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Influential factors of public intention to improve the air quality in China

Bitian Fu [a, b, c], Kiyo Kurisu [d], Keisuke Hanaki [d, e], Yue Che [a, b, c, *]

[a] School of Ecological and Environmental Sciences, East China Normal University, Shanghai, 200241, China
[b] Shanghai Key Lab for Urban Ecological Processes and Eco-Restoration, East China Normal University, Shanghai, 200241, China
[c] Institute of Eco-Chongming (IEC), Shanghai, 200062, China
[d] Department of Urban Engineering, The University of Tokyo, 7-3-1, Hongo, Bunkyo, Tokyo, 113-8656, Japan
[e] Graduate School of Information Networking for Innovation and Design, Toyo University, 1-7-11, Akabanedai, Kita-ku, Tokyo, 115-0053, Japan

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ABSTRACT

Current deteriorating air quality has become a severe threat for human health in the past several years in China. However, the insufficient understanding of public pro-environmental intentions and behaviors has become a barrier to implementing appropriate regulations for air quality improvement. This study aimed to seek the determinants of residents' intentions to improve air quality by using the extended Theory of Planned Behavior method. A survey that included 625 respondents from six urban cities (Beijing, Guangzhou, Hangzhou, Nanjing, Chongqing, and Kunming) was conducted to measure the intention to act by using the willingness to pay (WTP) monetary scale. The results showed that: (1) the mean WTP was 821 RMB per household per year, which accounted for 1.93% of the annual income; and the highest WTP (917 RMB) and most positive attitudes were observed for the respondents in Hangzhou; (2) the introduction of environmental concern and sense of duty can improve the predictive utility of the original TPB model (from 29% to 62%); (3) subjective norms, attitude and environmental awareness were the major influencing factors in predicting intention; (4) residents in the five advanced cities (Beijing, Guangzhou, Hangzhou, Nanjing, Chongqing) had stronger complaints, environmental knowledge, attitudes, subjective norms, perceived control and sense of duty for paying for air quality improvement than those in Kunming city; (5) the respondents who presented a greater likelihood of showing a higher WTP included males, middle-aged men, highly educated people, high-income earners, and people who spent longer amounts of time outdoors. The results could also provide policymakers with insights into residents' internal thinking and motivations toward air pollution prevention.

1. Introduction

Air pollution is one of the main environmental problems that threatens human health. Rapid economic growth has resulted in an increase in motor vehicles and industrial activities and caused severe air pollution. According to estimates by the WHO (World Health Organization), ambient outdoor air pollution causes 1.3 million urban deaths worldwide each year, and this burden is disproportionately observed in people living in middle-income countries (WHO, 2016).

China has suffered from an increasing level of air pollution in its major urban centers. China is the second-largest energy producer in the world following the United States, and 65–70% of its energy sources come from coal (WHO, 2016). A recent study showed that approximately 4000 people are killed daily by air pollution in China and more than one-third of Chinese people live in long-term, unhealthy air quality conditions (Rohde and Muller, 2015). To address this problem, the Chinese government has started to regard air pollution governance as the most significant issue affecting resident livelihoods and has included it in the government's agenda since 2011. A series of legislative and regulation improvements have been advanced, such as the renewal of the Standard for Ambient Air Quality (2012), the Air Pollution Prevention and Control Action Plan (APAP) in 2013, and the revised Atmospheric Pollution Prevention and Control Law in 2015. The new Ambient Air Quality Standard has been implemented in all Chinese cities since

* Corresponding author. School of Ecological and Environmental Sciences, East China Normal University, No.500 Dongchuan Road, Shanghai, 200241. China.
E-mail address: yche@des.ecnu.edu.cn (Y. Che).

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2016, which defines the standard for particulate matter below 2.5 μm ($PM_{2.5}$) and ozone (O_3) concentrations over a period of 8 h. However, two-thirds of Chinese cities do not meet the new national standards (WPRO, 2016), and residents of major cities, especially the northern cities, have suffered through choking air pollution for the longest period ever recorded in the country (Jia and Wang, 2017).

In addition to the government's efforts to develop a legal system using technological tools or top-down approaches, public participation is also essential to achieve sustainable development. However, public environmental participation to address the air pollution crisis in China is poor, and whether the Chinese people have sufficient motivation to improve air quality has not been clarified. Therefore, the population's current motivations must be determined, and their internal environmental actions must be clarified.

Many previous studies have focused on the public willingness to pay (WTP) for air pollution control to evaluate the economic value of non-market products, such as clean air, by using the Contingent Valuation Method (CVM) (Cai and Zheng, 2007; Carlsson and Johansson-Stenmana, 2000; Sun et al., 2016; Wang and Mullahy, 2006; Wang and Zhang, 2009; Wang et al., 2016b; Wei and Wu, 2017; Zeng et al., 2015). Although residents wished to pay for air quality improvement, their motivations for and feelings about the payment were unknown. In addition, previous studies primarily focused on socioeconomic factors, such as gender, age, earnings, and educational level (Carlsson and Johansson-Stenmana, 2000; López-Mosquera, 2016; Wang and Mullahy, 2006; Wang et al., 2016b; Wang and Zhang, 2009; Wei and Wu, 2017), which can only partially explain public air protection intention.

Recent studies have attached more importance to psychological factors, such as attitudes, beliefs, and values, to explain people's intentions. The most popular and widely accepted psychological model to explain people's intentions and behaviors is the Theory of Planned Behavior (TPB) model proposed by Ajzen (1991), which has been used to explain pro-environmental behaviors (de Leeuw et al., 2015; Masud et al., 2016). Previous studies have used the WTP accompanied by the TPB model to measure intentions to conserve the environment, such as public park conservation (López-Mosquera et al., 2014) and vehicle emission reductions (Bazrbachi et al., 2017). Ryan and Spash (2011) also tested the effectiveness of the WTP in the TPB model by targeting two environmental conservation actions: a trust fund aimed to transform agricultural land to wetland and electric utility bills increment for biodiversity protection. However, studies focusing on the public payment intention for air quality improvements based on the TPB model are limited, and intentions have only been measured using the Likert scale (Masud et al., 2016; Shi et al., 2017a).

