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Exploring the impacts of social capital on preferences for air quality changes: a hybrid choice model approach

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ABSTRACT

Air pollution is a globally recognised problem that causes premature deaths and economic loss. 95% of these premature deaths occur in developing countries, which often trade off investing in air quality improvement against economic growth. In these countries, economic growth may be prioritised by governments due to resource constraints, causing citizens to experience future air quality deterioration. Evidence from studies in developed countries suggests that social capital can be a potential impactful mediator urging the government to implement more pro-environmental policies. However, little empirical evidence exists for developing countries where environmental governance is often complicated by competing policy priorities. We investigated residents' preferences for clean air in Beijing, China, using a discrete choice experiment. In the experiment, attributes of air pollution were specified as either an improvement or a deterioration as a result of policy prioritisation. The effects of social capital (consisting of social trust, norms and networks) were examined by incorporating social capital indicators into a novel hybrid choice model. The results suggest that social capital was positively associated with individual preferences when air quality was projected to be improved (i.e., higher social capital leads to higher preferences for air quality improvement) as well as deteriorated (i.e., higher social capital leads to higher resistance to air quality deterioration). Our findings imply that in a society with high social capital, policymakers who prioritise economic growth at the expense of the environment are likely to cause considerable public welfare losses.

Keywords: Air quality; discrete choice experiment; social capital; social trust; social norms; social networks.

JEL classification: D6, Q51, Q53.

1. Introduction

Air pollution is a widely recognised problem in many developing countries such as China. Severe air pollution can lead to strokes, respiratory and cardiovascular diseases. It is estimated that air pollution in 2019 alone was responsible for 1.85 million deaths in China (Abbafati et al., 2020), and this has raised public concern over the past 10-15 years. The level of China's air quality ranked the 13th worst in the world, with the annual average concentration of PM2.5 (particulate matter less than 2.5 microns wide) being several times higher than the standard of 15 μg/m3 set by the World Health Organisation (WHO) guideline (Greenstone and Hasenkopf, 2023). China's average life expectancy would be increased by 2.5 years if the level of air pollution was reduced to the WHO level (Greenstone and Hasenkopf, 2023).

In the light of these concerns, recent literature has highlighted the role of social capital as a key facilitator of environmental governance (Zhang et al., 2006; Liu et al., 2014). Although there is little consensus on the concept and measures of social capital (Fukuyama, 2001), this paper uses the definition by (Coleman, 1990) for social capital as anything that facilitates individual and social collective actions through networks and norms. A substantial body of evidence suggest that social capital is correlated to individual preference for environmental and resource management through the effect of information and collective behaviour (Pretty, 2003; Cramb, 2005; Liu et al., 2014). In the stated preference (SP) literature, most studies have found that social trust and norms are positively related to WTP or preferences for more stringent environmental protection (Zhang et al., 2006; Jones et al., 2009, 2010, 2015; Polyzou et al., 2011; Halkos and Jones, 2012; Smith et al., 2012b; Hagedoorn et al., 2019), whilst the effects of social networks on WTP and other pro-environmental behaviours are inconsistent (Halkos and Jones, 2012; Jones et al., 2015). However, most of these studies are based on developed countries, yet little is known about whether such correlation holds in developing countries where either environmental improvement or degradation could occur due to policy prioritisation.

In this study, we address the gap by examining how social capital could shape individual preferences for air quality management in China - a unique context where environmental policy involves complex trade-offs between health and environmental benefits and economic growth. These trade-offs are particularly salient in many developing countries, where governments may opt to sacrifice air quality to maintain economic development. In China, several structural factors exacerbate this dilemma. First, China is dependent on polluting energy sources such as coal, and it is seen to be unlikely to make a complete shift to clean energy in the short term (Myllyvirta et al., 2025). Coal consumption represents 56% of the total primary energy consumption in China (BP, 2023), contributing to nearly half of the country's PM2.5 pollutants (He et al., 2017). For many years, China has been the world's largest coal consumer, with 54% of the total global coal consumption in 2022 (Enerdata, 2023).[1] Second, the promotion mechanism of local officials prioritises economic growth over environmental protection, which provides incentives for them to prioritise economic gains (often measured by gross GDP) and weaken policy implementation regarding air pollution given the limited governmental budget (He et al., 2017; Jia, 2017). The inherent conflict between the short assessment period of local leaders and the long-term benefits of air quality improvement also encourages the prioritisation of economic development (Jia, 2017). [2]

