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Does air pollution affect earnings management? Evidence from China

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ABSTRACT

By utilizing listed firms inand China from 2014 to 2018, this paper investigates how air pollution affects firms' accrual earnings management. Empirical results show that higher air pollution promotes a firm's earnings management. Next, we conduct a series of robustness checks, including a random discontinuity design regression and an instrumental variable regression; and confirm the causal effect of air pollution on companies' earnings manipulation behaviors. Our results indicate that air pollution affects earnings management by lowering labor productivity and strengthening executives' negative sentiments. In the additional analysis, air pollution transfers firms' real earnings management to accrual earnings management. Finally, we found that the positive effect of air pollution on earnings management is more pronounced in firms in low polluting industries and non-state-owned firms. In summary, our study not only enriches the literature on how the external natural environment reshapes firms' behaviors but also contributes to the literature on the determinants of firms' earnings management. Our research could also provide policy implications for developing countries to balance the relationship between environmental protection and economic development

1. Introduction

In most developing countries, rapid economic development and industrialization are associated with environmental pollution, especially air pollution. According to the 2018 Environmental Performance Index Report, which was constructed by Yale University and Columbia University, China's environmental performance ranks 120th out of 180 countries, and 20% of the deaths in China are associated with air pollution. In addition to physical health, air pollution could also reshape human sentiment and decisions (Qin and Zhu, 2018; Roback, 1982) and affect firms' behaviors (Shen et al., 2020; Tan et al., 2021; Wang et al., 2021a; Wang et al., 2021b; Zhang et al., 2021). Our paper intends to examine the impact of air pollution on firms' accruals earnings management.

Air pollution might reshape a firm's earnings management in two ways. First, air pollution is detrimental to labor productivity and increases operating costs (Chang et al., 2016; Graff Zivin and Neidell, 2012; Zhu et al., 2022). The existing literature shows that air

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pollution lowers employees' cognitive capacity and psychological concentration, finally resulting in lower productivity (Graff Zivin and Neidell, 2012; Heyes et al., 2016) and reducing firms' total factor productivity (Li et al., 2020). On the other hand, air pollution might affect managerial sentiment and finally change firms' earnings management. Previous studies show that air pollution could reshape investors' and funds managers' sentiment, thereby altering their risk preferences and lowering investment returns and volatility (Ding et al., 2021; Lepori, 2016; Wu et al., 2018). Besides, air pollution could also impact managerial sentiment and ultimately promote a firm's investment in social responsibility. Combining these analyses together, air pollution could reshape labor productivity and managerial sentiment and finally affect a firm's earnings management. Yao and Liu (2020) analyze the uncertainty of air quality and confirm that stronger uncertainty regarding air quality could promote a firm's downside earnings management. However, it is still unclear how air quality affects firms' earnings manipulation. Our studies enrich the research on the economic consequences of air quality and extend the external determinants of earnings management.

To investigate the relationship between air pollution and earnings management, we utilize Chinese listed firms from 2014 to 2018 as the research sample. China provides us with an appropriate background to examine the relationship between air pollution and earnings management. First, China experienced the highest economic development for decades, but the air quality became poorer (Han et al., 2014). According to the '2018 Environmental Performance Index Report', China's air quality ranks 120 out of 180 countries. Accordingly, China's air pollution data are an ideal setting for us to examine the impact of air pollution. Second, in China, different cities have longer spatial distances from other cities such that air pollution is unlikely to be transferred among cities (Wu et al., 2018). Consequently, our empirical results do not suffer from the interaction effects among cities. Third, the unique 'central heating system subsidies policy' of China provides us with the opportunity to conduct a random discontinuity design and address possible endogeneity concerns (Ebenstein et al., 2017). More specifically, China's government only provides subsidies for the central heating systems in the cities on the north side of Qin Mountain and the Huai River. Central heating systems burn huge amounts of coal and discharge massive amounts of air pollutants, such as PM2.5 and PM10. Thus, the air quality is poorer in the north side cities than south side cities, providing an ideal setting for a random discontinuity design.

Our paper contributes to previous studies in three ways. First, our research extends the literature on the consequences of air pollution. We reveal how air pollution could alter firms' financial decisions from the perspective of earnings management. Second, we enrich the studies about the determinants of earnings management. Our paper examines the determinants from the external environment and shows that the natural environment plays a crucial role in affecting firms' financial policies. Our results might enable governments and investors to value local environmental protection, thereby restricting firms' earnings management and improving the transparency of the capital market. Third, our studies reveal two new underlying mechanisms through which air pollution affects earnings management. Cho et al. (2021) indicates that air pollution reshapes firms' earnings manipulation by affecting executives' cognitive capacity and firms' legal environment. Our studies extend the channels and indicate that managerial sentiment and labor productivity are potential channels through which air pollution affects earnings management. We analyze the heterogeneity of the effect of air pollution. More specifically, our results divide the earnings manipulation into downtrends and uptrends and indicate that air pollution has substantial effects on both downside and upside earnings management. Next, our research also examines the impacts on real earnings management and implies that only accrual earnings management is affected. Besides, our paper investigates the impacts of state ownership and polluting industries on the relationship between air pollution and earnings manipulation. In summary, our studies have material differences from Cho et al. (2021) in both the underlying mechanisms and research designs. Thus, our studies further confirm the impact of air pollution on firms' earnings manipulation and substantially contribute to the existing literature. Finally, our study harnesses a typical developing country, China, as the research sample; and our results might provide policy implications for other developing countries to balance the relationship between economic development and environmental protection.

Our main results show that stronger air pollution promotes a firm's accrual earnings manipulation. Furthermore, we found that air pollution might affect firms' earnings management through two mechanisms. First, as most previous literature stated, air pollution impedes labor efficiency and increases labor costs (Chang et al., 2016; Graff Zivin and Neidell, 2012; Zhu et al., 2022). To keep earnings stable, firms might increase their earnings through earnings management. Second, poor air quality makes executives more depressed and conservative (Eisenberg et al., 1998; Kashdan et al., 2006; Lorian and Grisham, 2011; Maner and Schmidt, 2006). Consequently, managers are more likely to engage in earnings management to keep their earnings smooth. In addition, we examine which direction of earnings management is more likely to be affected by air pollution and indicate that firms are more likely to adjust their earnings higher. Next, our studies prove that earnings management is not transferred and that only accrual earnings management is affected by air pollution. Finally, we also explore the interaction effect of the polluting industry and state-owned enterprises (SOEs) and reveal that the relationship between air pollution and earnings management is more pronounced in nonpolluting industries and non-SOEs.

The remainder of this study is organized as follows. Section 2 reports the hypothesis development, and Section 3 introduces the data and main research methodologies. Section 4 shows the empirical results, and Section 5 offers the conclusions and remarks.

