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Hedda Flatø

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Trust is in the air: pollution and Chinese citizens' attitudes towards local, regional and central levels of government

Hedda Flatø[a,b]

[a]Fafo Research Foundation, Oslo, Norway; [b]Department of Culture Studies and Oriental Languages, University of Oslo, Oslo, Norway

ABSTRACT

Scholars, commentators and Chinese policymakers point to air pollution as a possible challenge to the popular standing of the Communist Party of China's rule. However, the question of whether air pollution is systematically linked with Chinese citizens' attitudes toward authorities has not been studied for the country as a whole, during the past decade's surge in attention to environmental problems. Analyzing high-quality, nationally representative survey data in combination with satellite-based PM2.5 estimates, this research finds that citizens who perceive local air to be of bad quality have lower probability than others for expressing trust in county and provincial governments. Air pollution did not make a significant difference to probability for trusting central government. The study contributes to hierarchical trust literature and identifies differential trust dynamics for observed and perceived air pollution and over time, across Mainland China's population.

Abbreviations: PM2.5: Particulate Matter with diameter less than 2.5 microns; GPS: Global Positioning System; PSU: Primary Sampling Unit; SSU: Secondary Sampling Unit; PPS: Probability Proportional to Size; GDP: Gross Domestic Product; svy: Survey commands; gologit: generalized ordered logit; AME: Average Marginal Effect; ADC: Average Discrete Change

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Air pollution; environmental perceptions; environmental governance; public opinion; political support; trust; legitimacy

Introduction

Chinese leaders have gradually elevated environmental priorities since at least 2006, particularly with regard to air pollution prevention and mitigation.[1] There was a surge in public and political attention to air pollution in the early 2010s, when several Chinese regions experienced extreme winter smog.[2] Considerable improvements in environmental transparency and several far-reaching anti-pollution policies followed,[3] including the 2013 Action Plan on Prevention and Control of Air Pollution and the 2014 revision of the Environmental Protection Law. Official anti-pollution rhetoric

CONTACT Hedda Flatø hef@fafo.no Fafo Research Foundation, Oslo, Norway

reached a high point in spring 2014, when Prime Minister Li Keqiang declared that China's government would wage and win a 'war on pollution'.[4]

Many observers suggested that the prioritization of air pollution prevention and mitigation in China was about something more than environmental management: China's air pollution and other environmental challenges could undermine the popular standing of its political regime.[5] However, there is a lack of evidence on whether this is really happening. While existing studies provided valuable information on linkages between air pollution and political support among selected individuals or localities,[6] there is no conclusive evidence of systematic relationships between air pollution and popular attitudes toward key political entities, across the Chinese population as a whole.

To address the knowledge gap regarding whether air pollution is connected with popular support for political authorities across Mainland China, this study asks, *are Chinese citizens who experience more air pollution less likely to express trust in county, provincial or central governments?* I employ high-quality, nationally representative survey data collected in 2014 in combination with satellite-based estimates of the local concentration of particulate matter with diameter less than 2.5 microns (PM2.5)[7] to empirically test associations between scientifically observed and subjectively perceived local air pollution on one hand, and Chinese citizens' political trust, on the other.

Results indicate that perceived bad air quality is associated with less reported trust in county and provincial governments but not with central government. Perceived air quality seems to be substantially more consequential for trust judgments than air quality measures estimated with natural science methods. Pooling data from 2014 with comparable survey data from 2009, I found that marginal effects of perceived air pollution had not changed significantly over time; but there were changes in the effects of observed air pollution.

Pollution, perceptions and hierarchical trust

Political trust links individual citizens with macro-level institutions and reflects people's basic evaluative orientation toward political systems.[8] It is a key component of political systems support, which helps citizens accept the state's legitimacy to govern.[9] Recent research by Lu and Dickson evaluated trust in central, provincial and county governments as useful indicators of support for authorities in China. Empirical studies showed that trust can indeed contribute to regime support, legitimacy and regime resilience, whereas low trust can do the opposite, making it more difficult for leaders to succeed.[10]

Theoretically, citizens' perceptions of state performance are assumed to be an important source of political trust: Easton argued that 'evaluation of outputs and performance may help to generate, and probably at all times will help to sustain, confidence in authorities'.[11] The proposition that political trust to some extent reflects evaluations of institutions' and state actors' performance capacity has support in several empirical studies, most of which focus on performance in terms of economic conditions, public goods provision and corruption. Citizens' perceptions of economic

performance, public goods provision and corruption have been found strongly associated with political trust internationally,[12] and in China—especially at local level.[13]

Chinese authorities seem to believe that not only economic performance, but environmental performance too can be of consequence to popular support. Alex Wang[14] described how Chinese environmental reforms aligned with the objective of securing popular support for the Communist Party of China's rule by upholding economic growth and preventing social unrest; and Ding's[15] extensive participatory observation on local environmental bureaucracy documented how local bureaucrats sought to sustain political support by pursuing an image of good environmental performance. Their works show that policymakers considered air pollution to have particularly strong potential for threatening popular political support, especially after the so-called 'airpocalypse' smog events in the 2010s.

Although theoretical and political reasoning imply that air pollution may undermine political trust and support in China, few have put the assumption to empirical testing by analyzing systematic variation in Chinese citizens' views. In order to do so, it is important to examine citizens' reported trust in institutions at several administrative levels.

The hierarchical trust literature suggests that the strength, drivers and dynamics of supportive attitudes differ for governments at different levels of China's administrative system. While political trust in China is high by international standards, Chinese citizens tend to report considerably more trust in higher rather than lower levels of government.[16] Li[17] argued that because the different government levels in China are part of the same system, trust in central government cannot separate completely from trust in lower-level governments. Instead, he demonstrated that 'hierarchical trust' could conceal public scepticism about the center's commitment and capacity to ensure local governments serve the public interest. Air pollution transcends administrative boundaries, and administrative centralization reforms as well as official communication strongly emphasize that not only local officials, but also regional and central governments are responsible for preventing and mitigating it.[18] I therefore expect air pollution to be associated with trust in not only county government, but also provincial and the central one.

It is also important to distinguish between individual perceptions of air pollution, on the one hand, and aggregate environmental performance outcomes such as estimates of local annual PM2.5 concentrations (hereafter referred to as 'observed' air pollution), on the other. Wang[19] and Ding[20] showed that authorities may prioritize 'symbolic', 'performative' measures meant to improve the public's *perceptions* of air quality, over measures that induce improvement in air quality as can be observed by natural science methods.[21] Perceived air quality may differ from observed air pollution for a number of reasons. PM2.5 concentrations observed with natural science methods are good but far-from-perfect approximations of actual air quality in respondents' localities, and many Chinese citizens still have limited access to scientific air-pollution information.[22] Research on risk perceptions has shown that, in addition to physically observable air pollutants such as PM2.5,[23] several non-scientific factors including sensory cues, culture and psychological mechanisms, play a role in forming beliefs about air pollution.[24]

In contrast to results on individuals' perceptions of performance, existing results for macro-level aggregate performance outcomes are inconsistent and sometimes contradictory.[25] Associations between Chinese citizens' air pollution perceptions and political

trust have not been tested with nationally representative data. However, previous and forthcoming studies did find significant associations with political trust for perceived food safety; [26] environmental risk awareness;[27] and environmental concern.[28] This gives reason to hypothesize that there are also relationships between individuals' evaluations of environmental performance in the form of air quality, and political trust.

(H1): Chinese citizens who perceive local air to be of worse quality have lower probability for reporting trust in county, province and central governments compared with citizens who perceive local air to be of better quality.

Interestingly, some studies found significant and negative associations between observed air pollution and political support in certain Chinese cities. A notable contribution was Alkon and Wang's[29] quasi-experimental study. They leveraged daily variation in air quality to provide evidence that high pollution reduced support for both city and central governments, among an online sample of Beijing residents in 2015. The suggestion that daily air quality fluctuations affect citizens' impression of government was also supported by Shi and Guo's[30] study, which found more online searches for 'corruption' on polluted days in selected cities.

Whereas the abovementioned research suggests a causal relationship between political trust and observed environmental performance in the form of daily air quality levels, more knowledge is needed to gauge the scope of such associations. Is there a relationship between political trust and longer-term variation in air pollution, not only among selected urbanites but in the entire country? This study tests the hypothesis that there is.

(H2): Chinese citizens living in localities with higher annual PM2.5 concentrations have lower probability for reporting trust in county, province and central governments compared with citizens in localities with lower PM2.5 concentrations.

The 'evaluative' approach to political support implies that associations between aggregate performance and individual trust judgments should be mediated by citizens' perceptions and evaluations of the aggregate performance—an assumption that found some support in international studies.[31] Some studies on environmental performance and political support in China indicate a similar pattern. Gong, Yang, and Zhang[32] and Huhe, Chen, and Chen[33] found that individual perceptions mediated indirect associations between observed, aggregate environmental outcomes and political support. Flatø[34] found that air quality perceptions mediated indirect associations between observed PM2.5 concentrations and local environmental policy preference in the country as a whole. On this basis, this study suggests hypothesis

(H3): PM 2.5 concentrations are indirectly associated with political trust because higher PM2.5 concentrations heighten the probability for perceiving local air to be of bad quality, and perceived bad air quality is associated with lower political trust probability.