Despite several studies that have elicited individuals' preferences for air quality improvement in China (Tang and Zhang, 2015; Huang et al., 2018; Sergi et al., 2019; Jin et al., 2020), SP literature provides little evidence of individuals' acceptance of policies when there is ambiguity regarding the direction of the policy impacts, i.e. an improvement or deterioration of air quality, caused by the management dilemma. The legitimacy of governmental actions can be challenged if citizens feel that air quality

[1] In 2017, the Beijing local government led an aggressive action plan, shutting down more than hundreds of polluting factories, which was subsequently expanded to a nation-wide campaign (Myllyvirta, 2017). However, many of these factories were reportedly either reopened or relocated to the surrounding areas away from the capital months or years after the authority-driven movement (Hornby L.; Zhang, 2017).

[2] In the central government's Three-year Action Plan set in 2018, the cities and areas targeted for air pollution reduction were expanded, yet the goals of air pollution reduction for some cities were relaxed. For example, the PM2.5 concentration in Beijing was 58ug/m3 by the end of 2017, whilst the target in the Three-year Action Plan is no more than 65.2ug/m3 by the end of 2020 (Hao, 2018). The flexibility of this policy leaves space for the local government to maintain economic growth, which may lead to air quality deterioration compared with the 2013-2017 period when stringent pollution policies were taking place (Wu, 2020).

deterioration is unacceptable.[3] Building on our previous experimental design (Wu et al., 2022), this study contributes to the literature in two significant ways. First, we add to the limited policy-oriented literature on the role of social capital in shaping public preference for environmental management using a discrete choice experiment (DCE). We are the first study that examine the effects of social capital in a unique context where either air quality improvement or degradation is possible due to policy prioritisation in China. In such a context, it remains unclear whether the positive relationship between social capital and public preferences for environmental improvement—well-documented in the literature under gain scenarios—persists when environmental degradation is also a potential outcome. This uncertainty is particularly salient in China, where cultural and political dynamics differ fundamentally from those in many Western societies (Zhang et al., 2019). Collective citizen action is often discouraged by the central government as it might cause uncertainty towards the authoritarian state (Wright, 2008; Vala and Carsten T., 2012). Therefore, civic participation entails a high-level of personal risk (Lorentzen, 2014). This suggests that in such contexts citizens may disengage from collective action when they conflict with central government's economic development policies to avoid personal risk, and that the positive effect of social capital on preferences for environmental management may not exist when the central government places higher priority on economic development. Second, we are also the first study that connect social capital indicators with individual preference data using a hybrid choice model (HCM) which can mitigate the issues of measurement error and endogeneity bias compared with traditional models in which social capital indicators are directly interacted with preference parameters (Daly et al., 2012; Czajkowski et al., 2017). Building on the gain-loss DCE framework mentioned above, this study investigates how different components of social capital – namely social trusts, social norms and social networks - influence individual preferences for both prospective

[3] Increasing evidence suggests that welfare losses due to environmental degradation cannot be simply inferred from gains of a same-sized environmental improvement (Bateman, 2009; Lanz et al., 2009; Glenk, 2011; Aravena et al., 2014; Ahtiainen et al., 2015; Bartczak et al., 2017). This effect is referred to as gain-loss asymmetry, of which a key explanation is loss aversion behaviour (Kahneman and Tversky', 1979; Tversky and Kahneman, 1992). Failure to account for gain-loss asymmetry in preference assessment can lead to biased welfare estimation (Hess et al., 2008).

environmental improvement and degradation by employing a unique choice experimental design in which gains and losses of environmental benefits are separately presented relative to reference points.

2. The survey

2.1Study background

The study area is Beijing, China, where the Chinese government has been striving to mitigate heavy air pollution since 2013, when PM2.5 reached its highest record (Wong, 2013). There are about 1,600,000 deaths annually due to air pollution in China (Institute for Health Metrics and Evaluation, 2015). The pollution has triggered both public and official concerns in China, and the local government in Beijing have developed and implemented stringent air pollution control measures targeting industries and households around the city since 2013, which affects citizens' decision making in many aspects of life. (Sun et al., 2014)However, air pollution reduction measures at the expense of economic growth and citizens' welfare are deemed to be too stringent at least by some stakeholders (Chen et al., 2020; Howe, 2024). It thus becomes important for policymakers to decide whether to improve air quality at the expense of economic growth, or to favour economic growth, which with China's current energy mix would cause air quality deterioration.

