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Financial Market Stability, Development of Digital Inclusive Finance and Enterprise Innovation Output

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Abstract: Based on the panel data of China's Shanghai and Shenzhen A-share listed companies from 2010 to 2018, this paper constructs A fixed-effect regression model and empirically explores the relationship mechanism between financial market stability, the development of digital inclusive finance and enterprise innovation output. The results show that the development of digital inclusive finance promotes the innovation output of enterprises; At the same time, financial market stability will enhance the role of digital financial inclusion development in promoting enterprise innovation. The above conclusion is still consistent with the result of benchmark regression after the robustness test of replacement variable and lag variable regression. Further analysis shows that the above conclusions are valid for enterprises with different ownership structures or power concentration. Based on the interaction Angle of financial market stability and the development of digital inclusive finance, this paper has enriched research literature on factors influencing enterprise innovation output, opened the role of financial market stability and the development of digital inclusive finance "black box", and also provides theoretical basis to help the healthy and steady development of financial market in our country.

1. Introduction

Ever since the United Nations first proposed the concept of "inclusive finance" in 2005, which aims to provide effective and inclusive services to all sectors and groups of society, the CPC Central Committee and The State Council have attached great importance to the development of inclusive finance. The Third Plenary Session of the 18th CPC Central Committee explicitly called for the development of inclusive finance. The 2015 Government Work Report calls for the development of inclusive finance so that all market players can share in the rain and rain of financial services. In order to promote the development of inclusive finance, improve the coverage, availability and satisfaction of financial services, and enhance the sense of access to financial services of all market players and the general public, the Development Plan for Promoting Inclusive Finance (2016-2020) (The State Council, 2016) is specially formulated to clarify the development goals of inclusive finance. At the same time, digital technology and Internet technology, as a powerful tool to improve the real-time performance and risk control ability of financial services, are integrated into inclusive finance, which better interprets the original intention and significance of fintech and enables the general public in

China to enjoy modern financial services. With the development of digital inclusive finance, the borrowing threshold and borrowing cost of all people have been lowered, investment and production activities have been promoted, and mass innovation and entrepreneurship have been promoted. At the same time, it will also promote the risk management capacity of the financial sector and improve financial inclusiveness and efficiency. In particular, the financing costs of farmers and the financial vulnerability of rural households are reduced [1], and the financial needs of people are better met [2]. In this way, the gap between urban and rural development can be narrowed and poverty reduction can be realized, thus effectively solving the problem of unbalanced and inadequate development in China and promoting social equity and harmonious development.

China's economic development depends on innovation. Continuous innovation is not only an important means for enterprises to grow and strengthen their core competitiveness, but also an important source for a country or region to promote technological progress by investing in scientific and technological research and development, thus driving sustainable economic growth. Guided by the policy of "mass innovation and entrepreneurship", data from China's Innovation Communique shows that in 2020, China invested 2.439.31 billion yuan in research and development (R&D), an increase of 224.95 billion yuan or 10.2 percent over the previous year. Enterprises contributed 76.6% to the growth of R&D expenditure, and enterprises are still the main driving force for the growth of R&D expenditure in the whole society. As the microentity of innovation, enterprises promote the implementation of innovation-driven development strategy. Enterprise innovation has gradually become the first driving force of our economic transformation and upgrading. Innovation is a new combination of new production factors and production conditions by entrepreneurs. In essence, it is to introduce new production factors and reintegrate new products and new technologies. Through this production process, new production functions can be constructed. Therefore, as the concentrated embodiment of entrepreneurship and value and an important factor of production, innovation is not only an important means for enterprises to survive, maintain competitive advantages and enhance core competitiveness, but also the power and source of promoting the long-term and high-quality development of a country's economy.

