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The Impact of Artificial Intelligence on Enterprises' Accrual Earnings Management

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Abstract

Based on the data of A-share listed companies in Shanghai and Shenzhen from 2012 to 2022, this paper explores the impact and mechanism of artificial intelligence on the management of accrued surplus of listed companies. The empirical results show that artificial intelligence can inhibit accrual earnings management. It is further found through the mediation effect test that AI suppresses accrual earnings management by alleviating financing constraints and reducing management expense ratio. Finally, the results of heterogeneity analysis show that AI can inhibit the level of accrual earnings management in both state-owned and non-state-owned enterprises, but the inhibitory effect is more significant for enterprises in the eastern region.

Keywords

Artificial Intelligence; Earnings Management; Financing Constraints; Management Expense Ratio.

1. Introduction

Capital markets, as a core component of the modern economic system, play a crucial role in resource allocation, corporate financing, provision of investment opportunities and promotion of economic growth. However, due to the complexity of the global economic situation and increased market volatility, investors' confidence and expectations in the capital market have further weakened. In order to alleviate investor anxiety and promote healthy corporate development, earnings management, which functions as a means of communicating information about the future surplus and value characteristics of a company, has begun to serve as an effective means for the management of listed companies to achieve their goals. However, as the principal-agent conflict between shareholders and management continues to intensify due to the global economic downturn and declining corporate profitability, the non-opportunistic motives of management for earnings management, such as lowering contractual costs and transmitting information, have gradually shifted to opportunistic motives, and the phenomenon of information manipulation in listed companies has become more and more frequent, for example, the prevalence of unusual accruals in U.S. listed companies, the frequency of financial restatements, and the Macy's internal control Macy's internal control has been significantly flawed due to erroneous accruals responsible for accounting for small parcel delivery costs; European listed companies have a variety of real earnings management techniques and significant industry differences, Credit Suisse Group has been able to falsely inflate profits through the whitewashing of financial reports to cover up operational difficulties. Literature research has further found that [1], as an emerging economy, China, because of the late start, market system design imperfections and other issues, its capital market information transfer function is even weaker. Therefore, for the purpose of establishing a sound capital market to optimize resource allocation, help enterprises to raise funds, and enhance economic efficiency, how to further improve the information transfer function of the capital market to

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inhibit the earnings management behaviors with opportunistic motives has become an urgent problem to be solved by all countries.

Nowadays, with the rapid development of information technology, artificial intelligence has become one of the most disruptive forces, and is widely used in various fields of the international community, such as in the medical field, artificial intelligence algorithms to improve the diagnosis accuracy of major diseases; in the financial field, the application of artificial intelligence platforms to help banks automatically monitor the cash flow of the lending enterprises and assess the credit risk. In the capital market, AI has brought about the optimization of investment decision-making, risk management, and supervision and management, such as through the rapid processing of massive market data, providing investors with more comprehensive and accurate information to assist in investment decisions; through the real-time monitoring and analysis of market risks, it can more keenly identify potential risk factors and issue early warning signals in a timely manner; and through the real-time monitoring and analysis of trading data, it can quickly identify abnormal trading behavior. Through real-time monitoring and analysis of trading data, it can quickly identify abnormal trading behaviors and maintain the normal order of the market.

Regarding the research on earnings management, existing scholars have made a great deal of discussion. From the perspective of external environment, previous studies on the analysis of factors affecting earnings management mostly focus on institutional investors [2], customers and suppliers [3], analysts [4], auditors [5], media attention [6], etc., whereas from the perspective of internal environment, most of the studies focus on the board of directors' structure [7], shareholding structure [8], supervisory boards [9], audit committees [10], management [11] etc. In addition to this, new research has shown that digital transformation can curb corporate earnings management by mitigating the information asymmetry between firms and stakeholders, curbing management's short-sighted behavior, and increasing the transparency of information within firms [12]. However, compared to digital transformation, which is the process of using digital technology to make all-round changes to enterprise business models, processes, etc. to enhance competitiveness, AI is a technology that automates and intellectualizes specific tasks by simulating human intelligence. With the rapid development of information technology, nowadays, there are more and more researches on AI, for example, in terms of corporate environmental, social, and corporate governance (ESG) performance, AI significantly improves the ESG performance of a company, and it can continuously advance the ESG performance of a company by alleviating the financing constraints, strengthening the internal control, and improving the overall performance of the enterprise [13]; in terms of corporate social responsibility (CSR), although companies are able to bring more innovations to themselves through the use of AI technology, however, the innovations brought by AI also weaken the positive impact of CSR [14]; in corporate environmental information disclosure (EID), AI collects, integrates, and analyzes a large amount of data, which can help to accurately identify the needs of the government, customers, and suppliers for environmental information in order to promote the relevance of the disclosed environmental information [15]. However, most of the existing studies focus on whether AI technology can improve the performance of enterprises in ESG, CSR, and EID by strengthening the advantages of truthfulness and transparency of corporate disclosure, and few scholars pay attention to the impact of AI on the disclosure of internal accounting information of enterprises. Therefore, this paper takes this as a gap to further study the impact of AI on accrual earnings management of listed companies.