2.2 Attributes and levels of the discrete choice experiment

Three attributes, namely health, visibility and cost, were selected. These attributes and their levels were based on existing DCE studies on outdoor air pollution (Diener et al., 1997; Yoo and Chae, 2001; Rizzi et al., 2014; Tang and Zhang, 2015). Expert consultation, a focus group and interviews were organised to assess the realism, validity, relevance and comprehension of the survey. The health attribute was described by the number of hospital admissions due to air pollution in Beijing, which is a common effect of PM2.5-led air pollution used in DCE studies, and based on several observational studies (Zhang et al., 2015; Xu et al., 2016; Tian et al., 2018). Poor visibility was also a product of air pollution associated with PM2.5 in China. The number of "bad visibility days" per month was used to represent the visibility effects, with the current situation being calculated based on (Rizzi et al., 2014)'s approach. The cost attribute was described by the household electricity, gas and central heating bill – a frequently used and broadly relevant payment vehicle to support environmental services in China (Sun et al., 2016; Sergi et al., 2019; Wu et al., 2022).

The final attribute levels are presented in Table 1. An example of the choice card that was presented to respondents is given in Figure 1.

Table 1 Attributes and levels of the discrete choice experiment

Attributes [a]	**L-3**	**L-2**	**L-1**	**Current Situation**	**L1**	**L2**	**L3**
Health effect (1000 hospital admissions/year) [c]	150	145	140	130	120	115	110
Visibility effect (bad visibility days/month)		12	10	8	6	4	
Change in electricity, gas and heating Bill (RMB/month) [b]	500 RMB decrease	300 RMB decrease	100 RMB decrease	No change in bill	100 RMB increase	200 RMB increase	500 RMB increase

Note: (a) L1, L2 and L3 are possible levels for environmental improvements (or bill increase for the cost attribute); L-1, L-2 and L-3 are possible levels for environmental deteriorations (or bill reduction for the cost attribute); Current Situation is the level of attributes under current air pollution implementation. (b) According to China National Bureau of Statistics, the deposable income per capita in 2017 in China is 25,974 RMB (i.e. $3,592, calculated via Google Finance using the exchange rate on 15 April, 2024). (c) The annual average PM2.5 (one of the main pollutants of air pollution) level in Beijing is 58ug/m3 in year 2017, while the PM2.5 requirement for class I air quality is <15ug/m3 and <35ug/m3 for the class II air quality (Nazarenko et al., 2021). Therefore, an assumption of a maximum 15% air quality change seems reasonable within the context of this study.

	Policy A	Policy B	Current policies
Health (hospital admissions/year)	**145** thousand per year (**15** thousand **more** or **11%** more) 	**120** thousand per year (**10** thousand less or **7.5%** less) 	**130** thousand per year (no change) 
Visibility (number of bad visibility days per month)	**12** days of bad visibility per month (**4** days more)	**4** days of bad visibility per month (**4** days less)	**8** days of bad visibility per month (no change)
Cost per household per month (change in electricity, gas and heating bill)	**100** RMB decrease/month（**1,200** RMB decrease/year）	**100** RMB increase/month（**1200** RMB increase/year）	No change in bill

Figure 1 An example of a choice card

2.3 Experimental design and procedures

A D-efficient fractional-factorial design was employed to generate 20 choice sets, which were then randomly allocated to two groups (blocks) of participants, so that each respondent received ten choice cards. The design ensures that the health, visibility and cost attributes vary independently. The survey text provided science-based explanations for this independence. But we also imposed a restriction on the design so that the bill cannot decrease (increase) if both health and visibility attributes improve (deteriorate). The experimental design was generated using Ngene software version 1.2.0 (ChoiceMetrics, 2018).

After presenting the participation and consent forms, participants were given an introduction to the issues of air pollution and relevant governmental policies, followed by ten DCE scenarios, in which people were asked to choose their most preferred option among two policy options (Policy A, Policy B) or keeping current policies. Respondents were asked several post-experimental questions such as their decision-making process in choice tasks and socio-demographic questions. Ethical approval for the survey was obtained from the ethics board of the associated organisation. Data collection was conducted through a reputable Chinese marketing company, which administered the survey through an online platform. Respondents who successfully finished the questionnaire were rewarded with credit points exchangeable for consumption goods worth 8 RMB.