2. Hypothesis development

Based on previous literature, air pollution might reshape firms' earnings manipulation by two mechanisms. The first mechanism is that air pollution affects earnings management through managerial sentiment. In other words, the external natural environment could affect individuals' sentiment, thereby changing their investment behaviors (Chen et al., 2017; Dehaan et al., 2017). In a typical natural environment, air pollution not only damages physical health (Baccarelli et al., 2014; Beelen et al., 2014; Sørensen et al., 2014) but also makes individuals negative and depressed (Bullinger, 1989). As executives are the essential decision makers in firms, their sentiments have crucial effects on firms' decisions (Chen et al., 2017; Fu et al., 2018; Pun et al., 2017; Song et al., 2017). For example, Salhin et al.

(2016) show that managerial sentiment materially affects firms' stock performance and sector performance. Hribar et al. (2017) assess the banking industry and reveal that positive managerial sentiment would lower the estimated accruals for loan loss provisions. Stronger air pollution would cause managers to be more miserable and conservative (Eisenberg et al., 1998; Kashdan et al., 2006; Lorian and Grisham, 2011). Thus, when exposed to highly polluted air, executives would be more negative and conservative and finally establish more conservative financial policy (Aghion et al., 2013) to make earnings smoother. Thus, air pollution might promote earnings manipulation.

Another possible mechanism is that air pollution could lower employees' working efficiency and productivity, leading to higher operating costs. Previous studies indicate that air pollution is detrimental to labor efficiency (Chang et al., 2016; Graff Zivin and Neidell, 2012; Lavy et al., 2014). More specifically, poor air quality lowers citizens' willingness to travel and go out (Bresnahan et al., 1997; Sexton, 2011) and cognitive capacities (Arvin and Lew, 2012; Pun et al., 2017) and might cause physical diseases (Knittel et al., 2016; Yuyu et al., 2013). Moreover, stronger air pollution could encourage employees to apply for work leave and decrease their attention (Graff Zivin and Neidell, 2012), thereby impeding working time and efficiency. Besides, air pollution could affect staff's mental health and status, reducing labor productivity (Chen et al., 2017; Knittel et al., 2016). When exposed to poor air quality, workers might worry about their physical health (Chen et al., 2017; Graff Zivin and Neidell, 2012) and life happiness (Dolan and Laffan, 2016; Schlenker and Walker, 2016). Thus, employees would be tired of working and seek to delay their work (Fehr et al., 2017). Therefore, air pollution could increase the operating costs, and firms might engage in earnings management to offset the impact of higher labor costs.

Based on these arguments, we propose the following hypothesis:

H1. Higher air pollution causes firms to engage in more earnings management activities.

3. Data and methodology

3.1. Data and sample selection

To investigate the relationship between air pollution and companies' earnings management, we need data on air quality and financial data. The air quality information was collected from the China National Urban Air Quality Real-Time Publishing Platform.[2] Besides, we acquire the financial information of firms from the Chinese Stock Market and Accounting Research Database (CSMAR). Furthermore, we also obtain city-level economic development information from the China Urban Statistics Report. Finally, managerial sentiment information is acquired from the Chinese Research Data Services Platform (CNRDS), and information on city-level environmental employees is acquired from the China City Competitiveness Yearbook.

We choose Chinese public companies from 2014 to 2018 as the research sample. Our sample starts in 2014 because China has released official air quality index information for most cities since 2014. In the sample selection procedure, we excluded firms in financial industries since their operating and financial statements are materially different from those of other industries. Next, the firm-year observations in the first year after an IPO are dropped because the stock price in the IPO year usually experiences higher volatility. Then, we eliminate the firm-year observations with special treatments, including ST, *ST, and PT, because these firms faced a high risk of being delisted. Besides, we delete the observations with missing variables and abnormal variables, such as those financial leverage over 1. Finally, we acquire 9216 firm-year observations of 2527 firms from 2014 to 2018.[3] In addition, all the variables are winsorized at the 1% level to alleviate the impacts of outliers.

3.2. Variables

3.2.1. Measurement for earnings management

There are various methodologies to estimate accrual-based earnings management. Following recent studies, we mainly utilized the modified Jones model (Dechow et al., 1995) and forward-looking modified Jones model (Dechow et al., 2003) to estimate accrual earnings management. More specifically, we regress Eq. (1) and Eq. (2) using each industry and each year. Next, we utilize the absolute values of these regression residuals as the proxies of accrual earnings management.

In the equations, $TA_{i,\,t}$ is the total accruals, which is operating income minus operating cash flow. A is the total assets, $\Delta Rev_{i,\,t}$ is the change in operating revenue from year t-1 to year t, and $\Delta Rec_{i,\,t}$ is the change in the total accounts receivable from year t-1 to year t. PPE is the property, plant, and equipment. In Eq. (2), k is estimated by Eq. (3). $GRREV_{i,\,t+1}$ is the revenue growth rate in year t + 1.

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{\Delta Rev_{i,t} - \Delta Rec_{i,t}}{A_{i,t-1}} + \alpha_3\frac{PPE_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \tag{1}$$

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{\Delta Rev_{i,t} - (1-k)\Delta Rec_{i,t}}{A_{i,t-1}} + \alpha_3\frac{PPE_{i,t}}{A_{i,t-1}} + \alpha_4\frac{TA_{i,t-1}}{A_{i,t-1}} + \alpha_5\frac{GRREV_{i,t+1}}{A_{i,t-1}} + \varepsilon_{i,t} \tag{2}$$

$$\Delta Rev_{i,t} = \alpha + k\Delta Rec_{i,t} + \varepsilon_{i,t} \tag{3}$$

[2] The air quality information is available at http://www.mee.gov.cn/hjzl/.

[3] A key dependent variable EM2 requires the data in year t + 1; therefore, EM2 utilizes the information in year 2018.

To verify the robustness of the empirical results, we also use the Jones model (Jones, 1991) and performance-adjusted Jones model (Kothari et al., 2005) to estimate the manipulated accruals. We also regress Eqs. (4) and (5) by each industry and year and utilize the absolute value of the residuals as the measurement for manipulated accruals.