Based on this background, three research questions were proposed: (1) Does measuring the public's intention to improve air quality via monetary payments provide effective results? (2) What psychological factors influence intention in the extended TPB model? In previous studies, the TPB model was almost exclusively applied to one region (Cai and Zheng, 2007; Filippini and Martínez-Cruz, 2016; Wang and Zhang, 2009; Zeng et al., 2015), and the differences between the citizens in different regions were not thoroughly discussed. Therefore, we also prepared an additional question: (3) Do the intentions and other psychological factor scores differ among the citizens from different regions in China, and what are the main influential factors under different economic development trends?

This study may contribute to the existing literature in the following three aspects: (1) Our study measures individuals' motivation regarding air quality improvement by a monetary payment scale (WTP), which can supplement the insufficient understanding of public behavior and intention of improvement of Chinese air quality; (2) on the basis of the original TPB model, we analyze the effect of additional psychological factors (such as environmental concern and duty for air quality improvement) on payment intention and study their contribution to the change in the TPB model explanation of the variance rate; and (3) we verify that different areas under different economic development statuses in China have different influential psychological factors and WTP intention for air quality improvement. The results of this paper can be applicable for policy-makers developing suitable environmental management measures according to local economic development conditions in developing countries from the perspective of public sentiment and attitude.

The remainder of this paper is organized as follows. Section 2 presents the extended TPB model framework and hypothetical model development. Section 3 introduces the questionnaire survey and data analysis methods, including covariance-based structural equation modeling (CB-SEM). Section 4 offers the results and discussion of mean WTP estimation, SEM model estimation, different influential factors' effects in different cities and different socio-demographic influences. Section 5 presents conclusions and policy implications.

2. Theory

2.1. TPB model framework

The TPB model originated from the Theory of Multiattribute Attitude (TMA) in 1963 (Fishbein, 1963) and the Theory of Reasoned Action (TRA) in 1975 (Fishbein and Aizen, 1975); these theories included behavior attitude (BA) and subjective norms (SN) to predict behavior intention, respectively. In 1985, perceived behavior control (PBC) was added into the TRA to form the Theory of Planned Behavior (TPB) and represent the actor's perception of how much they can control the behavior (Aizen, 1985, 1991; Kurisu, 2015). Attitude is an important factor to explain various behaviors including pro-environmental behaviors. The expectations from family or friends and belief in the individual's ability can be considered SN and PBC, respectively, and these factors can have positive effects on BI (Aizen, 1985, 1991; Bock et al., 2005; Krueger et al., 2000; Mathieson, 1991; Venkatesh, 2000). The original TPB includes five factors, including BA, SN, PBC, behavioral intention (BI), and behavior (B). BI is the factor that directly determines B; BA, SN and PBC are the three significant variables in predicting BI. Based on the research questions, the WTP for air quality improvement was set as the BI in this study. The WTP is based on an imaginary condition; therefore, we excluded the variable reflecting the actual B in the model.

2.2. Hypothetical model development

Behavior attitude (BA) represents people's positive or negative feelings about the targeted behavior (Ajzen, 1991; Fishbein and Ajzen, 1975). Behavioral beliefs can produce a favorable or unfavorable BA and then provide subjective evaluation toward the behavior (Ajzen, 1991). Most previous studies have considered that a positive BA had a significant influence on predicting environmental BI (Lee and Lehto, 2013; Paul et al., 2016; Shi et al., 2017b; Yada and Pathak, 2016). Sánchez et al. (2018) and Wang et al. (2018) found that attitudes toward environmental behaviors can positively influence the responsible environmental behavior and WTP intention for environment pollution. Subjective norms (SN) represent the perceived social pressure to perform the behavior, which can reflect the influence on the decision from an important organization or person (Tonglet et al., 2004; Wang et al., 2016c). Normative beliefs and motivation to comply can induce SN then affect corresponding behavior (Ajzen, 1991). Previous studies have confirmed that individual with stronger pressure from the significant person, such as family, friends and public figure, usually have a greater probability on performing related pro-environmental behavior (Chen and Tung, 2014; López-Mosquera et al., 2014; Wang et al., 2016a). Goh et al. (2017) considered that SN was the strongest predictor of visitor non-compliant behavior at a national park. Shi et al. (2017b) showed that SN had a positive effect on resident's intention to join PM 2.5 reduction behavior. Perceived behavior control (PBC) refers to public cognition of the behavioral promotion or obstacles and the public understanding of behavior implementation and is considered to control beliefs and perceived power. PBC usually depends on measuring the cost and benefit of performing a behavior such as financial cost, efforts and time. Many previous studies confirmed that behaviors with more ease can be paid more intention to participate in (Deng et al., 2016; Paul et al., 2016; Visschers et al., 2016). Chen and Tung (2014) considered that people who controlled over the chances, time and resources to perform a target behavior had more possibility to visit green hotels. Yuriev et al. (2018) made a conclusion that overcoming organizational and individual barriers can improve intention to enact pro-environmental behavior. Based on these components, we prepared the following three hypotheses (H1-H3):

H1. Residents' BA has a positive effect on the BI for air quality improvement;

H2. Residents' SN have a positive effect on the BI for air quality improvement;

H3. Residents' PBC has a positive effect on the BI for air quality improvement.

SN can lead to a person's more favorable attitudes and perceived behavioral control and then affect BIs (Bagozzi et al., 2004; Chang, 1998; Han et al., 2010; Kim et al., 2009; Peters et al., 2011; Ryu and Jang, 2006). People think about others' expectations and their willingness to comply when they form their own attitudes. Meanwhile, social pressure to act will affect people's perceptions of external obstacles (Quintal et al., 2010; Zhang et al., 2017). López-Mosquera et al. (2014) found the positive relationship between SN and BA and that between SN and PBC. Nair and Little (2016) supported the same hypotheses that SN had a positive effect on BA and PBC towards green consumption and psychological theories. Sánchez et al. (2018) also showed that SN positively affected BA and PBC towards WTP intention on noise pollution reduction in road transportation. Accordingly, the following two hypotheses were proposed:

H4. Residents' SN positively affect the BA for air quality improvement;

H5. Residents' SN positively affect the PBC for air quality improvement.