2.4 Social capital indicators

Attitudes towards social trust, social norms and social networks were used to measure social capital in this context (see Appendix A.1 for the questions presented in the questionnaire). Two general social trust questions were selected from the World Value Survey (Inglehart et al., 2014) and the General Social Survey 2016 (Smith et al., 2018). Another two context-specific questions were constructed to elicit social trust attitudes in relation to air quality. A general social norm question was used to elicit individuals' acceptance of non-compliance behaviour. Two context-specific social norm questions were constructed to elicit individuals' perceptions of descriptive norm and an injunctive norm based on (Cialdini et al., 1990)'s definition and the wording of social norm questions in other contexts (Thøgersen, 2008; Coent et al., 2018). A personal norm question was also included as the effect of social norms could be mediated by personal norms (Schwartz, 1977; Thøgersen, 2006).

Modelling framework

DCE modelling is based on random utility theory as developed in (McFadden, 1974), which assumes that individuals make decisions to maximise their utility. The basic utility function can be written as:

$$U_{ni} = v_{ni} + \varepsilon_{ni} = \beta X_{ni} + \varepsilon_{ni} \quad (1)$$

where v_{ni} is the value function of alternative i chosen by individual n, which represents the deterministic part of the utility function. X_{ni} is an attribute vector (including the health, visibility and cost attributes), whilst ε_{ni} is an error term assuming to be independent and identically distributed (IID).

The IID assumption of the error term is often violated in empirical analysis, due to preference heterogeneity across respondents. Unobserved heterogeneity is modelled through a mixed logit model (Hensher and Greene, 2003), in which attribute parameters are specified as non-fixed. The utility function in Equation 1 becomes:

$$\mathrm{U}_{ni} = \beta_n X_{ni} + \varepsilon_{ni} = \alpha X_{ni} + \zeta_n X_{ni} + \varepsilon_{ni} \quad (2)$$

where the error term ε_{ni} is still assumed to be IID, yet $\beta_n X_{ni}$ now contains two separate parts, where α captures the mean of individual preference and ζ_n captures the deviation around the mean. The IID assumption is relaxed as the utility is allowed to be correlated across alternatives.

For the value function, in this study a linear asymmetric specification was employed to reflect the asymmetrical responses in utility between health and environmental gains and losses. This specification allows researchers to model the effects of an attribute's improvement and deterioration on utility separately and has been applied in several DCE studies on environmental conservation (Lanz et al., 2009; Glenk, 2011; Ahtiainen et al., 2015; Bartczak et al., 2017). The linear asymmetric value function is specified in equation 3.

$$v_{ni} = ASC_{SQ,i} + \beta_H^{imp} H_{ni}^{imp} + \beta_V^{imp} V_{ni}^{imp} + \beta_H^{det} H_{ni}^{det} + \beta_V^{det} V_{ni}^{det} + \beta_C C_{ni} \quad (3)$$

where $H^{\mathrm{imp}} = \max(H_{SQ} - \mathrm{H}, 0)$ indicates an improvement in the health attribute relative to its reference point (i.e., the current health level), and $H^{det} = \max(H - H_{SQ}, 0)$ a deterioration. The same transformation is applied to the visibility attribute.

We also employed a hybrid choice model (HCM) to incorporate attitudinal questions related to social capital, respondents' socio-demographic characteristics and discrete choices. The hybrid choice model has several merits: (1) Social capital measures are incorporated into the model as latent variables and only indirectly linked to the attitudinal variables, which can mitigate the issue of measurement error (Daly et al., 2012; Czajkowski et al., 2017); (2) endogeneity bias can be mitigated as attitudinal variables are not directly linked to the choice data; and (3) as coefficients for the socio-demographic, attitudinal and discrete choice variables are simultaneously included in the model, better statistical efficiency can be achieved (Czajkowski et al., 2017).This is the first DCE study that investigates the effects of social capital on environmental preferences using HCM.

