Digital Financial Inclusion, Financing Constraints, and Stock Price Volatility

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Abstract: Stock price stability plays a crucial role in maintaining the stability of financial markets. With the rapid advancement of technology, digital financial inclusion has been widely adopted. However, its potential impact on stock price volatility remains underexplored.This study matches provincial-level digital financial inclusion data from 2011 to 2022 with the stock price volatility data of A-share listed firms in China to empirically examine the influence of digital financial inclusion on stock price volatility. The results reveal that digital financial inclusion significantly reduces stock price volatility. Mechanism analysis shows that the development of digital finance alleviates corporate financing constraints, and the relaxation of such constraints plays a significant role in reducing stock price volatility. The heterogeneity analysis indicates that the suppressing effect of digital finance on stock volatility is more pronounced among large-scale and private enterprises. This paper enriches the research on digital financial inclusion and stock market volatility and provides theoretical and policy implications for promoting the stability of financial and capital markets.

*Keywords:*digital financial inclusion, financing constraints, stock price volatility

1. Introduction

As China's economy enters a new phase of high-quality development, it faces a complex environment characterized by structural adjustments, growth deceleration, and global economic uncertainty. The downward economic pressure has intensified(Chang et al., 2023)[1],making the survival and growth of enterprises increasingly challenging due to weakened market expectations, contracting foreign trade, and fragile supply chains. Meanwhile, mismatched talent structures and unmet funding needs exacerbate these difficulties. Economic development is the foundation for addressing China's major challenges, while enterprises constitute the backbone of that development(Tang et al.,2022)[2].Only when enterprises maintain robust growth under the complex global political and economic landscape can the national economy sustain vitality and resilience(Feng et al., 2022)[3].

The relationship between stock markets and economic growth has long been a topic of debate among scholars and policymakers. Some argue that stock prices can predict economic trends ("supply-leading" hypothesis),while others believe that economic growth drives stock market expansion(Croux and Reusens,2013;Tiwari et al,2015)[4][5].

Meanwhile, technological advances have enabled the rise of digital finance—an innovation that integrates financial services with digital technologies to enhance information flow, reduce transaction costs, and improve transparency(Lin and Ma,2022)[6].Compared with traditional finance, digital finance broadens access to capital and lowers financing costs for firms(Liu et al., 2021)[7].

This study selects the stock price volatility of China's A-share listed companies from 2011 to 2022 and empirically investigates the effect of digital financial inclusion on market stability. We find that the development of digital finance significantly reduces corporate stock price volatility. The effect is more evident in regions and firms with better digital financial infrastructure.

Compared with the existing literature, this paper makes the following contributions: (1) It broadens the scope of research related to the field of digital finance and stock price volatility. (2) While most existing studies examine stock price volatility from perspectives such as firm size and margin trading, this paper investigates financing constraints as a mediating mechanism from the perspective of digital finance, given that information asymmetry can influence financing constraints. (3) This paper conducts a heterogeneity analysis of firms across different regions and with varying ownership structures, exploring whether digital finance exerts differential effects on the stock prices of different types of enterprises.

2. Literature Review

Miller (1977)[8] suggested that margin trading mechanisms could lower market volatility. Fang and Peress (2009) [9] found that greater media attention correlates negatively with average monthly stock returns. Dasgupta et al.(2010) [10]

showed that a more transparent information environment helps investors evaluate managerial quality more accurately, leading to smoother price reactions and less volatility. Conversely, Manry et al. (2004) [11]argued that higher R&D expenditure increases stock price fluctuations. Chiyachantana et al. (2004)[12] documented that volatility asymmetry depends on market conditions—bull markets, dominated by buyers, feature higher price swings than bear markets.

Internationally, other scholars have focused on more nuanced issues, such as the relationship between stock price volatility and the economic cycle. However, these conclusions remain contradictory. For instance, Zhu and Zhu (2014) [13] found that economic cycles can accurately predict European stock returns, while Paetz and Gupta (2016) [14] demonstrated that, for South Africa, part of production volatility can be explained by stock price shocks. Only a few papers have addressed the stock price volatility–economic cycle relationship in BRICS countries, and none of these studies employed a quantile causality approach. Moreover, earlier research indicated that the dependence structure between the stock market and economic growth is nonlinear and dynamic (Croux and Reusens, 2013; Guo, 2015) [4][15].

In summary, while research on digital finance and financing constraints in China is relatively comprehensive, studies examining the impact of digital financial inclusion on stock price volatility remain relatively scarce.