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{\Delta Rev_{i,t}}{A_{i,t-1}} + \alpha_3\frac{PPE_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \tag{4}$$

$$\frac{TA_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{\Delta Rev_{i,t}}{A_{i,t-1}} + \alpha_3\frac{PPE_{i,t}}{A_{i,t-1}} + \alpha_4\frac{Earnings_{i,t}}{A_{i,t-1}} + \varepsilon_{i,t} \tag{5}$$

Besides accrual earnings management, there is another type of earnings management: real earnings management (Roychowdhury, 2006). Companies could conduct earnings management in the following ways: (1) Increase production (PROD) and reduce marginal costs. Accordingly, the total production costs would be lower. (2) Increase sales by giving more sales discounts, leading to higher operating profits but a lower operating cash flow (CFO). (3) Lower discretionary expenses (DISEXP), including research and development (R&D) expenses, administration costs, and advertising expenses. Therefore, firms would lower their costs and acquire higher profits. We run the regressions in Eqs. (6) to (8) using each industry and year and employ the residual parts as the manipulation in OCF, PROD, and DISEXP. Finally, we calculate the total real earnings management by employing Eq. (9).

In these equations, $OCF_{i,\ t}$ is the total operating cash flow; $Sale_{i,\ t}$ is operating sales; $PROD_{i,\ t}$ denotes the total costs of selling goods and inventory; and $DISEXP_{i,\ t}$ represents the total research and development (R&D) expenses, administration costs and advertising expenses.

$$\frac{CFO_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{Sale_{i,t}}{A_{i,t-1}} + \alpha_3\frac{\Delta Sale_{i,t}}{A_{i,t-1}} + \varepsilon 1_{i,t} \tag{6}$$

$$\frac{PROD_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{Sale_{i,t}}{A_{i,t-1}} + \alpha_3\frac{\Delta Sale_{i,t}}{A_{i,t-1}} + \alpha_4\frac{\Delta Sale_{i,t-1}}{A_{i,t-1}} + \varepsilon 2_{i,t} \tag{7}$$

$$\frac{DISEXP_{i,t}}{A_{i,t-1}} = \alpha_0 + \alpha_1\frac{1}{A_{i,t-1}} + \alpha_2\frac{Sale_{i,t-1}}{A_{i,t-1}} + \varepsilon 3_{i,t} \tag{8}$$

$$REM_{i,t} = -\varepsilon 1_{i,t} + A\varepsilon 2_{i,t} - \varepsilon 3_{i,t} \tag{9}$$

3.2.2. Measurement for air pollution

We measure air pollution by using the air quality index (AQI). This index is collected from the China National Urban air quality real-time publishing platform and is constructed based on six types of air pollutants, including SO2, NO2, PM10, PM2.5, CO, and O3. A larger AQI index represents higher air pollution and lower air quality. Besides, we follow Han et al. (2014) and employ the density of PM2.5 as an alternative proxy measure for air pollution.

3.2.3. Control variables

To evaluate the impact of air quality on accrual earnings management, we calculate the regression in Eq. (10).

$$EM_{i,t} = \beta_0 + \beta_1 Air_{i,t} + \gamma Control_{i,t-1} + \delta_i + \theta_t + \varepsilon_{i,t} \tag{10}$$

δ_i represents the firm-level fixed effect, and θ_t denotes the year fixed effect. Regarding the control variables, we follow Kim et al. (2019) and Gao et al. (2019) to include firm-specific variables that are related to earnings management. First, we control Loss, which is equal to one if a firm experiences an operating loss because firms with operating losses are more likely to manipulate earnings (DeFond and Jiambalvo, 1991; Kim et al., 2019). Recent studies also show that large firms usually engage less in earnings management(Cho et al., 2021), so we control firm size (Size), which is the natural logarithm of total assets. To control the potential correlationship between sales growth and earnings management (Collins et al., 2017), we include sales growth (Growth) as the control variable. Previous studies show that cash flows have substantial effects on earnings manipulation (Kothari et al., 2005); accordingly, we incorporate the cash flow from operations (CFO), which is the total cash flow from operating activities scaled by total assets, in our model. Firm leverage (Leverage), which is the ratio of total liabilities to total assets, is controlled because high-leverage companies are more likely to manipulate earnings (Kim et al., 2019). The existing literature indicates that Big 4 auditors restrict a firm's accounting accrurals (Krishnan, 2003), so our model includes Big 4, which is a dummy variable that equals one if a firm is audited by one of the international Big Four auditors, including Deloitte, Ernst & Young, KPMG, and PricewaterhouseCoopers. State ownership, whether a firm's actual controller is the government, is included since state-owned enterprises are unlikely to manipulate earnings (Cheng et al., 2015). To control the potential correlationship between the largest shareholder and earnings management (Guo and Ma, 2015), our model incorporates the ownership of the largest shareholder (Top1), which is the shareholding percentage of the largest shareholder. Institutional shareholders could curb a firm's earnings management (Hadani et al., 2011), so we control institutional ownership, which is the total ownership percentage of institutional shareholders. Previous studies show that the characteristics of the board of directors, such as board size, the number of independent directors and the number of board meetings, (Gao et al., 2019; García-Meca and Sánchez-Ballesta, 2009) have material impacts on a firm's accounting accruals. Therefore, we control the impacts of board size (Bsize), which is the natural logarithm of the number of directors on boards; board independence (BInd), which is the ratio of independent directors to total directors on boards of directors; and board meetings (BMeet), which is the natural logarithm of the number of board of directors meetings. The variable analysts, which is the natural logarithm of one plus the number of analysts following the company, is controlled because firms with more analysts following them engage in less earnings manipulation (Yu, 2008).

To control the potential effect of regional economic environment on earnings management (Wang et al., 2015; Yung and Root, 2019), we control the GDP per capita, which is the gross domestic productivity per capita at the city level; the industrial ratio, which is the ratio of industrial GDP to total GDP; and GDP growth, which is the GDP growth rate at the city level.

4. Empirical result

4.1. Summary statistic

We present the descriptive statistics and Pearson correlation statistics for the main variables in Panel A and Panel B of Table 2. According to Panel A of Table 2, 10.2% of sample firms experience operating losses, 6.1% of companies are audited by international Big 4 auditors, and 37.5% of the companies are state-owned enterprises. In addition, sample firms have 20.3% sales growth, 4.2% operating cash flow relative to total assets, 7.057% institutional ownership, and 42.9% financial leverage and 37.4% of the directors are independent directors on average. For variable definition and details of their construction see Table 1.

In panel B of Table 2, the largest correlation coefficient among independent variables and control variables is 0.563 between Leverage and Size. This number is larger than 0.5 and might cause multicollinearity problems. To alleviate this concern, we calculate the variance inflation factors (VIFs) for the main regression, and the largest VIF is 2.36. This value is lower than the threshold of 10 (Ryan, 2009), implying that the multicollinearity problem is not serious in our paper.

4.2. Main regression results

In Table 3, the univariate regression results are shown in columns 1 and 3, and multivariate regression results are reported in columns 2 and 4. The adjusted R-squared is larger than 0.22, and all the models pass the F test at the 1% level, showing the relatively high explanatory power and significance of our model.