In previous studies, stock price crash, as an important economic consequence of financial markets, has been widely discussed. Existing studies mainly discuss from the aspects of management characteristics [3], such as CEO overconfidence [4], ownership structure [5], accounting information quality [6], tax avoidance [7], etc. As an explicit loss uncertainty, the stock price crash risk hides some information of the enterprise, no matter whether the information comes from the management level or the management level. When the crash risk occurs, the risk will be transmitted to the economic market as a signal, bringing unpredictable economic consequences. First of all, the risk of stock price collapse and the economic consequences of stock investors are the most direct and intuitive, which will directly damage the wealth of investors and bring huge economic losses to investors. As a result, it will cause stock market turmoil, affect the smooth operation and operation efficiency of the financial market, and even affect the efficiency of resource allocation in the capital market, disrupt the normal development of the capital market, and then cause systemic financial risks. Therefore, the study of stock price crash risk not only has strong theoretical significance, but also has strong practical significance. It has important guiding significance for financial regulators to strengthen market supervision and avoid systemic financial risks. If the stock price crash risk can be handled well in the future, it has important theoretical and practical significance for protecting investors' rights and interests, reducing financial risks in the capital market and promoting the stable development of the stock market.

Therefore, using the panel data of China's A-share listed companies in Shanghai and Shenzhen during 2010-2018, this paper constructs A fixed-effect regression model and empirically explores the relationship mechanism between financial market stability, development of digital inclusive finance

and enterprise innovation output. The results show that the development of digital inclusive finance promotes the innovation output of enterprises; At the same time, financial market stability will enhance the role of digital financial inclusion development in promoting enterprise innovation. The above conclusion is still consistent with the result of benchmark regression after the robustness test of replacement variable and lag variable regression. Further analysis shows that the above conclusions are valid for enterprises with different ownership structures or power concentration. Based on the interaction Angle of financial market stability and the development of digital inclusive finance, this paper has enriched research literature on factors influencing enterprise innovation output, opened the role of financial market stability and the development of digital inclusive finance "black box", and also provides theoretical basis to help the healthy and steady development of financial market in our country.

2. Theory and hypothesis

Digital financial inclusion can improve financing constraints and play a role in improving fundamentals, reducing operational risks and reducing liquidity crises. Enterprise innovation is an activity of high risk and high investment. Therefore, the introduction of digital inclusive finance can promote enterprise innovation from the perspective of reducing innovation and operational risks.

At the same time, digital technology and Internet technology, as a sharp tool to improve the real-time performance and risk control ability of financial services, are integrated into inclusive finance, constituting the development of digital inclusive finance. Digital inclusive finance has improved the information environment, created a good atmosphere for innovation, increased the vitality of enterprises' innovation subjects, and thus increased the innovation performance and output of enterprises. Therefore, hypothesis H1 is proposed in this paper.

H1: The development of digital financial inclusion promotes enterprise innovation.

The risk of stock price crash weakens investors' positive expectations, while the accumulation of negative expectations leads to financing difficulties for enterprises, weakening corporate fundamentals and worsening liquidity crisis, which in turn weakens the promoting effect of digital financial inclusion on enterprise innovation and weakens the effect of digital financial inclusion.

At the same time, when there is a risk of stock price crash, the information environment created by digital inclusive finance will accelerate the spread of bad news, thus reducing the vitality of enterprises' innovation subjects and affecting the innovation atmosphere, innovation performance and innovation output. Therefore, hypothesis H2 is proposed in this paper.

H2: The risk of stock price crash reduces the promotion effect of the development of digital inclusive finance on enterprise innovation.

3. Models, variables, and data

(1) Sample selection and data sources

In this paper, all A-share listed companies from 2010 to 2018 are selected as samples, and according to the method of Du Yong[8], the samples are screened according to certain conditions: (1) Financial insurance and real estate listed companies are excluded; (2) listed companies with delisting risk warning and special treatment of ST are excluded; (3) listed companies with missing data. The data used in this paper come from the National Tai 'an database, and after the author collated. In order to reduce the influence of extreme values on the analysis, it is necessary to deal with outliers, so the data required in the analysis is processed by tail reduction.