3. Theoretical Hypotheses

3.1 Digital Financial Inclusion and Stock Price Volatility

Driven by technological advancements and market demands, digital financial inclusion has emerged, providing more convenient financial services. The advent of algorithmic trading and high-frequency trading has enhanced the efficiency of financial transactions, and this ability to adjust rapidly has contributed to reducing stock price volatility. Secondly, the development of digital finance has made financial resources more accessible, attracting more investors and capital to the financial industry, thereby improving market liquidity. Information transparency, agency costs, and stock price synchronicity enable digital finance to mitigate stock price crashes (Ai Y et al., 2023) [16]. Due to the digital and informational nature of digital finance, the overall stock market pricing becomes more efficient, reducing information asymmetry, which in turn lowers stock price volatility. Moreover, digital transformation has a strong mitigating effect on stock price crash risk in areas with small-scale enterprises, low analyst coverage, technology sectors, and high trust levels (Jiang K et al.,2022) [17]. Furthermore, the existence of digital platforms makes it easier for investors to access various relevant information. This not only reduces information asymmetry but also enhances investors' financial literacy, enabling them to make more rational decisions during the investment process.

Based on the above analysis, the following hypothesis is proposed:

H1: The development of digital financial inclusion will reduce stock price volatility.

3.2 Digital Financial Inclusion, Financing Constraints, and Stock Price Volatility

In real financial markets, the presence of information asymmetry increases the cost of acquiring information, further leading to difficulties in external financing for enterprises (Myers and Majluf, 1984) [18]. Information asymmetry is one of the main causes of financing constraints (Kaplan and Zingales, 1997) [19]. As mentioned above, the development of digital finance can enhance information transparency, reduce information asymmetry, and enable financial institutions to assess risks more accurately, thereby alleviating financing constraints caused by information asymmetry. The development of digital finance can provide enterprises with more financing channels and services, reducing financing constraints. Additionally, digital finance integrates and collects idle funds in the financial market, offering enterprises more financing opportunities and capital. Therefore, the development of digital finance reduces financing constraints and improves the efficiency and cost of external financing.

Based on the above analysis, the following hypothesis is proposed:

H2: The development of digital finance reduces stock price volatility by alleviating financing constraints.

4. Data Sources and Empirical Model

4.1 Data Sources and Variable Definitions

The explanatory variable in this paper is the Digital Financial Inclusion Index compiled by Peking University. The explained variable is derived from data of A-share listed companies in the Shanghai and Shenzhen stock exchanges, with relevant corporate data screened accordingly. The above data primarily come from the CSMAR database and the Wind database.

(1) Explained variable: Stock price volatility (VAR). VAR represents the variance of the stock return of company i

in year t. A larger VAR indicates greater stock price volatility. This study selects data of companies listed on the Shanghai and Shenzhen A-share markets from 2011 to 2022, spanning eleven years. Companies under special treatment (ST, *ST), particular transfer (PT), those delisted during the sample period, and those with missing data were excluded, resulting in a final sample of over 19,000 observations.

(2) Explanatory variable: Digital Financial Inclusion Index (Index). This index is generally divided into three measurement dimensions: the breadth of digital finance coverage, the depth of digital finance usage, and the level of digitalization of financial inclusion. This study selects the Digital Financial Inclusion Index for 31 provinces, municipalities, and autonomous regions across China, which underwent standardization. Due to data unavailability, the index does not include data from Hong Kong, Macao, and Taiwan.

(3) Mediating variable: This study uses financing constraints as the mediating variable to examine the pathway mechanism through which digital finance development affects stock price volatility. The FC index is employed as the indicator for financing constraints, where a higher index value signifies a greater degree of financing constraints.

Control variables: Drawing on existing research on stock price volatility, the following variables that may influence stock price volatility are controlled for: asset-liability ratio (Lev), profitability (ROA), stock return (StY), firm size (Size), proportion of independent directors (Indep), and current ratio (Rat). The main variables involved in this study are presented in Table 1.

Table 1. Variable Definitions

Variable	Variable Name	Variable Definition
Explained Variable	Stock Price Volatility (VAR)	The variance of the stock returns of company i in year t.
Explanatory Variable	Digital Financial Inclusion Index (Index)	The provincial-level Peking University Digital Financial Inclusion Index, standardized.
Mediating Variable	Financing Constraints (FC)	The Financing Constraints Index (FC).
Control Variables	Leverage Ratio (Lev)	The ratio of the company's total liabilities to total assets for the year.
	Profitability (ROA)	The ratio of net profit to total assets for the year.
	Stock Yield (StY)	The annual stock return rate, considering the reinvestment of cash dividends.
	Firm Size (Size)	The natural logarithm of the company's total assets for the year.
	Proportion of Independent Directors (Indep)	The ratio of the number of independent directors to the total number of board members.
	Current Ratio (Rat)	The ratio of current assets to current liabilities.

