Digital Economy and Stock Price Synchronization

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Abstract: Selecting Chinese A-share listed companies from 2011 to 2019 as research samples, this paper empirically tests that the higher the development of the regional digital economy, the lower the synchronization of corporate stock prices. The same conclusion is obtained after the robustness test. The mediation effect test shows that the digital economy reduces stock price synchronization by inhibiting real earnings management. Further research proves that the digital economy has more significant synchronization with enterprise stock prices in non-state-owned enterprises with close attention paid by analysts. The research conclusion has important enlightenment for listed companies, regulatory authorities, and investors.

Keywords: Digital Economy; Stock Price Synchronization; Earnings Management.

1. Introduction

Nowadays, the development of the digital economy has attracted worldwide attention. Since the 18th National Congress of the Communist Party of China, the central government has boosted the construction of a country strong in the Internet and issued the 14th Five-Year Plan for the development of the digital economy. Meanwhile, relevant departments have implemented the plan and vigorously promoted digital industrialization and industrial digitalization, which laid a solid foundation for the sustainable development of the digital economy. People's Daily shows that China's digital economy expanded rapidly from 2012 to 2021, ranking second in the world for many years. Its prosperous development has improved the macro economy (Liu et al., 2023) and transformed micro enterprises (Yang, 2022).

Compared with the mature capital market, China's capital market is still in the initial stage of development. In an effective market, the stock price should be very close to its intrinsic value, and the fluctuation of the stock price should embody its fundamental information. But the single stock price severely fluctuates with the average market price in China, that is, "rising and falling simultaneously", which means that the stock price in China's stock market has a high synchronization. However, based on excessive stock price synchronization, the company's stock price reflects that market information is not unique information, which will cause serious damage to the efficiency of resource allocation in the capital market (Gul et al., 2009) and increase the risk of financial market collapse (Lan & Xian, 2020). Therefore, the study on the factors affecting stock price synchronization is conducive to improving the quality of stock price information and the stable development of the economic market. With the development of technologies with high efficiency such as the Internet, artificial intelligence, and big data, analysts' attention can be attracted to enhance information transparency. Internally, it can strengthen management supervision, effectively prevent information fraud, and alleviate enterprises' information asymmetry in all directions, thus reducing the synchronization of stock prices. Thus, it is necessary to study the influence of the digital economy on stock price synchronization, which benefits the stable market development and the long-term development of China's trading market.

Does the digital economy affect the synchronization of enterprise stock prices and what is the internal impact mechanism? This paper can be used for reference to explore the above problems based on Chinese A-share listed companies from 2011 to 2019. This paper has the following innovations. (1) Supplement the research on economic consequences in the digital economy and deepen the understanding of digital economy. (2) Enrich the research on the influencing factors of the stock price synchronization to better analyze its influence mechanism. (3) Use heterogeneity test to provide

empirical evidence for macro-influence on micro-enterprise development and new ideas for enterprises and investors with economic value.

2. Literature Review

(1) Digital Economy

The digital economy emerged in the United States in the 1990s, which initially contained new fields such as computers, information and communication technology, e-commerce, and digital payment. Then, with the rapid development of digital technologies such as big data, cloud computing, artificial intelligence, and blockchain, the theoretical connotation of the digital economy has been greatly expanded. Through the research of Qi et al. (2020), it is concluded that enterprises improve enterprise governance by reducing the irrationality and information asymmetry of managers' decision-making. Sun Hui (2022) believed that the digital economy can improve the efficiency of enterprise information transmission and communication, thus reducing the information errors caused by multi-level transmission, and finally promoting the clarity of enterprise information transmission. Hu Shan and Yu Yongze (2022) analyzed the impact of enterprise digital investment on enterprise innovation and concluded that digitalization can improve enterprise innovation. Taking Chinese A-share listed companies as empirical samples to verify that the digital economy can increase enterprise cost stickiness, this paper discusses the relationship between the digital economy and enterprise cost stickiness.