Based on the literature review of the original theoretical model (TPB model), we introduced environmental concern (EC) as an influential factor into the TPB model and analyzed the relationship between EC and payment intention for air quality improvement (Wang et al., 2014, 2016b). EC was usually defined as the individual's general orientation towards the environment and the willingness of solving environmental issues (Dunlap and Jones, 2002; Kim and Choi, 2005). More and more studies have attached importance to EC especially in pro-environmental behavior areas (Pothitou et al., 2016; Trivedi et al., 2018). It has been confirmed that EC has a direct effect on specific environmental behaviors and attitudes (Donald et al., 2014; Singh and Verma, 2017). Chen and Tung (2014) considered that consumers' environmental concern indeed has a positive influence on BA toward visiting green hotels. Vicente-Molina et al. (2013) and Li et al. (2018) found that environmental knowledge can influence pro-environmental behavior. Trivedi et al. (2018) also found a positive link between ecological concern and environmental attitude towards green purchasing. The following two hypotheses were included in the model:

H6. Residents' EC has a positive effect on the BI for air quality improvement;

H7. Residents' EC has a positive effect on the BA for air quality improvement.

In addition to the TPB model, one of the most important factors explaining people's environmental behaviors is moral norms (Manstead, 2000; Schwartz, 1977). A moral norm is sometimes called a personal norm or moral obligation (Manstead, 2000), which is one of the common factors for predicting pro-environmental behaviors. Moral norms refer to individuals' pride or guilty feelings when participating in a special behavior. In our paper, we regarded a sense of duty to pay for air quality (DT) as a kind of moral norm. Previous studies have considered that moral norms can improve the explanation of pro-environmental intentions and behaviors (Chen, 2016; López-Mosquera et al., 2014; Verma and Chandra, 2018; Yazdanpanah and Forouzani, 2015), while others have taken a more skeptical view (Donald et al., 2014; Kaiser and Scheuthle, 2003; Kaiser et al., 2005). On this basis, we assumed H8 to analyze the relationship between the moral norm and our target behavior, attention for air quality improvement. Moral norms are closely associated with social norms and behavior attitude, which can emphasize individual's internal emotions (Arvola et al., 2008; Kaiser, 2006; López-Mosquera et al., 2014; Lopez-Mosquera, 2016; Raats et al., 1995; Shi et al., 2017a). Kaiser and Scheuthle (2003) considered that attitude and moral norms had a sizeable overlap between them, which means that the moral norm was already represented in people's environmental attitude. On this basis, we proposed H9 to analyze whether individual's attitude can predict his or her moral obligation. Some studies proved that subjective norms can determine moral norms (López-Mosquera et al., 2014; Lopez-Mosquera, 2016; Peters et al., 2011; Quintal et al., 2010), which means that the social pressure or important people around individuals will affect their moral perception and obligation. The following three hypotheses were included in the hypothetical model:

H8. Residents' DT positively affects the BI for air quality improvement;

H9. Residents' BA positively affects the DT for air quality improvement;

H10. Residents' SN positively affect the DT for air quality improvement.

In addition to the main components of the TPB model indicated above, additional statements considering the possible influences related to “social norms” were prepared. Norms, which can be categorized into social and personal norms, are considered one of the most important influential factors in evaluating individual's behavior. Social norms contain descriptive norms (DN) and subjective norms (SN). The perceptions of other people's behaviors represent an influential factor on people's pro-environmental behaviors and are called “descriptive norms” (DN) (de Leeuw et al., 2015; Donald et al., 2014; Grønhøj and Thøgersen. 2012; Harland et al., 2007; Steg and Vlek, 2009). Individuals are more likely to follow behaviors of other people who are important to them and made the same choice. Ajzen (1991) proposed that DN should be included in questionnaires to understand how different social norms impact a behavior. Shi et al. (2017a) reported stronger relationship between DN and household PM 2.5 reduction behavior in urban areas in China. Therefore, H11 was built to study the explanation of DN and behavioral intention.

H11. Residents' DN positively affect the BI for air quality improvement.

The developed hypothetical model and hypotheses in this study are shown in Fig. 1. The abbreviations of all the variables are shown in Table S1 in Appendix A.

3. Materials and methods

3.1. Study area

The six cities of Beijing, Chongqing, Guangzhou, Hangzhou, Kunming, and Nanjing were selected based on their economic development and current air quality situations. The Jing-Jin-Ji Region, the Yangtze River Delta, and the Pearl River Delta are the three most important economic belts in China and have been selected as the main areas of the Air Pollution Prevention and Control Action Plan (APAP) issued by the State Council in 2013. The action plan promises that in five years, the targets of fine particulate matter concentration (including PM 2.5) reduction in the Jing-Jin-Ji Region, the Yangtze River Delta, and the Pearl River Delta will be 25%, 20% and 15%, respectively (SCC, 2013). The Chengdu-Chongqing Economic Zone is one of the most important economic centers of western China and will be one of the strongest comprehensive economic zones in China in 2020, equal to the Yangtze River Delta and the Pearl River Delta. The Chengdu-Chongqing Economic Zone has been selected as the main area of Air Pollution Inter-regional Prevention and Control in the twelfth five-year plan. Moreover, Chongqing is also a joining-point city of the One Belt, One Road region and the Yangtze River Economic Delta (Wang, 2017), and it faces huge international challenges to mitigate air pollution. In addition to these selections, we added a western developing city, Kunming, as a reference to analyze the difference of air quality improvement intention between Kunming and other five advanced cities. Kunming was selected because it is known as a tourist city and presents better air quality; in fact, it was the 8th among 74 cities to execute the new air quality standard in 2015 (Wang et al., 2015).