This paper empirically analyzes the impact of artificial intelligence on the management of accrual earnings management of listed companies based on the data of A-share listed companies in 2012-2022. The empirical results show that AI can inhibit the level of accrued

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earnings management of listed companies and realize it through the two paths of alleviating financing constraints and reducing management costs.

The contributions of this paper are that (1) previous studies have focused on the impact of AI on corporate disclosure in terms of ESG, CSR, EID, etc., and fewer have explored the impact of AI on corporate internal accounting disclosure, i.e., accrued earnings management. Based on this, this paper extends this theory; (2) the path of AI to suppress the level of earnings management by alleviating financing constraints and reducing overhead costs is different compared to digital transformation; (3) further, through the analysis of heterogeneity, it is found that AI is able to suppress the level of accrued earnings management in both state-owned enterprises and non-state-owned enterprises, but the suppression effect is stronger in the eastern region.

The remainder of this paper is as follows: the second part is the theoretical analysis and hypothesis formulation, based on the existing principal-agent theory, transaction cost theory, resource allocation theory and so on to put forward the core hypotheses of this paper; the third part is the research design of this paper, including the data source, the definition of the variables, the model setup; the fourth part is the empirical results; and the fifth part is the research conclusions and recommendations.

2. Research Hypotheses Proposed

2.1. The Impact of Artificial Intelligence on the Management of Accrual Earnings Management

Accrued earnings management is the behavior of the management of an enterprise on the basis of compliance with accounting standards, through the management and adjustment of the enterprise's accruals, so as to control or adjust the enterprise's externally reported information on accounting earnings in order to achieve a specific purpose. Although not all accrual earnings management is motivated by opportunism, corporate management is often influenced by a combination of factors from both the internal and external environments when engaging in accrual earnings management. From the perspective of the external environment, taking principal-agent theory as a logical starting point, the application of artificial intelligence technology can alleviate the information asymmetry between enterprises and institutional investors, customers, and suppliers, improve the transparency of information disclosure, and inhibit the management and adjustment of accruals by enterprises [2,3]; analysts and auditors are able to utilize AI technology to conduct in-depth analysis and auditing of financial as well as non-financial information of enterprises, establish a sound supervision mechanism, and conduct in-depth analysis and audit of accruals. auditing, establish a sound monitoring mechanism, and improve the quality of information disclosure [4,5]; and the media can track the dynamic information of enterprises in a timely manner through artificial intelligence technology, giving management more market pressure and suppressing its accrual earnings management behavior [6]. Based on this, the following research hypothesis is proposed:

H1: Other conditions remain unchanged, artificial intelligence can inhibit accrual earnings management.

2.2. Artificial Intelligence, Management Expense Ratio and Accrued Earnings Management

Management expense ratio reflects the enterprise's ability to control management expenses and the efficiency of operation and management. The lower the ratio, the better the enterprise does in management cost control and the higher the efficiency of resource utilization; on the contrary, it may mean that the enterprise has mismanagement, resource waste and other problems. Artificial intelligence can optimize the allocation of resources, improve the efficiency

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of resource utilization [16], so as to strengthen the supervision and analysis of management costs to reduce the management cost ratio. Firstly, AI can realize human-computer synergy to reduce management costs by accelerating integration with management activities; secondly, with the help of AI, it can more accurately match the needs of various departments within the enterprise, improve resource utilization efficiency through rational allocation of resources, and thus enhance the efficiency of operation and management; lastly, in the process of collecting data, analyzing data, and predicting the future, AI is also capable of timely handling of abnormal management expenses and find out the key points of expense control, so as to reduce the management expense rate. And the reduction of the enterprise management expense rate means the improvement of its enterprise operation and management level as well as profitability, and the management no longer needs to inflate the profit through the management of accrual earnings management; at the same time, the saved management expenses can be invested in research and development, marketing, etc., which can promote the business development and realize the smooth growth of profitability. Based on this, the following research hypothesis is proposed:

H2: Other conditions remain unchanged, artificial intelligence can restrain accrual earnings management by reducing the management expense ratio.