(2) Stock Price Synchronization

Stock price synchronization originated from the capital asset pricing model (CAPM) of Sharpe (1964), which slowly took shape from the unique perspective of Roll (1988). After Morck et al. (2000) followed Roll's thinking and compared the R^2 of many countries, it was found that the countries with lower capital market openness and financial liberalization had higher information collection costs, which led to higher stock price synchronization. In other words, the stock price synchronization of developed countries was lower than that of non-developed countries. According to Liu Na (2021), there is an inverted U-shaped curve relationship between investor protection and stock price synchronization, which further strengthens investor protection, emphasizes improving the quality of accounting information, and intensifies internal control, thus reducing stock price synchronization. Chen Cheng (2017) found that investor protection significantly reduced the stock price synchronization of listed companies and enhanced the efficiency of capital market pricing mechanisms. Yi Zhihong et al. (2019) manifested that analysts can attract investors and reduce stock price synchronization by providing information on corporate characteristics. According to Xiao Qi and Shen Huayu (2021), media attention mainly reduces stock price synchronization through the "noise channel". The higher the media attention, the lower the stock price synchronization.

To sum up, by enhancing investor protection, the attention of analysts and media as well as information asymmetry will be reduced, which will decrease the stock price synchronization.

3. Theoretical Analysis

Under the tide of digital economy, great changes have taken place in the survival and development of enterprises. In addition to alleviating information asymmetry, increasing the attention of analysts, and reducing earnings management, the operation of digitally empowered enterprises can also improve the transparency of enterprise information, optimize the internal governance environment, etc., and then leave an impact on the synchronization of enterprise stock prices. The main logic is as follows:

Firstly, the digital economy accelerates the accuracy and mobility of enterprise information and improves information asymmetry. According to the theory of information asymmetry, there is an "information gap" between enterprises and external investors, which will reduce the inflow of enterprise characteristic information and lead to higher stock price synchronization (Kalok & Yue-

Cheong, 2014). However, the digital economy can alleviate the information asymmetry, transmit more enterprise-characteristic information to the outside, and then reduce stock price synchronization. First of all, as a new model integrating big data, blockchain, cloud computing, and artificial intelligence (Tang et al., 2020), the digital economy can change the way of information dissemination, improve the transmission efficiency, and enhance the ability and willingness of enterprises to disclose information (Qi et al., 2020), which plays a great role in alleviating the information asymmetry between enterprises and external investors, thus transmitting enterprise characteristic information to external investors more efficiently. Secondly, under the background of big data, enterprises use new technologies such as big data, the Internet, and cloud computing to realize intelligent management of production, operation, warehousing, and sales. After forming relatively complete new information, through multi-dimensional and multi-faceted packaging and storage, the information features accuracy, completeness, and traceability, which improves the ability and quality of information disclosure, improves the transparency of enterprise information, reduces information uncertainty, and facilitates external investors to obtain special information and make decision analysis. Finally, the popularization of digital technology can effectively improve the transparency of enterprise finance and management (Goldfarb & Tucker, 2019). To sum up, the digital economy can improve the content of special information in the stock price of enterprises through the quality of information disclosure.

Secondly, because the digital economy strengthens the internal and external enterprises' governance, earnings management behavior will be alleviated. Earnings management refers that managers using certain means to manipulate earnings purposefully to maximize their utility, thus misleading enterprise stakeholders' understanding of accounting earnings (Zhang, 2013). In terms of the supervision effect, the application of the digital economy enhances external supervision, which leads to the small and medium shareholders participating in corporate governance with the right to appropriately inhibit the earnings management behavior. After the listed companies with high reputations are supervised by securities analysts, the earnings management behavior is restrained to a certain extent (Li et al. 2014); In terms of internal pressure, the digital economy itself has the ability to resist risks. Enterprises may improve the characteristic information content in stock prices through digital transformation, improve information transparency, and inhibit real earnings management, thus reducing the synchronization of stock prices (Guo & Wang, 2022). The digital economy significantly inhibits real earnings management behavior by improving the quality of information disclosure, reducing the information asymmetry between principals and agents, and alleviating financing constraints (Zhang et al., 2022) The influence of the digital economy makes enterprise data more real-time and comprehensive. Besides, business processes are more transparent, which not only provides sufficient big data analysis samples for regulatory authorities, but also improves the accuracy, timeliness, and effectiveness of enterprise information acquisition, thus significantly increasing the transparency of enterprise information and then reducing the motivation of real earnings management behavior (Mo et al., 2023). At the same time, with the use of big data, employees can become new participants in enterprise decision-making, value creation, and governance (Qi & Xiao, 2020). In addition, they can expand the internal supervisors and supervise managers' behavior in multiple directions, thus reducing the space for managers to implement real earnings management.