Materials and methods

In order to investigate possible associations between political trust and air pollution in China, this study mainly relies on data from the 2014 National Survey of Inequality and Distributive Justice, directed by Fafo in cooperation with partners who previously

performed comparable surveys in China.[35] Altogether 3800 dwellings were selected and 2507 face-to-face interviews successfully completed between July and November 2014 (66% response rate). To ensure the same cases were analyzed for each of the three outcome variables, only cases without missing values were included, leaving 2171 observations in the analyses.

As an additional test, data from 2014 were combined with data from the 2009 China Survey of Inequality and Distributive Justice to assess change over time. The 2014 survey employed a similar sampling design and repeated many questions from the one conducted in 2009, which was directed by Professor Martin Whyte. For the 2009 cross-sectional survey, 4279 households were sampled, and 2866 face-to-face interviews completed between October and December (67% response rate).

High-quality random sampling procedures ensure that survey data are representative of all citizens aged 18–70 years residing in Mainland China. GPS-assisted random area sampling with multistage probabilities proportional to size (PPS), a method developed by Landry and Shen,[36] was employed to obtain a representative sample of the Chinese population. After regional stratification, the survey team sampled 40 primary sampling units (PSUs) consisting of cells of spatial grids defined as half-square degrees of latitude and longitude; two secondary sampling units (SSUs) consisting of half-square minutes (about 1 km $\times$ 1 km) within each PSU; and tertiary sampling units of approximately 90 m $\times$ 90 m within each SSU. Trained surveyors equipped with GPS receivers located and enumerated all dwellings within the tertiary sampling unit before making a final random PPS sample of dwellings. Finally, interviewers selected individual respondents from dwellings using Kish-Grid methodology. The interviewers were university students who had undertaken a 1-day systematic training course and were supervised by professional staff from the Chinese academic survey institute.

Outcome variables

This study incorporated three outcome variables: *Trust in rural county/urban city, provincial,* and *central governments*. The variables were measured using the survey question: What is your level of trust in the following organizations? Among the organizations listed were central, provincial and county/city governments. Respondents selected from an answer card with four alternatives: *much*, *some*, *little*, or *no trust*. Mishler and Rose[37] have argued that such subjective and generic measures are preferable to survey questions that ask specifically about trust in what government 'does', because the latter introduce bias favoring performance explanations of trust. The battery of trust questions regarding county/city, provincial and central governments are commonly used in surveys in China.

Previous studies sought to assess whether fear of retaliation induced Chinese citizens to overstate political trust or support or refrain from replying to questions they deem politically sensitive.[38] Studies on dissimulation and nonresponse bias in China implied that trust levels are somewhat overrated—especially for central government, as discussed in this study's literature review. Although the existing results suggested that actual levels of trust may be lower than the surveys reported, this does not mean that survey data or relationships identified using such data are invalid. Despite the

difficulties, surveys remain the best available instrument for understanding large-scale systematic variation in Chinese public opinion.

Explanatory variables

While many studies have sought to explain political trust in China, the aim of this study is limited to assessing whether trust in any level of government is associated with two independent variables: Perceived and observed air pollution.

The explanatory variable *Perceived air quality* was measured based on the survey question, 'What do you think about the quality of air where you live?' Respondents chose from five response categories: *very good*, *good*, *neutral*, *bad* or *very bad*. With such scales there is a risk of response bias whereby systematic variation in the variable reflect differences in propensity to opt for or avoid extreme ends of a scale rather than qualitative differences in opinion. In order to mitigate such risk, I constructed a dichotomous air perception variable coded 1 for responses 'bad' or 'very bad' and 0 otherwise. The dichotomous variable was employed in main analyses, but tests employing the full scale of the variable are reported as an additional test.

The second explanatory variable, *observed air pollution,* represents annual average PM2.5 concentration (ug/m^3) within the approximately 1-by-1 square kilometer where respondents lived. The data source is van Donkelaar et al.'s regional PM2.5 estimates, downloaded from the Atmospheric Composition Analysis Group website at Dalhousie University.[39] The estimates are based on NASA satellite data combined with information from the monitoring network in China and a chemical transport model to calculate historical estimates of annual PM2.5 concentrations. This method is advantageous because pure satellite data may underestimate extreme pollution events.[40] The PM2.5 estimates were gridded at $0.01^\circ \times 0.01^\circ$, as were survey SSUs. I used ArcGIS software to overlay the 2014 and 2009 PM2.5 estimates with latitude and longitude coordinates and produced tables of annual PM2.5 estimates for each SSU.

The PM2.5 variable employed here provides no information on the sources of the air pollution observed in respondents' immediate locality. Associations between air pollution and trust may vary depending on whether the air pollution originated within the jurisdiction of the administrative unit for which respondents are making trust judgments. Unfortunately, it is currently almost impossible to determine the sources of air pollution in small geographical units such as the ones investigated here. Estimating the extent to which air pollution is imported into or exported out of a locality would require an extensive and different research endeavor, complicated by similar business/pollution cycles in neighboring localities and frequent changes in wind directions.[41]

Control variables

The existing literature implied that certain variables simultaneously may influence Chinese respondents' observed or perceived exposure to air pollution, and their trust in government. Such variables could suppress associations between air pollution and trust—or spuriously cause the false appearance of such associations—and therefore should be controlled in analyses in order to mitigate the risk of omitted-variable bias.

However, the inclusion of control variables in regression models can be problematic due to risks of collinearity bias and other reasons. I, therefore, use a small set of controls with a strong theoretical justification in the main analyses. As additional tests, I compare results from models without controls, and I conduct further tests with additional control variables.

It follows from the logic of the performance thesis that if good economic or social performance coincides with observed and/or perceived poor environmental performance outcomes, the trust effect from good socio-economic conditions may suppress statistical associations between the pollution and political trust, or spuriously cause the appearance of a positive relationship between air pollution and trust. Modernization theory suggests that development is accompanied by increasingly positive citizen attitudes toward government and low environmental awareness and concern only up to a certain point. After industrial development peaks and enters an increasingly post-industrial stage that allows citizens to feel secure that their basic needs will be fulfilled, there will be a larger presence of 'critical citizens' who are less inclined to express 'blind trust' in government and are more aware of and concerned about environmental pollution.[42]

Industrialization may suppress the appearance of statistical associations between perceived air pollution and political trust, and/or spuriously cause apparent associations with observed air pollution. According to modernization theory we may expect more political trust and observed pollution in localities with more intense industrialization, but at the same time citizens in such localities are expected to be less aware of the pollution. Associations between industrialization and political trust have not been investigated in large-scale research in China, but several studies on observed and perceived air pollution do examine the impact of industrialization. The contribution of secondary industry to local Gross Domestic Product (GDP) has been identified as an important determinant of observed air pollution in China.[43] However, qualitative studies reported that citizens in communities where polluting industry was important to the local economy sometimes were reluctant to acknowledge the full extent of local pollution and more accepting of its presence.[44] While Chen, Chen, and Landry[45] found that citizens living in counties with higher industrial output were on average more likely to report poor local environmental quality, studies on environmental concern found negative associations with industry-intensive types of regional pollution and high rates of secondary and tertiary industry.[46]

To mitigate the risk that industrialization confounds associations between air pollution and political trust, I control for *county/city industrialization rates* in analyses. The variable was measured as the percent of total value-added from secondary industry in 2014 in county/city GDP, centered on its grand mean. Data were compiled from official statistical yearbook data in the database *China Data Insights*. For sampling units located in rural counties, data from the same county were used. For sampling units located in districts, which are the urban equivalent to county-level administrative units, data on the variables of interest were not always available. To ensure consistency, I used city-level statistics for survey localities located in urban districts.

Existing findings imply that *aggregate economic conditions* could spuriously cause the appearance that worse air quality perceptions but better-observed air quality are

associated with lower political trust. Chinese citizens living in localities with higher GDP per capita were less likely to express political trust and more likely to express awareness of or concern about environmental pollution.[47] Observed air pollution levels were higher with higher GDP per capita up until a certain level, beyond which GDP per capita correlated with lower concentrations of air pollutants.[48] To mitigate the risk of spurious effects from aggregate economic conditions, I control for *county/city GDP per capita* in analyses. Again, the data source was official yearbooks in the database *China Data Insights*.

In contrast with aggregate economic performance outcomes such as GDP, existing research suggests that *individual economic conditions* may spuriously cause the appearance of positive relationships between perceived air pollution and political trust, and it may suppress trust associations with observed air pollution. Previous studies have found positive associations between individual/household economic situation and political trust.[49] Environmental justice and 'threadmill of production' literature show that individual affluence also tends to be associated with lower observed pollution, as economically disadvantaged households tend to live in localities with the most intense rates of observed pollution.[50] Yet, some studies that controlled for environmental conditions found more pollution awareness among citizens with more economic resources.[51]

I control for *individual economic situation* in order to mitigate the risk that individual economic situation confound statistical associations between air pollution and political trust. The data source is the 2014 inequality survey. Because many respondents did not disclose their household's actual incomes, I did not adopt a quantitative income measurement in this study.[52] Instead, I measured *individual economic situation* by a subjective assessment of how respondents' family income situation compared with 5 years before the research: *much better*, *a little better*, *no change*, *a bit worse* and *much worse*. The two latter categories were collapsed into one due to few cases in the 'worse' categories.