The coefficients of Air are positive and statistically significant, implying that a higher level of air pollution would drive more accrual earnings management. More specifically, a one standard deviation increase in air pollution would increase EM by approximately 46.56% (0.027/0.058 = 46.56%) and EM2 by 33.33% (0.018/0.054 = 33.33%) relative to the average level. These results

Table 1
Variable definition.

Variable	Definition
EM	Accrual-based earnings management, which is estimated by the modified Jones model and shown in section 3.2 (Dechow et al., 1995)
EM2	Accrual-based earnings management, which is estimated by the forward-looking modified Jones model and shown in section 3.2 (Dechow et al., 2003)
EM3	Accrual-based earnings management, which is estimated by the Jones model and shown in section 3.2 (Jones, 1991)
EM4	Accrual-based earnings management, which is estimated by the performance adjusted Jones model and shown in section 3.2 (Kothari et al., 2005)
REM PROD	The real earnings management in production costs, including the costs of sold goods and inventory
REM DISEXP	The real earnings management in discretionary spending or expenses, including R&D expenditures, advertising costs and sales and general administration costs
REM CFO	The real earnings management in the operating cash flow
REM	The total real earnings management, and it is calculated as *-REM CFO* + *REM DISEXP* + *REM PROD*
Air	The natural logarithm of the air quality index
Air2	The natural logarithm of the PM2.5 density
Distance	The city's latitude minus the latitude of the Qin Mountain and Huai River
Loss	A dummy variable that equals to one when a firm experiences operating losses
Size	The natural logarithm of a firm's total assets
Growth	The sales growth rate from year t-1 to year t
CFO	The total operating cash flow scaled by the total assets
Lev	The ratio of total liabilities to total assets
Big4	A dummy variable that equals to one if a firm is audited by one of the international Big Four auditors, including Deloitte, Ernst & Young, KPMG, and PricewaterhouseCoopers.
State	A dummy variable that equals to one if a firm is a state-owned enterprise
Top1	The shareholding ratio of the largest shareholders
IO	The percentage of total ownership of institutional shareholders
BSize	Board size, which is the natural logarithm of the number of directors on a board of directors
BInd	Board independence, which is the ratio of independent directors to total directors in firms
BMeet	Board meetings, which is the natural logarithm of the number of meetings of the board of directors
Analysts	Natural logarithm of one plus the number of analysts following the firm
GDP Per Capita	The natural logarithm of gross domestic productivity per capita (city level)
Indratio	The percentage of GDP of the industrial industry with respect to the total GDP of all industries (city level)
GDP Growth	The growth rate of GDP from year t-1 to year t (city level)

Table 2
Summary statistics.

Panel A description statistics

Variable	N	MEAN	SD	MIN	P25	P50	P75	MAX
EM	9216	0.058	0.061	0.000	0.018	0.040	0.075	0.387
EM2	9216	0.054	0.057	0.001	0.017	0.038	0.071	0.369
EM3	9216	0.057	0.060	0.001	0.018	0.039	0.075	0.367
EM4	9216	0.052	0.053	0.001	0.016	0.037	0.068	0.373
REM	9216	−0.002	0.199	−0.705	−0.092	0.018	0.114	0.535
REM PROD	9216	−0.002	0.109	−0.401	−0.050	0.007	0.057	0.345
REM DISEXP	9216	0.000	0.070	−0.137	−0.039	−0.011	0.018	0.317
REM CFO	9216	0.000	0.074	−0.326	−0.039	0.000	0.041	0.242
Air	9216	4.310	0.269	3.687	4.122	4.324	4.496	4.930
Air2	9216	3.821	0.337	2.839	3.589	3.834	4.051	4.596
Distance	9216	−1.977	6.109	−15.390	−5.390	−2.410	3.030	14.090
Loss	9216	0.102	0.302	0.000	0.000	0.000	0.000	1.000
Size	9216	22.320	1.232	19.930	21.450	22.150	23.030	26.240
Growth	9216	0.203	0.469	−0.559	−0.012	0.114	0.284	4.124
CFO	9216	0.042	0.073	−0.670	0.006	0.041	0.081	0.876
Lev	9216	0.429	0.203	0.046	0.266	0.420	0.582	0.876
Big4	9216	0.061	0.239	0.000	0.000	0.000	0.000	1.000
State	9216	0.375	0.484	0.000	0.000	0.000	1.000	1.000
Top1	9216	34.520	14.450	9.086	23.140	32.550	44.040	75.460
IO	9216	7.057	6.754	0.002	1.796	5.065	10.430	34.420
BSize	9216	2.134	0.197	1.609	1.946	2.197	2.197	2.708
BInd	9216	0.374	0.053	0.300	0.333	0.333	0.429	0.600
BMeet	9216	2.230	0.391	1.099	1.946	2.197	2.485	3.296
Analysts	9216	1.610	1.095	0.000	0.693	1.792	2.485	3.807
Per GDP	4902	11.320	0.437	9.407	11.050	11.470	11.650	12.200
Indratio	4902	42.010	10.600	19.260	35.300	43.880	49.880	67.110
GDP Growth	4858	8.199	1.516	4.950	7.100	8.000	9.000	19.200

Panel B: Pearson correlation analysis

	1	2	3	4	5	6	7
1. EM	1						
2. EM2	0.869***	1					
3. Air	−0.025**	−0.035***	1				
4. Loss	0.201***	0.194***	−0.018*	1			
5. Size	−0.077***	−0.075***	0.058***	−0.027***	1		
6. Growth	0.059***	0.063***	−0.045***	−0.050***	0.044***	1	
7. CFO	−0.130***	−0.138***	−0.012	−0.159***	0.048***	−0.046***	1
8. Lev	0.057***	0.059***	0.048***	0.094***	0.563***	0.023**	−0.091***
9. Big4	−0.046***	−0.051***	0.038***	−0.050***	0.369***	−0.029***	0.082***
10. State	−0.066***	−0.068***	0.134***	−0.001	0.363***	−0.124***	0.016
11. Top1	−0.037***	−0.031***	0.057***	−0.057***	0.240***	−0.026**	0.102***
12. IO	−0.007	−0.020*	0.013	−0.092***	0.139***	0.082***	0.055***
13. BSize	−0.064***	−0.070***	0.089***	−0.025**	0.266***	−0.040***	0.062***
14. BInd	0.029***	0.035***	−0.059***	0.016	−0.005	0.002	−0.041***
15. BMeet	0.079***	0.078***	−0.090***	0.017*	0.231***	0.159***	−0.161***
16. Analysts	−0.067***	−0.076***	0.024**	−0.155***	0.330***	0.099***	0.142***

Panel C: Pearson correlation analysis

	8	9	10	11	12	13	14	15
8. Lev	1							
9. Big4	0.123***	1						
10. State	0.295***	0.159***	1					
11. Top1	0.098***	0.167***	0.222***	1				
12. IO	0.029***	0.007	−0.044***	−0.133***	1			
13. BSize	0.165***	0.087***	0.265***	0.034***	−0.008	1		
14. BInd	−0.025**	0.042***	−0.062***	0.033***	0.014	−0.534***	1	
15. BMeet	0.251***	−0.009	−0.082***	−0.068***	0.109***	−0.048***	0.072***	1
16. Analysts	−0.026**	0.139***	−0.090***	0.047***	0.429***	0.069***	0.014	0.131***

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 3
The main regression results.