3.1. Number of Authorized Patents

Domestic and foreign research literature mainly uses R&D investment, patent quantity and new product category to measure enterprise innovation ability. Considering the risk of enterprise innovation itself and the principle of maximizing effective samples, most scholars widely use the number of patents as an index to measure enterprise innovation ability. Therefore, referring to the practice of existing studies, this paper focuses on the total number of patents granted by listed companies. Granted patent is a right recognized by law. Among the three types of patents (invention patent, utility model patent and design patent) under the Chinese Patent Law, the application conditions and licensing process for invention patent are stricter and generally of higher quality[9,10].

3.2. Peking University Digital Financial Inclusion Index (PKU-DFIIC, hereinafter abbreviated as DFIIC)

The Peking University Digital Financial Inclusion Index was released by the university's Internet Finance Research Center. The Internet Finance Research Center of Peking University, together with Ant Financial, collected massive digital financial data. Based on the existing literature on the establishment of inclusive financial indicators, 33 indicators were selected from the three dimensions of coverage breadth, use depth and digital support service degree to construct the "inclusive financial Index (2011-2018)" reflecting the actual situation in China. Coverage breadth mainly reflects the coverage of electronic accounts. Digital finance breaks through the limitation of space and time. Most financial services are provided through electronic accounts, so the coverage breadth reflects the coverage degree of regional digital financial infrastructure to some extent. The depth of use tends to measure the actual service status of digital finance. Corresponding indicators are mainly established based on the actual use of Internet financial services such as payment, money fund, credit, insurance, investment and credit, which can reflect the level of digital financial services in a region. The degree of digital support services is mainly reflected by the index of mobility, affordability, credit and facilitation. The higher the degree of digital support services, the lower the cost and higher the efficiency of financial services for enterprises. This paper selects the total digital financial inclusion index at the city level from 2011 to 2018 as the main explanatory variable in the empirical model.

3.3. Adjustment variable: stock price crash index (stock price crash risk)

Referring to the existing studies [3,4,6,9,10,11,12], the following two stock price crash risk indicators are adopted in this paper as the dependent variables of the hi analysis. The specific algorithm is as follows.

Firstly, we eliminate the influence of market factors on the yield of individual stocks through model (1). In Model (1), dayis the weighted average return of company i's stock in week t. The residualrepresents the portion of an individual stock's return that cannot be explained by fluctuations in market return. We will define this as the weekly rate of return of the company.

$$r_{i,t} = \alpha_i + \beta_1 r_{M,t-2} + \beta_2 r_{M,t-1} + \beta_3 r_{M,t} + \beta_4 r_{M,t+1} + \beta_5 r_{M,t+2} + \varepsilon_{i,t} \quad (1)$$

The first indicator to measure the risk of stock price crash is negative conditional return skewness, which is calculated as shown in Formula (2). Where, n is the number of weeks that stock i trades in year t. The greater the NCSKEW is, the higher the negative skew coefficient is, and the greater the stock price crash risk is.

$$NCSKEW_{i,t} = -[n(n-1)^{3/2} \sum W_{i,t}^3]/[(n-1)(n-2)(\sum W_{i,t}^2)^{3/2}] \quad (2)$$

The second indicator to measure the risk of stock price crash is the ratio of the rise and fall of the

company's stock yield, denoted as DUVOL. The calculation method is shown as Formula (3).

$$DUVOL = log\{[(n_u - 1)\sum_{Down} W_{i,t}^2]/[(n_d - 1)\sum_{Up} W_{i,t}^2]\} \quad (3)$$

is the number of weeks in which stock i's weekly return is above (below) the average return of the year. The greater the DUVOL, the greater the leftward skew of yield, and the higher the stock price crash risk.

3.4. Control variables

In terms of control variables, by referring to existing literature [8], we select property right nature (STATE), asset-liability ratio (LEV), senior executive shareholding ratio (SR), board SIZE (BORAD), enterprise size (SIZE) and enterprise AGE (AGE). Industryfe and Yearfe are also controlled.