2.3. Artificial Intelligence, Financing Constraints and Accrued Earnings Management

Financing constraints refer to the various restrictions and obstacles faced by enterprises in the process of external financing, which make it difficult to obtain sufficient funds or need to pay higher financing costs. Artificial intelligence, as a product brought about by the new round of technological revolution in the field of science and technology, can alleviate financing constraints by alleviating the information asymmetry in the capital market in order to reduce the transaction costs of enterprises, broaden the financing channels of enterprises and improve the efficiency of financing [17,18]. Firstly, AI can collect and integrate information through multiple drivers to provide more comprehensive information for each demand side; secondly, AI can improve the level of enterprise specialization, thus reducing the search cost, transaction negotiation cost and losses caused by default of the transaction object; lastly, the application of AI reduces the investment threshold, attracting more investors while using algorithms for investors and capital demand side to Accurate matching is carried out, which not only broadens the financing channels of enterprises, but also improves the efficiency of financing. And when the financing constraints faced by enterprises are eased, the management no longer needs to manage and adjust accruals to whitewash the financial statements to obtain financing, which to a certain extent weakens the incentives for managers to manage the surplus; with the broadening of financing channels at the same time, the management will be subjected to more pressure from external supervision and market constraints, which increases the consequences of the enterprise to carry out irregularities that are detected. Therefore, management will be more cautious and more willing to improve the quality of information disclosure. Based on this, the following research hypothesis is proposed:

H3: All other conditions being equal, AI can inhibit accrual earnings management by alleviating financing constraints.

3. Research Design

3.1. Data Source and Sample Selection

In this paper, A-share listed companies in Shanghai and Shenzhen are selected as the initial research sample from 2012 to 2022, and the following exclusions are made: (1) the samples of listed companies in finance and insurance industry are excluded; (2) the samples that have had

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ST and *ST in the period of 2012-2022 are excluded; (3) the samples that have missing important variables and anomalies are excluded; (4) the samples that have all the continuous variables with 1% and 99% quantile shrinkage, and finally a total of 32,301 sample data are obtained. The data in this paper come from Wind database and WAND database.

3.2. Definition of Variables

(1) Artificial intelligence patents. The explanatory variable in this paper is artificial intelligence patents. In recent years, with the advent of the wave of China's artificial intelligence, China's A-share listed companies have applied for more and more patents related to smart chips, smart robots, etc., which not only bring greater economic benefits to the company, but also provide more impetus for the development of China's artificial intellectualization. Referring to the existing related research, this paper firstly screens the A-share listed companies in Shanghai and Shenzhen from the database of the State Intellectual Property Office of China; secondly, based on the key words and phrases containing automation, intelligence and other AI-related words and phrases, it carries out statistics on the number of artificial patents applied for by each company in the years of 2012-2022; lastly, it takes the natural logarithm taken by adding 1 to the number of AI patents applied for by A-share listed companies in Shanghai and Shenzhen in the same year and adds 1 to the number of patents applied for. Finally, the number of AI patents applied by Shanghai and Shenzhen A-share listed companies in the same year is added to the natural logarithm of 1 as an indicator to measure the AI patents.

(2) earnings management level. The explanatory variable in this paper is the level of earnings management, which is specifically measured by da (manipulative accrued profits) and dd (regression residuals).

Referring to the research of Dechowetal[19], this paper adopts the modified Jones model to calculate da (manipulative accrued profit), the specific model is as follows:

$$\frac{TA_{i,t}}{A_{i,t-1}} = \beta_0 \frac{1}{A_{i,t-1}} + \beta_1 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}} + \beta_2 \left(\frac{PPE_{i,t}}{A_{i,t-1}}\right) + \varepsilon_{i,t} \tag{1}$$

$$\frac{NDA_{i,t}}{A_{i,t-1}} = \hat{\beta}_0 \frac{1}{A_{i,t-1}} + \hat{\beta}_1 \frac{\Delta REV_{i,t} - \Delta REC_{i,t}}{A_{i,t-1}} + \hat{\beta}_2 \left(\frac{PPE_{i,t}}{A_{i,t-1}}\right) \tag{2}$$

$$DA_{i,t} = TA_{i,t} - NDA_{i,t} \tag{3}$$

TA is the total accrued profit, NDA is the non-manipulative accrued profit, A is the total assets of the firm, ΔREV is the change in operating income, ΔREC is the change in accounts receivable, and PPE is the net fixed assets. Finally, DA calculated by equation (3) is used as a measure of the company's earnings management level, which is denoted as da.

Drawing on the research of Patricia M.Dechow and Ilia D.Dichev[20], this paper adopts the DD model to regress liquidity accruals on cash flows from operating activities to obtain the degree of match between the company's accrued accounting profit and cash flows from operating activities. And use dd (regression residual) to measure the level of earnings management, the specific model is as follows:

$$\frac{WCA_{i,t}}{A_{i,t-1}} = \beta_0 + \beta_1 \frac{CEO_{i,t-1}}{A_{i,t-1}} + \beta_2 \frac{CFO_{i,t}}{A_{i,t-1}} + \beta_3 \frac{CFO_{i,t+1}}{A_{i,t-1}} + \varepsilon_{i,t} \tag{4}$$

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WCA is the change in working capital, CFO is the net cash flow from operating activities, and A is the total assets of the firm. Finally, the regression residuals calculated by (4) are used as a measure of the firm's level of earnings management, denoted as dd.