3.2. Questionnaire design

Based on the hypothetical model shown in Fig. 1, questions on each component were prepared. To identify people's intentions to improve the air quality (BI), the WTP was directly queried. Prior to the survey, a pre-test was conducted to determine the appropriate ranges of WTP choices for 50 people in Wujing Town in Shanghai from May 15 to 16 in 2016. In the pre-test, a series of monthly payment choices ranging from 10 to 5000 RMB (1 RMB = 0.15 US$ as of November 2017) were shown as the payment options. Taking 95.4% of the probability of selection, 30 bids ranging from 10 to 500 RMB were applied to the survey. If a respondent has a higher WTP than 500 RMB, he/she was asked to write the WTP directly on the survey. The complete avoidance of payment (WTP = 0) was also included as one of the options. Other items in the questionnaire, such as the EC, BA, SN, PBC, DT, DN and sociodemographic (SD) variables, were also tested in the pilot survey.

People's concerns about air quality were determined in seven questions (EC1–EC7). In this part, the respondents showed their concerns about current air quality by answering statements (e.g., *I am very dissatisfied with current air quality* (EC1)) using a 5-point scale ranging from “strongly agree” to “strongly disagree.” This scale was also used for other components, such as the BA, DT, SN and PBC.

For BA, six statements (BA1–BA6) were prepared, and the respondents were asked to provide positive or negative evaluations about paying for air quality improvement (e.g., *To me, paying for air quality improvement is what I absolutely love to do* (BA5)).

For SN, considering the expectations from close people (e.g., family and friends), three questions were prepared (SN1-SN3) that touched on their support.

For PBC, the target issue in this study is payment intention; therefore, the perception of their economic ability was determined (PBC1). Additionally, how much the behavior can be controlled or decided by the actor was also determined (PBC2).

Three statements were prepared to evaluate the DT. The

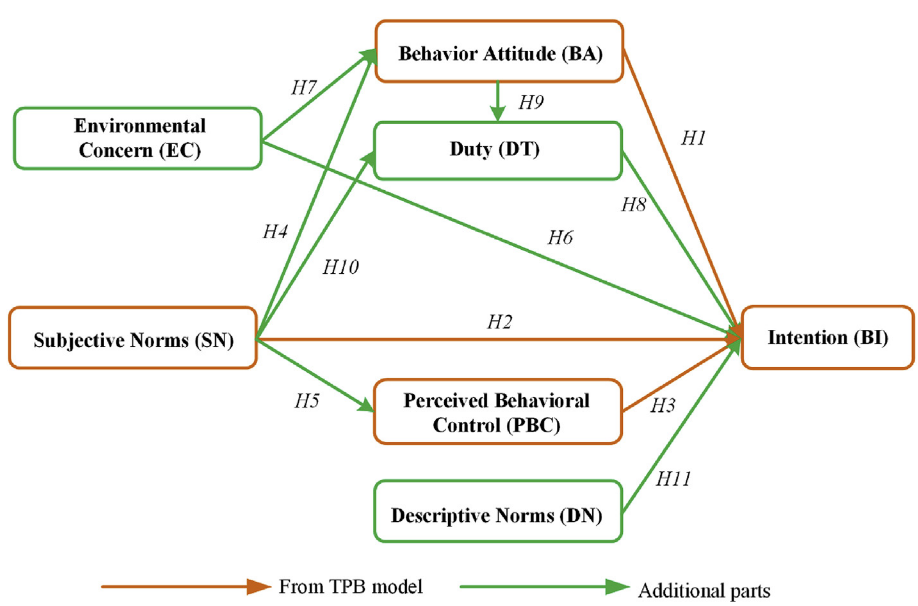


Fig. 1. Hypothetic model construction.

respondents were asked to describe the level of DT they feel to pay to improve air quality (DT2 and DT3) and perform beneficial actions to maintain a good living environment (DT1). The respondents felt that it was their responsibility and DT to support specific environmental issues (such as air quality) as well as overall environmental problems, and this responsibility presented an embedding effect and generated positive emotions in previous CVM studies (Guagnano, 2001; López-Mosquera et al., 2014; Johnson et al., 2007). Therefore, we asked DT1 in addition to DT2 and DT3.

For DN, focusing on the behaviors of people close to the respondent, two statements were prepared (DN1, DN2). In addition, the perception about the influence from governmental pressure was also prepared as statement DN3.

For the SD variables, questions associated with gender, age, place of residence, educational level, and individual income were asked. In addition, the respondents were asked for how long they usually engaged in outdoor activities. The questionnaire items are shown in Table S2 in Appendix A.

3.3. Data collection

The survey was conducted from May 27 to September 29, 2016, through face-to-face interviews in the six study cities. The schedules and sample numbers obtained are shown in Table 1. The sample profile was determined based on the population of each city in terms of gender and age. The respondents were selected to complete the questionnaire at random from individuals observed in the streets, residential areas, and parks at the time of the survey. One hundred respondents were planned for each city, and a total of 625 respondents were obtained. The respondents' demographic statistics are shown in Table S3 in Appendix A.

3.4. Data analysis

3.4.1. Mean WTP estimation

To calculate the mean WTP value in each city, the logit model was applied (Hanemann, 1984). In this model, the probability that Xi is accepted (Pi) is described in Eq. (1).

$$P_i = 1/1 + e^{(-a-b\ \ln x_i)} \tag{1}$$

where a and b are the coefficients that will be estimated. In this case, the log likelihood function ln L is described in Eq. (2).

$$\ln L = \sum_i [d_Y \ln P_i + d_N (1 - \ln P_i)] \tag{2}$$

where d_Y and d_N are the dummy variables, which become 1 when the respondent accepts or rejects the WTP, respectively. To maximize the ln L, the coefficients of a and b in Eq. (2) will be determined. The mean WTP value is estimated by the integration of the Pi function.

