Polluted IPOs

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Motivations

- The recent economics literature examines the effects of transitory air pollution on the productivity of workers and individuals.
  - ▶ Pear pickers (Chang, Zivin, Gross, and Neidell, 2016)
  - ▶ Students taking matriculation exams (Ebenstein, Lavy, and Roth, 2016)
  - ▶ Individuals buying health insurance (Chang, Huang, and Wang, 2018)
  - ▶ Call center workers (Chang, Zivin, Gross, and Neidell, 2019)
  - ▶ Retail investors (Huang, Xu, and Yu, 2020)
  - ▶ Garment factory workers (Adhvaryu, Kala, and Nyshadham, 2022)

This paper

Research question:

- Does air pollution affect the productivity of *high-stakes decision-makers in the economic system*?

Unique setting:

- Financial regulators approving Initial Public Offerings (IPOs) in China

Fine particulate matter (PM2.5) air pollution in Beijing

Beijing has suffered severe air pollution for years as a result of Huai River Policy.

Monthly PM2.5 at Xizhimen Station (closest to CSRC)

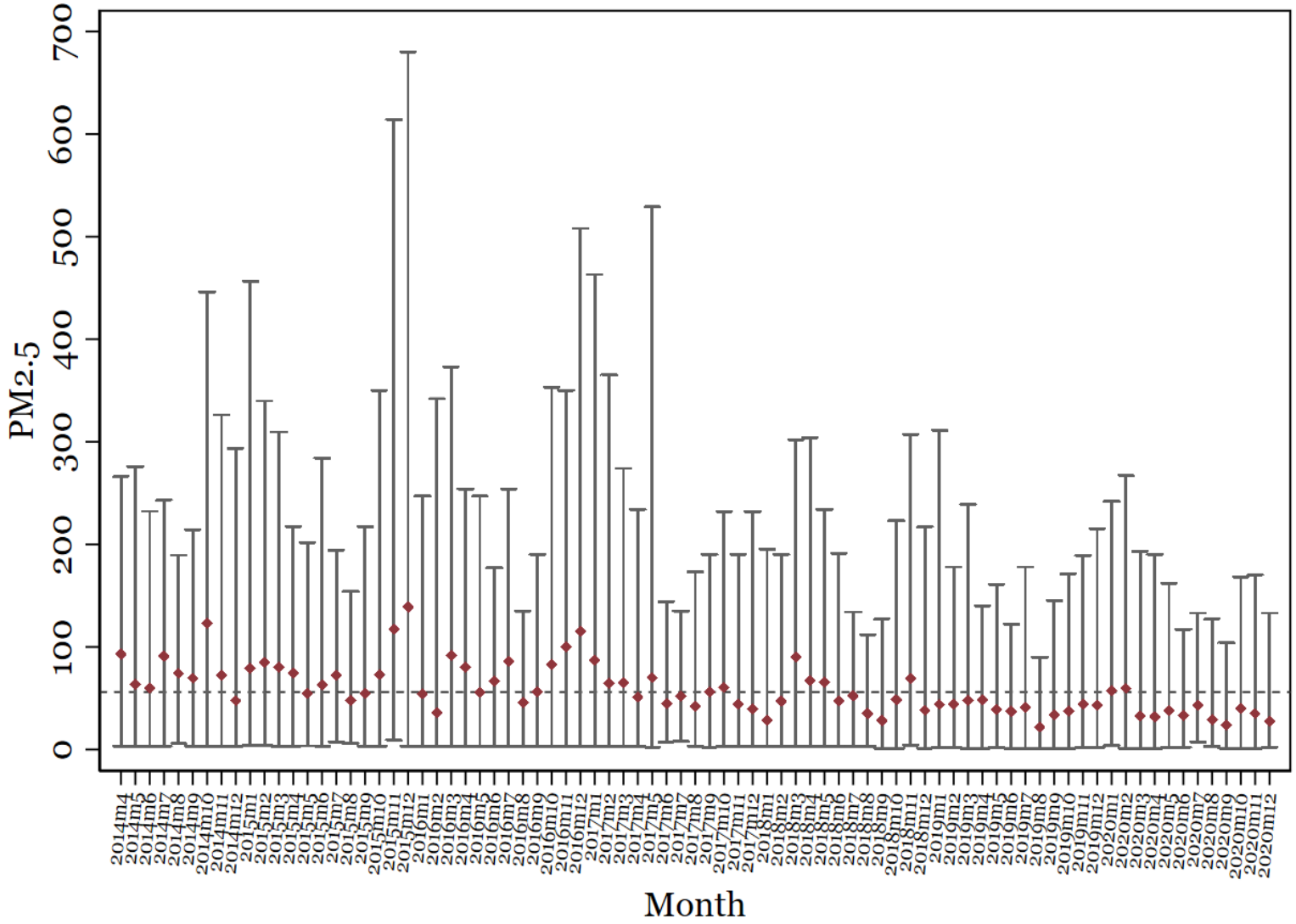
Chinese standards (PM2.5)

Good: <75 (*ug/M^3*)