(2) Research model

This paper constructs the following three models to be tested. The first model verifies hypothesis H1, and the second and third models verify hypothesis H2 based on different stock price crash risk indicators NCSKEW and DUVOL respectively:

$$PATENT_{i,t} = \gamma_0 + \gamma_1 DFIIC_{i,t} + \gamma_2 CVs_{i,t} + \sum Industryfe + \sum Yearfe + \varepsilon_{i,t} \quad (4)$$

$$PATENT_{i,t} = \alpha_0 + \alpha_1 DFIIC_{i,t} + \alpha_2 DFIIC\_NCSKEW_{i,t} + \alpha_3 CVs_{i,t} + \sum Industryfe + \sum Yearfe + \varepsilon_{i,t} \quad (5)$$

$$PATENT_{i,t} = \beta_0 + \beta_1 DFIIC_{i,t} + \beta_2 DFIIC\_DUVOL_{i,t} + \beta_3 CVs_{i,t} + \sum Industryfe + \sum Yearfe + \varepsilon_{i,t} \quad (6)$$

4. Empirical analysis

Table 1: Descriptive results of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
patents sum	9083	286.119	1521.194	0	62696
index aggregate	9083	196.889	63.306	25.8	302.98
ncskew	9083	-0.252	0.702	-2.707	2.139
duvol	9083	-0.155	0.482	-1.588	1.272
lev	9083	0.381	0.198	0.008	1.352
size	9083	21.931	1.243	19.199	28.52
board	9083	2.124	0.191	1.386	2.89
sr	9083	0.194	0.226	0	3.012
state	9083	0.274	0.446	0	1
age	9083	2.661	0.409	0.693	3.932

(1) Descriptive statistics and correlation analysis

The descriptive results of the variables show that the mean value of patents_sum is 286.119, the standard deviation is 1521.194, the minimum value is 0, and the maximum value is 62696, which indicates that the degree of innovation of listed companies is different, and some enterprises even have a big difference[13]. The mean value of Peking University's index_aggregate was 196.889, the standard deviation was 63.306, the minimum value was 25.8 and the maximum value was 302.98. NCSKEW, the first index of stock price crash risk, has a mean value of -0.252, a standard deviation of 0.702, a minimum value of -2.707 and a maximum value of 2.139. The second measure of stock price crash risk, DUVOL, has a mean of -0.155, a standard deviation of 0.482, a minimum of -1.588 and a maximum of 1.272. The mean value, standard deviation, minimum value and maximum value of asset-liability ratio (lev) were 0.381, 0.198, 0.008, and 1.352. The mean value of firm size (size) is 21.931, the standard deviation is 1.243, the minimum value is 19.199 and the maximum value is 28.52. The mean value of board size is 2.124, the standard deviation is 0.191, the minimum is 1.386, and the maximum is 2.89. The mean value, standard deviation, minimum value and maximum value of sr

were 0.194, 0.226, 0 and 3.012. As a 0-1 variable, property right nature (state) has a mean value of 0.274 and a standard deviation of 0.446. The mean value, standard deviation, minimum value, and maximum value of the age of the firm were 2.661, 0.409, 0.693, and 3.932.

The correlation coefficient matrix of the main variables shows that, The number of patents granted (patents_sum) and Peking University's index_aggregate Digital Financial Inclusion Index, the first index NCSKEW of stock price crash risk, the second index DUVOL of stock price crash risk, asset-liability ratio (lev), enterprise size, board size), senior executive shareholding ratio (sr), property right nature (state), and enterprise age (age) were 0.059, -0.023, -0.036, 0.128, 0.295, 0.032, -0.063, 0.078, and -0.006, respectively. On the whole, the correlation coefficient between the control variables is not large, indicating that the multicollinearity problem is not serious[14,15].