(3) Financing constraints and management expense ratio. The mediating variable in this paper is the management expense ratio of financing constraints.

Drawing on the research of Hadlock and Pierce[21], the SA index is constructed based on the total assets and the number of years on the market to measure the relative degree of financing constraints, and the smaller the SA index, the greater the degree of financing constraints faced by the enterprise.

Referring to the existing literature, the ratio of administrative expenses to operating income is used to measure the principal-agent cost. The larger the management expense ratio is, the higher the agency cost is.

(4) Control variables. Referring to the existing related studies, the following control variables are selected: gearing ratio, enterprise size, return on net assets, operating income growth rate, equity checks and balances, book-to-market ratio, large shareholders' fund utilization, whether the four largest, and the company's establishment years. The specific variable measurements are shown in Table 1.

Table 1. Variable Definition

Variable	Variable Name	Variable Symbol	Variable Definition
Independent Variable	Artificial Intelligence Patents	ai_patent	Natural logarithm of the number of AI patents filed by the company in the year plus 1
Dependent Variable	Earnings Management Level	da	Manipulated Accrued Profit DA calculated using the Modified Jones model
		dd	Regression Residuals ε calculated using the DD model
Mediating Variable	Financing Constraints	SA	SA Index constructed based on total corporate assets and number of years on the stock market
	Management Expense Ratio	Mfee	Administrative Expenses/Operating Income
Control Variable	Firm Size	size	Natural logarithm of the number of employees of the company
	Asset Liability Ratio	lev	Total Debt/Total Assets
	Return on Net Assets	roe	Net Income/Average Shareholder's Equity
	Operating Income Growth Rate	growth	Operating Income of the current year /Previous year's operating income-1
	Equity Checks and Balances	balance1	Proportion of second largest shareholders / Proportion of first largest shareholder
	Book-to-Market Ratio	bm	Carrying value / Total market capitalization
	Utilization of Funds by Majority Shareholders	occupy	Net other receivables / Total assets
	Whether Big Four	big4	The natural logarithm taken by the company being audited by the Big 4 (PwC, Deloitte, KPMG, Ernst & Young) as 1, otherwise 0
	Years of Firm Establishment	firmage	The current year less the year of the company's listing plus 1

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3.3. Model Construction

(1) Benchmark regression model

In this paper, a two-way fixed effects model is used in the following form:

$$da_{it} = \alpha_0 + \alpha_1 ai\_patent_{it} + \alpha_2 \sum Control_{it} + \alpha_3 Year + \alpha_4 \sum Industry + \varepsilon_{it} \quad (5)$$

$$dd_{it} = \beta_0 + \beta_1 ai\_patent_{it} + \beta_2 \sum Control_{it} + \beta_3 Year + \beta_4 \sum Industry + \varepsilon_{it} \quad (6)$$

da and dd denote earnings management level, and ai_patent denotes artificial intelligence patents. control denotes control variables, Year denotes yearly control effect, and Industry denotes industry control effect.

(2) Mediation effect model

In order to further test the mediation effect, based on (5), (6), the cross-multiplier term of earnings management level with financing constraints and management expense ratio is introduced, the specific model is as follows:

$$da_{it} = \delta_0 + \delta_1 ai\_patent_{it} + \delta_2 KZ_{it} + \delta_3 Mfee_{it} + \delta_4 KZ \times ai\_patent_{it} + \delta_5 Mfee \times ai\_patent_{it} + \delta_6 \sum Control_{it} + \delta_7 Year + \delta_8 \sum Industry + \varepsilon_{it} \quad (7)$$

$$dd_{it} = \gamma_0 + \gamma_1 ai\_patent_{it} + \gamma_2 KZ_{it} + \gamma_3 Mfee_{it} + \gamma_4 KZ \times ai\_patent_{it} + \gamma_5 Mfee \times ai\_patent_{it} + \gamma_6 \sum Control_{it} + \gamma_7 Year + \gamma_8 \sum Industry + \varepsilon_{it} \quad (8)$$

4. Empirical Analysis

4.1. Descriptive Statistics

Prior to the fixed effects regression analysis of the model, the main variables were analyzed with descriptive statistics and the results are shown in Table 2.