Lightly polluted: 75-115

Heavily polluted: 115-150

Extremely polluted: >150

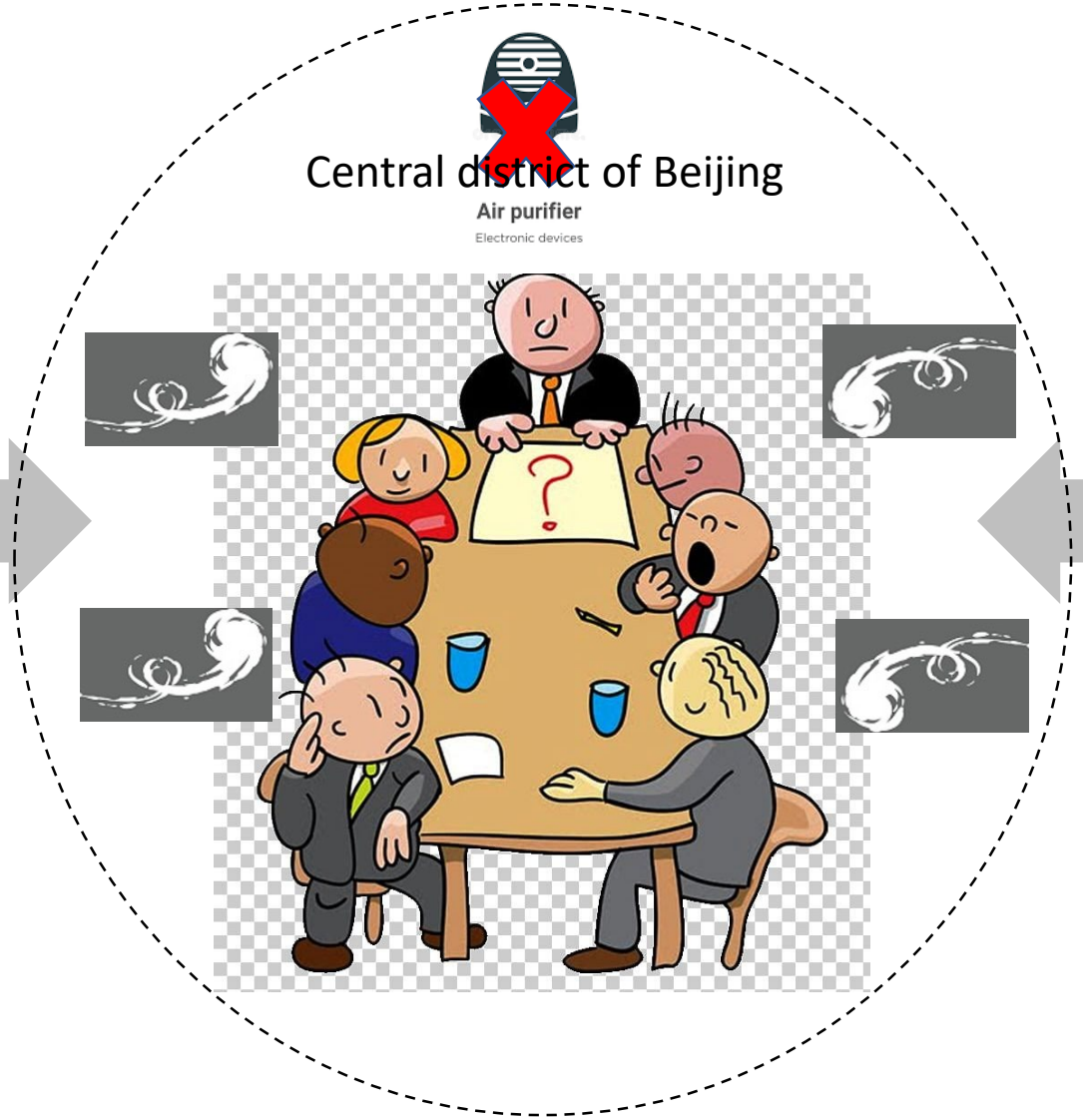


Regulatory approval for IPOs

- Firms going to the public in China must obtain approval from the Securities Regulatory Commission of China (CSRC) for their IPOs.

- *The final (key) step:* A review committee appointed by the CSRC organizes a Q&A session to determine whether to approval the IPO.
  - Seven members randomly selected from a pool of more than 60 members.
  - Some are full-time members of the CSRC and others are finance, accounting, and law professionals as well as academics.
  - Attendees are IPO firm's executives and underwriters.
  - The committee makes a final decision at the end of the meeting.

PM2.5 travels indoors



Identification in a nutshell

- Review committee composition randomly determined by the CSRC for each IPO using a lottery system.
  - No endogenous matching between firm and committee member
- Review date determined one week before the review; members cannot take leave of absence on the review day.
  - Because of zero correlation between PM2.5 on the review day and one week earlier, review members cannot prepare interviews differently.
- Industry, location, calendar quarter and committee chair fixed effects.
- Falsification tests using PM2.5 measured at different locations/times.
- Using wind speed as an IV.

How does transitory air pollution affect IPO approval?

- Exposure to PM2.5 reduces human *physical and cognitive capacity* (e.g., Brunekreef and Holgate, 2002; Ebenstein et al., 2016; Zhang et al.. 2018; Huang et al., 2020; and Adhvaryu et al., 2022)
  - ► Higher passing rate

- Exposure to PM2.5 imposes *psychological pressure and depresses mood* (e.g., Fonken et al., 2011; Bondy et al., 2020; Dong et al., 2021)
  - ► Lower passing rate