	(1)	(2)	(3)	(4)
Variables	EM	EM	EM2	EM2
Air	0.031***	0.027***	0.021**	0.018*
	(3.046)	(2.579)	(2.148)	(1.894)
Loss		0.037***		0.031***
		(11.237)		(10.425)
Size		−0.026***		−0.017***
		(−8.292)		(−5.428)
Growth		−0.001		−0.001
		(−0.267)		(−0.573)
CFO		−0.037		−0.036*
		(−1.556)		(−1.800)
Lev		0.023**		0.023**
		(2.270)		(2.331)
Big4		0.006		0.007
		(0.735)		(0.913)
State		−0.007		−0.009
		(−0.775)		(−1.018)
Top1		−0.000		−0.000
		(−0.454)		(−0.388)
IO		0.000*		0.000
		(1.846)		(0.534)
BSize		0.014		0.012
		(1.424)		(1.251)
BInd		0.026		0.031
		(0.946)		(1.159)
BMeet		0.004		0.002
		(1.615)		(0.828)
Analysts		0.002**		0.002*
		(2.148)		(1.674)
Constant	−0.075*	0.469***	−0.034	0.310***
	(−1.714)	(5.213)	(−0.829)	(3.464)
Observations	9216	9216	9216	9216
Adjusted R-squared	0.230	0.269	0.227	0.256
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	9.277	17.06	4.614	11.77

Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$

indicate that the impacts of air pollution are both statistically and economically significant. The coefficient of Air is negative and significant in panel B of Table 2. This coefficient only reflects the raw correlation relationship between Air and EM. These different results show that the omitted variables could affect the relationship between Air and EM and lead to endogeneity concerns (He and Tian, 2013). For example, the impact of Air on EM varies for different sized firms. Large firms are less likely to be affected by air pollution, and the empirical results show that large firms are less likely to engage in earnings management. Thus, firm size affects the relationship between air pollution and earnings manipulation. In other words, air pollution has a positive effect on earnings management. This result is in line with the findings of Cho et al. (2021) and confirms the promotional effect of air pollution on earnings manipulation. Because air pollution affects managers' decision making and labor productivity, firms exposed to high air pollution are more likely to manipulate earnings.

Regarding the control variables, Loss presents a positively significant coefficient, demonstrating that firms are eager to manipulate earnings when a firm experienced operating losses in the previous year. This result is consistent with previous studies (DeFond and Jiambalvo, 1991; Kim et al., 2019) and verifies that firms with operating losses have a stronger incentive to manipulate earnings. Negative earnings would impede a firm's image among investors, and firms with continuous losses would receive the '*special treatment* (ST)' designation in China. Accordingly, firms with operating losses are more likely to engage in earnings management. Size shows a negative coefficient, implying that larger firms are unwilling to engage in earnings management. This result is in line with Cho et al. (2021). A possible reason is that large firms are more likely to receive attention from investors and analysts, which restricts their earnings manipulation. The coefficient of Big 4 is positive, showing that firms audited by international Big 4 auditors are more likely to manipulate their earnings. This result is contrary to the traditional literature (Krishnan, 2003). A possible reason is that frequent accounting standard adjustments in China provide firms with more legitimate chances to manipulate their earnings so that Big 4 auditors cannot effectively identify the manipulation. Growth, CFO, Lev, State, Top1, IO, BSize, Bind, BMeet, and Analysts have nonsignificant coefficients, implying that sales growth, opearing cash flow, financial leverage, state ownership, ownership of the largest shareholder, institutional shareholders, board size, board independence, board meetings and analysts have no substantial effect on earnings manipulation.

4.3. Underlying mechanism

Previous results reveal the positive relationship between air pollution and earnings management. In this section, we further examine the possible underlying mechanism through employees and top executives.

As we stated in section 2, air pollution might lower employees' mental and physical health, leading to lower working efficiency and higher medical expenditures. If air pollution impedes a firm's labor productivity, then the impact of air pollution on earnings management should be stronger in firms with higher labor efficiency since the reduction potential is larger in these firms. We follow previous studies and utilize firm added value per staff member to measure labor productivity (LProd) (Delmas and Pekovic, 2013; Salis and Williams, 2010).

To verify this underlying mechanism, we conduct interaction analysis and present the results in panel A of Table 4. If employment productivity is a possible underlying mechanism, then it is expected that Air x LProd has a positive and significant coefficient. The coefficients of Air x LProd are positive and statistically significant, implying that the promotional effect of air pollution on earnings management is stronger in firms with high labor productivity. This result is consistent with our expectation and confirms that the impact of air pollution on earnings manipulation occurs through labor productivity. These results are also in line with previous studies showing that air pollution reduces labor productivity (Chang et al., 2016; Graff Zivin and Neidell, 2012; Lavy et al., 2014; Li et al., 2020). Air pollution is detrimental to the psychological and mental health of employees by lowering labor productivity and increasing operating costs. Accordingly, firms exposed to high air pollution are more likely to adjust their earnings.

Furthermore, air pollution might affect earnings management by affecting managers' sentiment. If air pollution promotes earnings manipulation by lowering managerial sentiment, then the effect of air pollution on accouting accurals should be stronger in firms with high managerial sentiment. The reduction potential for firms with high managerial sentiment is higher than that for firms with low managerial sentiment. Accordingly, the relationship between air pollution and earnings management should be more pronounced in

Table 4
Underlying mechanism analysis.