Table 2: Correlation coefficient matrix of main variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) patents_sum	1.000									
(2index_aggregate	0.059	1.000								
(3) ncskew	-0.023	-0.012	1.000							
(4) duvol	-0.036	-0.007	0.878	1.000						
(5) lev	0.128	0.044	-0.072	-0.088	1.000					
(6) size	0.295	0.131	-0.055	-0.088	0.578	1.000				
(7) board	0.032	-0.123	-0.027	-0.035	0.166	0.243	1.000			
(8) sr	-0.063	0.025	0.060	0.075	-0.352	-0.390	-0.205	1.000		
(9) state	0.078	-0.077	-0.080	-0.088	0.354	0.417	0.246	-0.501	1.000	
(10) age	-0.006	0.376	-0.042	-0.049	0.156	0.154	0.054	-0.222	0.207	1.000

(2) Regression analysis

Table 3: Enterprise innovation and digital financial inclusion

	(1)	(2)
	PATENT	PATENT
DFIIC	4.181*** (4.96)	4.049*** (4.96)
_cons	-325.882*** (-7.86)	-9033.945*** (-21.66)
CVs	no	yes
Industryfe	yes	yes
Yearfe	yes	yes
F	6.495	33.973
R-squared	0.018	0.104
N	9083	9083

Note: *, ** and *** represent significant at the level of 10%, 5% and 1% respectively, and the brackets are robust standard error. CVs is the control variable, including a series of control variables mentioned above. Meanwhile, dummy variable "i." is used to control Industryfe and Yearfe. The following tables are the same.

1) Enterprise innovation and Digital financial inclusion. Table 3 reports the test results of model (1). Under the condition of controlling industry fixed effect (Industryfe) and year fixed effect (Yearfe), the explained variable is the local Beijing University Digital Financial Inclusion Index (DFIIC) of the company in the sample in that year. The explanatory variable was the number of enterprise patents granted in the sample. As shown in the results in column (1), the estimated coefficient of DFIIC is 4.181, which is significantly positive at the 1% level (t=4.96), indicating that digital financial inclusion is positively correlated with enterprise innovation, which confirms H1. In order to prevent the interference of other attributes of the enterprise on the results, other variables such as asset-

liability ratio (LEV) are controlled in this paper. The results are shown in column (2). DFIIC is significantly positive (t=4.049) at the 1% level, indicating that digital inclusion finance is positively correlated with enterprise innovation, that is, the better the development of digital inclusion finance in the local area at that time, The higher the degree of enterprise innovation. These results all support the expected hypothesis that the development of digital financial inclusion promotes enterprise innovation.

2) Adjustment of stock price crash risk on the relationship between digital finance and enterprise innovation output. Table 4 reports the test results of models (2) and (3). Under the condition of controlling industry fixed effect (Industryfe) and year fixed effect (Yearfe), the explained variable is the product of the local Peking University Digital Inclusion Financial Index (DFIIC), digital inclusion financial index and stock price crash risk index (NCSKEW or DUVOL, two different calculation methods) of the company in the sample. That is, the interactive term, and the explanatory variable is still the number of enterprise patents granted in the sample.

Table 4: Adjustment of stock price crash risk on the relationship between digital finance and enterprise innovation output

	(1)	(2)			(3)	(4)
	PATENT	PATENT	Industry level clustering standard error after correction		PATENT	PATENT
DFIIC	4.161*** (4.94)	4.019*** (4.92)	4.019*** (5.53)	DFIIC	4.147*** (4.93)	4.014*** (4.92)
DFIIC_NCSKEW	-0.169* (-1.57)	-0.153* (-1.49)	-0.153*** (-3.02)	DFIIC_DUVOL	-0.436*** (-2.76)	-0.265* (-1.75)
_cons	-321.435* (-1.84)	-9032.544***(-21.66)	-9032.544***(-7.18)	_cons	-319.429* (-1.82)	-9013.644*** (-21.60)
CVs	no	yes	yes	CVs	no	yes
Industryfe	yes	yes	yes	Industryfe	yes	yes
Yearfe	yes	yes	yes	Yearfe	yes	yes
F	6.341	32.984	.	F	6.542	33.014
R2	0.018	0.104	0.104	R-squared	0.018	0.105
N	9083	9083	9083	N	9083	9083

Note: *, ** and *** respectively represent significant at the level of 10%, 5% and 1%. CVs is the control variable, including a series of control variables mentioned above. Meanwhile, dummy variable "i." is used to control Industryfe and Yearfe. Adding "vce(cluster industry_fe)" to correct industry-level clustering standard error, overcoming the similarity between enterprises in the same industry, ultimately making the independence of each enterprise sample and enhancing the robustness of the model.