Main Findings

1. IPO approval rate is at least 4.5 pp higher on polluted days (12 pp higher on extremely polluted days).

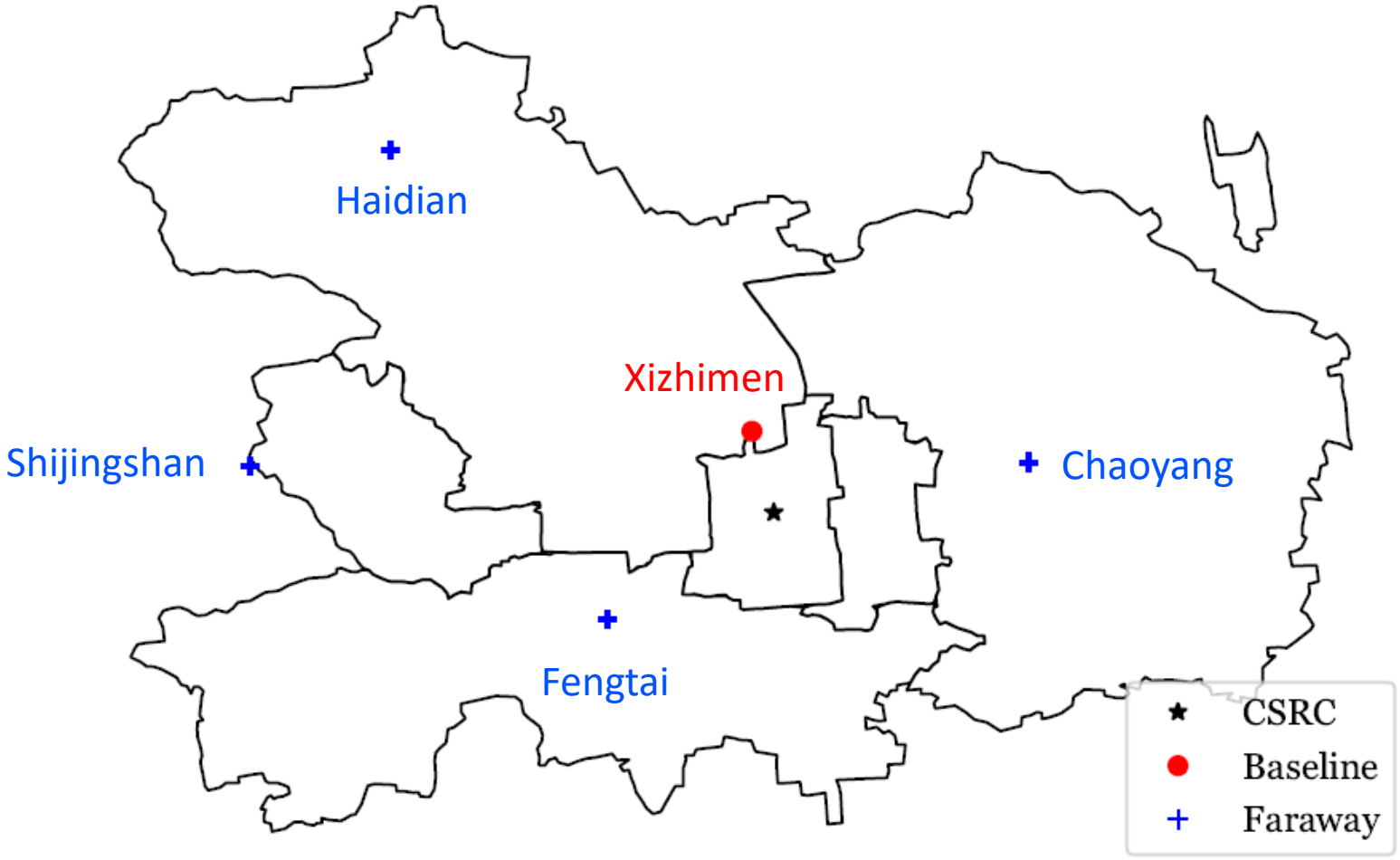
2. Firms in pollution (green) industries are less (more) likely to be approved on polluted days.

3. IPOs approved on polluted days have lower post-IPO abnormal stock returns and profitability (investors lost 28 billion RMB between 2014-2020.)

4. Mechanisms: cognitive capacity
   - Natural language processing of review questions: fewer, shorter, and less complex questions on polluted days
   - Effects stronger among reviewers who are not from Beijing or older.

5. Alternative mechanism: efforts
   - Review members who are close to reappointment exert more efforts.

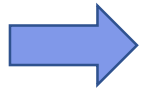
Location of PM2.5 Monitoring Stations in the Central Districts of Beijing



Empirical model

$$1[Passing\ review]_{i,t} = \beta PM2.5_{i,t} + \delta \mathrm{X}_{i,t} + \mu_s + \gamma_p + \theta_t + \lambda_c + \epsilon_{i,t}$$

- Dependent variable: indicator on IPO approval
- Firm controls: firm size, leverage, profitability, intangible assets, current ratio, SOE indicator, foreign ownership indicator
- Committee member controls: gender, full-time status, education, and experience.
- Weather controls: temperature and precipitation
- Fixed effects: industry, firm headquarters province, calendar quarter, and committee chairman
- No differences in univariate comparison



Chinese standards (PM2.5)

Good: <75 (*ug/M^3*)