Table 2. Descriptive Statistical Analysis

Variable	N	Mean	SD	Min	Max	p25	p50	p75
da	30392	0.530	0.060	0.220	0.860	0.520	0.530	0.540
dd	30392	0.470	0.100	0.130	0.840	0.420	0.470	0.510
ai_patent	30392	0.300	0.650	0.000	3.090	0.000	0.000	0.000
size	30392	7.650	1.160	4.960	10.83	6.840	7.590	8.410
lev	30392	0.420	0.200	0.060	0.870	0.260	0.410	0.570
roe	30392	0.060	0.130	-0.560	0.340	0.0300	0.070	0.120
growth	30392	0.150	0.340	-0.510	1.810	-0.030	0.100	0.260
balance1	30392	0.360	0.290	0.010	0.990	0.120	0.280	0.580
bm	30392	0.620	0.250	0.130	1.180	0.430	0.620	0.800
occupy	30392	0.010	0.020	0.000	0.130	0.000	0.010	0.020
big4	30392	0.050	0.220	0.000	1.000	0.000	0.000	0.000
firmage	30392	2.930	0.320	1.950	3.530	2.710	3.000	3.180

First, the maximum value of the independent variable artificial intelligence patents (ai_patent) is 3.090, the minimum value is 0, and the mean value is 0.300, which indicates that there is a

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large difference in the level of artificial intelligence development of different listed companies. Second, for the dependent variable, the maximum value of manipulative accrual profit (da) is 0.860, the minimum value is 0.220, and the mean value is 0.530; while the maximum value of regression residual (dd) is 0.840, the minimum value is 0.130, and the mean value is 0.470, which indicates that the level of listed company's earnings management is higher, and that there is a large difference in the level of different company's earnings management, so there is a large correction space. Finally, each control variable is similar to the description of existing literature and will not be repeated here.

4.2. Regression Analysis

In order to verify H1, i.e., when other conditions remain unchanged, AI can inhibit accrual earnings management, model (1) is used to carry out fixed-effects regression analysis, and the results are shown in Table 3.

Table 3. Main Regression Analysis

	(1)	(2)
VARIABLES	da	dd
ai_patent	-0.004***	-0.004***
	(-5.77)	(-4.65)
size	0.003***	0.001
	(3.05)	(1.22)
lev	-0.013***	0.019***
	(-4.72)	(4.89)
roe	0.143***	0.081***
	(28.85)	(14.64)
growth	-0.007***	0.057***
	(-5.49)	(20.54)
balance1	-0.002	0.011***
	(-0.87)	(5.19)
bm	-0.004*	0.008**
	(-1.68)	(2.53)
occupy	0.025	-0.234***
	(0.74)	(-6.84)
big4	0.008*	-0.007***
	(1.85)	(-2.66)
firmage	-0.005**	-0.008***
	(-2.44)	(-3.51)
Constant	0.527***	0.459***
	(71.97)	(60.39)
Observations	30,391	30,391
R-squared	0.132	0.072
Year FE	YES	YES
Industry FE	YES	YES

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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The empirical results show that the independent variables ai_patent are all negatively significant at the 1% level, indicating that AI patents significantly reduce da and dd. thus AI is able to significantly inhibit the level of corporate accrued earnings management, and H1 is verified.

4.3. Robustness Test

(1) Replacement of explanatory variables. In order to verify the robustness of the results of the main regression analysis, this paper replaces the measurement of the level of artificial intelligence development, using the text of artificial intelligence patents to measure the level of development of artificial intelligence technology in listed companies.

Table 4. Substitution of Explanatory Variables

	(1)	(2)
VARIABLES	da	dd
ai_word	-0.002***	-0.002***
	(-3.51)	(-3.43)
size	0.002***	0.001
	(2.76)	(0.89)
lev	-0.013***	0.019***
	(-4.70)	(4.88)
roe	0.141***	0.080***
	(28.75)	(14.43)
growth	-0.007***	0.057***
	(-5.31)	(20.62)
balance1	-0.001	0.011***
	(-0.76)	(5.28)
bm	-0.004*	0.008**
	(-1.68)	(2.52)
occupy	0.028	-0.230***
	(0.82)	(-6.72)
big4	0.008*	-0.007***
	(1.80)	(-2.70)
firmage	-0.005**	-0.008***
	(-2.40)	(-3.50)
Constant	0.528***	0.461***
	(72.22)	(60.74)
Observations	30,391	30,391
R-squared	0.131	0.072
Year FE	YES	YES
Industry FE	YES	YES

As shown in Table 4, the independent variable Artificial Intelligence Patent Text (ai_word) is negatively significant at the 1% level, indicating that Artificial Intelligence significantly suppresses the level of corporate accrual earnings management, and therefore the results of the main regression analysis in this paper are robust.