Other individual socio-economic characteristics may also correlate simultaneously with political trust, exposure to and perceptions of air pollution. The most consistent existing findings regard age, gender and education. Older age has been found positively associated with political trust and negatively associated with environmental awareness in China.[53] I control for age to mitigate the risk that age may suppress associations between perceived air pollution and political trust. *Age* was computed by subtracting year of birth from 2014 (the survey year). Ranging from 17 to 71 years, the age variable was centered on its grand mean.

Some studies have found women more likely to express trust in government and more likely to express environmental concern compared with men.[54] I control for gender to mitigate the risk that this spuriously enhance the appearance of negative associations between perceived pollution and trust. *Gender* had been coded as *male* or *female* by interviewers in the 2014 survey. Education has been found negatively related with political trust and positively related with environmental awareness;[55] it is held constant in my regression models in order to mitigate the risk of suppression effects. The *education* variable used here was based on a question about respondents' highest degree and recoded from seven to four categories, using primary school or

lower as the reference group. Finally, China's residence registration system can give rise to bias because residence status is of substantial consequence to citizens' relationship with the state and their perceived as well as observed exposure to air pollution.[56] *Residence registration* was categorized as *urban-local, urban-migrant*, *rural-migrant* and *rural-local* according to respondents' residence registration and whether they lived in their registered county/city.

Analytical strategy

Analyses proceeded in five steps. In all analyses, Stata's survey (svy) commands were used to estimate corrected standard errors in the presence of stratification and clustering.[57]

First, I conducted generalized ordered logit (gologit) regression for complex sampling design to estimate the three ordinal outcome variables, *trust in county*, *provincial* and *central government*, from perceived and observed air pollution as well as predictor variables. The gologit model was chosen because it is less restrictive than ordinary logistic regression but more parsimonious than methods that ignore the ordering of categories, such as multinomial logit regression.[58] Brant tests indicated that the proportional odds assumption required by the ordered logit model—commonly used to analyze ordinal response variables—was violated. The gologit model relaxes the assumptions of the ordered logit model only as needed, making it preferable for this study.

Second, I conducted post-estimation on the gologit coefficients to calculate predicted probabilities and marginal effects of perceived and observed air pollution. I focus on probabilities and marginal effects for several reasons. The main reason is that with logit regression, identification problems render comparison across categories and models invalid.[59] Untestable identification assumptions are not required when comparing groups using probabilities or marginal effects.[60] In addition, conclusions in the natural metric of probabilities are easier to interpret than conclusions in logit. Comparison of probabilities also allows for assessing more complex relationships between perceived and observed air pollution on the one hand, and political trust on the other, than what can be done with regression coefficients alone. Several authors, therefore, recommend interpreting regression coefficients and comparing group differences by estimating marginal effects of regressors on the probability of an outcome, rather than comparison of odds ratios or regression coefficients.[61]

Third, I assessed possible indirect associations between observed air pollution and the three trust variables, mediated by air perceptions. It may be problematic to have perceived and observed air pollution in the same model: If the two air variables are correlated, there may appear to be no effect when in fact there is an indirect one. I, therefore, estimated the extent to which associations between perceived air quality and trust in each level of government could be indirectly attributed to observed PM2.5 concentrations. To avoid the abovementioned problems inhibiting group comparisons across logit coefficients, I employed Mize, Doan and Long's general method for comparing probabilities and marginal effects across models.[62]

Fifth, I present several additional tests. Importantly, I assessed whether air pollution-trust dynamics changed over time. I pooled data from 2014 with those from 2009 and conducted regression analyses on the pooled sample before estimating predicted probabilities for the 2009 and 2014 sample separately. I then took advantage of Mize, Doan, and Long's[63] approach to calculate average discrete change when moving from low to high perceived and observed pollution, and to estimate the size and significance of changes in the effects of the two air pollution variables over time. I also assessed whether results for 2014 were significantly different when perceived air pollution was used as the only predictor variable; when additional control variables reflecting local quality of governance were added to the model; and when using the original 5-category coding on the air perceptions variable rather than the dichotomous one.

Results

Descriptive statistics for all variables used in the main analyses are provided in Table 1. As expected, trust fell with lower levels of government: 89% and 81% of respondents reported much or some trust in central and provincial governments, respectively, whereas 65% said they trusted their county/city's government. Annual average PM2.5 estimates were higher than the World Health Organization's recommended threshold of 10 ug/m^3 for all sampled localities, and both mean and median estimates of about 55 ug/m^3 were well above the Chinese standard for good air quality (35 ug/m^3). Despite the high PM2.5 concentrations, only 22% of respondents considered the air quality where they lived to be bad or very bad.

Generalized ordered logit (gologit) models adjusted for the complex survey design were fitted to estimate the three outcome variables, *trust in county*, *provincial* and *central government*, from predictor variables. Williams' user-written Stata program gologit2 was used to estimate the gologit models.[64] In the unconstrained gologit model, the original ordinal variable is recoded into two categories, and a series of cumulative binary logit regressions are run. First, it is category no trust *vs.* categories little, some and much trust; second, categories no trust and little trust *vs.* some and much trust; and third no, little or some trust *vs.* much trust. Table 2 provides the parameter and standard error estimates from gologit models with perceived and observed air pollution plus control variables as predictors.

Perceived bad air quality was significantly associated with trust in all levels of government in the gologit models. Citizens who perceived local air to be of bad quality had lower odds for reporting anything above no trust, and for reporting much or some trust rather than little or no trust, in county and provincial government. The results for county and provincial government were significant at $p<.001$. Perceived bad air also gave lower odds for predicting anything more than 'no trust' in central government, but the association for central government was significant only at .05 level. Observed annual PM2.5 concentrations were not significantly associated with trust in any level of government except one: For trust in province government, an increase in PM2.5 concentration of 10 ug/m^3 was associated with somewhat lower log odds for reporting some or much rather than little or no trust.

Several control variables were also significantly associated with political trust. County GDP per capita had weak but significant positive associations with trust in county government but not with trust in provincial or central governments. Individuals who considered their economic situation to be much better than 5 years ago were much more likely to report trust in all three levels of governments compared with those who reported that their economic situation was only a little better, the same as or worse than five years ago. Men had slightly lower probability for reporting trust in any level of government compared with women, and trust probability for all levels of government increased slightly with age. Education had weakly significant associations with trust in central government, but not with trust in provincial or county governments: Odds for reporting trust in central government were slightly lower for citizens who had middle school, high school or higher education compared with those who had primary education or lower.

Regression coefficients alone offer limited opportunity to draw conclusions on the question of interest here: Relationships between outcomes and predictors may be non-linear, and group comparisons are hampered by unobserved heterogeneity and identification problems.[65] Predicted probabilities and marginal effects provide more informative and tangible insight on the complex relationship between observed and perceived air pollution *vs.* trust in county, provincial and central governments.

Results from the post-estimations provide partial support for Hypothesis 1. They show that probabilities for reporting trust in county and provincial governments were significantly and substantially lower among citizens who perceived local air to be of bad quality compared with others. However, perceived air quality made no significant difference to probability for trusting central government.

I used Stata's margins post-estimation commands to calculate predicted probability for reporting some or much trust in each of the three levels of government, at various levels and combinations of the two air pollution variables. Figure 1 displays results based on the gologit model with perceived and observed air variables plus controls as predictors. Probability for reporting trust in county government varied from 0.7—that is, 70%—among citizens living with the lowest PM2.5 concentrations who did not consider air to be of bad quality, to 54% among citizens in localities with the highest PM2.5 levels observed in the sample who considered air to be of bad or very bad quality (Figure 1). Probability for reporting some or much trust in province government was reduced from 90% for citizens living in localities with annual PM2.5 concentration 10 ug/m^3 who considered local air not to be of bad quality to 64% for citizens living with 100 ug PM2.5 per m^3 who considered local air to be of bad quality (Figure 1). Probability for reporting trust in central government was 91% among citizens living at the lowest PM2.5 concentrations who did not consider local air to be of bad quality, and 82% among those living in the highest levels of observed pollution who did evaluate local air as having bad quality.

Average marginal effects (AME) were estimated to assess the size and significance of differences between the predicted probabilities. Trust probabilities were contrasted for citizens who perceived local air to be of bad quality *vs.* others, and at each PM2.5 interval compared with the lowest concentration (Figure 2). The average difference in predicted probability for trusting county government was

Table 1. Descriptive statistics.