Lightly polluted: 75-115

Heavily polluted: 115-150

Extremely polluted: >150

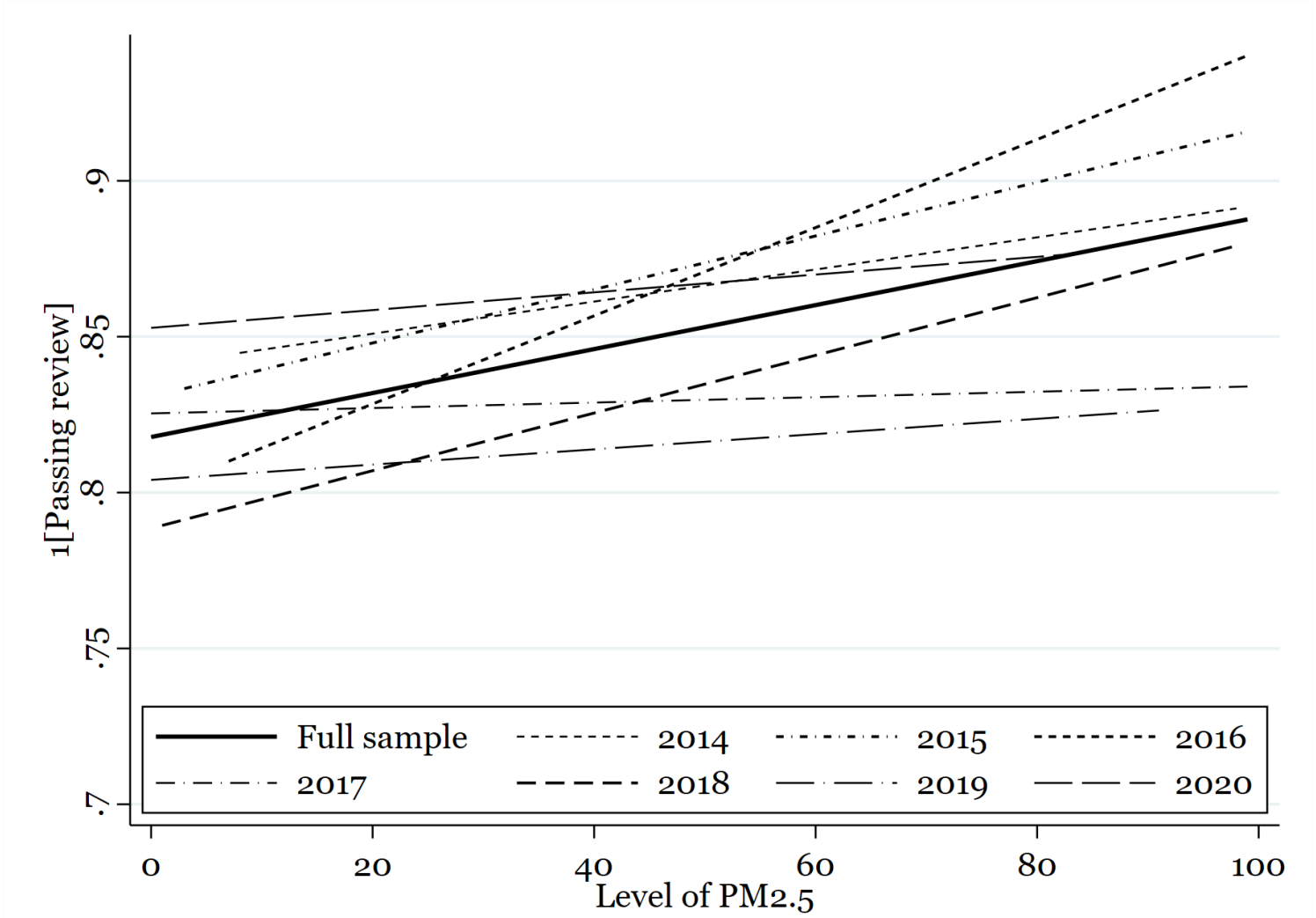
Dependent variable: 1[Passing review]

	Baseline	Month FE	Excluding stimulus period	Excluding pollution control Period	Excluding COVID period	Pollution intensity
	(1)	(2)	(3)	(4)	(5)	(6)
PM2.5	0.045***	0.043***	0.060***	0.059**	0.046***	
	(0.009)	(0.009)	(0.016)	(0.023)	(0.009)	
PM2.5 (75-115)						0.014
						(0.026)
PM2.5 (115-150)						0.060**
						(0.024)
PM2.5 (>150)						0.123***
						(0.034)
lnSales	0.063***	0.062***	0.064***	0.073***	0.067***	
	(0.011)	(0.010)	(0.013)	(0.024)	(0.012)	(0.011)
Profitability	0.674***	0.662***	0.730***	0.981***	0.672***	0.668***
	(0.133)	(0.132)	(0.150)	(0.191)	(0.141)	(0.133)
Leverage	0.088	0.082	0.041	0.054	0.077	0.086
	(0.056)	(0.058)	(0.069)	(0.064)	(0.060)	(0.056)
Intangibles	0.817***	0.859***	0.869***	0.647	0.918***	0.800***
	(0.144)	(0.153)	(0.219)	(0.405)	(0.157)	(0.142)
CurrentRatio	-0.002	-0.002	-0.008	-0.007	-0.003	-0.002
	(0.004)	(0.005)	(0.007)	(0.005)	(0.004)	(0.004)
1[SOE]	-0.037	-0.045	0.022	0.094*	-0.052*	-0.035
	(0.027)	(0.027)	(0.040)	(0.048)	(0.028)	(0.027)
1[Foreign]	-0.025	-0.023	-0.049	-0.013	-0.035	-0.026
	(0.039)	(0.036)	(0.048)	(0.052)	(0.043)	(0.039)
1[FirstReview]	-0.100***	-0.099***	-0.097***	-0.077**	-0.110***	-0.100***
	(0.024)	(0.025)	(0.026)	(0.031)	(0.033)	(0.024)
Temperature	0.002	0.002	0.003*	0.004*	0.002	0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
1[Rain]	0.023	0.014	0.024	-0.015	0.022	0.021
	(0.016)	(0.019)	(0.024)	(0.042)	(0.016)	(0.016)
1[Female]_mean	0.001	-0.004	0.031	0.107	-0.015	-0.001
	(0.041)	(0.038)	(0.047)	(0.080)	(0.042)	(0.040)
1[Fulltime]_mean	-0.223*	-0.227*	-0.790***	-	-0.219*	-0.222*
	(0.112)	(0.122)	(0.171)	-	(0.112)	(0.113)
1[Bachelor]_mean	-0.020	-0.021	-0.011	-0.003	-0.023	-0.019
	(0.013)	(0.014)	(0.021)	(0.030)	(0.014)	(0.013)
Experience_mean	0.081***	0.093***	0.072	0.046	0.087***	0.082***
	(0.024)	(0.025)	(0.047)	(0.129)	(0.023)	(0.023)
Industry FE	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y	Y	Y
Observations	1,488	1,487	905	464	1,296	1,488
Adjusted R^2	0.357	0.359	0.396	0.551	0.356	0.357

Robustness Checks

- Annual regressions
- Falsification tests
- Dynamic effects
- IV regressions

Annual regressions



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Falsification tests

Dependent variable: 1[Passing review]		
	Distance	Time
	(1)	(2)
PM2.5	0.088*	0.035**
	(0.046)	(0.014)
PM2.5_East Beijing	-0.042	
	(0.045)	
PM2.5_West Beijing	-0.074	
	(0.049)	
PM2.5_South Beijing	0.029	
	(0.028)	
PM2.5_North Beijing	0.040	
	(0.042)	
PM2.5_night		0.018
		(0.012)
PM2.5_dawn		-0.003
		(0.017)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	1,488	1,488
Adjusted R^2	0.356	0.356