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(2) Delete sample data. In order to further verify the robustness of the results of the main regression analysis, this paper firstly deletes the sample data affected by the new crown epidemic in 2021 and 2022, and re-performs the fixed effects regression analysis on the deleted data; secondly, deletes the sample data of Beijing, Shanghai and Shenzhen, and re-performs the fixed effects regression analysis on the deleted data.

Table 5. Deletion of Years and Cities

	Deletion of Years	Deletion of Years	Deletion of Cities	Deletion of Cities
VARIABLES	da	dd	da	dd
ai_patent	-0.005***	-0.007***	-0.002***	-0.004***
	(-5.85)	(-5.74)	(-3.58)	(-3.81)
size	0.003***	0.001	0.001	0.000
	(3.27)	(0.84)	(1.38)	(0.22)
lev	-0.014***	0.017***	-0.013***	0.018***
	(-4.49)	(3.68)	(-4.25)	(4.02)
roe	0.143***	0.072***	0.136***	0.079***
	(26.11)	(10.14)	(24.87)	(12.12)
growth	-0.009***	0.060***	-0.006***	0.055***
	(-6.43)	(18.00)	(-4.35)	(16.89)
balance1	-0.002	0.012***	-0.000	0.012***
	(-0.79)	(4.52)	(-0.02)	(4.85)
bm	0.001	0.014***	-0.005*	0.011***
	(0.31)	(3.32)	(-1.72)	(3.01)
occupy	0.031	-0.233***	0.034	-0.222***
	(0.87)	(-5.85)	(1.03)	(-5.52)
big4	0.009*	-0.008**	0.001	-0.007*
	(1.74)	(-2.47)	(0.20)	(-1.84)
firmage	-0.006***	-0.006**	-0.001	-0.010***
	(-2.69)	(-2.29)	(-0.71)	(-3.83)
Constant	0.524***	0.451***	0.526***	0.468***
	(64.70)	(48.53)	(75.15)	(50.97)
Observations	22,996	22,996	22,410	22,410
R-squared	0.141	0.064	0.136	0.072
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES

As shown in Table 5, the independent variables ai_patent are all negatively significant at the 1% level, indicating that AI significantly suppresses the level of firms' accrued earnings management, thus indicating that the results of the main regression analysis in this paper are robust.

(3) Lagged one-period independent variables. As the suppression of listed companies' earnings management needs a period of time to adjust for changes, the impact effect may have a certain time lag. Therefore, this paper lags the independent variables and control variables by one period for the robustness test. The results which are in Tables 6 and 7 show that the lagged one-period independent variables are still negatively significant at the 1% level, so the results of the main regression analysis in this paper are still robust.

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(4) Instrumental variables method. Considering the problems of joint causality and measurement error of the empirical results, after referring to previous studies, this paper adopts the median of ai_patent at the city-industry level (ai_patent-IV) as an instrumental variable for the robustness test, and the results are shown in Tables 6 and 7. In the first stage regression, the instrumental variable is positively significant at the 1% level, while in the second stage regression, ai_patent is negatively significant at the 1% level. According to the econometric theory, the instrumental variable is valid and further indicates that AI significantly suppresses the level of firms' accrual earnings management. Therefore, the results of the main regression analysis in this paper remain robust.

(5) PSM test. Considering the possible self-selection problem of the sample, the PSM test is used for robustness testing. In this paper, one-to-one nearest neighbor matching is used, and fixed effect regression is performed based on the matched samples when the matching effect is good. As shown in Tables 6 and 7, ai_patent is negatively significant at least at the 5% level, so the results of the main regression analysis in this paper are relatively robust.

Table 6. PSM, 2SLS, and Lagged One-Period Regression Results on da

	(1)	(2)	(3)	(4)
VARIABLES	PSM	Phase I	Phase II	Lagged One-period
ai_patent	-0.003**		-0.006***	-0.003***
	(-2.59)		(-4.99)	(-4.61)
ai_patent-IV		0.676***		
		(47.77)		

Table 7. PSM, 2SLS, and Lagged One-Period Regression Results on dd

	(1)	(2)	(3)	(4)
VARIABLES	PSM	Phase I	Phase II	Lagged One-period
ai_patent	-0.005***		-0.006***	-0.003***
	(-2.92)		(-2.67)	(-2.96)
ai_patent-IV		0.676***		
		(47.77)		

4.4. Mediation Effect Test

To verify H2 and H3, i.e., when other conditions remain unchanged, AI is able to inhibit accrual earnings management by alleviating financing constraints and lowering the management expense ratio, fixed effect regression analysis is conducted by applying models (2) and (3), and the results are shown in Table 8.