To this end, the HCM framework includes a structural equation (equation 4) connecting the attitudinal variables (social capital indicators) with some socio-demographic variables, a measurement equation (equation 5) in which attitudinal variables representing social capital indicators are treated as latent variables, alongside the choice model (equation 3). The structural equation is given in equation 4:

$$LV_{qn} = f(Z_n, \Upsilon_q) + \delta_{qn} \quad (4)$$

where LV_{qn} denotes the *q-th* latent variable, Z_n, denotes the observed socio-demographic variables with Υ_q being a vector of parameters, and δ_{qn} denotes the error term assuming to follow a standard normal distribution. The structural equation helps to explain factors contributing to the latent variable (i.e. social capital). These factors may include demographic and socio-economic variables such as age, income and education level.

In the measurement equation (equation 5), the *l-th* attitudinal variable (I_{qln}) was treated as the dependent variable, which was linked to the latent variable (LV_{qn}) and a random disturbance (ω_{qn}) which indicates measurement errors and was assumed to be IID:

$$I_{qn} = f(LV_{qn}, \tau_q) + \omega_{qn} \quad (5)$$

For statistical efficiency, we assumed a continuous attitudinal measurement model, and therefore answers to the attitudinal questions are assumed to be normally distributed. This is reflected in equation 6.

$$f\left(LV_{qn}, \tau_q\right) = \frac{1}{\sqrt{2\pi\theta}} e^{-\frac{(I_{qni} - \overline{I_{qn}}) - \tau_q * LV_{qn}}{2\theta^2}} \quad (6)$$

where θ is the estimated standard deviation. We subtract the mean of the social capital indicators across the sample to avoid the need to estimate the mean of the normal density (Hess and Palma, 2019).

An exploratory factor analysis was conducted to identify the social capital indicators that were most relevant to the latent variables and to reduce the number of dimensions in the structural equation (Daly et al., 2012). We used the function *factanal* in R (version 4.3.2), in which Varimax with Kaiser normalization was adopted as the rotation method with a threshold of 0.9 for the Eigenvalue score, being the threshold to select the number of components extracted from the analysis. Bartlett's weighted least-squares method was used to generate factor scores. The results of the factor analysis are presented in Appendix A.2.

The probability function of subject *n* choosing alternative *i* in choice set *t* in a mixed logit model is given by:

$$P_{ni} = \int (\prod_t \frac{\exp(\beta_n X_{nit})}{\sum_{i=1}^{I} \exp(\beta_n X_{nit})} f(\beta) d\beta \quad (7)$$

with $f(\beta)$ being the density function of coefficient β.

$$LL(\theta\ \zeta, \tau, \Upsilon) = \sum_{n=1}^{N} ln \int_{\delta} \left(P_n \prod_{l=1}^{L_q} \prod_{q=1}^{Q} L_{I_{qln}}\right) g(\delta) d \quad (8)$$

Willingness-to-pay (WTP) can be calculated as the ratio of the coefficient for a certain attribute to the one for the cost attribute, which is shown as below:

$$WTP = \beta_x / \beta_c \quad (9)$$

where β_x and β_c are the coefficients for the non-monetary and monetary attribute, respectively. The standard errors of the WTP estimates are calculated based on the Delta method (Bliemer and Rose, 2013).

All attributes, including the alternative specific constant (ASC) were assumed to be random and normally distributed in the mixed logit model based on 500 MLHS draws, except for the cost attribute which was assumed to be log-normally distributed following standard practice in DCE modelling (Glenk et al., 2019). To avoid identification issues such as non-convergence caused by data over-exploitation in choice modelling, the health and visibility attributes in the HCM were assumed to be non-random. For the same reason, we only present the model results with the interactions of the health attribute and latent variables. Results of HCM with health and visibility interacted with latent variables are presented in the Appendix A.3. We used the *Apollo* package in R to estimate the choice models (Hess and Palma, 2019).

5. Results

5.1 Sample characteristics

The final survey was completed by 230 respondents. Sample descriptive statistics are given in Table 2. Comparing the characteristics of the sample with those of the Beijing general population, the sample tends to be more educated and younger. This is potentially due to the fact that this is a web-based experiment where selected respondents need to have online access and registered accounts with the marketing company. Most respondents had a positive view regarding social trust in the city they resided. 83% of the respondents considered that people in their city can generally be trusted, and 64% of the respondents thought that people would not take advantage of them. A slightly different pattern was observed for the social norm responses: a considerable number of responses were observed on each side of the Likert scale for the first social norm question (SNorm1), whilst respondents mostly stayed positive in their responses to the other second and fourth social norm questions (SNorm2 and SNorm4). Regarding social networks, most respondents felt that air quality issues were often mentioned by people around them and that they had at least some knowledge of air pollution.