3.4.2. Consistency of the proposed scales

To determine the adequacy of the proposed scales, a factor analysis was applied to the 24 items (EC, BA, DT, SN, PBC, and DN). Scores ranging from 5 (“strongly agree”) to 1 (“strongly disagree”) were assigned to the answers. The Promax rotation and maximum likelihood method were used (SPSS 19.0, IBM). The KMO value of the calculation was 0.968, which is greater than 0.5, and the sphericity was significant ($p < .05$). As shown in Table S4 in Appendix A, eight factors were extracted. Cronbach's α was calculated to verify the consistency of each scale, and values greater than 0.6 were observed, which is an acceptable criterion (Cronbach, 1951).

All the items fit the assumed scales except for EC, which was divided into three factors. The first of these consisted of EC3 and EC1, which were considered complaints (CM) about the current air quality. The second factor consisted of EC4, EC6, EC7, and EC2, which represented people's worries and concerns about air quality and the necessity for improvement; therefore, it was named concerns (CN) for current air quality. The third factor consisted solely of EC5, “*I know the heavy air pollution issues of my city*”; therefore, it was considered the knowledge (KN) about the current air quality (EC5).

According to the development of new factors, the following additional hypotheses were prepared:

H6-1. Residents' CM positively affect the BI for air quality improvement,

H6-2. Residents' CN positively affect the BI for air quality improvement,

H6-3. Residents' KN positively affects the BI for air quality improvement,

H7-1. Residents' CM positively affect the BA for air quality improvement,

H7-2. Residents' CN positively affect the BA for air quality improvement, and

H7-3. Residents' KN positively affects the BA for air quality improvement.

3.4.3. Structural equation modeling

To identify the strength of each path of the hypothetical model and verify the appropriateness of the model, Structural Equation Modeling (SEM) was conducted. CB-SEM is the most common approach in SEM, and it follows a maximum likelihood (ML) estimation procedure and aims to minimize the difference between the observed and estimated covariance matrix (Astrachan et al., 2014; Hair et al., 2011). AMOS is one of the commonly used software applications for covariance-based SEM (CB-SEM) estimation. Because the questionnaire samples had a substantially larger sample size and the questionnaire data basically fitted the normal distribution, our study chose the CB-SEM method (by using SPSS AMOS 17.0, IBM) to explain the relationship between influential factors and payment intention for air quality improvement.

Table 1
Questionnaire survey details.

City	Survey Districts	Survey period in 2016	Gained sample No.
Beijing	Dongcheng, Chaoyang, Fengcheng, Changping	Aug. 5 - Aug. 7	104
Chongqing	Shapingba, Yuzhong, Jiangbei	Aug. 26 - Aug. 28	103
Guangzhou	Tianhe, Haizhu, Yuexiu	July 1 - July 3	107
Hangzhou	Xiacheng, Xihu, Jianggan, Yuhang	May 27 - May 29	101
Kunming	Wuhua, Panlong, Xishan	Sept. 26 - Sept. 29	106
Nanjing	Xuanwu, Qixia, Gulou, Qinhuai	Aug. 8 - Aug. 10	104

The WTP values (0, 10, 20–40, 50–90, 100–150, 200–400, 400–500, >500) were converted into scores from 1 to 8 because, compared with the other variables, these values were distributed to a much greater degree. To check the reliability of the model, the goodness-of-fit index was used (Jöreskog and Sörbom, 1996; Wu, 2009).

4. Results and discussion

4.1. WTP estimation

The mean WTP, which also included WTP values of 0, was 68.4 RMB per month per household of the total questionnaire sample. Hangzhou showed the highest mean WTP values (76.4 RMB), followed by Guangzhou (74.9 RMB), Beijing (74.4 RMB), Chongqing (64.4 RMB), Nanjing (62.8 RMB), and Kunming (61.5 RMB). Fig. 2 shows the relationships between each city's WTP and the AQI and income level. Fig. 2 (a) shows that a positive relationship occurred between the WTP and the AQI in Beijing (BJ), Chongqing (CQ), Nanjing (NJ), and Kunming (KM). Guangzhou (GZ) and Hangzhou (HZ) showed higher WTPs in this relationship, which was associated with their higher income levels as shown in Fig. 2 (b).

The results of the mean WTP in this study were compared with the results of previous studies that focused on evaluating the economic value of air quality improvement. The ratio of the WTP value to income appeared to remain at a relatively moderate level (0.20–3.05%), even if different samples and study areas were used (Table 2). The comparison also verified that income was indeed one of the important determinants of WTP, and the mean WTP calculated in this study was reasonable and reliable under the rapid economic development and increased incomes observed in recent years in China.

Of the 625 respondents, 135 people elected to avoid payment, which accounted for 21.6% of the entire sample. The highest avoidance ratio was observed in Beijing (31.7%), whereas the lowest ratio was shown in Kunming (12.3%). In our study, we found a higher ratio of payment rejection attitudes. The factor score comparison between the payment rejection group (n = 135) and the acceptance group (n = 490) is shown in Fig. 3. The payment rejected group showed lower CM, CN, BA, SN, DN, PBC and higher DT than the accepted group.

