as shown in Table 5(3), also demonstrate the robustness of the baseline regression.

5. Mechanism Analysis

The previous research has proved that financial technology can drive EPHT. Based on the results of the heterogeneous regression, we further investigate the boundary conditions that shape the relationship between financial technology and the development of high-tech industries, using the level of innovation development as a moderating variable. The results of this analysis are presented in Table 6.

Result (1) indicate that, even after introducing the interaction terms, the main effect of the overall financial technology index remains significantly positive. Furthermore, the interaction between *Innovation* and *Index_Aggregate* is also positive and passes the significance tests at the 1% and 10% levels respectively. These findings suggest that technological innovation plays a positive moderating role in the process financial technology driving EPHT, thereby supporting *H4* of this study.

From a dimensional perspective, when *Usage_Depth* is used as the independent variable in result (3), the regression finding is same as result (1). This indicates that technological innovation positively moderates the influence of *Usage_Depth* on EPHT. However, this positive moderating effect is not evident in the dimensions of *Coverage_Breadth* and *Digitalization_Level.*

These findings suggest that technological innovation primarily moderates the relationship between financial technology and EPHT in terms of *Usage_Depth*, while its moderating effect on *Coverage_Breadth* and *Digitalization_Level* dimensions is limited. This could be attributed to the fact that, at a high level of technological innovation, companies continuously explore and develop new technological solutions, enabling in-depth analysis and specialized exploration of financial services, thus maximizing the potential of *Usage_Depth* in financial technology to promote EPHT.

Table 6. Moderating effect results

Variables	(1) *Index_Aggregate*	(2) *Coverage_Breadth*	(3) *Usage_Depth*	(4) *Digitization_Level*
DIF	0.486*** (3.229)	0.123 (1.334)	0.391*** (3.040)	-0.484*** (-3.138)
DIF × *Innovation*	0.0227* (1.673)	0.0174 (1.447)	0.0246* (1.769)	0.00962 (0.824)
Control	Yes	Yes	Yes	Yes
Province FE *Year FE*	Yes Yes	Yes Yes	Yes Yes	Yes Yes
Constant	2.922 (0.684)	4.773 (1.091)	-0.229 (-0.055)	2.386 (0.556)
R^2	0.678	0.675	0.686	0.673
Obs	310	310	310	310

6. Conclusion and Policy Recommendations

This study employs panel data from 31 provinces in China spanning from 2011 to 2020. Using econometric models, it empirically investigates the impact of financial technology on EPHT and explores the transmission mechanisms. The main conclusions are as follows: (1) The overall index of financial technology drives EPHT. The robustness tests, including alternative variable approach, instrumental variable approach, and sample exclusion approach, confirm these findings. (2) For

structural heterogeneity test, the subdimension of *Coverage_Breadth* and *Usage_Depth* significantly enhances EPHT, while the positive impact of *Digitalization_Level* on EPHT is not significant. (3) In terms of reginal heterogeneity test, financial technology has a significant positive impact on EPHT in developed provinces, but that in underdeveloped provinces is not significant. (4) Technological innovation plays a positive moderating role in the process of financial technology driving EPHT. Particularly, the moderating effect is most evident in the sub-dimension of *Usage_Depth* in financial technology.

Based on the main conclusions of the study, the following policy recommendations are proposed in this paper:

Firstly, the government should increase support for the development of financial technology by providing more policies and financial assistance. This will strengthen the construction of the digital economy and information level, enabling financial technology to better serve the development of high-tech industries.

Secondly, the government should prioritize the development of *Coverage_Breadth* and *Usage_Depth* in financial technology to promote EPHT more significantly, and at the same time, actively explore and unlock the potential of *Digitalization_Level*. For example, the government can increase the investment in robust digital infrastructure and connectivity to expand *Coverage_Breadth* in financial technology.

Thirdly, policy principles in different regions should be based on overall planning and tailored measures. On the one hand, facilitated by financial technology, developed provinces should fully leverage advanced technological support and harness the potential for industrial upgrading. This will maximize the development of high-tech industries and maintain a path of high-quality economic growth. On the other hand, for underdeveloped provinces, efforts should be made to enhance infrastructure construction and talent attraction. Active promotion of deep integration between finance and digital technology should be pursued through various channels to facilitate the development of high-tech industries.

Finally, the government should encourage enterprises to increase investment in technological research and development, actively engage in technological innovation, and coordinate their efforts especially with the sub-dimension of *Usage_Depth* in financial technology. This will drive the development of high-tech industries to the greatest extent possible.

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