Based on the research of NCSKEW, a stock price crash index, the results in column (1) show that the estimated coefficient of DFIIC is 4.161, which is significantly positive at the 1% level (t=4.94). The coefficient of the interaction term (DFIIC_NCSKEW) is significantly negative at the level close to 10%, indicating that the stock price crash risk negatively regulates the relationship between digital finance and enterprise innovation output, which confirms H2. In order to prevent other attributes of the enterprise from interfering with the results, other variables such as asset-liability ratio (LEV) were controlled in this paper. The results are shown in column (2), and DFIIC is significantly positive

(t=4.92) at the 1% level. The coefficient of the interaction term (DFIIC_NCSKEW) is significantly negative at the level of close to 10%. In particular, after the addition of "vce (cluster industry_fe)", the coefficient significance of interaction terms increased to 1% level. After the modification of industry-level clustering standard error, the similarity between enterprises in the same industry can be overcome, and finally the independence of each enterprise sample can be made and the robustness of the model can be enhanced. It shows that the stock price crash risk reduces the promoting effect of the development of digital inclusive finance on enterprise innovation, which confirms the above H2 results support the expected hypothesis.

Based on the research of DUVOL, an index of stock price crash, the results in column (3) show that the estimated coefficient of DFIIC is 4.147, which is significantly positive (t=4.93) at the 1% level. The coefficient of interaction term (DFIIC_DUVOL) is significantly negative at the level of 1%, indicating that stock price crash risk negatively regulates the relationship between digital finance and enterprise innovation output, which confirms H2. In order to prevent other attributes of the enterprise from interfering with the results, other variables such as asset-liability ratio (LEV) were controlled in this paper. The results are shown in column (4), and DFIIC is significantly positive (t=4.92) at the 1% level. The coefficient of the interaction term (DFIIC_NCSKEW) is significantly negative at the level of 10%, indicating that the stock price crash risk reduces the promoting effect of the development of digital inclusive finance on enterprise innovation. Similarly, the above results all support the expected hypothesis.

5. Heterogeneity analysis

5.1. Enterprises with different ownership nature

Table 5: Heterogeneity of enterprise ownership

	State-owned enterprise			Non-state-owned enterprise		
	PATENT (1)	PATENT (2)	PATENT (3)	PATENT (4)	PATENT (5)	PATENT (6)
DFIIC	6.596*** (5.16)	6.524*** (5.22)	6.439*** (5.14)	1.857*** (4.00)	1.852*** (4.01)	1.855*** (4.00)
DFIIC_NCSKEW	——	-0.344* (-2.12)	——	——	-0.032** (-2.34)	——
DFIIC_DUVOL	——	——	-0.735** (-2.90)	——	——	-0.022* (-1.22)
_cons	-9559.366*** (-3.99)	-9505.911*** (-3.99)	-9449.013*** (-4.02)	-7169.879*** (-5.95)	-7174.653*** (-5.94)	-7169.954*** (-5.94)
CVs	yes	yes	yes	yes	yes	yes
Industryfe	yes	yes	yes	yes	yes	yes
Yearfe	yes	yes	yes	yes	yes	yes
N	2486	2486	2486	6597	6597	6597
R2	0.148	0.149	0.149	0.067	0.067	0.067

According to theoretical analysis, the promoting effect of digital inclusive finance on enterprise innovation and the regulating effect of stock price crash risk must be different in different ownership enterprises. Due to the special nature of state-owned enterprises, the government often acts as an invisible guarantor in the process of lending to them, so state-owned enterprises are easier to obtain bank credit and have more adequate credit resources. In contrast, the information asymmetry between private enterprises and financial markets is relatively high, and the accompanying financial risks of enterprises are also high, so they are vulnerable to credit discrimination. In the following part, we

classify and test the samples of state-owned enterprises and non-state-owned enterprises respectively, and describe the ownership heterogeneity of the promoting effect of digital financial inclusion on enterprise innovation and the moderating effect of stock price crash risk on enterprise innovation in more detail. (Here, the industry-level clustering standard error is corrected to increase the robustness of heterogeneity analysis). Table 5 shows the test results.