Key variables of interest	Total ($N = 2507$)	Control variables	Total ($N = 2507$)
Political trust		*County/city-level controls*	
Trust in city/county government		GDP per capita 2014 (Yuan)	
1 No trust	5.0%	Mean (SD)	46,793 (31,146)
2 little trust	30.2%	Median (Q1, Q3)	38,951 (25,630, 59,735)
3 some trust	42.0%	Min, max	6869, 137,967
4 much trust	22.8%	Secondary industry % of GDP 2014	
Trust in province government		Mean (SD)	48 (13)
1 No trust	1.8%	Median (Q1, Q3)	49 (39, 55)
2 little trust	16.8%	Min, max	21, 76
3 some trust	49.2%	*Individual socio-economic controls*	
4 much trust	32.1%	Male gender	50.9%
Trust in central government		Age (years)	
1 No trust	1.2%	Mean (SD)	43.45 (14.36)
2 little trust	10.3%	Median (Q1, Q3)	43.0 (31.0, 56.0)
3 some trust	41.7%	Min, Max	17.0, 71.0
4 much trust	46.8%	Highest education completed	
Air pollution		Primary or less	30.9%
Perceived bad/very bad air	22.3%	Middle school	30.4%
2014 annual average local PM2.5 (ug/m^3)		High school or vocational	27.9%
Mean (SD)	55.59 (22.15)	University	10.8%
Median (Q1, Q3)	55.1 (37.0, 72.6)	Family economic change 5 years	
Min, max	11.7, 98.8	Much better	19.0%
		A little better	60.3%
		No change	17.0%
		A little worse/much worse	3.7%
		Residence registration	
		Urban local	30.8%
		Urban migrant	8.4%
		Rural migrant	14.7%
		Rural local	46.1%

0.12 (12% points) lower if citizens' air perceptions were changed to perceiving local air to be of bad quality. With regard to trust in provincial government, the gap in predicted probability between air perceptions categories was 0.9 (9% points). Air perceptions made a significant difference to probability for trusting county and provincial governments, supporting Hypothesis 1. Yet, contrary to the hypothesis, air perceptions did not make a significant difference to predicted probability for trusting central government,

Results provide mixed support also for Hypothesis 2. As can be seen from Figure 2, probability for trusting provincial government was significantly lower at each higher PM2.5 concentration compared with the lowest level estimated here, at 10 ug/m^3. Changing the PM2.5 variable from 10 to 20 ug/m^3 reduced trust probability by a miniscule but significant .01 (1% point). At PM2.5 100 ug/m^3 (right above the highest level observed in the sample), trust probability was 16% points lower. Thus, Hypothesis 2 is supported for provincial government trust. However, contrary to the hypothesis, probabilities for trusting county or central governments did not differ significantly at any higher PM2.5 concentrations compared with the lowest estimate.

Hypothesis 3 suggests that it may be more appropriate to model the relationship between trust and the two air pollution variables as indirect ones, whereby observed air quality affects perceived air quality and perceptions affect trust. In linear models,

mediation can be measured by comparing regression coefficients of the same variable across models with different mediating variables. This follows from the principles of path analysis, whereby the total effect of a predictor on an outcome may be decomposed into one part mediated by a control variable (the indirect effect), another unmediated (the direct effect).[66] As mentioned, comparison across coefficients and models is problematic with logit regression. Mize and colleagues propose a method for comparing marginal effects across models. Using seemingly unrelated estimation to combine estimates from multiple models, their method allows tests of the equality of predictions and effects across models.

Stata's gsem command was used to implement the path analysis. As the gsem command is unable to fit gologit models, I recoded the trust variables in the same way as the gologit command and ran a series of binary logit regressions. The cumulative binary regressions can be interpreted in the same way as the gologit results, even though small differences are usually found.[67] After estimating the cumulative logit regression models, Stata's margins command was used to calculate average marginal effects, which were then compared across models with and without the PM2.5 predictor to derive the possible indirect effect.

The results do *not* support Hypothesis 3. As can be seen from Panel B in Table 3, the differences in trust probability when air pollution was perceived as bad/very bad rather than not, did not change much when PM2.5 was added to the model. The largest difference was for provincial government: PM2.5 appeared to account for about 2 of the 10.9% point gap in provincial trust probability across perceptions groups, but the difference was significant at $p=.07$ only. None of the differences between models were statistically significant at 0.05 level, indicating that no significant part of the association between perceived air pollution and trust could be attributed to the impact of observed air pollution on perceptions.

Additional tests

Comparing with 2009

In order to assess whether the relationships between air pollution and trust probabilities were different at a different time point, I pooled the 2014 data with data from a comparable survey conducted in 2009. Again, I employed Mize, Doan, and Long's[68] approach implemented with Stata's gsem command to run a series of binary logit regressions mimicking the gologit model. This approach allows for assessing differences in probabilities and in the size and significance of probability gaps across different samples. For air perceptions, probability when local air was perceived as bad or very bad was contrasted with the probability when local air was perceived to not be bad. For PM2.5, I compared probabilities among citizens living in localities at the 25th percentile of air pollution perceptions with those at the 75th percentile. Table 4 reports the average discrete change (ADC) in trust probabilities when moving from low to high values on the air pollution variables, and the differences in ADCs between 2009 and 2014.

ADCs for perceived air quality did not differ significantly over time. Both in 2009 and in 2014, probabilities for reporting some or much trust in county and provincial

TABLE 2. Regression results from generalized ordered logit model, 2014.

	County government trust			Province government trust			Central government trust		
Variable	>No	>Little	>Some	>No	>Little	>Some	>No	>Little	>Some
Perceived bad air	−1.163***	−0.534***	−0.055	−1.451***	−0.558***	0.091	−1.342*	−0.361	0.110
	(0.313)	(0.131)	(0.175)	(0.315)	(0.143)	(0.160)	(0.597)	(0.197)	(0.164)
PM2.5	0.114	−0.018	0.014	−0.031	−0.123*	−0.076	−0.046	−0.051	−0.034
	(0.087)	(0.085)	(0.082)	(0.093)	(0.048)	(0.064)	(0.102)	(0.058)	(0.053)
Gdp pp.	0.001	0.006*	0.009*	−0.000	−0.001	0.006	−0.002	−0.005	−0.001
	(0.003)	(0.002)	(0.003)	(0.005)	(0.002)	(0.003)	(0.006)	(0.003)	(0.003)
Industrialization	0.009	0.008	0.005	0.007	0.007	0.007	0.004	−0.007	−0.006
	(0.012)	(0.006)	(0.010)	(0.015)	(0.006)	(0.010)	(0.019)	(0.007)	(0.010)
Male gender	−0.026	−0.335**	−0.081	−0.120	−0.328*	−0.144	0.142	−0.455**	−0.041
	(0.282)	(0.111)	(0.115)	(0.358)	(0.124)	(0.102)	(0.505)	(0.153)	(0.097)
Age	0.005	0.009*	0.014*	0.017	0.018**	0.011	0.002	0.020*	0.009
	(0.008)	(0.004)	(0.005)	(0.011)	(0.006)	(0.006)	(0.015)	(0.008)	(0.006)
Middle school	−0.007	0.299*	0.096	−0.174	0.142	0.034	−0.631	0.131	−0.251
	(0.349)	(0.139)	(0.151)	(0.466)	(0.145)	(0.152)	(0.547)	(0.176)	(0.149)
High/vocational school	0.592	0.112	−0.243	0.616	0.055	−0.092	0.462	−0.076	−0.412*
	(0.381)	(0.202)	(0.177)	(0.438)	(0.208)	(0.186)	(0.717)	(0.257)	(0.171)
University	0.197	0.087	−0.583*	0.589	0.009	−0.472	0.580	0.011	−0.668**
	(0.602)	(0.300)	(0.258)	(0.739)	(0.282)	(0.272)	(1.187)	(0.281)	(0.240)
Economy little better	−0.035	−0.477**	−0.707**	0.348	−0.450*	−0.640***	−0.660	−0.341	−0.419**
	(0.303)	(0.159)	(0.212)	(0.505)	(0.204)	(0.158)	(0.736)	(0.219)	(0.149)
Economy no change	−0.376	−0.966***	−0.998***	−0.577	−1.205***	−1.003***	−1.087	−1.125***	−0.771***
	(0.466)	(0.173)	(0.160)	(0.615)	(0.224)	(0.157)	(0.678)	(0.270)	(0.209)
Economy worse	−0.402	−1.240***	−1.042*	−0.881	−1.561***	−1.085*	−1.631	−1.142***	−1.060**
	(0.580)	(0.254)	(0.412)	(0.873)	(0.266)	(0.401)	(1.040)	(0.306)	(0.332)
Urban migrant	−0.283	−0.429*	−0.282	0.106	−0.131	−0.186	1.339	0.117	−0.113
	(0.831)	(0.206)	(0.323)	(0.775)	(0.249)	(0.235)	(1.135)	(0.289)	(0.206)
Rural migrant	−0.757*	−0.360	−0.487	−0.501	−0.179	−0.069	−0.594	−0.191	−0.133
	(0.309)	(0.190)	(0.316)	(0.467)	(0.235)	(0.257)	(0.612)	(0.247)	(0.231)
Rural local	−0.504	−0.214	−0.031	−0.114	−0.040	0.032	−0.740	−0.047	−0.077
	(0.277)	(0.184)	(0.303)	(0.417)	(0.233)	(0.306)	(0.629)	(0.242)	(0.290)
Constant	3.178***	1.649**	−0.385	4.794***	3.107***	0.413	6.315***	3.198***	0.793
	(0.751)	(0.567)	(0.609)	(0.986)	(0.353)	(0.528)	(1.482)	(0.421)	(0.424)
Observations	2171	2171	2171	2171	2171	2171	2171	2171	2171

Note: The table displays parameter estimates for three underlying binary logistic models whose outcome variables are dichotomized from the ordinal response variable. The three models compare outcomes that are above a category relative to being at or below that category. Model 1 displays log odds for selecting any categories above 'no trust'; Model 2 reports 'some' or 'much' trust rather than 'no' or 'little' trust; and Model 3 reports 'much trust' rather than any less-trusting category. Standard errors adjusted for the complex survey design are reported in parentheses.