4.2. Model estimation for all data

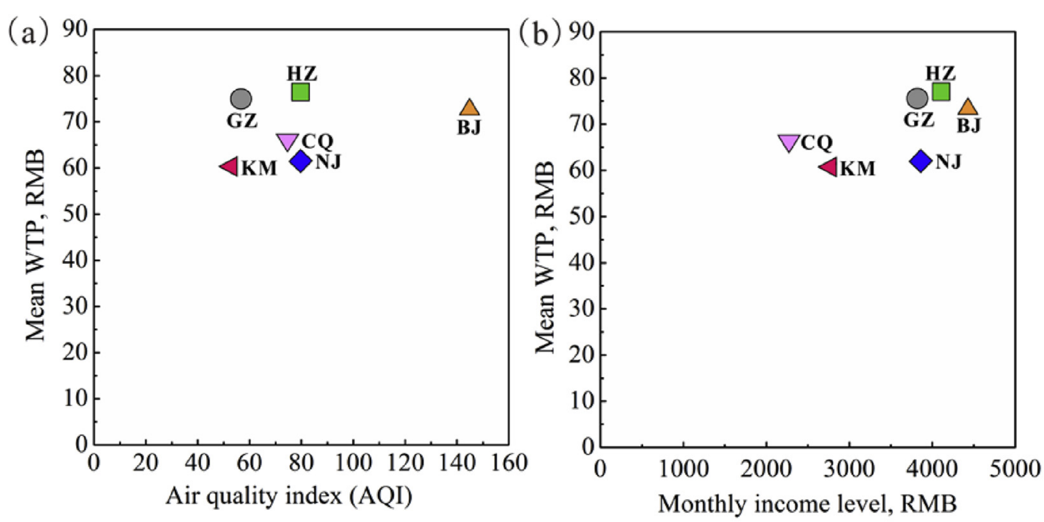
The final SEM model and model fit indices for all data (n = 625) are shown in Fig. 4 and Table 3, respectively. As shown in Fig. 4, all the hypotheses were proven to be valid except for H8. The hypotheses (H1, H2 and H3) from the original TPB model passed the hypothetic testing, which reflects that BA (0.755), SN (0.308) and PBC (0.372) have a stronger influence on BI. H4 and H5 were also proven, which means that SN has a significant positive effect on BA (0.707) and PBC (0.695). CM (0.380), CN (0.114), and KN (0.052) had a positive effect on BI, and the factors that influenced the BA were SN (0.707), CM (0.279), CN (0.106) and KN (0.123). H8 (the positive relationship between DT and BI) was rejected. H9 was also proven to be valid, which represents that BA (0.575) had a positive impact on individuals' environmental feelings of duty. H10 verified that SN (0.259) can positively influence an individual's environmental sense of responsibility. H11 can be proved that DN (0.127) also had a positive effect on BI.

As shown in Table 3, the final model showed acceptable model indices. The criterion of χ^2 is $p > .05$, although this is easily rejected when the sample size is large enough; therefore, other indices that consider sample size should be used (Rigdon, 1995). The R^2 of BI (0.62), which represented the ratio of variance explained by this model, also indicated that this model was acceptable for explaining BI.

Considering the direct and indirect effects on BI, the total estimated effect of each psychological factor is shown in Table 4. SN (0.947), BA (0.622) and (0.554) had a stronger total effect on BI. Comparing the model estimation results in the extended TPB model with the original TPB model in Table 4, it is easy to see that the addition of EC (CM, CN and KN), DN and DT will enhance the SEM model explanation variance from 29% to 62%.

4.3. Effect of influential factors on WTP intention of different areas

The mean factor scores for the psychological factors are shown in Fig. 5. Beijing showed the highest CM score, whereas Kunming and Guangzhou showed lower scores. The CM section clearly shows that the residents who suffered worse air quality presented higher



Note: BJ: Beijing, CQ: Chongqing, GZ: Guangzhou, HZ: Hangzhou, KM: Kunming, NJ: Nanjing.

Fig. 2. Relationship between the mean WTP and the AQI (left) and income level (right).

Table 2
WTP results comparison with other studies targeting air quality.

Country	City/Region	Mean WTP		Income[c] (thousand RMB/year)	Ratio (%)	Reference
		(RMB/year)[a]	([b])			
Sweden	Nationwide	1580	(P)	89.3[a]	1.77	Carlsson and Johansson-Stenmana (2000)
Taiwan	Taipei, Taichung, and Kaoshiung	190	(P)	97.9[b]	0.20	Chien et al. (2005)
Mexico	Mexico city	1820	(P)	59.6[c]	0.63	Filippini and Martínez-Cruz (2016)
China	Nationwide	1590	(H)	27.0[d]	1.90	Sun et al. (2016)
	Beijing	143	(H)	13.8[e]	1.04	Wang et al. (2006)
	Beijing	652	(H)	34.2[f]	1.91	Cai and Zheng (2007)
	Beijing	273–478	(P)	43.9[g]	1.09	Zeng et al. (2015)
	Ji'nan	100	(P)	14.3[h]	0.70	Wang and Zhang (2009)
	Chongqing	14.3	(P)	3.6[i]	0.40	Wang and Mullahy (2006)
	Zibo	>960	(P)	31.5[j]	3.05	Wang et al. (2016a)
	Jing-jin-ji region	602	(P)	37.3[k]	1.61	Wei and Wu (2017)
China	Below six cities	821	(H)	42.5	1.93	This study
	Beijing	893	(H)	52.9	1.69	
	Chongqing	773	(H)	27.2	2.84	
	Guangzhou	900	(H)	46.7	1.93	
	Hangzhou	917	(H)	48.3	1.90	
	Kunming	738	(H)	34.0	2.17	
	Nanjing	754	(H)	46.1	1.64	

[a] Original data were converted to RMB as follows: Sweden (2000 SEK, 1 SEK = 0.79 RMB), Taiwan (72 TWD, 1 TWD = 0.22 RMB), Mexico (262 US$, 1 US$ = 0.15 RMB) using the exchange rate in November 2017.
[b] P: WTP per person; H: WTP per household.
[c] Income data were collected from the following data sources: a) Carlsson and Johansson-Stenmana (2000); b) National Statistics of Republic of China (Taiwan) (1951–2000); NBS (1994); c) Centro de Estudios de las Finanzas Pu'blicas ((CEFP 2008)) and Instituto Nacional de Estadı ́stica y Geografı ́a (INEGI) (2010); d) NBS (2013); e) Beijing Municipal Bureau of Statistics (2005); f) Beijing Municipal Bureau of Statistics (2005); g) Zeng et al. (2015); h) Ji'nan Municipal Bureau of Statistics (2005, 2006); i) Wang and Mullahy (2006); j) Shandong Provincial Bureau of Statistics (2013); k) NBS (2015).