According to the whole Table 5, it can be found that the promoting effect of digital inclusive finance on enterprise innovation and the regulating effect of stock price crash risk are significant in both state-owned enterprises and non-state-owned enterprises. The coefficients of DFIIC in columns (1) and (4) of Table 5 show that the development of digital inclusive finance has a stronger promoting effect on enterprise innovation in state-owned enterprises. By comparing the coefficient of DFIIC in column (2) and (5) of Table 5 and the coefficient of DFIIC_NCSKEW interaction item, it is found that the calculation method of stock price crash risk index based on NCSKEW can verify that in state-owned enterprises, the reduction of stock price crash risk has a greater promoting effect on enterprise innovation.

5.2. Enterprises of different sizes

Table 6: Heterogeneity of firm size

	Large-scale enterprise			Small-scale enterprise		
	PATENT (1)	PATENT (2)	PATENT (3)	PATENT (4)	PATENT (5)	PATENT (6)
DFIIC	5.508*** (6.86)	5.489*** (6.95)	5.474*** (6.98)	0.899*** (6.84)	0.908*** (6.87)	0.907*** (6.81)
DFIIC_NCSKEW	——	-0.182** (-2.69)	——	——	0.039*** (6.37)	——
DFIIC_DUVOL	——	——	-0.373*** (-3.14)	——	——	0.055*** (4.33)
_cons	-16965.076*** (-8.89)	-16939.946*** (-8.90)	-16903.611*** (-8.96)	-1183.449*** (-14.92)	-1169.981*** (-14.98)	-1173.865*** (-15.11)
CVs	Yes	Yes	Yes	Yes	Yes	Yes
Industryfe	Yes	Yes	Yes	Yes	Yes	Yes
Yearfe	Yes	Yes	Yes	Yes	Yes	Yes
N	4541	4541	4541	4542	4542	4542
R2	0.135	0.135	0.135	0.044	0.045	0.045

In traditional financial markets, small and medium-sized enterprises are often rejected by formal financial institutions due to their small scale and lack of better risk control and management. However, digital inclusive finance is more inclusive and convenient by innovating existing financial products and financing channels through inclusive concepts and technical means. Therefore, compared with large-scale enterprises that are more favored in traditional financial markets, digital inclusive finance plays a more "timely role" in the innovation of small and medium-sized enterprises. To be specific, all samples are divided according to the median size of enterprises. Enterprises larger than the median size are taken as large-scale enterprises, and enterprises smaller than or equal to the median size are taken as small-scale enterprises, and empirical research is carried out in groups. Table 6 reports the test results.

The coefficients of DFIIC in columns (1) and (4) of Table 6 show that the promotion effect of the development of digital inclusive finance on enterprise innovation is stronger in large-scale enterprises. In the adjustment effect of stock price crash risk, large and small enterprises show completely

different adjustment effect. For large enterprises, the risk of stock price collapse will reduce the promotion effect of the development of digital inclusive finance on enterprise innovation. However, for small enterprises, the risk of stock price collapse will enhance the promotion effect of the development of digital financial inclusion on enterprise innovation. This indicates that the financial market has different expectations for enterprises of different sizes, which leads to opposite regulating forces brought by the risk of stock price crash.

6. Robustness analysis

6.1. Lag variable

H1 is confirmed above: the development of digital inclusion finance promotes enterprise innovation, but it may also be that enterprises with a higher degree of innovation make better use of the dividends brought by the development of digital inclusion finance, that is, the endogenous problem of reverse causation may exist in this paper. In order to solve this endogeneity problem, this paper analyzes the digital inclusion finance index after one stage lag (DFIIC). Regardless of whether the control variable is present, the coefficient of the digital inclusion finance index is significantly positive when it is less than 5%, which indicates that the development of digital inclusion finance has caused the innovation and development of enterprises. Therefore, the results of this paper are still stable after considering the endogeneity.