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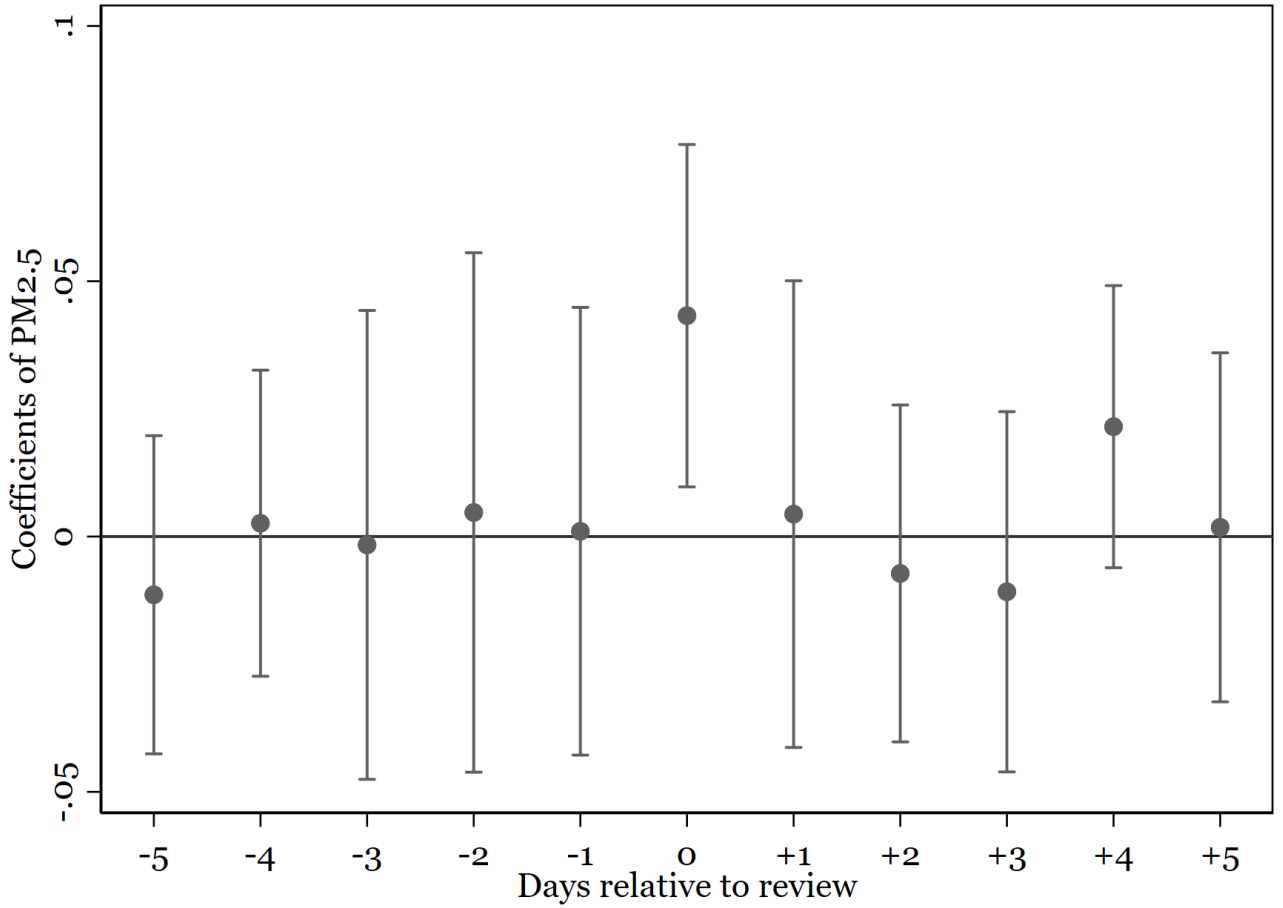
Dynamic effects



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Instrumental variable regressions

$$PM2.5_{i,t} = \beta_0 lnWindspeed_{i,t} + \beta_1 lnWindspeed_{i,t-1} + \delta X_{i,t} + \mu_s + \gamma_p + \theta_t + \lambda_c + \epsilon_{i,t}$$

$$1[Passing\ review]_{i,t} = \beta \hat{PM2.5}_{i,t} + \delta X_{i,t} + \mu_s + \gamma_p + \theta_t + \lambda_c + \omega_{i,t}$$

- IV: wind speed on the review day and the day before
- Alternative IV: average of wind speed of both days

- Relevance: strong wind helps dilute pollutant density in the air
- Exclusion: wind should not directly affect review as it is held indoors

IV results

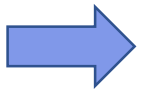
Instrument variables	$ln(Windspeed_t)$ & $ln(Windspeed_{t-1})$		$ln(AverageWindspeed)$	
	1st stage	2nd stage	1st stage	2nd stage
	(1)	(2)	(3)	(4)
$ln(Windspeed_t)$	-0.258***			
	(0.066)			
$ln(Windspeed_{t-1})$	-0.430***			
	(0.073)			
$ln(AverageWindspeed)$			-0.662***	
			(0.099)	
PM2.5		0.072**		0.071**
		(0.030)		(0.032)
Control variables	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y
F-stat	23.55***		44.77***	
Observations	1,488	1,488	1,488	1,488
Adjusted R^2	0.287	0.0379	0.282	0.0382