*Statistically significant at 95% level ($p < .05$); **statistically significant at 99% level ($p < .01$); ***statistically significant at 99.9% level ($p < .001$).

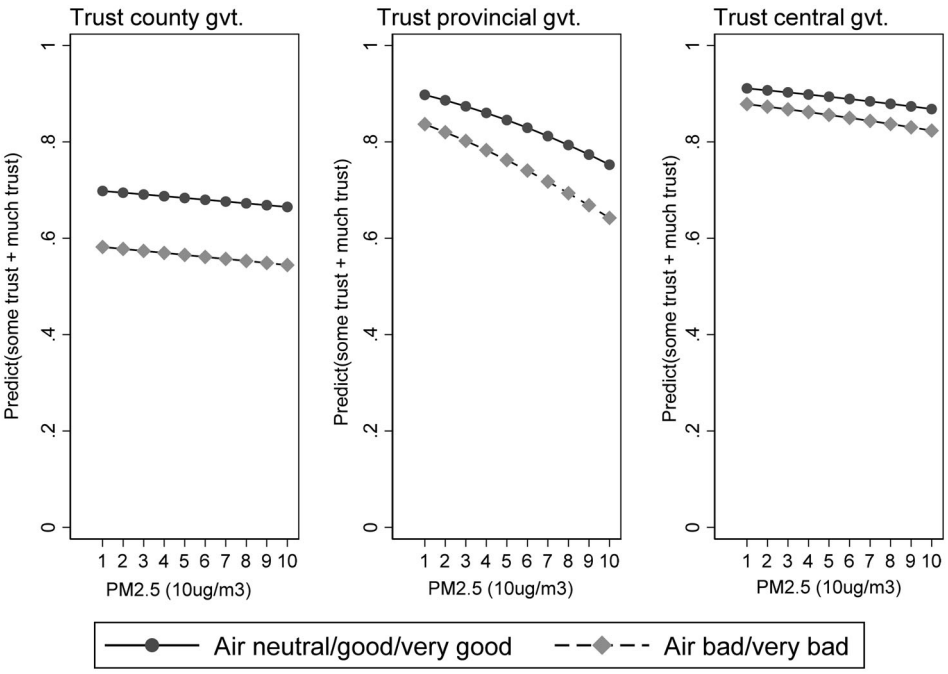

Figure 1. Predictive margins for reporting some or much political trust at various air perceptions and PM2.5 levels.
Note: Predicted probabilities calculated on basis of the partial proportional odds coefficients in Table 2
.

governments were significantly lower for citizens who perceived local air to be of bad quality compared with others. As for probability differences between high and low levels of observed air pollution, most changes in probability gaps over time were also not significant. However, there is one curious change: In2009, citizens living with high PM2.5 levels had 0.15 *higher* probability for reporting much trust in central government, compared with those at lower PM2.5 levels. The estimate for 2009 and the difference with 2014 are significant. The difference across PM2.5 levels had vanished by 2014.

Binary models and added controls

In order to assess whether results would be different without control variables or with additional control variables, I employed the same procedure as for the test for indirect effects. I used the gsem command to estimate quasi-gologit trust models with only air perceptions (M1) and only PM2.5 (M2) as predictors, before calculating ADC in each trust probability when moving from low to high values on the air variables. I then calculated the size and significance of the difference in ADC between each of the two binary models and the main model hitherto discussed (M3).

I tested for a fourth model with additional control variables to address concerns related to the fact that air quality and trust evaluations may be a function of poor governance in the locality. Alkon and Wang[69] used a quasi-experimental design to control for such possible endogeneity and proved a causal relationship between air

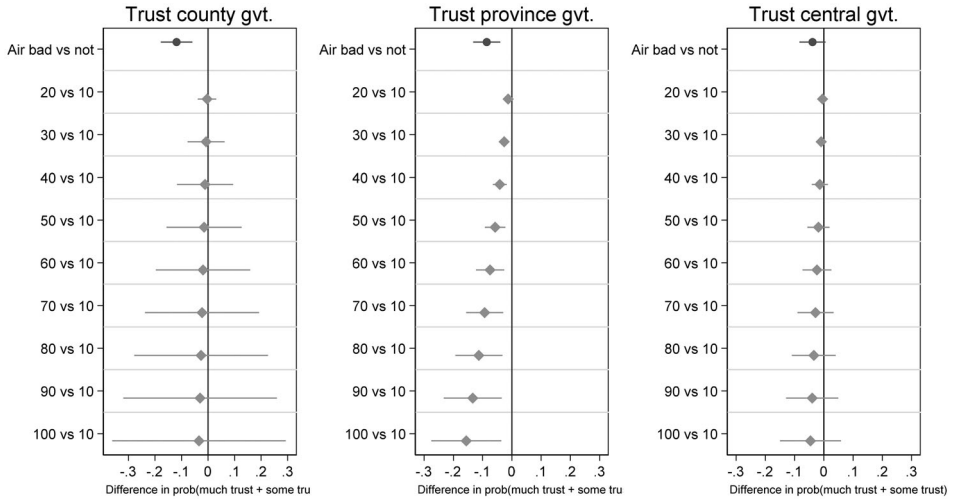

Figure 2. Marginal effects of air perceptions and PM2.5 on probability for political trust.
Note: Differences in predicted probabilities calculated on basis of the partial proportional odds coefficients in Table 2
.

pollution and political support. However, it is not possible to use such a research design for the country as a whole; thus, this study cannot provide finite evidence of causality. Nevertheless, I conducted additional analyses controlling for certain experiences with or attitudes about government that reflect poor local governance (M4). Poor governance could cause both air pollution and low trust, and the attitudes tested may reflect underlying dissatisfaction leading to critical evaluations of both air quality and government trust. Three dichotomous attitude variables were added to the model: *Official unfairness* was measured based on a question on whether anyone in respondents' households experienced unfair treatment by officials during the past three years. Degree of agreement with the statement, 'Government does not care what ordinary people like me think', measured *political alienation* (1 for *strongly agree* or *agree* and 0 otherwise). *Perceived corruption* was measured by a ranking of the severity of official corruption in the country, coded 1 for 'very severe' and 0 otherwise.

Results on ADCs for all models and differences between them are provided in Appendix A. There were few significant differences between the binary models testing perceived and observed air pollution only (M1 and M2) and the main model used so far (M3). When attitudes related to quality of governance were added (M4), the effect of perceived air pollution for trust in county and provincial governments was significantly reduced. However, the effects remained significant, and the reductions were quite small in substantial terms, ranging from −.014 to −0.36. For differences in observed air pollution (contrasting pm2.5 concentrations at the 25th percentile with the 75th), differences between binary and main models and the model with additional controls were miniscule.

Recoding the air perceptions variable

The use of a dichotomous air perceptions variable mitigates the risk of bias due to systematic differences in propensity to opt for extreme ends of a scale. However, this

comes at the price of considerable information loss. To assess whether dichotomizing the air perceptions variable had implications for the results, I compared the ADCs in probabilities when moving from the lowest to highest air perceptions category on the two different air perceptions variables. Results are available in Appendix B. The ADCs for the dichotomous variable appear smaller than for the 5-category variable, but none of the differences between air perceptions variables were statistically significant. Due to the risk of extreme variable bias I report mainly on the more moderate results from the dichotomous air perceptions variable.

Discussion

Many assume that air pollution has become consequential for Chinese citizens' attitudes toward authorities, but few have put the assumption to empirical testing. In the following, I highlight how this study supports the notion that there are linkages between air pollution and political trust in China, while also identifying differences in the dynamics of perceived *vs.* observed air pollution, across time, and across levels of government. Finally, I discuss possible explanatory mechanisms and implications in light of hierarchical trust literature.

This study documents that if otherwise average Chinese citizens perceive the air they live with to be of bad quality, they are less to express trust in county and provincial government compared with those who do not. Hypothesis 1 is thus partially supported. The results for county and provincial government trust are in accordance with Alkon and Wang's[70] finding of a causal relationship between air pollution and support for local government in Beijing, and imply that air pollution is relevant to political trust in the country as a whole.

The weak link observed between air pollution and probability for reporting trust in central government does *not* support the hypothesis that air pollution would also be associated with central government trust. This is in contrast with Alkon and Wang's finding of associations between daily air quality and support for central government among Beijing residents.