Table 7: Robustness test of the relationship between enterprise innovation and digital financial inclusion

	(1)	(2)
	PATENT	PATENT
DFIIC	5.132** (2.87)	4.448*** (3.91)
_cons	-365.455*** (-3.36)	-10178.176*** (-17.69)
CVs	no	yes
Industryfe	yes	yes
Yearfe	yes	yes
R-squared	0.024	0.118
N	5938	5938

7. Conclusion and enlightenment

In the critical period of China's economic transformation, as the leading role of China's economy, the impact research of enterprise innovation has become important[16]. At present, with the vigorous development of digital inclusive finance, it becomes particularly important to study its influence on the leading factor of China's economy -- enterprise innovation[17]. It is also worth discussing the moderating effect of stock price crash risk, which can produce a "barometer" effect in financial market stability, on the above influence degree. In view of this, this paper selects panel data of China's A-share listed companies in Shanghai and Shenzhen from 2008 to 2018 as samples, constructs A fixed effect regression model, and empirically studies the relationship mechanism between financial market stability and the development of digital inclusive finance on enterprise innovation output from the perspective of stock price crash risk. The results show that the development of digital inclusive finance has a promoting effect on enterprise innovation, and the risk of stock price crash reduces the promoting effect of digital inclusive finance development on enterprise innovation, that is, financial market stability will enhance the promoting effect of digital inclusive finance development on

enterprise innovation. At the same time, in state-owned enterprises and large-scale enterprises, the development of digital inclusive finance has a stronger positive impact on enterprise innovation, and the development of digital inclusive finance has a greater promoting effect on enterprise innovation to reduce the risk of stock price crash[18]. However, for small-scale enterprises, the financial market expects the opposite. The risk of stock price collapse will enhance the promotion effect of the development of digital financial inclusion on enterprise innovation[19,20]. Based on this, this paper draws the following enlightenment:

(1) For companies, in order to do a good job in enterprise innovation, escort their survival, maintain their competitive advantages and enhance their core competitiveness, they need to pay attention to the opportunities brought by digital inclusive finance. Because innovation activities have the characteristics of long periodicity and high uncertainty, high dependence on capital. Under normal circumstances, only relying on the enterprise's own internal funds cannot meet the capital needed for research and development. Therefore, enterprises often need to make up the capital gap through direct or indirect external financing, and the inclusion and convenience of digital inclusive finance can meet this capital demand. At the same time, enterprises should also pay attention to maintaining stock price stability, so as to enjoy the positive adjustment effect brought by financial market stability. Stock price stability and regular positive dividends are necessary conditions and positive signals for the sound development of enterprises, which can enhance investment confidence and investment expectations for the company's investors, and help enterprises to raise funds for the development of innovation.

(2) For government regulatory departments and policy-making departments, in order to promote national economic growth, encourage "mass entrepreneurship and innovation", and advocate the transformation from "Made in China" to "Made in China", enterprises, as an important subject, should be paid more attention to the development of digital inclusive finance, financial market stability and other factors that affect enterprise innovation. Digital financial inclusion policies that are more favorable to enterprises, especially small and medium-sized enterprises, and regulatory policies that maintain financial market stability should be vigorously developed. In particular, relevant laws and regulations should be actively introduced to effectively constrain non-compliance by institutional investors and intensify efforts to crack down on irregular investment behaviors such as stock price manipulation.

(3) For investors, if they want to invest in a company with good innovation output, they should also pay attention to the driving factors of enterprise innovation to reasonably analyze the investment strategy. In particular, guiding market value investment and maintaining financial market stability should be the natural mission of institutional investors. At the same time, for individual investors, quantifiable data such as stock price crash risk that will be disclosed are more corporate information that they can use to justify their investment choices.

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