	(1)	(2)
Variables	EM	EM
Panel A: The impact of labor efficiency		
Air	0.024**	0.021*
	(2.360)	(1.958)
LProd	−22.369**	−19.328**
	(−2.302)	(−2.087)
Air x LProd	4.542**	4.184*
	(2.003)	(1.928)
Constant	−0.043	0.500***
	(−0.974)	(5.597)
Observations	9216	9216
Adjusted R-squared	0.244	0.274
Control	No	Yes
Year FE	Yes	Yes
Firm FE	Yes	Yes
F	11.95***	15.80***
Panel B: The impact of managerial sentiment		
Air	−0.827***	−0.782***
	(−3.243)	(−3.207)
Sentiment	−4.105***	−3.809***
	(−3.421)	(−3.350)
Air x Sentiment	0.922***	0.868***
	(3.368)	(3.325)
Constant	3.746***	4.013***
	(3.351)	(3.766)
Observations	9216	9216
Adjusted R-squared	0.231	0.270
Control	Yes	Yes
Year FE	Yes	Yes
Firm FE	Yes	Yes
F	7.208***	15.32***

Robust t-statistics in parentheses.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 5
Additional analysis.

Panel A: The impact on the direction of earnings manipulation.

	(1)	(2)	(3)	(4)
	Negative		Positive	
Variables	EM	EM2	EM	EM2
Air	0.011	0.012	0.048***	0.036***
	(0.863)	(0.893)	(3.668)	(2.922)
Observations	4850	4755	4366	4461
Adjusted R-squared	0.506	0.418	0.570	0.520
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	44.52	38.38	36.43	27.34

Panel B The impact on real earnings management

	(1)	(2)	(3)	(4)
VARIABLES	REM	REM_PROD	REM_DISEXP	REM_CFO
Air	−0.008	−0.022	0.002	−0.016***
	(−0.373)	(−1.512)	(0.201)	(−2.567)
Observations	9216	9216	9216	9216
Adjusted R-squared	0.803	0.615	0.811	0.860
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	108.2	24.86	10.09	207.9

Panel C The impact of polluting industry

	(1)	(2)	(3)	(4)
	Nonpolluting		Polluting	
Variables	EM	EM2	EM	EM2
Air	0.027**	0.020*	0.008	−0.002
	(2.362)	(1.922)	(0.366)	(−0.089)
Observations	7766	7766	1450	1450
Adjusted R-squared	0.279	0.266	0.211	0.196
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	13.75	9.950	4.443	3.692

Panel D The impact of state ownership

	(1)	(2)	(3)	(4)
	Non SOE		SOE	
Variables	EM	EM2	EM	EM2
Air	0.032**	0.032**	0.009	−0.012
	(2.130)	(2.297)	(0.651)	(−0.998)
Observations	5762	5762	3454	3454
Adjusted R-squared	0.274	0.268	0.263	0.235
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	14.29	11.06	6.319	3.383

Robust t-statistics in parentheses.
*** $p < 0.01$
** $p < 0.05$
* $p < 0.1$

firms with high managerial sentiment.

To examine this underlying mechanism, we conducted interaction analysis. Previous literature utilizes survey data to measure managerial sentiment (Hribar et al., 2017; Salhin et al., 2016). However, it is difficult to conduct a survey of all listed firms in China. Jiang et al. (2019) utilize the tone of financial statements, including 10-K and 8-K forms, to measure managerial sentiment for US listed firms. We follow Jiang et al. (2019) and conduct textual analysis of financial statements and utilize the ratio of negative words in financial statements as a proxy for managerial sentiment. We collect managerial sentiment information from the Chinese Research Data Services Platform (CNRDS). We utilize one minus the ratio of negative words as the final proxy for managerial sentiment (Sentiment) so that a higher value of Sentiment represents a more positive managerial sentiment.

In panel B of Table 4, the coefficients of Air x Sentiment are positively significant, implying that the impact of air pollution is more substantial in firms with high managerial sentiment. This result proves that managerial sentiment is an underlying mechanism through which air pollution promotes earnings management. This mechanism is consistent with previous studies and confirms that air pollution could affect managers' sentiment and finally reshape their decision making (Liu et al., 2019; Wu et al., 2020).

4.4. Additional analysis

4.4.1. The direction of earnings management

In this part, we examine the direction of earnings management that is more likely to be affected by air pollution. We divided the samples into two groups based on whether the residuals from Eqs. (1) and (2) were positive, and the results are presented in panel A of Table 5. Coefficients of Air are positive and significant in the positive group, showing that firms in highly polluted cities engage more in positive earnings manipulation. Air pollution makes executives more conservative (Eisenberg et al., 1998; Kashdan et al., 2006; Lorian and Grisham, 2011; Maner and Schmidt, 2006), so these managers are more likely to adjust their earnings to achieve a conservative financial policy (Aghion et al., 2013).

4.4.2. Is the earnings management transferred?

There are two main types of earnings management: accrual earnings management and real earnings management. Our results show that firms engage in accrual earnings management. Previous studies show that firms employ real earnings management as a substitute for accrual earnings management (Zang, 2012). A concern that accrual earnings management might be transferred to real earnings management arises. To alleviate this concern, we conduct the regression based on real earnings management and present the results in panel B of Table 5. Air presents negatively significant coefficients for REM_CFO, implying that air pollution reduces the real earnings management due to cash flows. Thus, some earnings management is transferred from real earnings management to accrual earnings management.

4.4.3. The impact of the polluting industry?

There might be a concern that the relationship between air pollution and earnings management would be affected by industrial pollution. In high polluting industries, expanding operations might produce more air pollutants, leading to poorer air quality. Thus, the relationship between air pollution and earnings management would suffer the reverse causality problems for high polluting industries.

To evaluate the impact of the level of pollution of industries, we conduct the main regression for high polluting and low polluting industries. After the 2012 'China haze' event, China restricted air pollutant emissions and focused on the cement, petrochemical, steel, nonferrous, thermal power, and chemical industries.[4] In panel C of Table 5, only low polluting industries present a significant coefficient, implying that the impact of air pollution on earnings management is more substantial in low polluting industries. Higher air pollution might represent the greater productivity of high polluting industries. Accordingly, the negative effect of air pollution on a firm's operations is nonsignificant, and companies would not engage in earnings management.

4.4.4. The impact of state ownership

In this part, we investigate the impact of state ownership on the promotional effect of air pollutants on earnings management. Acquiring earnings is only part of the mission of state-owned enterprises (SOEs). SOEs still need to improve social welfare, such as hiring more employees and paying more taxes (Boyd, 1995; Qunyan et al., 2005). Therefore, the incentive for earnings management is weaker for SOEs, and we should observe a more substantial effect of air pollution in non-SOEs. In panel D of Table 5, Air is statistically significant only for non-SOEs, showing that the impact of air pollution is effective only for non-SOEs. This result is also consistent with our expectations and in line with previous studies (Du et al., 2015), which show that earnings management is more pronounced in non-SOEs.