Based on the above analysis, this paper puts forward the assumption that the digital economy reduces the stock price synchronization of enterprises.

4. Research Design

(1) Sample Selection and Data Sources

1. Sample Selection

Referring to the research of Zhao Tao et al. (2020) and Tang Song et al. (2020), this paper selects 2011-2019 as the research sample for these reasons. Firstly, the statistical time range of the Inclusive Financing Index is 2011-2021. Secondly, it was impacted by the COVID-19 pandemic in 2020 and 2021. Based on the initial research samples, this paper eliminates the special treatment samples and

financial industry samples. Inclusive Financing Index originates from Peking University Inclusive Financing Index Database, and other research data originate from the CSMAR database. In this paper, the continuous variables are treated with 1% tail reduction.

(2) Definition of Variables

1. Dependent Variable

Stock price synchronization (SYN). Referring to the research methods of Huang Jun and Guo Zhaorui (2014), the annual R^2 of individual stocks is estimated by using model (1) with logarithms R^2 shown in model (2). Finally, the index of stock price synchronization is obtained.

$$RETi,t = \beta_0 + \beta_1 * MARKET_t + \beta_1 * INDRET_{j,t} + \varepsilon_t \quad (1)$$

$$SYNCHi = \ln\left(\frac{R_i^2}{1 - R_i^2}\right) \quad (2)$$

Where RETi, t is the return rate of stock i in week t, and MARKETt is the market return rate in week t; INDRETj, t is the return rate of the industry j for the company in week t, and R^2 is the annual regression goodness of fit of the model (1).

Independent Variables

Digital economy (Dif) and non-inclusive financing independent variables refer to Guan Huayu (2022) and Huang Qunhui (2019). Internet penetration rate (Ip), number of Internet broadband access users (Bbs), mobile telephone penetration rate (Mtp), number of mobile phone users (Pca), total post and telecommunications business (Pacy), and total revenue of software and information service industry (Sii) are selected as six indexes. According to the benchmark test, the combination of independent variables without inclusive financing is analyzed by hypothetical principal component firstly, which got the comprehensive index x3 by standardization method. Meanwhile, the combination of independent variables including inclusive financing is obtained by principal component analysis as x4, which is used as the index of the robust test.

3. Control Variables

Referring to Chen Chunhua et al. (2021), Song Jun and Lu Wei (2015), this paper selects the year of corporate establishment (Age), company size (Size), return on total assets (Roa), financial leverage (Lev), shareholding ratio of the institutional investor (Inst), board size (Board), independent director ratio (Indeep), shareholding ratio of the largest shareholder, and whether or not to accept four big audits as control variables.

Table 1 Variable Definitions

Name	Symbol	Definition
Year of Corporate Establishment	Age	Ln (current year-year of establishment +1)
Company Size	Size	Natural logarithm of annual total assets
Return on Total Assets	Roa	Net profit divided by average assets balance
Financial Leverage	Lev	Total liabilities divided by total assets
Shareholding Ratio of Institutional Investor	Inst	Net profit divided by average assets balance
Board Size	Board	Logarithm of the number of directors
Independent Director Ratio	Indep	Independent directors divided by the number of directors
Shareholding Ratio of the Largest Shareholder	Topl	The proportion of the number of shares held by the largest shareholder to the total number of shares
Whether or Not to Accept Four Big Audits	Big4	Accept four major audits, it's 1; otherwise it's 0

(3) Model Construction

To verify the paper hypothesis, the following regression model is constructed.

$$SYN_{i,t} = \beta_0 + \beta_1 DT_{i,t} + \sum Controls + \sum INDUSTRY + \sum YEAR + \varepsilon \quad (3)$$

Where SYN is stock price synchronization, x is the digital economy, and the coefficient represents the influence of the digital economy on stock price synchronization. Controls represent the control

variables of this study. If it is significantly negative, it indicates that the digital economy reduces stock price synchronization. On the contrary, the digital economy intensifies real earnings management. This model is based on the stock price synchronization in the digital economy without inclusive financing standardization but the comprehensive market equal weight average, which increases the fixed effects of industries, years, and provinces.