Table 2 Summary statistics of respondent characteristics

Variables	Sample	General population [c]
Age		
18-25 years	4.8%	21%
25-35 years	46.5 %	23%
35-45 years	39.6 %	19%
45-55 years	7.8 %	18%
>55 years	1.3 %	20%
Gender (male %)	48.2 %	51.2%
Highest level of education completed		
High school or lower	0.4 %	67%
Undergraduate	94.4 %	29%
Postgraduate or higher	5.7 %	4%
Annual gross household income (RMB)		
80,000 or less	8.3%	
80,000-200,000	66.5%	
200,000-300,000	19.6%	
300,000 or higher	5.7%	
Income (mean) [a]	168,690	113,073
Responsible for bill [b]	92.2%	

Social capital indicators

	Strongly/slightly agree
General trust (ST1)	83%
People won't take advantage of me (ST2)	64%
Others will contribute money (ST3)	87%
Others won't sacrifice the air (ST4)	77%
Cheat on tax (SNorm1)	40%
Others contribute time/money [d] (SNorm2)	100%
I will contribute time/money (SNorm3)	15%
People's obligation to contribute (SNorm4)	89%
Air pollution mentioned frequently [d] (SNetwork1)	100%
Know some/a lot about air pollution [d] (SNetwork2)	99%
Number of respondents	230

Note: (a) The mean of income for the sample is represented by the weighted sum of means of each income category. (b) Responsible for Bill is the individual self-reported responsibility for the household bill (Yes/No). (c) Age and education data for the general population are from the 2010 Population Census of China, and gender and income data are from the Beijing Statistical Yearbook 2017. (d) these responses were measured on a 3-point Likert scale. See the Appendix A.1 for detail.

5.2Preference and willingness-to-pay estimation

The results of the mixed logit model are presented in Table 3. First, the negative and significant coefficient of the alternative specific constant indicated that participants generally preferred to choose the proposed new policies rather than keeping the current policy. All attribute coefficients had the expected signs, although the parameter for better visibility when scenarios were described as an improvement was insignificant. For example, the positive health parameter in the improvement domain indicated preferences for less hospital admissions due to air pollution per year, whilst the negative health parameter in the deterioration domain suggested disutility for increased hospital admissions.

Regarding WTP values, the results suggested that participants were willing to pay 417.3 RMB (≈$57.7)[4] per household per month for every 10,000 fewer hospital admissions, whilst the estimated WTP (in absolute value) for every 10,000 more hospital admissions due to air quality deterioration was -969.5 RMB per month (≈$-133.9), higher (in absolute value) than the WTP for the same amount of air quality gain, suggesting the existence of gain-loss asymmetry. The WTP for a visibility improvement (i.e. for a one-day reduction in bad visibility days) and deterioration (for a one-day reduction in bad visibility days) were 49.0 RMB (≈$6.8), and -157.3 RMB ($\approx -\$21.7$) per month, respectively, which reveals participants' asymmetrical responses towards the same-sized air quality changes in the gain versus loss domains.

[4] The equivalent dollar amount was calculated via Google Finance using the exchange rate on 15 April, 2024.

Table 3 Estimation results of the mixed logit model

Variables [a]	**Mean**	**S.D.**	**Mean WTP (RMB/household/month)**
ASC SQ	-1.186***	1.430***	
	(0.182)	(0.174)	
H^{imp}	0.438***	0.891***	417.3
	(0.090)	(0.101)	(105.8)
H^{det}	-1.017***	1.580***	-969.5
	(0.140)	(0.146)	(202.5)
V^{imp}	0.051	0.163***	49.0
	(0.036)	(0.049)	(36.2)
V^{det}	-0.165***	0.290***	-157.3
	(0.040)	(0.044)	(43.2)
Cost	-4.092***	1.917***	
	(0.564)	(0.264)	
Model Statistics			
Log-likelihood	-2031		
AIC	4086		
BIC	4154		
No. of observations	2,300		