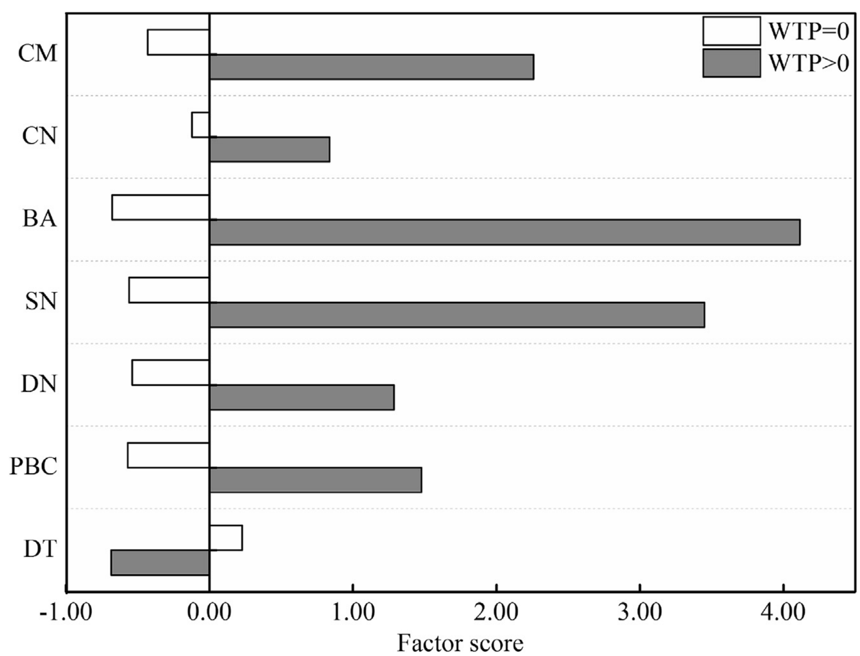


Fig. 3. Psychological factor scores of the payment rejection group and acceptance group.

CM values for the current air quality. However, a clear relationship between the scores of the other factors and air quality was not observed among the six cities. When we consider the scores for Kunming, they were the lowest for CM, BA, and PBC. These low scores reflect their lowest mean WTP, which can be derived from their better air quality. Beijing and Chongqing residents showed higher CM levels but lower DT on air quality, which reflects their higher rejection of payment.

The psychological effects on BI in the five advanced cities and Kunming, as estimated by the CB-SEM model, are shown in Table 5. The five advanced cities had stronger attitude, perceived control, subjective and descriptive norms, environmental awareness and responsibility for environmental protection by paying intention for air quality improvement. As Kunming had the lowest mean WTP (61.5 RMB), most residents in Kunming were satisfied with their living environment and did not have stronger willingness to pay for air quality improvement.

SN had the strongest effect on BI through not only direct effects (0.308) but also indirect effects (0.639), which is consistent with previous studies by López-Mosquera et al. (2014), Peters et al.

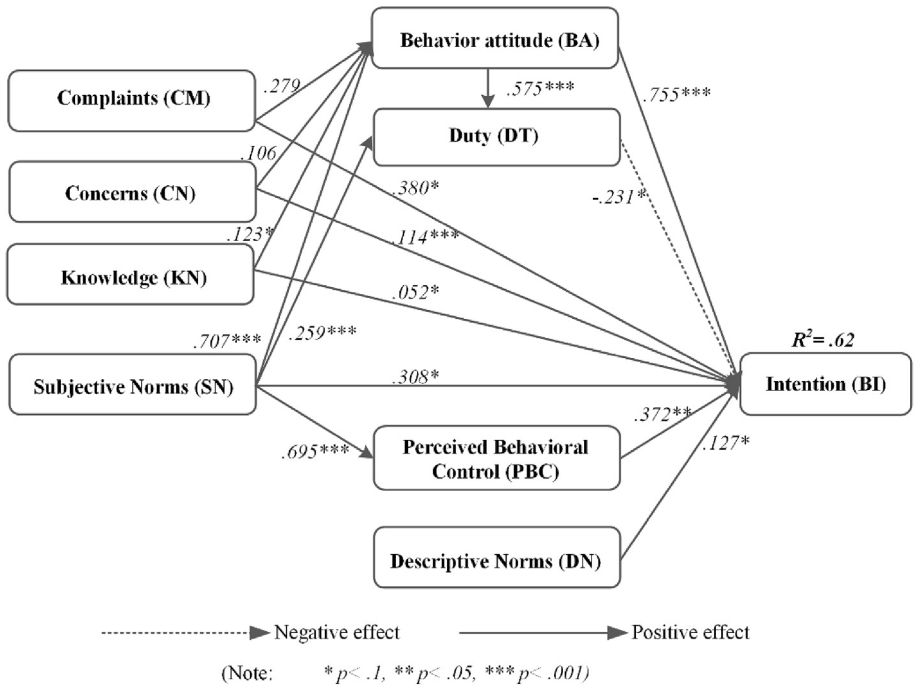


Fig. 4. Model estimation using all data (n = 625).

Table 3
Model fit results of the final model.

	Indicators		Criteria	Results
Absolute fit measures	χ^2	Chi-square	>.05	.000
	RMSEA	Root Mean Square Error of Approximation	<.08	.060
	AGFI	Adjusted Goodness of Fit Index	>.80	.879
	GFI	Goodness of Fit Index	>.80	.911
	SRMR	Standard Root Mean-square Residual	<.08	.072
Incremental fit measures	NFI	Normed Fit Index	>.90	.945
	CFI	Comparative Fit Index	>.90	.961
	IFI	Incremental fit index	>.90	.961
	TLI	Tucker Lewis Index	>.90	.951
Parsimonious fit measures	PGFI	Parsimonious Goodness of Fit Index	>.50	.673
	PNFI	Parsimonious Normed Fit Index	>.50	.762
	PCFI	Parsimonious Comparative Fit Index	>.50	.775

Table 4
Effect of each psychological factor in the extended and original TPB model.