Salience bias: heterogeneous effects by firms' industries

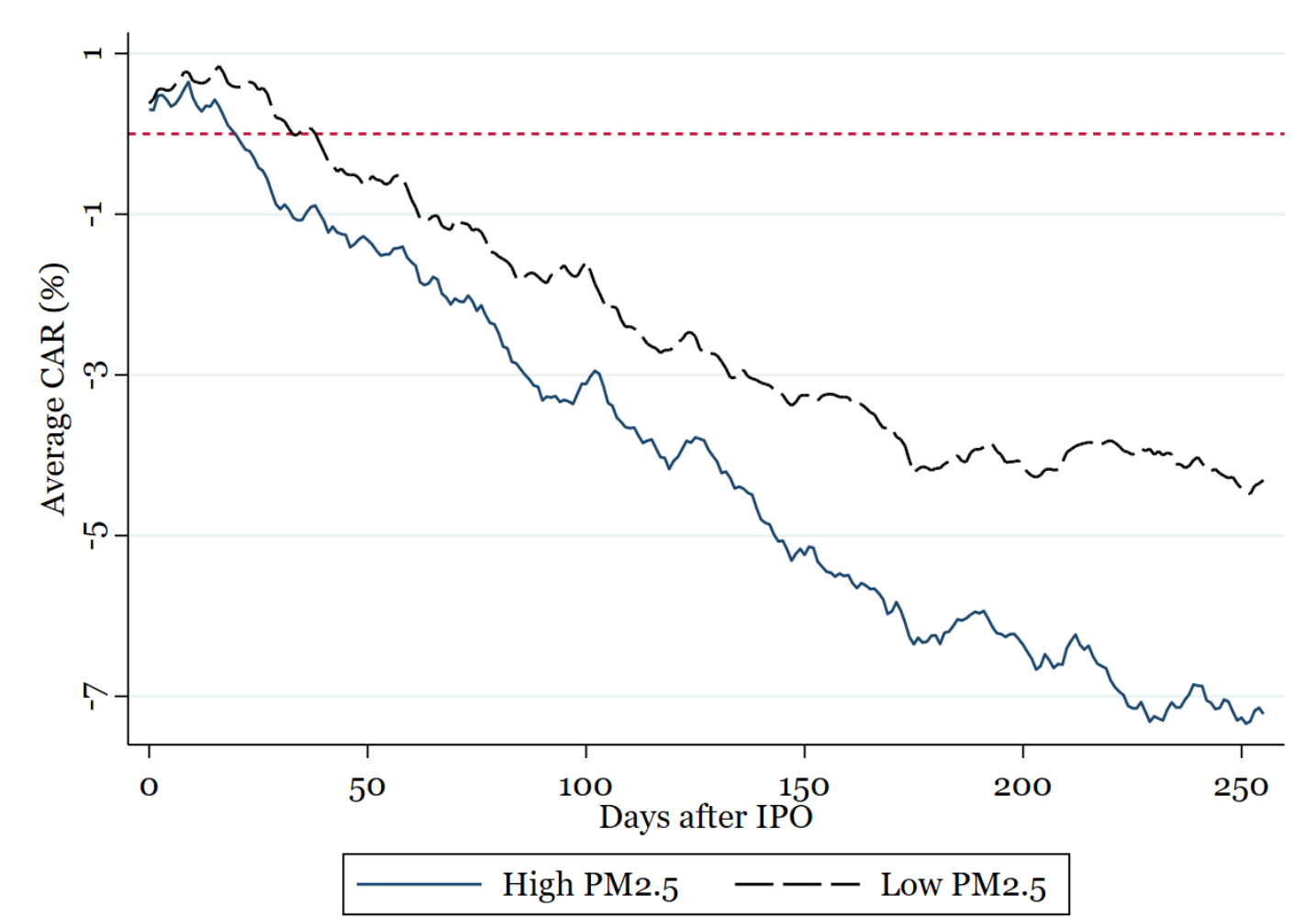
Dependent variable: 1[Passing review]				
Key Indicator:	1[Polluting industries]		1[Green industries]	
	(1)	(2)	(3)	(4)
PM2.5	0.045***	0.050***	0.045***	0.039***
	(0.009)	(0.010)	(0.009)	(0.008)
Key Indicator	-0.000	0.027	-0.019	-0.086
	(0.020)	(0.029)	(0.067)	(0.080)
PM2.5 * Key Indicator		-0.054**		0.153**
		(0.027)		(0.065)
Control variables	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y
Observations	1,488	1,488	1,488	1,488
Adjusted R^2	0.356	0.356	0.356	0.359

Operating performance and stock performance

Dependent Variable:	1yr CAR	Profit Margin	ROE	EPS
	(1)	(2)	(3)	(4)
PM2.5	-0.053***	-0.016*	-0.631*	-0.034*
	(0.018)	(0.009)	(0.370)	(0.019)
Control variables	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Province FE	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y
Observations	1,041	1,203	1,203	1,133
Adjusted R^2	0.141	0.082	0.199	0.078

Results robust to controlling for PM2.5 on first trading day 

Post-IPO stock performance



Mechanisms

- Evidence consistent with the interpretation that the review committee members' decision-making quality is worse on polluted days, likely as a result of the effect of air pollution on *cognitive capability* rather than *mood*.

- Two sets of tests to further pin down this channel:
  - Textual analysis of questions raised during the review session
  - Review member heterogeneity

Natural language processing

- Use latent Dirichlet allocation (LDA) model of natural language processing to extract the essence of each question during the review session.
- Identify top 2,000 words for the analysis
- Determine the number of topics according to the Perplexity score
- Final number of topics is set to 8.