5. Empirical Results and Robustness Test

(1) Descriptive Statistics and Correlation Analysis

Table 2 shows the descriptive statistical results of the main variables in this paper. The minimum of stock price synchronization (SYN) is -7.8015 and the maximum is 22.8979, which proves that there are great differences in stock synchronization of listed companies. The minimum of digital economy (Dif) is 0.0533 and the maximum is 0.8382, which indicates that the digital economy varies among provinces, providing conditions for this study.

Table 2 Descriptive Statistics

VarName	Obs	Mean	SD	Min	Median	Max
SYN	22858	4.3802	6.914	-7.8015	3.3782	22.8979
Dif	20755	0.4553	0.186	0.0533	0.4609	0.8382
Age	22420	2.8649	0.335	1.8190	2.9142	3.4850
Size	24526	22.1395	1.426	19.5701	21.9074	27.1159
Roa	20032	0.0415	0.060	-0.2607	0.0405	0.1942
Lev	24526	0.4296	0.216	0.0503	0.4176	0.9349
Inst	22335	43.5756	24.985	0.3260	45.2869	91.5328
Board	24479	2.1392	0.205	1.6094	2.1972	2.7081
Indep	24479	0.3744	0.053	0.3000	0.3333	0.5714
Topl	24479	34.8839	15.110	8.7700	32.8300	75.4200
Big4	22376	0.0553	0.229	0.0000	0.0000	1.0000

(2) Benchmark Regression

Column (1) in Table 3 reports the regression results of how the digital economy affects stock price synchronization. It can be seen that the coefficient of the digital economy (Dif) is significant at the level of 0.5%, which indicates that the higher the development of the digital economy, the weaker the synchronization of enterprise stock price. The hypothesis has been proved. To further exclude the impact of financial events, this paper eliminates the sample data of 2015 as shown in column (2), and regresses the model (1) again, with the results unchanged. In the correlation analysis, the correlation coefficient between the control variables is less than 0.5, which indicates that there is no serious multicollinearity among the variables.

Table 3 Baseline Regression

	(1)	(2)	(3)
VARIABLES	syn	y	Lnum
x3	-0.0020***	-0.0014***	-0.0024***
	(-9.3663)	(-4.1999)	(-10.8782)
Controls	NO	YES	YES
Constant	0.4685***	0.1960***	-0.1183***
	(277.0231)	(3.8502)	(-3.0320)
Observations	16,249	18,547	16,249
R-squared	0.005	0.231	0.029
INDUSTRY FE	YES	YES	NO
YEAR FE	YES	YES	YES
PROVINCE FE	YES	NO	NO
r^2_a	0.0053	0.2274	0.0281
F	87.7270	NO	48.0462
FIRM FE	NO	NO	YES

t-statistics in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1. The following is the same.

(3) Robustness Test

Firstly, drawing lessons from the research of Wang Hongjian et al. (2017) and Chen Chunhua (2021), this paper replaces the explanatory variables with the digital economy including inclusive financing (x4) under the principal component analysis. Secondly, to alleviate the endogenousness, this paper has done a one-stage lag treatment. x3 is regressed with one-stage lag at first, then x3 and the control variables in the model (1) are all treated with one-stage lag. This paper also introduces "regional financial pressure" to test the tool variable. Through the above robustness test method, the research conclusion has not changed. Due to the space limitation, it's not listed.