The results show that in columns 1 and 2 of Table 8, the cross-multiplier terms of AI patents and management expense ratio significantly suppress the level of firms' accrued earnings management, suggesting that AI is able to suppress firms' accrued earnings management by mitigating the management expense ratio.H2 is validated; in columns 3 and 4 of Table 8, the cross-multiplier terms of AI patents and financing constraint index significantly suppress the level of firms' accrued earnings management, suggesting that AI can suppress accrual earnings management by alleviating financing constraints.H3 is verified.

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Table 8. Mediation Effect Test

	(1)	(2)	(3)	(4)
VARIABLES	dd	da	dd	da
ai_patent	-0.004***	-0.004***	-0.004***	-0.004***
	(-4.98)	(-5.97)	(-4.67)	(-5.88)
Mfee	0.001	0.011*		
	(0.10)	(1.72)		
SA			-0.015**	0.031**
			(-2.01)	(2.31)
ai_patent×Mfee	-0.058***	-0.036***		
	(-4.25)	(-3.83)		
ai_patent×SA			-0.013***	-0.016***
			(-3.73)	(-4.05)
size	0.001	0.003***	0.001	0.002***
	(1.25)	(3.12)	(1.26)	(3.05)
lev	0.019***	-0.012***	0.019***	-0.014***
	(4.89)	(-4.39)	(4.99)	(-4.80)
roe	0.082***	0.145***	0.081***	0.143***
	(14.33)	(28.39)	(14.69)	(29.02)
growth	0.057***	-0.007***	0.057***	-0.007***
	(20.59)	(-5.20)	(20.52)	(-5.35)
balance1	0.011***	-0.002	0.011***	-0.002
	(5.16)	(-0.92)	(5.27)	(-1.06)
bm	0.009***	-0.003	0.008**	-0.003
	(2.72)	(-1.32)	(2.36)	(-1.21)
occupy	-0.236***	0.023	-0.230***	0.016
	(-6.89)	(0.67)	(-6.66)	(0.51)
big4	-0.007***	0.008*	-0.005**	0.007
	(-2.63)	(1.85)	(-2.14)	(1.50)
firmage	-0.008***	-0.005**	-0.018***	0.017*
	(-3.58)	(-2.50)	(-3.00)	(1.81)
Constant	0.458***	0.525***	0.430***	0.581***
	(58.29)	(69.59)	(28.90)	(27.55)
Observations	30,391	30,391	30,391	30,391
R-squared	0.073	0.133	0.073	0.136
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
r2_a	0.0696	0.130	0.0697	0.133
F	94.11	87.76	93.16	87.09

4.5. Heterogeneity Analysis

Considering that different regions and the nature of corporate ownership can lead to heterogeneity, it is necessary to test the stability of the research findings under different subsamples. In this paper, according to the nature of ownership of listed companies, listed companies are divided into state-owned enterprises and non-state-owned enterprises for fixed effects regression analysis.

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Table 9. Heterogeneity Analysis Results I

	SOEs	Non-SOEs	SOEs	Non-SOEs
VARIABLES	dd	dd	da	da
ai_patent	-0.005***	-0.003*	-0.002***	-0.007***
	(-4.121)	(-1.704)	(-3.484)	(-4.253)
size	0.001	0.002	-0.001*	0.009***
	(1.056)	(1.382)	(-1.646)	(4.989)
lev	0.031***	0.008	-0.004	-0.031***
	(5.896)	(1.253)	(-1.444)	(-4.826)
roe	0.083***	0.071***	0.137***	0.161***
	(11.774)	(7.179)	(24.313)	(15.733)
growth	0.061***	0.047***	-0.002	-0.016***
	(18.285)	(9.119)	(-1.460)	(-5.532)
balance1	0.013***	0.006*	0.000	-0.001
	(4.717)	(1.772)	(0.265)	(-0.230)
bm	0.013***	0.005	0.000	-0.016***
	(3.103)	(0.960)	(0.092)	(-2.683)
occupy	-0.262***	-0.188***	0.031	0.029
	(-5.686)	(-3.572)	(0.891)	(0.412)
big4	-0.008**	-0.005	-0.001	0.015**
	(-2.077)	(-1.319)	(-0.224)	(2.157)
firmage	-0.007**	-0.006	-0.000	-0.020***
	(-2.425)	(-1.391)	(-0.314)	(-3.480)
Constant	0.448***	0.453***	0.532***	0.542***
	(45.604)	(31.983)	(74.272)	(28.068)
Observations	19,440	10,356	19,440	10,356
R-squared	0.080	0.069	0.170	0.135

The results, as shown in Table 9, show that in state-owned enterprises, ai_patent can significantly suppress the level of accrued earnings management; while in non-state-owned enterprises, ai_patent is significant at least at the 10% level. This indicates that AI can suppress the level of accrued earnings management in SOEs and non-SOEs, which may be due to the fact that SOEs and non-SOEs are facing the same political, economic, and industry competitive environment, and both of them will engage in earnings management for reasons such as financial difficulties and principal-agent problems. With its powerful data mining and processing capabilities, AI can quickly collect internal and external information and continuously monitor daily transactions, making the financial status of enterprises and the information they disclose more transparent and further curbing opportunistic earnings management incentives. However, considering that the regression results of SOEs and non-SOEs based on the Modified Jones model and DD model still differ in regression coefficients and significance, it suggests that due to the advantages of SOEs in financing support and access to resources, the degree of influence of AI on the level of accrued earnings management of the two is different.