Analysis of review questions

Dependent variable:	Total number of questions	Length of questions	Number of topics	Number of follow-up questions	1[Complex > Intuitive questions]	Complex questions (%)
	(1)	(2)	(3)	(4)	(5)	(6)
PM2.5	-0.460*	-34.730***	-0.009	-0.142**	-0.054**	-0.032***
	(0.259)	(10.933)	(0.061)	(0.060)	(0.022)	(0.010)
Control variables	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y
Province FE	Y	Y	Y	Y	Y	Y
Quarter FE	Y	Y	Y	Y	Y	Y
Chairman FE	Y	Y	Y	Y	Y	Y
Observations	1,173	1,173	1,173	1,172	1,172	1,172
Adjusted R^2	0.564	0.564	0.564	0.564	0.0862	0.0723

Review member heterogeneity

Dependent variable: 1[Passing review]		
Key Indicator:	Non-Beijing resident	Elder
	(1)	(2)
PM2.5	0.029***	0.017***
	(0.007)	(0.006)
Key Indicator	-0.012*	-0.003
	(0.006)	(0.005)
PM2.5 * Key Indicator	0.012*	0.016**
	(0.007)	(0.007)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	9,024	4,195
Adjusted R^2	0.380	0.591

Evidence on the lack of efforts

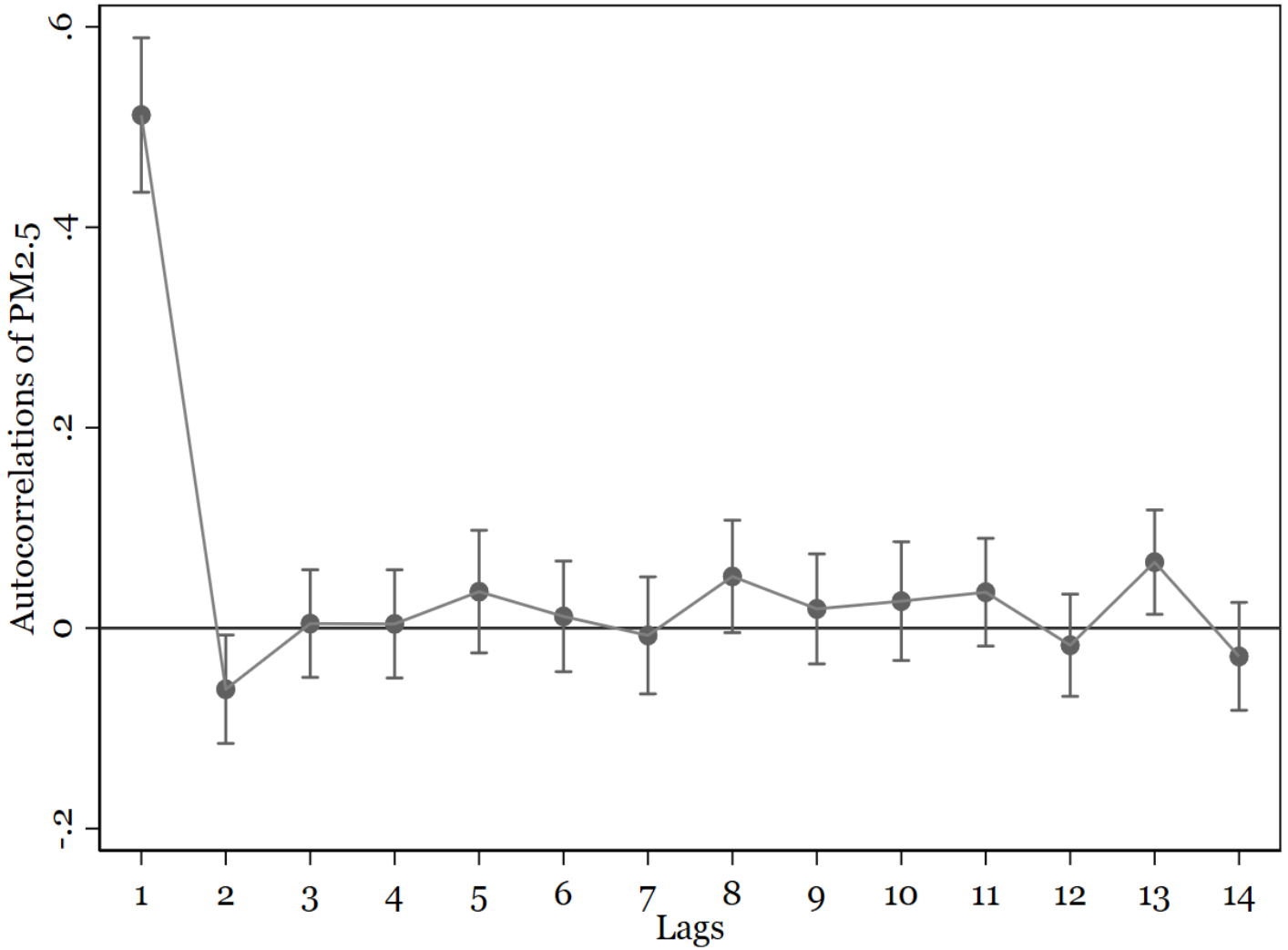
Dependent variable: 1[Passing review]		
Key Indicator:	1[Before reappointment]	
	(1)	(2)
PM2.5	0.039***	0.052***
	(0.008)	(0.014)
Key Indicator	0.041	0.042
	(0.029)	(0.029)
PM2.5 * Key Indicator	-0.080**	-0.082**
	(0.035)	(0.034)
Experience		0.003
		(0.003)
PM2.5 * Experience		-0.008
		(0.005)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	9,024	9,024
Adjusted R^2	0.380	0.381

Conclusion

- The deleterious effects of transitory air pollution on the quality of high-stakes decisions.
  - Far-reaching effects on financial markets.
  - Investor lose as a result of lax regulatory oversight.

- Policy implications
  - Adharyu, Kala, and Nyshadham (2022, JPE): attentive managers reallocate sensitive workers upon pollution shock.