6. Further Analysis

(1) Based on the Mechanism Test Analysis of Real Earnings Management

In this paper, benchmark regression has been carried out to prove the relationship between x and y. According to the previous analysis, the possible channel for the digital economy to affect the synchronization of enterprise stock prices is to inhibit their real earnings management. To test the mechanism, this paper refers to the analysis of the intermediary effect by Wen Zhonglin and Ye Baojuan (2014) and selects Real Earnings Management (Rem) for verification. To depict the specific mechanism of the digital economy affecting the synchronization of enterprise stock prices, the following models (4) and (5) are constructed.

$$M = \beta_0 + \beta_1 X + \beta C + \sum Ind + \sum YEAR + \varepsilon \quad (4)$$

$$Y = \beta_0 + \beta_1 X + \beta_2 M + \beta C + \sum Industry + \sum Year + \varepsilon \quad (5)$$

Model (3) is to test the influence of the digital economy (Dif) on real earnings management (Rem), while model (4) is to test the influence of the digital economy (Dif) on stock price synchronization (SYN) after increasing the year of corporate establishment (Age), company size (Size), return on total assets (Roa), financial leverage (Lev), shareholding ratio of institutional investor (Inst), board size (Board), independent director ratio (Indeep), shareholding ratio of the largest shareholder (Topl) and whether or not to accept four big audits as control variables (Big4).

According to Table 7, the mediating effect test of real earnings management as an explained variable, digital economy (Dif) and real earnings management (Rem) are significantly negative, and the development of digital economy reduces real earnings management. The regression coefficient of column (1) Dif is significantly negative at 1%, indicating that the digital economy can reduce stock price synchronization. After adding the intermediary variable real earnings management (Rem) as shown in column (3), the coefficient of Dif is still significantly negative at 1%, manifesting that the digital economy further reduces the stock price synchronization by reducing real earnings management. This also shows that the higher the real earnings management, the less information is disclosed. Meanwhile, there may be strong information asymmetry, which improves stock price synchronization.

Table 4 Mechanism Test Based on Real Earnings Management

	(1)	(2)	(3)
VARIABLES	y	y	y
x3	-0.0014***	-0.0014***	-0.0014***
	(-5.2158)	(-3.9644)	(-5.1109)
Rem	NO	NO	0.0197***
			(3.0915)
Controls	YES	YES	YES
Constant	0.2384***	-0.3822***	0.2459***
	(5.6792)	(-5.8450)	(5.8526)
Observations	16,249	16,249	16,249
R-squared	0.235	0.107	0.236
INDUSTRY FE	YES	YES	YES
YEAR FE	YES	YES	YES
r^2_a	0.2310	0.1019	0.2316

(2) Heterogeneity Analysis

In addition to analyzing the heterogeneity from the property right nature (En) and the attention of analysts (AA), this paper constructs the analysis model (6).

$$Y = \beta_0 + \beta_1 X + \beta_2 M + \beta_3 M * X + \beta C + \sum Ind + \sum YEAR + \varepsilon \quad (6)$$

Model (4) increases the influence of the digital economy (x3) on stock price synchronization (y4) under the conditions of property right nature (En) and analyst attention (AA) respectively.

Table 5 Heterogeneity Test

	(1)	(2)
VARIABLES	y	y
En*x3	-0.0012***	
	(-4.1170)	
En	0.0455***	
	(13.2923)	
Controls	YES	YES
x3*AA		-0.0001***
		(-6.2496)
AA		-0.0017***
		(-9.7341)
Constant	0.3419***	0.1433***
	(8.0461)	(3.0618)
Observations	16,249	13,135
R-squared	0.245	0.269
INDUSTRY FE	YES	YES
YEAR FE	YES	YES
r^2 a	0.2411	0.2646