4.5. Robust check

4.5.1. Random discontinuity design

There might be some endogeneity concerns regarding our conclusions. For example, some climate characteristics, such as temperature, humidity, and sunshine, would affect air pollution and might also affect a firm's earnings management, leading to

[4] Based on 2012 CSRC industry classification, we define the following industries as the high polluting industries: B07, B08, B09, C25, C26, C28, C29, C30, C31, C32, D44.

endogeneity problems due to omitted variables. To address these concerns, we follow Ebenstein et al. (2017) and conduct a random discontinuity design by utilizing the Qin Mountain and Huai River (QMaHR) line in China. Cities on the north side of the QMaHR line can acquire subsidies for their 'central heating system' from the government. These systems burn massive amounts of coal and produce more PM2.5 and PM10, leading to poor air quality. Therefore, the north side of the QMaHR line has more air pollution than the south side. However, this system is unlikely to affect a firm's decision regarding earnings management. By utilizing the QMaHR line, we could implement a random discontinuity design to address endogeneity concerns.

The latitude of the QMaHR ranges from 33.03 to 34.25. We follow Yuyu et al. (2013) to set the median point 33.64 as the breakpoint and create a variable distance to represent the latitude difference of the city to the breakpoint. To be more specific, we harness the Fuzzy Random Discontinuity (FRD) and 2 SLS regressions to estimate the impact of the breakpoint. The equation is shown as following:

$$North_c = \begin{cases} 1, Distance_c \geq 0 \\ 0, Distance_c < 0 \end{cases} \tag{11}$$

$$Air_{i,t} = \alpha_0 + \alpha_1 North_{i,t} + \alpha_2 \mathrm{f}(Distance_c) + \alpha Control_{i,t-1} + \delta_i + \theta_t + \varepsilon_{i,t} \tag{12}$$

$$EM_{i,t} = \gamma_0 + \gamma_1 North_{i,t} + \gamma_2 f(Distance_c) + \gamma Control_{i,t-1} + \delta_i + \theta_t + \varepsilon_{i,t} \tag{13}$$

$$EM_{i,t} = \beta_0 + \beta_1 Air_{i,t} + \beta_2 f(Distance_c) + \beta Control_{i,t-1} + \delta_i + \theta_t + \varepsilon_{i,t} \tag{14}$$

where North_c is a dummy variable that equals one if a city is located the north side of the QMaHR line, and $\mathrm{f}(\mathrm{Distance}_c)$ is the polynomial function based on $\mathrm{Distance}_c$. Eqs. (12) to (13) are the first-stage regression, and Eq. (14) is the second-stage regression. By utilizing the rdplot command in Stata 14.2, we plot the figure around the breakpoint and show the results in Fig. 1. In panel A and panel B, there is a significant breakpoint at approximately 0. Both the AQI and earnings management increase significantly, and these results indicate that the QMaHR line exerts a significant effect on air pollution and earnings management. Next, we utilize the rd command in Stata 14.2[5] to estimate the bin length, and the results show that 2.3 degrees around the QMaHR line is an appropriate breakpoint. Thus, we reconduct the regression based on the firms located near 2.3 degrees around the QMahHR line and show the results in panel A of Table 6. Besides, a narrow bin would lose many samples, so we also conduct the regression based on 10 degrees, 15 degrees, and 20 degrees. In the results, all the coefficients of Air are positively significant, showing that air pollution materially promotes earnings management. These results prove that our conclusions are still valid after addressing the endogeneity concern.

4.5.2. Instrumental variable regression

To further resolve the possible endogeneity, we conduct an instrumental variable (IV) regression. We follow Tan et al. (2021) and Shen et al. (2020) to utilize the number of city-level environmental employees as the instrumental variable. We collect city-level environmental employees from the China City Competitiveness Yearbook. A city's number of environmental employees is positively correlated with air pollution because stronger air pollution needs more environmental workers to handle it. Furthermore, city-level environmental employees are unlikely to affect a firm's earnings management directly. Thus, we conduct the two-stage GMM regression and present the results in panel B of Table 6. The Cragg-Donald Wald F statistics in the two columns are larger than the 10% Stock-Yogo weak ID test critical value, implying that our IV regression does not suffer from a weak instrumental variable. The coefficient of Air is still positively significant, indicating that air pollution has a casual positive effect on earnings management. This result further confirms our conclusion and indicates that the impact of air pollution on earnings management is casual.

4.5.3. Quantile regression

Next, we include a new quantile regression in panel C of Table 6. The ordinary least squares (OLS) reflects the average reaction of the dependent variable to the independent variable, and this methodology is easily affected by extreme values. To address this concern, we follow Chen et al. (2020) and Jiang et al. (2020) and conduct a quantile regression based on the first quartile, second quartile, and third quartile. Air still possesses positively significant coefficients, verifying the robustness of our results.

4.5.4. With more control variables

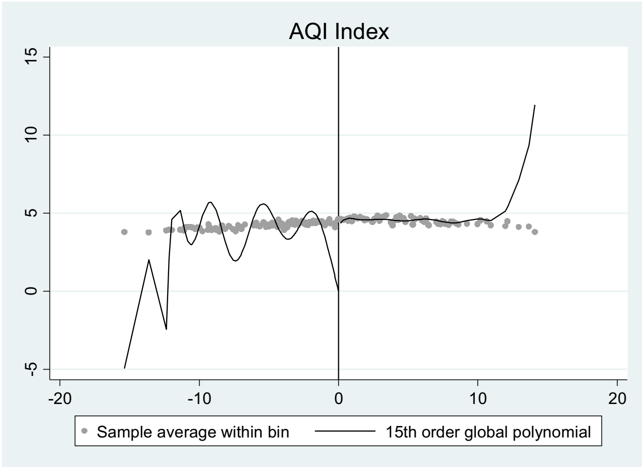
Another endogeneity concern is that regional-level characteristics might affect the regression results. For example, cities with high GDP per capita are usually associated with higher air pollution, and firms in these cities may be more likely to engage in earnings management. To alleviate these concerns, we include the province-year fixed effect to capture the provincial dynamic effect, as shown in columns 1 and 2 of panel D of Table 6. Besides, we also include the city-level GDP per capita, industrial ratio and GDP growth as the control variables, reported in columns 3 and 4 of panel B of Table 6. The coefficients of Air are still positively significant in all the columns. These results are consistent with the main results and verify the robustness of our conclusions.

4.5.5. Alternative measure for earnings management

We utilize the Jones model and performance-adjusted Jones model to estimate earnings management and reconduct the regression

[5] We did not utilize the rdplot to estimate the bin length because this command does not allow the control variables in the model.