Autocorrelation of PM2.5



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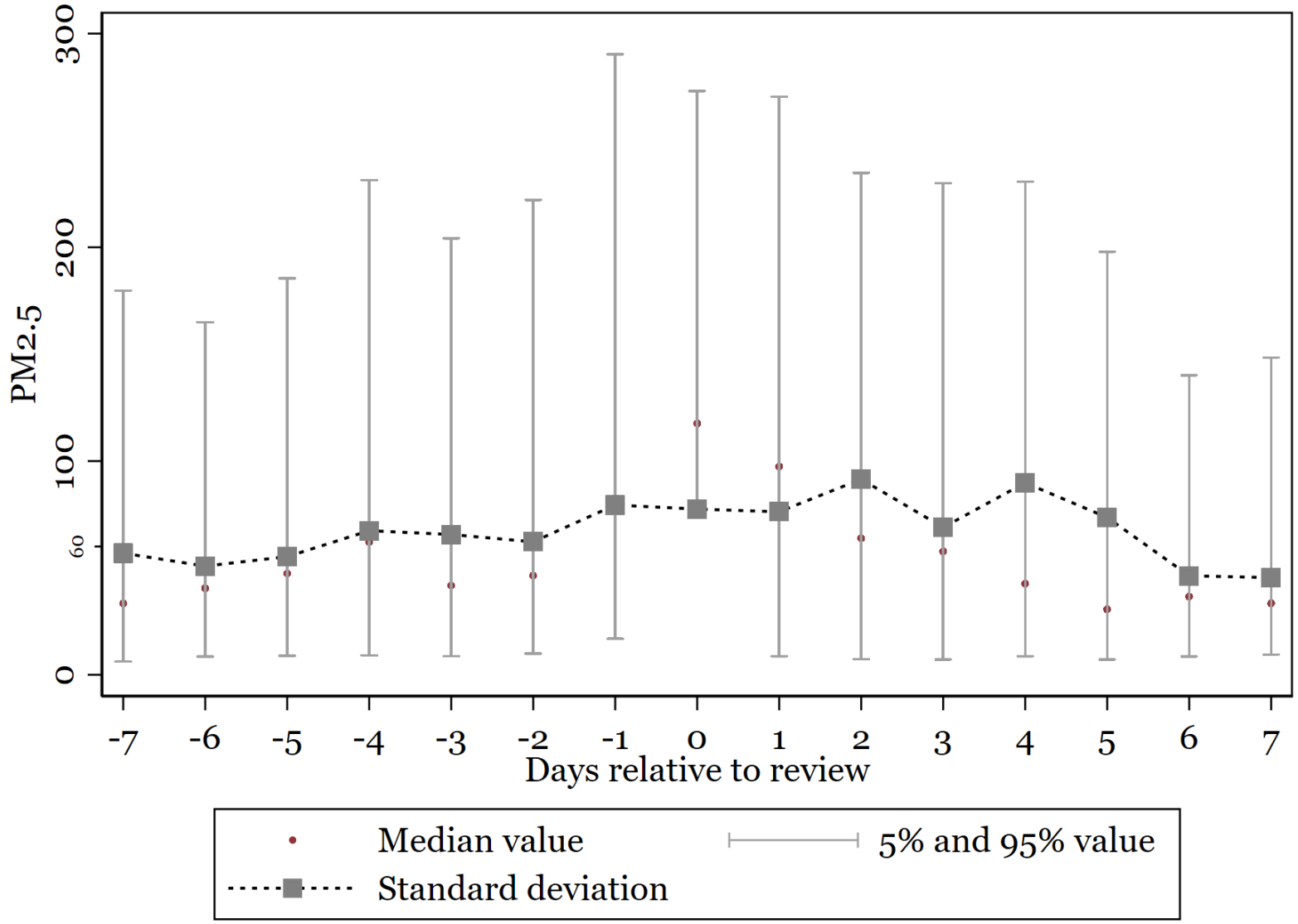
PM2.5 around review days with PM2.5>75



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Univariate comparison

	Low Pollution		*High Pollution*		*Diff (Low-High)*	*p-value*
	N	Mean	N	Mean		
Panel A. Firm characteristics						
Assets (in Billion RMB)	753	12.497	735	20.597	-8.099	0.546
Sales (in Billion RMB)	753	1.323	735	1.945	-0.622	0.227
Profitability	753	0.157	735	0.152	0.005	0.382
Leverage	753	0.422	735	0.407	0.016	0.15
Intangibles	753	0.049	735	0.048	0.001	0.628
CurrentRatio	753	2.42	735	2.228	0.192	0.111
1[SOE]	753	0.07	735	0.09	-0.019	0.168
1[Foreign]	753	0.029	735	0.039	-0.01	0.278
1[FirstReview]	753	0.938	735	0.956	-0.019	0.105
Panel B. Member characteristics						
1[Female]	753	0.268	735	0.244	0.024	0.097*
1[Fulltime]	753	0.869	735	0.877	-0.008	0.447
1[Bachelor]	753	0.691	735	0.681	0.01	0.751
Experience	753	1.315	735	1.324	-0.009	0.686
Age	306	44.159	304	44.219	-0.06	0.782

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Controlling for air pollution on the listing day

Dependent variable: 1 year CAR			
Key indicator:	City	Exchange	Beijing
	(1)	(2)	(3)
PM2.5	-0.073***	-0.065***	-0.063***
	(0.024)	(0.022)	(0.017)
Key indicator	0.115	0.064	0.065*
	(0.075)	(0.052)	(0.037)
Control variables	Y	Y	Y
Industry FE	Y	Y	Y
Province FE	Y	Y	Y
Quarter FE	Y	Y	Y
Chairman FE	Y	Y	Y
Observations	1,035	1,035	1,035
Adjusted R-squared	0.147	0.141	0.144

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Complex firms

Dependent variable: 1[Passing the review]		
Key Indicator:(dummy variables)	Positive RD expense	Operating in more than 10 cities
	(1)	(2)
PM2.5	0.035***	0.033***
	(0.009)	(0.010)
Key Indicator	-0.404***	-0.132***
	(0.072)	(0.021)
PM2.5 * Key Indicator	0.123*	0.028*
	(0.063)	(0.016)
Control variables	Y	Y
Industry FE	Y	Y
Province FE	Y	Y
Quarter FE	Y	Y
Chairman FE	Y	Y
Observations	1,488	1,488
Adjusted R-squared	0.424	0.378

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