The research showed notable differences in air pollution-trust dynamics depending on whether air pollution was measured in terms of natural science observations or as citizen perceptions. It provided mixed support for Hypothesis 2, which suggested lower trust probability among citizens living in localities with higher PM2.5 levels. Probability for trusting provincial government was higher for localities with more observed air pollution, regardless of citizen perceptions. Yet, PM2.5 did not make a significant difference to probability for reporting trust in county or central governments. The international literature has reported consistent associations between performance evaluations and political trust, but inconsistent relationships between 'objective' performance outcomes and political trust.[71] My results indicate that similar dynamics may be at play regarding individuals' subjective perceptions and observed air quality outcomes in China.

This study did not find significant indirect associations between PM2.5 and probabilities for trusting any level of government, mediated by perceptions. Hypothesis 3

Table 3. Associations between perceived air quality and trust in three levels of government, using average discrete changes from binary logit models.

	Model 1			Model 2		
	Perceived air quality + controls			+ PM2.5		
	(No trust) *vs.* (little, some, much trust)	(No, little trust) *vs.* (some, much trust)	(No, little, some trust) *vs.* (much trust)	(No trust) *vs.* (little, some, much trust)	(No, little trust) *vs.* (some, much trust)	(No, little, some trust) *vs.* (much trust)
Panel A: Average discrete change (ADC) from perceived bad air						
County gvt	−0.056** (0.019)	−0.124** (0.034)	−0.010 (0.028)	−0.062** (0.019)	−0.118** (0.031)	−0.011 (0.029)
Province gvt	−0.035** (0.011)	−0.109*** (0.027)	0.001 (0.035)	−0.034** (0.011)	−0.089** (0.023)	0.017 (0.033)
Central gvt	−0.018 (0.010)	−0.048 (0.026)	0.016 (0.043)	−0.018 (0.009)	−0.043 (0.024)	0.024 (0.040)
Panel B: Effect of perceived bad air indirectly attributable to PM2.5						
			(No trust) *vs.* (little, some, much trust)	(No, little trust) *vs.* (some, much trust)	(no, little, some trust) *vs.* (much trust)	
County (ADC Model 2) − (ADC Model 1) =	−0.006 (0.005)	0.005 (0.018)	−0.001 (0.013)			
Province (ADC Model 2) − (ADC Model 1) =	0.000 (0.002)	0.020 (0.011)	0.016 (0.014)			
Central (ADC Model 2) − (ADC Model 1) =	0.001 (0.002)	0.005 (0.007)	0.008 (0.013)			

Note: Controls include county industrialization rate; county GDP per capita; individual economic situation; gender; age; education; and residence status. Adjusted standard errors are in parentheses.
***$p < .001$, **$p < .01$.

Table 4. Average discrete change, using the 2009 and 2014 China Surveys on Inequality and distributional justice samples.

	County gvt.	Province gvt.	Central gvt.
A: Perceived air quality bad/very bad air *vs.* very good/good/neutral			
Pr1: (no trust) *vs.* (little, some and much trust)			
2009	−0.041** (0.014)	−0.033* (0.015)	−0.023* (0.011)
2014	−0.062** (0.019)	−0.034** (0.011)	−0.018 (0.009)
Difference 2014–2009	0.021 (0.023)	0.002 (0.018)	−0.005 (0.014)
Pr2: (no, little trust) *vs.* (some and much trust)			
2009	−0.138** (0.042)	−0.07 (0.058)	−0.041 (0.035)
2014	−0.118*** (0.031)	−0.089*** (0.023)	−0.018 (0.009)
Difference	−0.02 (0.053)	0.019 (0.062)	−0.023 (0.036)
Pr3: (no, little, some trust) *vs.* (much trust)			
2009	−0.058* (0.025)	−0.057 (0.031)	−0.085 (0.043)
2014	−0.011 (0.029)	−0.026 (0.023)	−0.018 (0.009)
Difference	−0.046 (0.038)	−0.031 (0.028)	−0.067 (0.044
B: PM2.5 at 75th percentile *vs.* 25th percentile			
Pr1: (no trust) *vs.* (little, some, much trust)			
2009	−0.014 (0.009)	−0.001 (0.008)	0 (0.004)
2014	0.014 (0.01)	−0.001 (0.004)	−0.001 (0.004)
	−0.028* (0.014)	−0.001 (0.009)	0.001 (0.006)
Difference 2014–2009			
Pr2: (no, little trust) *vs.* (some, much trust)			
2009	0.059 (0.066)	−0.005 (0.030)	−0.004 (0.019)
2014	−0.015 (0.053)	−0.050** (0.019)	−0.001 (0.004)
Difference	0.075 (0.084)	0.046 (0.035)	−0.003 (0.019)
Pr3: (no, little, some trust) *vs.* (much trust)			
2009	0.036 (0.045)	0.097 (0.054)	0.153** (0.046)
2014	0.003 (0.04)	0.026 (0.031)	−0.001 (0.004)
Difference	0.033 (0.06)	0.071 (0.035)	0.155** (0.046)

Note: Regressors include perceived air quality, observed air quality, county industrialization rate; county GDP per capita; individual economic situation; gender; age; education; and residence status. Average discrete changes were calculated using only the sample-specific observations. Standard errors adjusted for the complex survey design are in parentheses.
***$p < .001$, **$p < .01$ and *$p < .05$.

was thus rejected, leading to the general conclusion that perceived air quality is more important to political trust in China than observed air quality.

Additional tests found that associations between perceived air pollution and trust in county and provincial governments were significant and negative not only in 2014 but also five years earlier, in 2009. Central government trust had little association with perceived air quality both in 2009 and 2014.

Few results for scientifically observed air were significantly different across time as well. Yet, there was one curious difference: Relationships between PM2.5 and central government trust was significantly *positive* in the 2009 sample but had vanished in 2014 one. The results indicate that there may have been a change during the years that passed between 2009 and 2014 regarding whether and how citizens in relatively polluted localities recognize and understand PM2.5 and its relationship with central government. It seems unlikely that pollution in itself increased central government trust in 2009, thus the result probably has to do with unobserved characteristics among the citizens or localities with high levels of air pollution in 2009 making them more prone to report trust in central government at the time. The reduction of the

positive pollution effect to zero by 2014 may reflect more awareness of air pollution as a problem that central government is partially responsible for handling in the relevant localities. The change may also have to do with changes in distribution of pollution during the same time period. Thus there may be systematic differences over time with regard to the localities with high or low pollution as well as the composition and characteristics of individuals residing in them.

The main contribution of the present research regards hierarchical trust. My findings imply that air pollution is mainly of consequence to reported trust in local and regional governments, rather than to central government trust. I speculate that China's decentralized environmental governance structure, coupled with symbolic environmentalism,[72] blame-shifting[73] and/or political caution,[74] make citizens take air pollution into account more when making trust judgments for county and provincial governments than for central government.

The comparatively weak link between air pollution and trust in central government compared with county and provincial ones may reflect the administrative decentralization of environmental responsibilities, much of which persists despite recent re-centralization efforts.[75] The central government promulgates binding environmental targets, but when these are passed down in the administrative hierarchy, each of the subnational administrative levels has authority to decide how and when to allocate and implement the targets among departments, subordinate governments and enterprises.[76] Provincial governments carry much authority in selecting and prioritizing policy instruments,[77] and at the lowest end of the hierarchy, rural county and urban city bureaucracies have considerable maneuvrability in implementing and determining the political system's ultimate outcomes.[78] For regional and local officials, environmental targets compete with other binding targets; among them, gross domestic product (GDP) growth remains the first priority.[79] Thus, although decentralization and flexibility sometimes enable local innovation and environmental achievements,[80] they often lead to discrepancies between the environmental ideal the central government promulgates and the local implementation citizens experience.[81]

Literature on blame-shifting suggested that the decentralized environmental administration, together with official propaganda, strongly encourages blaming suboptimal environmental outcomes on local governments' failure to properly implement well-intended central policies.[82] In addition, studies indicated that Chinese citizens may be more cautious in their responses to survey questions about trust in central government than those about subnational governments.[83] A cultural predisposition for deference to authorities also may play into the hierarchical trust pattern.[84]

Li Lianjiang argued that 'hierarchical trust' actually reflected only partial trust: a mixture of stronger confidence in the central government's policy intent and weaker confidence in its capability to control local policy implementation and outcomes.[85] Other authors argue that Chinese citizens' attitudes about central government are 'imaginary', whereas attitudes toward local government are to a larger extent based on personal experience with on-the-ground outcomes.[86] On this basis, I speculate that Chinese citizens' trust in central authorities may rely more on 'blind faith', while taking experiences and outcomes, such as air pollution into more consideration when evaluating trust in subnational government.

In sum, various administrative levels play distinct roles in environmental governance, and this together with asymmetric power distribution and cultural factors, give considerable reason for Chinese citizens to weigh environmental outcomes differently when considering support for various levels of government.