Panel A: The discontinuity plot of AQI



Panel B: The discontinuity plot of earnings management (EM)

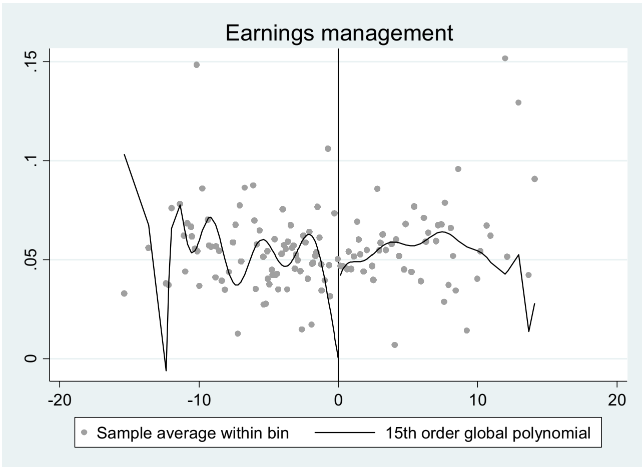


Fig. 1. Random discontinuity design.
Panel A: The discontinuity plot of AQI.
Panel B: The discontinuity plot of earnings management (EM).

in panel E of Table 6. Air presents significant and positive coefficients in all columns, indicating that air pollution promotes earnings management. This result is in line with previous results and confirms the robustness of our results.

4.5.6. *Alternative measure for air quality*

Finally, we employ the density of PM2.5 as the measure of air pollution and show the results in panel F of Table 6. The regression coefficients of Air2 are significantly positive in all the columns, demonstrating that air pollution further enhances accrual earnings management and provides further support for our conclusions.

5. Conclusions

By utilizing the data on public companies in China from 2014 to 2018, we investigate the causal relationship between air pollution and accrual earnings management. Our results show that firms engage in more earnings management when air pollution is stronger. This result is robust to alternative measurements for earnings management and air pollution and the random discontinuity design. Moreover, air pollution affects earnings manipulation by affecting managerial sentiment and labor productivity. This is reflected by the impact of air pollution being stronger in firms with higher labor productivity and lower negative managerial sentiments. In addition, we find that firms are more likely to positively manipulate earnings when air pollution is high. Then, we show that real earnings management is reduced by air pollution, indicating that earnings management is transferred. Finally, the relationship between air pollution and earnings manipulation is weaker in firms in polluting industries and state-owned firms.

Our studies extend the research on the externalities related to environmental quality. Poor air quality strengthens accrual earnings

Table 6
Robustness check.

Panel A: Regression discontinuity designs

	(1)	(2)	(3)	(4)	(5)	(6)
	5 degrees		10 degrees		20 degrees	
VARIABLES	EM	EM2	EM	EM2	EM	EM2
Air	0.028**	0.018*	0.027***	0.018*	0.027**	0.018*
	(2.366)	(1.680)	(2.585)	(1.930)	(2.562)	(1.908)
Observations	7350	7350	9207	9207	9214	9214
Adjusted R-squared	0.280	0.261	0.269	0.256	0.269	0.256
Control	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F	12.52	7.759	17.08	11.80	17.07	11.77

Panel B: Two-stage GMM regression

	(1)	(2)
Variables	EM	EM
Air	0.094**	0.073*
	(2.296)	(1.816)
Observations	6804	6804
Control	No	Yes
Year FE	Yes	Yes
Province FE	Yes	Yes
Weake idenfication test Cragg-Donald Wald F statistic	669.045	560.191
10% Stock-Yogo weak ID test critical value	16.38	16.38
F	5.272***	9.866***

Panel C: Quantile regression

	(1)	(2)	(3)
	Q1/4	Q1/2	Q3/4
Variables	EM	EM	EM
Air	0.023*	0.026**	0.030*
	(1.829)	(2.541)	(1.896)
Observations	9216	9216	9216
Control	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Panel D: With more control variables

	(1)	(2)	(3)	(4)
Variables	EM	EM2	EM	EM2
Air	0.051***	0.047***	0.083***	0.067**
	(2.662)	(2.615)	(2.599)	(2.127)
GDP Per Capita			0.007	0.001
			(0.130)	(0.020)
Indratio			0.000	−0.001
			(0.040)	(−0.369)
GDP Growth			0.001	0.002
			(0.747)	(1.489)
Observations	9214	9214	4858	4858
Adjusted R-squared	0.270	0.258	0.305	0.267
Control	Yes	Yes	Yes	Yes
Province x Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	16.65	11.44	3.905	2.127

Panel E: Alternative measure for earnings management

	(1)	(2)	(3)	(4)
Variables	EM3	EM3	EM4	EM4
Air	0.031***	0.027***	0.023***	0.020***
	(3.066)	(2.680)	(2.769)	(2.653)
Observations	9216	9216	9168	9168
Adjusted R-squared	0.230	0.267	0.243	0.342
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	9.401	16.68	7.666	29.72

Panel F: Alternative measure for air quality.

	(1)	(2)	(3)	(4)
Variables	EM	EM	EM2	EM2
Air2	0.024***	0.023***	0.015**	0.014**
	(3.372)	(3.099)	(2.239)	(2.121)
Observations	9216	9216	9216	9216
Adjusted R-squared	0.230	0.270	0.227	0.256
Control	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
F	11.37	17.38	5.013	11.86

Robust t-statistics in parentheses.
*** $p < 0.01$
** $p < 0.05$
* $p < 0.1$

manipulation, providing new evidence about how air pollution shapes companies' behaviors. Next, our research contributes to the determinants of earnings management. Most previous literature neglects the impact of the local environment, especially the air quality. Besides, our research reveals two new underlying mechanisms. Our results indicate that air pollution affects earnings manipulation through labor productivity and managerial sentiment, revealing how firms' earnings management could be affected by the local environment. Our results also provide policy implications for developing countries. Better air quality could restrict earnings management and improve accounting quality. Therefore, the government could strengthen environmental protection to alleviate firms' earnings management and improve stock market transparency.

Our studies still have some limitations. First, we hypothesize that air pollution could affect the mental and physical health of managers and ordinary employees. However, we did not prove these channels using a direct measure of the mental and physical health status of executives and staff. Next, some endogeneity concerns still exist, even though we tested the random discontinuity design. The wind direction, water supply, and managers' characteristics would affect the relationship between air pollution and earnings management. However, we cannot acquire these variables, and we cannot exclude the impacts of these factors.

CRediT authorship contribution statement

Dequan Jiang: Conceptualization, Methodology, Project administration, Validation, Resources, Funding acquisition. **Weiping Li:** Data curation, Software, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. **Yongjian Shen:** Software, Funding acquisition, Data curation, Writing – review & editing. **Shuangli Yu:** Methodology, Conceptualization, Writing – review & editing.

Declaration of Competing Interest

None.

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