1. Nature of Property Rights (En)

Property right refers to the ownership of legal property, which is the legal manifestation of economic ownership relationship, mainly including state-owned enterprises, private enterprises, foreign capital, and others. In China, there are differences between state-owned enterprises and non-state-owned enterprises (including private enterprises and foreign enterprises) in enterprise resources, strategic objectives, financing constraints, etc. In this heterogeneity test, the nature of property rights is taken as the regulating variable, 0 represents state-owned enterprises, and 1 represents non-state-owned enterprises. Taking the nature of enterprise property rights as a regulating variable, this paper investigates the influence of the digital economy (Dif) on stock price homogeneity (SYN) whether interfered with by the nature of property rights (En) or not. Column (1) of Table 8 shows the moderating effect test on the nature of property rights. It can be seen that the coefficient of state-owned enterprises is significantly negative at 1%, while the coefficient of non-state-owned enterprises is smaller than that of state-owned enterprises. This proves that the digital economy has a lower inhibitory effect on the stock price synchronization of state-owned enterprises than that of non-state-owned enterprises. The reasons can be seen in the differences between state-owned enterprises and non-state-owned enterprises. State-owned enterprises are national enterprises with better political resources and a lack of motivation to disclose information. It is difficult for the digital economy to play a role in restraining stock price synchronization against insufficient power. On the contrary, for non-state-owned enterprises, the market competition is fierce and external financing is needed. Only when external investors see the credit and characteristic information of their enterprises can they have the opportunity to harvest financing. In other words, they should disclose the true information of enterprises to the outside. Under the digital economy environment, the information dissemination, disclosure, and analysis of non-state-owned enterprises are enhanced, so that the digital economy has a stronger inhibitory effect on the stock price synchronization of non-state-owned enterprises.

2. Attention Paid by Analysts (AA)

Attention paid by analysts refers to the follow-up attention analysis conducted by analysts or analyst teams to listed companies over a certain period. Column (2) of Table 8 shows the moderating effect test on analyst attention. It can be seen that the regression coefficient of analyst attention (AA) is -0. 0001, the digital economy (x3) and analyst attention (AA) are significantly negative at 1%. Besides, analysts' attention and digital economy have a synergistic effect. The development of the digital economy provides advanced data analysis technology. As for analysts, their analysis tools become powerful, which enhances their ability to obtain information and increase the amount of information. The stronger their ability to analyze information, the more authentic enterprise information is obtained by analysts and disclosed to the market, which will reduce the information asymmetry inside and outside the company, eventually reducing stock price synchronization.

7. Conclusion and Enlightenment

Selecting Chinese A-share listed companies from 2011 to 2019 as research samples, this paper empirically tests the impact of the digital economy on stock price synchronization and the intermediary and adjustment mechanism of the digital economy inhibiting stock price synchronization. It is found that the development of the digital economy has a significant inhibitory effect on the synchronization of enterprise stock prices. The mediation effect test shows that the digital economy reduces stock price synchronization by inhibiting real earnings management. According to further research, compared with state-owned enterprises, the digital economy in non-state-owned enterprises has more significant synchronization with the stock price of enterprises. In addition, this paper uses variable substitution, instrumental variable test, sample reduction, one-time lag, and other robustness tests, and the research conclusions remain stable. The research conclusions have important enlightenment to listed companies, regulatory authorities, and investors. Based on the research conclusions, the following enlightenment is drawn.

First of all, for companies, especially non-state-owned enterprises, the digital economy can greatly alleviate the financial pressure and financing binding force faced by enterprises. Companies can conform to the trend of the times, strengthen and improve relevant supporting mechanisms, and join the wave of digital transformation. Meanwhile, apart from digging deep into the internal and external data of enterprises, they can make use of digital technology to disclose information of enterprise characteristics more conveniently, innovate financing methods, reduce the information asymmetry of enterprises, and the synchronization of stock prices to stabilize stock prices. There is no doubt that enterprises should recognize their current situation and the risks of the digital economy, and rationally leverage this technology for financing to achieve their strategic goals. Secondly, for regulators, it is necessary to further promote the development of the digital economy, innovate the supervision mode, help enterprises improve information transparency, and reduce the observation cost of investors, so as to provide a strong guarantee for the orderly and stable development of the market. At the same time, it is necessary to carry out stricter supervision for enterprises of different natures. For example, for state-owned enterprises, the digital economy does not play its due governance role, so it is necessary for regulators to add additional supervision means or improve the quality of external governance. Finally, for investors, it is necessary to conform to the development trend of digital economy and use digital technology to obtain more relevant characteristic information about enterprises. It is conducive to enhancing the accuracy and validity of investment evidence and fully preparing for investment decisions.

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