Conclusion

This study's findings contribute to better understanding of the consequences of China's air-pollution crisis for popular regime support across Mainland China's population. The study documented robust negative associations between perceived bad air quality and probability for reporting trust in county and provincial governments as well as significant relationships between provincial government trust and observed PM2.5 concentrations. This supports the notion that air pollution is unfavorable for popular political support in China, especially when reflected in citizens' subjective air quality perceptions.

Linkages between air pollution and popular trust in government could imply potential for pro-environmental engagement favorable to air pollution governance. Existing studies indicated that public pressure or fear of public discontent spurred some (although selective) environmental efforts by local or regional governments.[87] Hierarchical trust literature suggests that stated distrust in provincial and county authorities may reflect latent doubts about central leaders and undermine support for the political regime as a whole.[88] Thereby, despite the weak associations with central government trust found in this study, the linking of air pollution with trust in county and provincial government could raise the stakes for Chinese authorities at all levels to prevent and/or mitigate air pollution.

The study points to several knowledge gaps that should be further explored. It cannot explain exactly why air pollution was associated with trust in subnational governments but not the central government. Neither can it explain why relationships between PM2.5 concentrations and trust differed in 2009 and 2014. To better understand the change, further studies are needed to investigate whether and how Chinese citizens' recognition of air pollution has evolved over time. Moreover, research on more recent data is needed to assess whether air pollution remains consequential for popular trust in government after the 'war on pollution' has been waged for several years and the Covid-19 crisis may have changed people's priorities and beliefs. Finally, linking air quality with political support could imply that other kinds of pollution are less important for national average trust in government—and policymakers more easily may ignore them. More research is needed on how other types of pollution matter for popular political attitudes in China.

Notes

1. Developments in Chinese environmental policymaking is described in, for example, Wang, "The Search for Sustainable Legitimacy"; Ahlers, Hansen, and Svarverud, *The Great Smog of China*.

2. See, e.g. Wong, "Polluted Skies Heighten Challenge for Chinese Government," *The New York Times*, December 10, 2015. https://www.nytimes.com/2015/12/11/world/asia/china-smog-challenge.html.
3. See Schwabe and Hassler, "The Impact of Periodic Air Pollution"; Wang, "Explaining Environmental Information"; Shen and Steuer, "Conflict or Cooperation".
4. See "政府工作报告（全文) [Government Work Report (Full Text)]," March 14, 2014. http://www.gov.cn/guowuyuan/2014-03/14/content_2638989.htm.
5. E.g. Economy, *The River Runs Black*, 26; Hsu, "Seeing through the Smog," 167–168; Johnson, "Environmental Risks and Authoritarian Resilience," 201–203; Shapiro, *China's Environmental Challenges*, 9–10; Zhuang, "'Airpocalypse' Dirties Credibility of Chinese Government". *South China Morning Post*, December 21, 2016. http://www.scmp.com/news/china/society/article/2056404/airpocalypse-dirties-credibility-chinese-government.
6. E.g. Alkon and Wang, "Pollution Lowers Support," 327–331.
7. See van Donkelaar et al., "Regional Estimates of Chemical Composition".
8. See Easton, *A Framework for Political Analysis*; Levi and Stoker, "Political Trust and Trustworthiness," Mischler and Rose, "What Are the Origins of Political Trust?"
9. See Easton, *A Framework for Political Analysis*; Lu and Dickson, "Revisiting the Eastonian Framework"; Norris, "The Conceptual Framework".
10. See Chen, "Local Distrust and Regime Support"; Dickson, *The Dictator's Dilemma*; Li, "Political Trust in Rural China"; Li, "Reassessing Trust in the Central Government," 100–121; Li, "Distrust in Government".
11. Easton, "A Re-Assessment," 449.
12. See Mishler and Rose, "What Are the Origins of Political Trust?" 30–62; van der Meer, "Democratic Input, Macroeconomic Output".
13. See Chu, "Sources of Regime Legitimacy"; Dickson, Shen and Yan, "Generating Regime Support"; Lü, "Social Policy and Regime Legitimacy"; Lyu and Li, "The Dual Effect of Economic Development".
14. Wang, "The Search for Sustainable Legitimacy," 365; Wang, "Explaining Environmental Information," 865–924; Wang, "Symbolic Legitimacy," 699.
15. Ding, "Performative Governance," 525–556.
16. See Dickson, Shen, and Yan, "Generating Regime Support"; Li, "Reassessing Trust in the Central Government," 100–121.
17. Li, "Reassessing Trust in the Central Government," 100–121.
18. See Kostka and Nahm, "Central–Local Relations," 567–582.
19. Wang, "Explaining Environmental Information," 865–924; Wang, "Symbolic Legitimacy," 699.
20. See note 16 above.
21. A similar suggestion was made in an unpublished manuscript by Huhe, Chen and Chen.
22. For a discussion on the relationship between scientifically measured and subjectively perceived air pollution, and suggestions on how to integrate the two, see Schmitt, "Measuring Micrometers of Matter," 48.
23. PM2.5 is mass per cubic metre of air particles generally less than 2.5 micrometres (μm) in diameter.
24. See Bickerstaff, "Risk Perception Research"; Renn and Rohrmann, *Cross-Cultural Risk Perception Research*. For studies on how Chinese citizens relate to air pollution, see, e.g. Moe, "Breathing in the Anthropocene: China's Environmental Crisis and the Eschatological Unconscious"; Xu et al., "雾霾感知风险与公众应对行为的实证分析 [Empirical Analysis of Perceived Smog Risk and Public Response Behavior]".
25. See van der Meer, "Democratic Input, Macroeconomic Output".
26. See Wu, Yang, and Chen, "The Politics of Quality-of-Life Issues".
27. See Gong, Yang, and Zhang, "Not Only Health," 575.
28. Huhe, Chen, and Chen, "Assessing Performance from Space".
29. See note 6 above.
30. Shi and Guo. "Do People Have a Negative Impression," 797–817.
31. See Mishler and Rose, "What Are the Origins of Political Trust?," 40–41; see note 26 above.

32. See note 28 above.
33. See note 29 above.
34. Flatø, "Socioeconomic Status, Air Pollution," 49–66.
35. See Whyte, *Myth of the Social Volcano*; Whyte, "China's Dormant and Active Social Volcanoes".
36. Landry, and Shen. "Reaching Migrants in Survey Research," 1–22.
37. Mishler and Rose, "What Are the Origins of Political Trust?" 30–62.
38. See Shi, "Cultural Values and Political Trust"; Dickson, Shen, and Yan, "Generating Regime Support," 132; Lei and Lu, "Revisiting Political Wariness"; Tang, *Populist Authoritarianism*, 150; Munro, "Does Refusal Bias Influence"; Ratigan and Rabin, "Re-Evaluating Political Trust"; Robinson and Tannenberg, "Self-Censorship of Regime Support".
39. http://fizz.phys.dal.ca/~atmos/martin/?page_id=140.
40. See Rohde and Muller, "Air Pollution in China".
41. See Xun and Ward, "Center-Periphery Gradients in Enforcement of Environmental Regulation"; Chen and Ye, "When the Wind Blows: Spatial Spillover Effects of Urban Air Pollution in China."
42. See Inglehart, *Modernization and Postmodernization*; Norris, *Critical Citizens*.
43. See Luo et al., "PM2.5 Mitigation in China".
44. See Bickerstaff, "Risk Perception Research"; Chen et al., *Chinese "Cancer Villages"*; Lora-Wainwright, *Resigned Activism*; Tilt, *The Struggle for Sustainability*; van Rooij et al., "Centralizing Trends and Pollution Law"; also Shi et al., "煤矿区居民对环境污染感知的空间分异研究——以陕西省韩城矿区为例 ["Spatial Differentiation of Environmental Pollution Perception of Residents in Coal Mining Areas: A Case Study of Hancheng Mining Area in Shaanxi Province]".
45. Chen, Chen, and Landry, "Migration, Environmental Hazards," 85–95.
46. See Hao and Song, "Environmental Concern in China," 1–26; Liu et al., "Examining Public Concern".
47. On associations between GDP and trust, see Dickson, Shen, and Yan, "Generating Regime Support"; Lyu and Li, "The Dual Effect of Economic Development". On awareness and concern, see Hao and Song, "Environmental Concern in China"; Hong and Park, "The Effects of Regional Characteristics".
48. See Luo et al., "PM2.5 Mitigation in China." Xie et al., "Is There an EKC between Economic Growth and Smog Pollution in China?," 873–883.
49. See Dickson, Shen, and Yan, "Generating Regime Support"; Lyu and Li, "The Dual Effect of Economic Development"; Zhao and Hu, "Determinants of Public Trust".
50. See Schnaiberg, Pellow, and Weinberg, "The Treadmill of Production"; Buttel and Flinn, "Social Class and Mass Environmental Beliefs"; Mishra and Smyth, "Environmental Regulation and Wages in China".
51. See Hao, "The Effect of Economic Affluence"; Hao and Song, "Environmental Concern in China"; Liu and Mu, "Public Environmental Concern"; Pu et al., "Spatial Distribution".
52. This common problem in China causes many survey-based studies to rely on subjective, relative income measures. See e.g. Dickson, Shen, and Yan, "Generating Regime Support," 224; Gong, Yang, and Zhang, "Not Only Health," 574.
53. See Gong, Yang, and Zhang, "Not Only Health"; Wang and You, "The Arrival of Critical Citizens"; Zhao and Hu, "Determinants of Public Trust".
54. More political trust among women compared with men was reported for example in Chen, "Local Distrust and Regime Support". In contrast with most international literature, lower environmental awareness among women was reported by Shields and Zeng, "The Reverse Environmental Gender Gap,"; Xiao and Hong, "Gender Differences in Environmental Behaviors". However, in their more recent article from 2017, Xiao and Hong suggested there is no longer a reverse environmental gender gap in China; this notion is supported by Liu et al.'s (2020) finding of significantly higher concern about global warming and climate change among Chinese women compared with men.