4.2 Research Design

This study first analyzes the impact of digital financial inclusion development on stock volatility by constructing the following regression model (1):

$$VAR_{ijt} = \alpha_0 + \alpha_1 Index_{it} + \alpha_2 Control_{ijt} + \varepsilon_{ijt} \tag{1}$$

In the equation above, VAR_{ijt} is the explained variable, stock price volatility. The explanatory variable $Index_{it}$ is the Digital Financial Inclusion Index. $Control_{ijt}$ represents a series of control variables. The subscripts *i*, *j*, and *t* denote the firm, province, and year, respectively. To examine the mechanism through which digital financial inclusion affects stock price volatility, this study employs a mediation effect testing procedure.

$$VAR_{ijt} = \alpha_0 + \alpha_1 Index_{it} + \alpha_2 Control_{ijt} + \varepsilon_{ijt} \tag{1}$$

$$FC_{ijt} = \beta_0 + \beta_1 Index_{it} + \beta_2 Control_{ijt} + \theta_{ijt} \tag{2}$$

$$VAR_{ijt} = \gamma_0 + \gamma_1 Index_{it} + \gamma_2 FC + \gamma_3 Control_{ijt} + \delta_{ijt} \tag{3}$$

The mediating variable is financing constraints (FC). Eq(1) shows digital finance's total effect on volatility. Eq(2) tests its effect on FC. In Eq(3), the coefficient product $(\gamma_2 \beta_1)$ quantifies the mediating effect transmitted through FC.

4.3 Descriptive Statistics

Table 2 shows stable variables with no outliers. The digital finance index has a narrow range (0.016-0.461), while stock volatility varies widely, consistent with market observations. No missing data supports further analysis.

Table 2. Descriptive Statistics of Variables

Variable	N	Mean	Standard Deviation	Min	Max
VAR	19185	1.252	0.774	0.168	7.794
Index	19185	0.281	0.104	0.016	0.461
FC	19185	0.481	0.276	0	0.986
Rat	19185	2.336	3.272	0.028	204.742
Lev	19185	0.433	0.2	0.007	0.998
Indep	19185	37.633	5.727	14.29	80
ROA	19185	0.031	.092	-3.994	0.786
Size	19185	22.26	1.279	17.641	28.636
StY	19185	0.151	0.566	-0.803	14.28

5. Empirical Analysis

5.1 Baseline Regression

This paper conducts regression analysis based on Equation (1), and the results are presented in Table 3. Column (1) includes only firm and year fixed effects without control variables, while column (2) incorporates a series of control variables that may influence stock price volatility. The empirical results consistently show that the coefficient of digital financial inclusion development on stock price volatility is negative at the 1% significance level, indicating that digital financial inclusion development significantly suppresses stock price volatility.

This paper argues that the development of digital finance enhances information transparency, allowing investors to access market information more easily, thereby reducing information asymmetry in financial markets. This, in turn, decreases volatility in the stock market. Additionally, the development of digital financial inclusion improves capital liquidity and reduces transaction costs, contributing to greater stability in the stock market. The results are consistent with Hypothesis 1.

Table 3. Baseline Regression: Digital Finance Index and Stock Price Volatility

	(1)	(2)
	VAR	VAR
Index	-2.390***	-2.042***
	(0.642)	(0.562)
Rat		0.00126
		(0.00164)
Lev		0.462***
		(0.0461)
Indep		0.00216*
		(0.00112)
ROA		-0.751***
		(0.0538)
Size		-0.115***
		(0.0108)
StY		0.586***
		(0.00856)
Control	NO	YES
Fixed	YES	YES
N	19185	19185
R^2	0.308	0.472
adj. R^2	0.193	0.384

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.2 Mechanism Analysis of Digital Finance on Stock Price Volatility

Table 4 results show digital finance significantly reduces financing constraints (Column 2, 1% level). After controlling for constraints, digital finance still suppresses stock volatility (Column 3, 1% level), while financing constraints increase volatility (10% level). This validates Hypothesis 2 that digital inclusion reduces stock volatility by alleviating financing constraints.

