

# The impact of digital financial inclusion on enterprises' innovation ability in China empirical evidence from high-tech SMEs

Wanqi Wu<sup>1,\*</sup>

<sup>1</sup>Business school, University of Sydney, Sydney, 201101, Australia

**Abstract.** Taking the technology-based SMEs as the research object, the principal component analysis method is utilized to construct the enterprise innovation capability index. The research shows that the development of digital inclusive finance has a significant positive impact on innovation capability, and the positive effect is still significant under the robustness test. However, there is no intermediary effect of financing constraints in the segmented market of small and medium-sized technology-based enterprises, which is partly due to the difficulty of efficient project identification of the digital inclusive platforms with mixed advantages and disadvantages in the market. The lag effect indicates that the impact of digital inclusive finance on the innovation of technology-based SMEs will be more obvious after a period of time.

## 1. Introduction

The key bolster for building a cutting-edge financial framework is driven by development [1]. Technology-based SMEs have solid advancement imperativeness, and their advancement has vital importance for extending work, expanding pay, and realizing financial change. "The Law of the People's Republic of China on the advancement of little and medium endeavours clearly states the objective of progressing the trade environment of SMEs and advancing their sound improvement." [2]. Therefore, the development of based small and medium-sized enterprises is highly valued by Chinese scholars. However, there are currently few articles that systematically analyse the impact of digital inclusive finance on the innovation capabilities of technology-based enterprises. This article conducts a series of empirical analyses with technology-based SMEs as the research subject.

## 2. Literature Review

The relationship between advanced comprehensive fund and corporate financing imperatives is talked about, but the investigate conclusions are diverse [3]. There are few articles that analyze the effect of computerized comprehensive fund on the advancement capacity of technology-based SMEs. The paper talks about the impact of financing imperatives on advancement capabilities of technology-based SMEs, as well as the impact of assessing advancement capabilities on the premise of financing imperatives.

## 3. Research methods

### 3.1 Innovation capability index system

Based on the existing research results and enterprise research, this paper constructs an enterprise innovation capability index system, as shown in Table 1.

**Table 1.** Enterprise innovation ability index system

Level I indicators	Secondary indicators	Measurement of indicators
Innovation output capacity	Total patents	Total number of patents applied in the year
	Number of invention patents	Annual total number of invention patents applied
	Number of utility model patents	Annual total number of applied utility model patents
	Number of design patents	Total number of design patents applied in the year
Innovation sustainability	Proportion of R&D personnel	Number of R&D personnel/total employees
	R&D expense rate	R&D expenses/total expenses
	Net profit growth rate	(Net profit of the current period/net profit of the previous period) - 1

\* Corresponding author: wuwanqi1804@sina.com

### 3.2. Principal Component Analysis

Principal component analysis is used to evaluate the innovation ability of enterprises [4].

The first step is to test the reliability and validity of the indicator system. The test results showed that the KMO value was 0.504, the significant level of Bartlett's spherical test Sig. was 0.000, and the cumulative variance contribution rate of the three main factors was 61%. Therefore, the indicator system is suitable for principal component analysis. Table 2 shows that the principal component matrix of innovation capability.

**Table 2.** Principal Component Matrix

Variable	Index	Component		
		F1	F2	F3
$X_1$	Total patents	0.0128	0.5843	-0.0337
$X_2$	Number of invention patents	0.9264	-0.1596	0.0221
$X_3$	Number of utility model patents	0.8966	-0.2566	-0.0130
$X_4$	Number of design patents	-0.1580	-0.2669	0.6391
$X_5$	Proportion of R&D personnel	0.2284	0.6887	0.1895
$X_6$	R&D expense rate	0.2990	0.5053	0.4101
$X_7$	Net profit growth rate	0.0995	0.1997	-0.7373

The second step is to comprehensively evaluate the innovation capability of enterprises. The principal components of innovation capability are shown in Formula (1), (2) and (3) below:

$$F_1 = 0.0128X_1 + 0.9264X_2 + 0.8966X_3 - 0.158X_4 + 0.2284X_5 + 0.229X_6 + 0.0995X_7 \quad (1)$$

$$F_2 = 0.5843X_1 - 0.1596X_2 - 0.2566X_3 - 0.2669 + 0.6887X_5 + 0.5053X_6 + 0.1997X_7 \quad (2)$$

$$F_3 = -0.0337 + 0.0221X_2 - 0.013X_3 + 0.6391X_4 + 0.1895X_5 + 0.4101X_6 - 0.7373X_7 \quad (3)$$

The variance contribution reflects the relative importance of the principal components. From the variance contribution rate, the scores of the principal components can be weighted and summed to obtain a comprehensive score, namely, the comprehensive evaluation index F of enterprise innovation capability, as shown in Formula (4):

$$F = (0.2570/0.6100) * F_1 + (0.1847/0.6100) * F_2 + (0.1683/0.6100) * F_3 \quad (4)$$

#### 3.2.1 Variable selection

The variables are divided into the explained variables, financial innovation index, and the core explanatory variables are the digital inclusive financial index and the depth of use of digital inclusive finance. The control variables include asset liability ratio, operating revenue growth rate, fixed asset ratio and operating index. The intermediary variable is financing constraint.