Note: (a) ASC SQ is the alternative specific constant for the "current policies" option; H^{imp} (H^{det}) is the health attribute described as improvement (deterioration) in hospital admissions ; V^{imp} (V^{det}) is the visibility attribute described as an improvement (deterioration) in the number of bad visibility days; Cost is the lognormally distributed cost attribute (parameters of underlying normal distribution are reported). Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

5.3 The effects of social capital on preferences for clean air

The results of the HCM are presented in Table 4, where we first present the results of the measurement equation (equation 5), which illustrate the relationship between the latent variables and the factors representing social capital. This is followed by the results of the structural equation (equation 4) which links the latent variables to the selected socio-demographic variables, and then the results of the choice model (equation 3) where the estimated coefficients of air quality management attribute levels along with the latent variables (interacted with the health parameters) are presented.

The effects of the first and second latent variables on the two factors were both positive and significant, suggesting that social capital indicators after factor scoring are good manifest variables reflecting the underlying latent variables. This significant relationship paves the way for meaningful connection between social capital and individual's choices made in the DCE. The results for the structural equation in the second panel show that none of the associations were statistically significant at a 5% level, except that those with attitudes represented by the first latent variable were likely to belong to the wealthier group. The results imply that unobserved instead of the observed individual characteristics may explain the latent variables better.

The key results of this study are those of the interaction terms between the health and latent variables, shown in the third panel. We found a positive (negative) association between the first and second latent variable, and the health parameter for air quality improvement (deterioration). This implies that higher social capital was related to a higher expectation of governmental actions leading to air quality improvement and higher resistance towards governmental inactions that results in air quality deterioration. However, the effects of the first latent variable on health deterioration and the second latent variable on health improvement were not statistically significant at a 5% level, suggesting that latent variable 1 (representing most of the social capital and social norm indicators) mainly affects preferences when a prospective policy was framed as improvement, and latent variable 2 (representing the social trust attitude that people take advantage of others and the social norm question that people cheat on tax) mainly affects preferences when a future policy was framed as deterioration. The signs for the other parameters remained qualitatively unchanged and WTP estimates are quite similar compared with the mixed logit model results.

Table 4 Hybrid choice model results

Measurement equations					
Variables	Mean	SD			
Factor score 1	0.282***	1.121***			
	(0.104)	(0.056)			
Factor score 2	0.457***	0.936***			
	(0.086)	(0.051)			
Structural equations	Latent variable 1	Latent variable 2			
Age	-0.133	0.001			
	(0.120)	(0.078)			
Sex	-0.339*	-0.010			
	(0.188)	(0.205)			
Income	0.171***	0.012			
	(0.058)	(0.066)			
Discrete choice model					
	Interactions		**Main effects**		
	Latent variable 1	Latent variable 2	Means (preference)	S.D. (preference)	Means [b] (WTP)
ASC SQ			-1.111***	1.486***	
			(0.194)	(0.170)	
H^{imp}	0.732***	0.259	0.405**		444.1
	(0.115)	(0.241)	(0.199)		(252.9)
H^{det}	-0.181	-1.353***	-0.900***		-986.0
	(0.540)	(0.132)	(0.203)		(817.4)
V^{imp}			0.060*		66.0

		(0.034)		(49.7)
V^{det}		-0.129***		-141.3
		(0.033)		(108.4)
Cost[a]		-3.793***	1.673***	
		(0.574)	(0.214)	
Model statistics				
Log-likelihood	-2717			
AIC	5477			
BIC	5553			
No. of observations	2,300			

Note: (a) The cost attribute is rescaled by 0.01 and is assumed to be (negatively) log-normally distributed; the parameters for the underlying normal distribution are reported. (b) WTP is measured in RMB/household/month

6. Discussion

This study contributes to the understanding of individual preferences for air quality improvements in China, and to research on the effects of social capital on environmental preferences using a discrete choice experiment. The unique gain-loss experimental design allows to quantify preferences in two divergent scenarios both for environmental improvement, implying welfare gains, and for environmental degradation, implying welfare losses. The results suggested that health and visibility effects were important attributes for protection of air quality. The preference results can be translated into WTP estimates. Our findings indicate that citizens in Beijing are willing to pay substantial amounts to avoid hospitalisation and reduced visibility caused by air pollution. Moreover, a higher WTP was found when future policy scenarios were framed as air quality deterioration rather than improvement, implying the presence of loss aversion also documented in other environmental valuation studies (Glenk, 2011; Ahtiainen et al., 2015).