55. See e.g. Zhong, "Do Chinese People Trust Their Local Government, and Why?"; Yu, "Is Environment 'a City Thing'".
56. See note 45 above; Liu and Mu, "Public Environmental Concern"; Tang, *Populist Authoritarianism*; Yu, "Is Environment 'a City Thing'"; Zhao and Hu, "Determinants of Public Trust".
57. For information on use of the svy commands to account for complex sample designs, see Kreuter and Valliant, "A Survey on Survey Statistics".
58. The gologit model was developed by Richard Williams. For more information on its characteristics and interpretation, see Williams, "Generalized Ordered Logit/Partial Proportional Odds"; Williams, "Understanding and Interpreting".
59. See Allison, "Comparing logit and probit coefficients".
60. See Long and Mustillo, "Using predictions and marginal effects"
61. See note 60 above; Mize, Doan and Long, "A General Framework," 152–189.
62. Mize, Doan and Long, "A General Framework," 152–189.
63. Ibid.
64. See Williams, "Generalized Ordered Logit/Partial Proportional Odds".
65. See note 60 above.
66. See Breen, Karlson and Holm, "Total, Direct, and Indirect Effects".
67. Coefficients tend to differ slightly because the gologit model estimates all the parameters simultaneously rather than one logit at a time. See Williams, "Understanding and Interpreting".
68. See note 62 above.
69. See note 6 above.
70. Ibid.
71. See note 26 above.
72. See note 16 above; Wang, "Symbolic Legitimacy and Chinese Environmental Reform," 699.
73. See Ran, "Understanding Blame Politics," 634–661.
74. See Wu and Wilkes, "Local–National Political Trust Patterns," 436–454.
75. See Ahlers, "Introduction: Chinese Governance," 236–237.
76. See Kostka, "Command without Control," 64, 72; Wang, "Explaining Environmental Information," 368.
77. See Zhang, "Carrots, Sticks, or Alternatives?" 153–169.
78. See Alpermann, "State and Society"; Kostka, "Command without Control".
79. See Kostka, 68–69.
80. Shen and Ahlers, "Local Environmental Governance".
81. See note 73 above; see note 19 above.
82. See Lü, "Social Policy and Regime Legitimacy"; see note 73 above.
83. See note 74 above.
84. See Shi, "Cultural Values and Political Trust" as well as O'Brien and Li, *Rightful Resistance in Rural China*.
85. See Li, "The Magnitude and Resilience," 113–15.
86. See Schubert, "Political Legitimacy"; see note 85 above. See also Dickson, Shen, and Yan, "Generating Regime Support".
87. E.g. see note 16 above; Zheng et al., "Incentives for China's Urban"; van Rooij et al., "Centralizing Trends and Pollution Law"; Tang, Chen and Wu, "Do Authoritarian Governments Respond to Public Opinion on the Environment?".
88. Li Lianjiang developed theory and produced empirical evidence regarding the implications of hierarchical trust patterns for relationships between local government trust and political system support. See also Chen, "Local Distrust and Regime Support".

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Notes on contributor

Hedda Flatø is a researcher at Fafo foundation in Oslo. Holding a PhD in China studies from the University of Oslo, she was trained in Political Science, International Relations and Chinese language in Norway and China. Her research interests include administrative reform and governance in the fields of environmental protection and social welfare, with particular attention to citizen perspectives on public goods provision and political support. Email: hef@fafo.no.

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Appendix A. ADC comparisons across models

A: Comparison of ADCs for air perceptions across models

	County gvt.		Province gvt.		Central gvt.	
	ADC air bad	SE	ADC air bad	SE	ADC air bad	SE
Pr1: (no trust) *vs.* (little, some, much trust)						
M1 (air bad only)	−0.054**	0.019	−0.036**	0.01	−0.018*	0.008
M3 (+ PM2.5 + controls)	−0.062**	0.019	−0.034**	0.011	−0.018	0.009
M4 (+ QOG att.)	−0.039*	0.014	−0.02*	0.008	−0.01	0.007
Difference M1–M3	0.008	0.008	−0.002	0.004	0	0.003
Difference M3–M4	−0.023**	0.007	−0.014**	0.004	−0.007*	0.003
Pr2: (no, little trust) *vs.* (some, much trust)						
M1 (air bad only)	−0.119**	0.034	−0.12***	0.027	−0.058*	0.027
M3 (+ PM2.5 + controls)	−0.118**	0.031	−0.089**	0.023	−0.043	0.024
M4 (+ QOG att.)	−0.083**	0.026	−0.055*	0.021	−0.017	0.021
Difference M1–M3	0	0.023	−0.032*	0.012	−0.014	0.01
Difference M3–M4	−0.036*	0.015	−0.034**	0.011	−0.026*	0.01
Pr3: (no, little, some trust) *vs.* (much trust)						
M1 (air bad only)	−0.003	0.034	0.004	0.036	0.006	0.048
M3 (+ PM2.5 + controls)	−0.011	0.029	0.017	0.033	0.024	0.04
M4 (+ QOG att.)	0.001	0.029	0.022	0.033	0.022	0.04
Difference M1–M3	0.009	0.02	−0.013	0.016	−0.018	0.017
Difference M3–M4	−0.012	0.007	−0.005	0.009	0.002	0.009

B: Comparison of ADCs for observed PM2.5 across models

	County gvt. ADC pm2.5	SE	Province gvt. ADC pm2.5	SE	Central gvt. ADC pm2.5	SE
Pr1: (no trust) *vs.* (little, some, much trust)						
M2 (PM2.5 only)	−0.013	0.012	0.004	0.006	0.002	0.004
M3 (+ air bad + controls)	−0.014	0.01	0.001	0.004	0.001	0.004
M4 (+ QOG att.)	−0.007	0.01	0.003	0.004	0.002	0.004
Difference M2–M3	0.001	0.005	0.003	0.003	0.001	0.002
Difference M3–M4	−0.007*	0.003	−0.003*	0.001	−0.001	0.001
Pr2: (no, little trust) *vs.* (some, much trust)						
M2 (PM2.5 only)	−0.011	0.056	0.05**	0.018	0.02	0.017
M3 (+ air bad + controls)	0.015	0.053	0.05*	0.019	0.013	0.016
M4 (+ QOG att.)	0.028	0.044	0.062**	0.017	0.021	0.016
Difference M2-M3	−0.026	0.015	0	0.009	0.008	0.006
Difference M3-M4	−0.012	0.015	−0.012	0.008	−0.008	0.007
Pr3: (no, little, some trust) *vs.* (much trust)						
M2 (PM2.5 only)	−0.033	0.045	0.015	0.046	0.027	0.045
M3 (+ air bad + controls)	−0.003	0.04	0.049	0.042	0.025	0.039
M4 (+ QOG att.)	0.001	0.037	0.05	0.039	0.023	0.037
Difference M2–M3	−0.03	0.015	−0.034	0.019	0.002	0.019
Difference M3–M4	−0.004	0.007	−0.001	0.006	0.001	0.005

Note: Average discrete change (ADC) calculated as the change in trust probabilities derived from a one-unit change in perceived and observed air quality.

Appendix B. ADCs and cross model differences with binary *vs.* 5-category air perceptions variables

	County gvt.		Province gvt.		Central gvt.	
	ADC	SE	ADC	SE	ADC	SE
Pr1: (no trust) *vs.* (little, some, much trust)						
Dichotomous air perceptions	−0.062**	0.019	−0.034**	0.011	−0.018	0.009
5-category air perceptions	−0.118**	0.034	−0.075**	0.023	−0.037	0.024
Difference	0.056	0.033	0.04	0.02	0.02	0.018
Pr2: (no, little trust) *vs.* (some, much trust)						
Dichotomous air perceptions	−0.118**	0.031	−0.089**	0.023	−0.043	0.024
5-category air perceptions	−0.237**	0.083	−0.178**	0.057	−0.121*	0.045
Difference	0.119	0.073	0.09	0.052	0.078	0.042
Pr3: (no, little, some trust) *vs.* (much trust)						
Dichotomous air perceptions	−0.011	0.029	0.017	0.033	0.024	0.04
5-category air perceptions	−0.075	0.066	−0.071	0.073	−0.105	0.089
Difference	0.064	0.057	0.088	0.061	0.129	0.075

Note: Average discrete change (ADC) calculated as the change in trust probabilities when moving from lowest to highest category on each air perceptions variable.