**Table 3.** Variable Symbols and Definitions

Variable Type	Variable symbol	Variable name
Interpreted variable	F	Enterprise innovation capability index
Core explanatory variables	DIFI	Digital inclusive financial index
	DCB	Coverage of digital inclusive finance
control variable	Lev	Asset liability ratio
	Probit	Growth rate of operating income
	Roe	Weighted average return on equity
	Gz	Fixed assets ratio
	q	Tobin Q value
	Yy	Operating index
Intermediary variable	SA	Financing constraints

#### 3.2.2 Data source

The data in this paper are from the SMEs of A share in the Tonghua Shun database. Firstly, ST, ST \* and PT are excluded from the sample, and then G information transportation, software and information technology service industries are selected. This industry refers to the use of computer communication network technology to compile, collect, process and use data, and provide terminal service activities and M scientific research and technical services, which refers to the use of modern scientific and technological knowledge and methods. An emerging industry that provides intelligent services to society. Finally, companies with abnormal financial data are eliminated.

## 4. Empirical analysis

### 4.1 Descriptive analysis

This paper collects panel data of technology-based SMEs in the A-share market from 2012 to 2020 for research. There are 150 pieces of data in the descriptive analysis of data. Table 4 reports the descriptive statistical results of specific variables. The results in Table 6 show that the standard deviation of enterprise innovation capability F is 6.795555, the average value is 2.193901, the maximum value is 44.29969, and the minimum value is -3.894914, which indicates that the innovation capability gap of the sample enterprises in this paper is large. The average value of DIFI is 270.7403, with a large gap between the maximum and minimum values. Different regions have different levels of digital inclusive finance.

**Table 4.** Descriptive statistics of main variables

Variab le	Obs	Mean	Std.De v.	Min	Max
F	150	2.193901	6.795555	-3.89491	44.29969
DIFI	149	270.7403	91.84927	39.82	431.93
DUD	149	276.0911	96.76948	53.56	488.68
Lev	150	.3908427	.1868537	.0103	.8586
Probit	146	.2754699	.5455964	-.7786	3.9764
Roe	150	.0835049	.1226574	-.9111	.3545
Gz	150	.2382207	.1580342	.0226	.6041
q	142	1.818182	.7004864	.9239	4.291
Yy	147	.7132259	2.311165	-14.908	10.6819
FM	126	-.0640411	.6754691	-.9903843	2.361475
SA	149	3.085371	.9013084	1.415722	6.589604

### 4.2 Benchmark regression analysis

The paper first analyzes the impact of the development of digital inclusive finance on enterprise innovation capability and constructs a regression model.

$$F_{it} = \alpha_0 + \alpha_1 DIFI_{it} + control + \delta_{it} + \theta_{it} + \varepsilon_{it} \quad (5)$$

Where, i represents the enterprise, j represents the city, and t represents the year. The explained variable F is the enterprise innovation capability; The explanatory variable DIFI is the digital inclusive financial index; Control refers to other control variables that may affect enterprise innovation at the enterprise or city level.  $\delta$  It refers to the fixed effect of individual companies.  $\theta$  Is a fixed time effect,  $\varepsilon$  Represents a random error term. It can be seen from Table 5 that the coefficient of DIFI is 37.60674, p is 0.004, indicating that this coefficient is estimated to be significant at the significance level of 5%, and the digital inclusive financial index has a positive impact on the innovation of technology-based SMEs.

**Table 5.** Benchmark Regression Results

F	Coef.	Std.Err.	t	p
DIFI	37.60674	12.87718	2.92	0.004
Lev	-23.49166	8.99596	-2.61	0.010
Probit	-.3141183	1.008777	-0.31	0.756
Roe	-2.700209	4.884451	-0.55	0.582
Gz	3.094402	7.705063	0.40	0.689
q	.1410411	1.158342	0.12	0.903
Yy	-.0264995	.2510937	-0.11	0.916
2012	-33.73299	9.172862	-3.68	0.000
2013	-48.86352	14.32807	-3.41	0.001
2014	-51.97923	15.70979	-3.31	0.001
2015	-55.71495	18.16317	-3.07	0.003
2016	-58.67557	18.54775	-3.16	0.002
2017	-67.4675	20.63865	-3.27	0.001
2018	-71.87008	22.10523	-3.25	0.002

2019	-74.02123	23.04243	-3.21	0.002
2020	-75.68086	23.57146	-3.21	0.002
cons	-136.701	51.04558	-2.68	0.009
F(16,96)	1.99	Prob>F=		
		0.0208		

### 4.3 Robustness test

This paper will replace the digital inclusive finance index with the digital inclusive finance coverage index for robustness test to verify the impact of the development of digital inclusive finance on the innovation ability of technology-based SMEs. The results are shown in Table 6. The coefficient of the coverage breadth index of digital inclusive finance is 21.35915, which is significantly positive at the level of 1%, which indicates that digital inclusive finance has a significant positive effect on the innovation ability of technology-based SMEs, which further verifies the benchmark regression analysis results.