This study confirms the positive correlation between social capital and preferences for environmental improvements found in previous contingent valuation methods(CVM) and DCE studies (Polyzou et al., 2011; Halkos and Jones, 2012; Smith et al., 2012a; Jones et al., 2015; Hagedoorn et al., 2019). Under the unique gain-loss framework of this study, social capital was also found to be positively related to individuals' resistance towards governmental inactions when air quality was projected to deteriorate. The results imply that in a society with high social capital, policies aimed at environmental improvement would gain public support, whereas citizens would oppose policies that prioritised economic growth at the expense of the environment. In such case, non-monetary based policies (e.g., pro-environmental nudging) could be effective (He et al., 2023).

An increasing number of studies have focused on the role of social capital in environmental protection in China (Zhang et al., 2006; Chen et al., 2014; Hao et al., 2019; Zhou et al., 2020). Our results from the HCM confirm that social norms and social trusts affect individuals' environmental preferences. Given the multiple environmental problems that China has encountered in recent years, information sharing within the realm of trusted social connections is important for awareness and collective action of citizens towards environmental protection. This is especially true in societies where information about environmental risks is absent or incomplete, due to political censorship (Hao et al., 2019).

The impact of visibility was included as a separate attribute in this study, yet has rarely been discussed in other stated preference studies on air pollution. Bad visibility may cause traffic jams or accidents, flight cancellations and restrictions on outdoor activities. The individual-level WTP for a one-day reduction of bad visibility was estimated at 196.0 RMB/year ($27.2) which is more than 10% of citizen's average annual expenditure on daily necessities in Beijing (National Statistical Bureaus of China, 2019). The result emphasised the non-negligible amount of welfare loss due to limited visibility in addition to the health effect.

Some limitations are acknowledged in this study. First, the range of levels for the health attribute in the DCE is potentially too narrow. The largest implied health change is 15%, which is relatively low compared to other DCE studies. Whilst the choice of attribute levels in this study was driven by actual health statistics, it is possible that the small magnitude in the health changes may have failed to create salient trade-offs in the choice scenarios. Furthermore, the WTP for every 10,000 fewer hospital admissions is estimated to be 5007.6 RMB per household per year, which corresponds to an average of 1,691.8 RMB per person per year ($234.0/year).[5] This is several times higher than several CVM and DCE studies in China, although the extent of air quality improvement in these studies is not often explicitly reported (see the Appendix A.4). Several reasons may explain this difference: (a) people located in more polluted areas (e.g., Beijing) are willing to pay more for better environmental amenity (Sergi et al., 2019; Liu et al., 2020); (b) the level of socioeconomic development significantly varies across different regions in China. Individual income in Beijing, the capital of China, is higher than in many other study areas, and hence citizens have higher ability-to-pay. (c) WTP has changed over time with increased awareness of the importance of environmental and public health (Cao et al., 2023); (d) The high WTP estimates can also result from non-attendance to cost or the perceived inconsequentiality of the experiment (Scarpa et al., 2009; Glenk et al., 2024).

This study confirms the important role of social capital in promoting collective action towards environmental conservation. Social capital affects environmental preferences through awareness of collective action and environmental concerns, and thus understanding preferences heterogeneity social capital levels is of importance for the acceptability of public policy. This is especially policy-relevant in countries where the importance of economic development and welfare improvement is deemed higher than environmental improvement. Given social and cultural heterogeneity are observed in many developing countries, future work should consider expanding the analysis to examine the effects of various types of social and moral attitudes on individuals' environmental preferences within their contexts.

[5] Individual-level WTP is calculated as the household-level WTP divided by the average household size in the sample, which is 2.96.

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Declaration of generative AI and AI-assisted technologies in the writing process

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CRediT authorship contribution statement

Hangjian Wu: Conceptualization, Methodology, Software, Validation, Funding acquisition, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review and editing, project administration. Emmanouil Mentzakis: Conceptualization, Methodology, Investigation, Supervision, Writing – review and editing. Marije Schaafsma: Conceptualization, Methodology, Investigation, Supervision, Writing – review and editing

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