Table 4. Digital Financial Inclusion, Financing Constraints, and Stock Price Volatility

	(1)	(2)	(3)
	VAR	FC	VAR
Index	-2.042***	-0.623***	-1.993***
	(0.562)	(0.103)	(0.563)
FC			0.0787*
			(0.0426)
_cons	3.401***	3.943***	3.091***
	(0.235)	(0.0429)	(0.289)
Control	YES	YES	YES
Fixed	YES	YES	YES
N	19185	19185	19185
R^2	0.472	0.496	0.472
adj. R^2	0.384	0.412	0.384

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Heterogeneity Analysis

Due to factors such as differing firm sizes, the extent of digital finance development may vary, leading to heterogeneity and consequently differing impacts on stock price volatility. Therefore, this study divides firms into three equal groups based on firm size—large, medium, and small enterprises—to conduct heterogeneity tests.

The results of the heterogeneity analysis based on firm size are presented in Table 5. As shown in the table, while the development of digital financial inclusion has a negative correlation with stock price volatility in small enterprises, the effect is not statistically significant. In contrast, for large enterprises, the development of digital finance significantly reduces stock price volatility. This paper argues that large enterprises typically possess sufficient cash flow, and their expansion slows after reaching a certain scale. As a result, the development of digital finance can effectively mitigate their stock price volatility. For small and medium-sized enterprises, however, insufficient cash flow and their ongoing expansion phase make stock price volatility a normal phenomenon. Consequently, the development of digital finance does not effectively suppress their stock price volatility.

Table 5. Heterogeneity Test: Firm Size Heterogeneity

Small Enterprises	Large Enterprises	
	(1) VAR	(2) VAR
Index	-1.854	-2.190***
	(1.128)	(0.753)
_cons	5.604***	3.727***
	(0.646)	(0.508)
Controls	YES	YES
FE	YES	YES
N	9335	9405
R²	0.608	0.643
adj. R²	0.517	0.580

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7. Robustness Tests — Endogeneity Tests

This paper employs the spherical distance to Hangzhou (Distance), standardized, as an instrumental variable for digital finance development. This is because digital finance originated in Hangzhou, suggesting that its development in Hangzhou should be at a leading level. On the other hand, considering the continuity of digital financial inclusion development, the development of digital financial inclusion in the previous year is likely to influence its development in the following year. Therefore, this paper uses the one-period lagged Digital Financial Inclusion Index ($Index_{t-1}$) as an instrumental variable for digital financial inclusion. The regression results are presented in Table 6.

The first-stage regression results in column (1) show that the spherical distance to Hangzhou is negatively correlated with digital finance development, while the current period's digital financial inclusion development is positively correlated with its one-period lagged value, both of which align with theoretical expectations. The second-stage regression results indicate that, after mitigating endogeneity concerns, digital financial inclusion continues to have a significant suppressive effect on stock price volatility.

Table 6. Endogeneity Test: Instrumental Variable Method

	(1) First stage	(2)Second stage
VARIABLES	Index	VAR
Index		-4.4417*** (1.073)
Distance	-0.1125** (0.055)	
L.Index	0.7333*** (0.009)	
Controls	YES	YES
Fixed Effects	YES	YES
C-D Wald F statistic	10416.55	
K-P Wald rk F statistic	2976.42	
K-P rk LM statistic	284.19	
Hansen J statistic	0.443	
Observations	15828	15828

Note: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

8. Conclusion

This study examines stock price volatility data of Chinese A-share listed companies and matches it with the Digital Financial Inclusion Index from 31 provinces across China to investigate the impact of digital financial inclusion development on stock price volatility, while delving into its mechanisms and pathways. The research finds that digital financial inclusion has a significant mitigating effect on stock price volatility. Further mechanism analysis reveals that financing constraints play a mediating role in this process. Additionally, when digital financial inclusion is measured across three distinct dimensions, the results consistently demonstrate its significant suppressive effect on stock price volatility.

Furthermore, the study explores the heterogeneous effects of digital financial inclusion on stock price volatility. The results indicate that the mitigating effect is more pronounced for larger enterprises. Regarding firms with different ownership structures, digital financial inclusion is found to suppress stock price volatility notably more effectively in non-state-owned enterprises compared to state-owned enterprises.

Finally, robustness tests conducted by shortening the time interval yield consistent results, confirming the stability of the conclusions and indicating that they are not influenced by variable selection. This study, from the perspective of financing constraints, verifies the effectiveness of digital finance development in alleviating stock price volatility, providing theoretical foundation and practical guidance for addressing corporate financing difficulties and fostering innovation.

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