**Table 6.** Robustness Test

F	Coef.	Std.Err.	t	p
DCB	21.35915	5.908193	3.62	0.000
Lev	-24.86634	8.726596	-2.85	0.005
Probit	-.1494794	.9905962	-0.15	0.880
Roe	-3.054931	4.782466	-0.64	0.524
Gz	-.6735292	7.743462	-0.09	0.931
q	-.0634764	1.137659	-0.06	0.956
Yy	-.0099884	.2459383	-0.04	0.968
2012	-20.20438	4.287979	-4.71	0.000
2013	-27.02839	5.979357	-4.52	0.000
2014	-32.18888	7.573361	-4.25	0.000
2015	-31.46159	8.392787	-3.75	0.000
2016	-34.40972	8.57264	-4.01	0.000
2017	-40.20434	9.373358	-4.29	0.000
2018	-43.4012	10.18493	-4.26	0.000
2019	-44.4449	10.63443	-4.18	0.000
2020	-45.34256	10.86252	-4.17	0.000
cons	-67.83162	22.47667	-3.02	0.003
F(16,96)	2.34	Prob>F=		
		0.0057		

### 4.4 An Analysis of the Intermediary Effect of Financing Constraints

In order to test the transmission mechanism of the influence of digital inclusive finance on the innovation capability of technology-based SMEs, this paper will focus on the intermediary effect of financing constraint SA [5]. Stata is used to produce the DIFI. Lev, probit, Roe, gz, q, and Yy are control variables. The specific model is as follows:

$$SA_{it} = \beta_0 + \beta_1 DIFI_{it} + control + \delta_{it} + \theta_{it} + \varepsilon_{it} \quad (6)$$

$$F_{it} = \gamma_0 + \gamma_1 DIFI_{it} + \gamma_2 SA_{it} + control + \delta_{it} + \theta_{it} + \varepsilon_{it} \quad (7)$$

Table 7 shows that digital inclusive financial DIFI has a negative relationship with financing constraint SA, while SA has a negative relationship with F. However, the two indirect effects are not significant. Digital inclusive financial DIFI has a significantly positive impact on F, and only 37.60674 is the main effect. It can be concluded

that the intermediary effect of financing constraint SA does not exist [6].

**Table 7.** Mediation effect

	SA	F	F
DIFI	-1.106236 (0.612)	37.33979 **	37.60674 (0.004)
SA		-.3267849 (0.595)	
Controls	Yes	Yes	Yes
F	1.99	2.09	2.60

#### 4.5 Hysteresis effect test

There's a lagging when it comes to the effect of advanced comprehensive back on the development of technology-based SMEs. In this section, the IF of the explained variable lagging one order is used as the new explained variable for regression, and the lag effect of the variable is tested. The lag regression analysis results are shown in Table XI. From the table 8, the coefficient of DIFI is 21.35915, and the P value is 0. The regression coefficient passed the significance test of 1%, so the lag effect exists, showing that the impact of digital inclusive finance on the innovation of technology-based SMEs will be more obvious after a period of time.

**Table 8.** Lag Regression Analysis

IF	Coef.	Std.Err.	t	p
DIFI	21.35915	5.908193	3.62	0.000
Lev	-24.86634	8.726596	-2.85	0.005
Probit	-.1494794	.9905962	-0.15	0.880
Roe	-3.054931	4.782466	-0.64	0.524
Gz	-.6735292	7.743462	-0.09	0.931
q	-.0634764	1.137659	-0.06	0.956
Yy	-.0099884	.2459383	-0.04	0.968
2012	-20.20438	4.287979	-4.71	0.000
2013	-27.02839	5.979357	-4.52	0.000
2014	-32.18888	7.573361	-4.25	0.000
2015	-31.46159	8.392787	-3.75	0.000
2016	-34.40972	8.57264	-4.01	0.000
2017	-40.20434	9.373358	-4.29	0.000
2018	-43.4012	10.18493	-4.26	0.000
2019	-44.4449	10.63443	-4.18	0.000
2020	-45.34256	10.86252	-4.17	0.000
cons	-67.83162	22.47667	-3.02	0.003
F(16,96)	2.34	Prob>F=		
		0.0057		

#### 5. Conclusion

The investigate protest of this paper is little and medium-sized technology-based endeavours, and it looks at the impact of advanced comprehensive back on undertaking development capacity, as well as the part of financing imperatives. The advancement of computerized comprehensive back includes a positive effect on the advancement of development capability of technology-based SMEs [7]. There's a slack within the effect of advanced comprehensive fund on the development capability of technology-based SMEs [8].

#### 6. Recommendations

The government should support the development of digital finance in depth, improve the depth of use on the basis of expanding coverage, improve the business functions of digital finance, and provide more convenient financial services for innovative activities of technology-based SMEs [9]. If technology-based SMEs want to achieve long-term development, they need to standardize their governance structure, and then improve their independent innovation ability, recruit professional talents, so as to improve their comprehensive strength [10].

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