According to the place of registration of listed companies, listed companies are divided into eastern region enterprises and non-eastern region enterprises for fixed effects regression analysis.

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Table 10. Heterogeneity Analysis Results II

	Non-Eastern Region	Eastern Region	Non-Eastern Region	Eastern Region
VARIABLES	dd	dd	da	da
ai_patent	-0.002	-0.005***	-0.002*	-0.004***
	(-1.390)	(-4.236)	(-1.648)	(-5.333)
size	0.000	0.001	0.002	0.003***
	(0.094)	(1.027)	(1.577)	(2.600)
lev	0.011	0.023***	-0.020***	-0.010***
	(1.551)	(4.949)	(-3.597)	(-3.123)
roe	0.072***	0.084***	0.142***	0.142***
	(6.905)	(12.695)	(16.239)	(23.977)
growth	0.045***	0.063***	-0.006**	-0.007***
	(9.019)	(18.979)	(-2.479)	(-4.587)
balance1	0.014***	0.010***	0.001	-0.002
	(3.218)	(3.978)	(0.399)	(-0.926)
bm	0.010*	0.008**	-0.002	-0.005
	(1.763)	(1.990)	(-0.552)	(-1.600)
occupy	-0.305***	-0.198***	0.049	0.010
	(-5.452)	(-4.652)	(1.408)	(0.210)
big4	-0.014***	-0.005*	0.002	0.010*
	(-2.746)	(-1.757)	(0.196)	(1.931)
firmage	-0.009**	-0.007***	-0.000	-0.006**
	(-2.044)	(-2.782)	(-0.095)	(-2.531)
Constant	0.471***	0.455***	0.518***	0.528***
	(30.866)	(51.482)	(47.046)	(57.726)
Observations	9,049	21,340	9,049	21,340
R-squared	0.077	0.077	0.151	0.137

The results are shown in Table 10, in the eastern region enterprises, ai_patent can significantly inhibit the level of accrued earnings management; while in the non-eastern region enterprises, ai_patent is significant at most at the 10% level, indicating that the inhibition effect of AI on the level of accrued earnings management in the non-eastern region is weaker than that in the eastern region. This may be due to the fact that the eastern region has a higher level of economic development, not only the capital market is more mature, but also the market transparency and regulation is higher, so it is able to better use AI to inhibit the level of accrued earnings management.

5. Conclusion and Suggestions

Artificial intelligence, as one of the most disruptive forces in the information age, effectively suppresses the level of accrued earnings management of listed companies by means of alleviating financing constraints and reducing management expense ratio. Based on the data of A-share listed companies in Shanghai and Shenzhen from 2012 to 2022, this paper empirically tests whether artificial intelligence can inhibit the accrual earnings management of listed companies. The main conclusions are as follows: (1) AI suppresses the accrual earnings management of listed companies; (2) AI effectively suppresses the accrual earnings management of listed companies by alleviating the financing constraints and reducing the

management expense ratio; (3) AI can suppress the level of accrual earnings management of both SOEs(state-owned) enterprises and non-SOEs(non-state-owned enterprises), but the suppression effect is more significant for the enterprises in eastern region than those in non-eastern region.

Based on the above conclusions, this paper puts forward the following suggestions: (1) listed companies should increase their investment in artificial intelligence, and improve the level of artificial intelligence of enterprises through self-development or introduction of relevant artificial intelligence technology, so as to inhibit the level of company's accrued earnings management; (2) listed companies should learn to analyze the financing demand and the market environment with the help of artificial intelligence technology, formulate a reasonable financing strategy, broaden the financing channels and reduce financing costs and alleviate financing constraints. At the same time, the use of artificial intelligence technology to optimize the internal management process, identify and cut unnecessary management costs, and improve its operational efficiency; (3) For government departments, it is necessary to further use artificial intelligence technology to improve the supervision mechanism, and strengthen the audit and monitoring of financial and non-financial information of state-owned enterprises and non-state-owned enterprises, improve the transparency of information disclosure, and provide more and more reasonable resources for the non-eastern enterprises, and provide more and more reasonable resources for the non-eastern enterprises. enterprises to provide more and reasonable resources to reduce the accrual earnings management behavior.

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