Independent variable	Effect in the extended TPB model		Effect in the original TPB model
	Direct effect on BI	Total effect on BI	Direct effect on BI
CM	.380	.554	
CN	.114	.180	
KN	.052	.129	
BA	.755	.622	.383
SN	.308	.947	.213
DN	.127	.127	
PBC	.371	.372	.378
DT	−.231	−.231	
R^2	.62		.29

(2011) and Thøgersen and Olander (2006). Exemplary behavior by parents or friends still has a strong influence in modern cities, such as Hangzhou, Guangzhou and Chongqing. Consistent with previous studies (Masud et al., 2016; Shi et al., 2017a; b), BA was the strongest factor (0.755) for directly explaining intention (BI). Fig. 5 shows that Nanjing and Kunming had lower BA levels, which would explain their lower WTP intention. CM was another significant predictor for BI through direct (.380) and indirect (0.174) effects. Residents presenting stronger CM will pay more than others, especially in cities with worse air quality, such as Beijing, Chongqing and Hangzhou. PBC had a stronger effect on BI (Pouta and Rekola, 2001; Spash et al., 2009; Zhang et al., 2014),

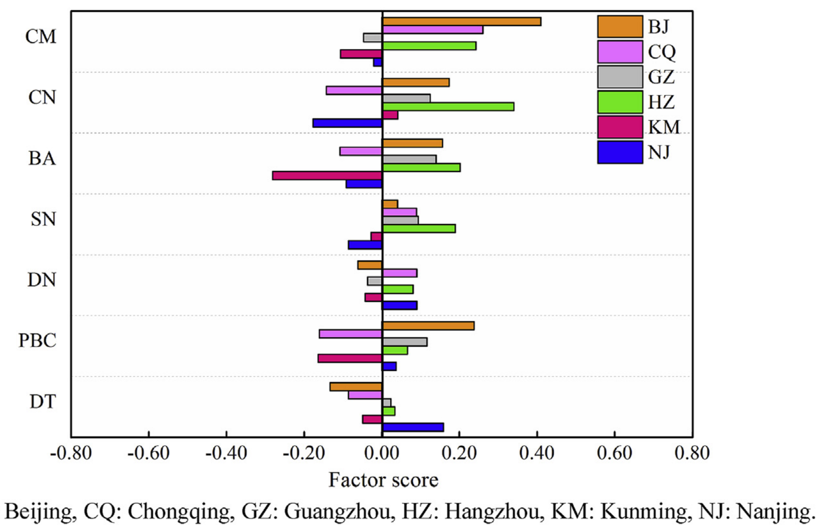


Fig. 5. Mean score of respondents for each psychological driving factor in six cities.

Table 5
Effect from each independent variable on BI.

Effect from Independent variables on BI	Five advanced cities	Kunming city
CM	.442**	.012*
CN	.119*	.211*
KN	.139*	.014*
BA	.786***	.147*
SN	.269*	.235*
DN	.141*	.113*
PBC	.501***	.373**
DT	−.089*	−.487
R^2	.54	.60

especially in Beijing, Guangzhou and Hangzhou, which indicated that certain necessary resources, such as individual economic ability and cognition of behavioral implementation, affected the BI in fast-growing cities that present higher GDP and income levels in China. DN also had a positive effect (.127) on BI, especially in Nanjing, Chongqing and Hangzhou. Therefore, the traditional concept that individuals prefer to follow an important public figure persists in China (Blok et al., 2015; Matthies et al., 2012). Compared with previous studies (Bamberg et al., 2007; López-Mosquera et al., 2014), DT (−0.231) showed a negative influence on BI. One possible explanation is that our study focused on the feelings of residents' DT and responsibility for payment, which may be inconsistent with narrowly defined personal norms and morals. It may be that people with a high sense of environmental responsibility prefer to protect the air environment by any other ways than just paying money.

4.4. *Sociodemographic influences on psychological factor scores*

Single correlations were checked between the BI and SD variables in Table S5 in Appendix A, and five variables showed significant effects: monthly income (0.320, $p < .05$), age (−0.259, $p < .001$), outdoor exposure time (0.208, $p < .001$), education level (0.166, $p < .05$), and gender (male = 1, −0.059, $p < .05$). Income level showed the highest positive influence on BI and was used to indicate the payment intention. A significant correlation was not observed between age and income level, and younger people showed a greater intention to pay for air quality improvement than elderly people. Outdoor exposure time was also an influential factor on BI.

The factor scores for the different SD categories are shown in Fig. 6 to illustrate the influence of each SD variable on each psychological factor. Males are more likely to pay than females, primarily because of their higher CM and CN. The young and middle-age groups had a higher BI because of their greater awareness of and concerns regarding unhealthy environmental impacts and body/health crises caused by air pollution. These groups may have more opportunities to access environmental protection information and stay outside longer. Although elderly people presented strong CM and desire, they did not have sufficient economic ability to make their own decisions to pay for the current polluted environment. As shown in other environmental issue studies (Carlsson and Johansson-Stenmana, 2000; Wei and Wu, 2017), education level played an important role in the respondents' perception and behavior. Respondents with a bachelor's degree or higher had a higher BI because of their higher BA, SN, better economic ability and higher air environmental protection knowledge. Residents with less than a bachelor's degree account for the majority of the urban population in China; thus, environmental education must be promoted at lower education levels. Income was the most influential SD factor for BI. Wealthier people were willing to pay more for current air pollution and had stronger pollution prevention initiatives (Wang and Mullahy, 2006; Wang and Zhang, 2009; Sun et al., 2016). Daily time outdoors was another influential factor on BI. People exposed to the ambient air over longer periods presented greater CM and higher BI.

5. Conclusions and policy implications

This study contributes to the study of the factors that influence residents' WTP intention for air quality improvement in six cities in China via an extended TPB model. This study attempts to understand which psychological determinants are important for residents to be more environmentally active and what must be done for policymaking. Major findings were observed. (1) The additional factors (EC and DT) improve the explanation variance rate and optimize the structure of the TPB model, which verifies that the extended TPB model can be applied to predict residents' WTP intentions; (2) the public intention for air quality improvement can be measured using a monetary payment scale (WTP); (3) different psychological factors have different effects on payment intention for improving air quality, and subjective norms (0.947) and

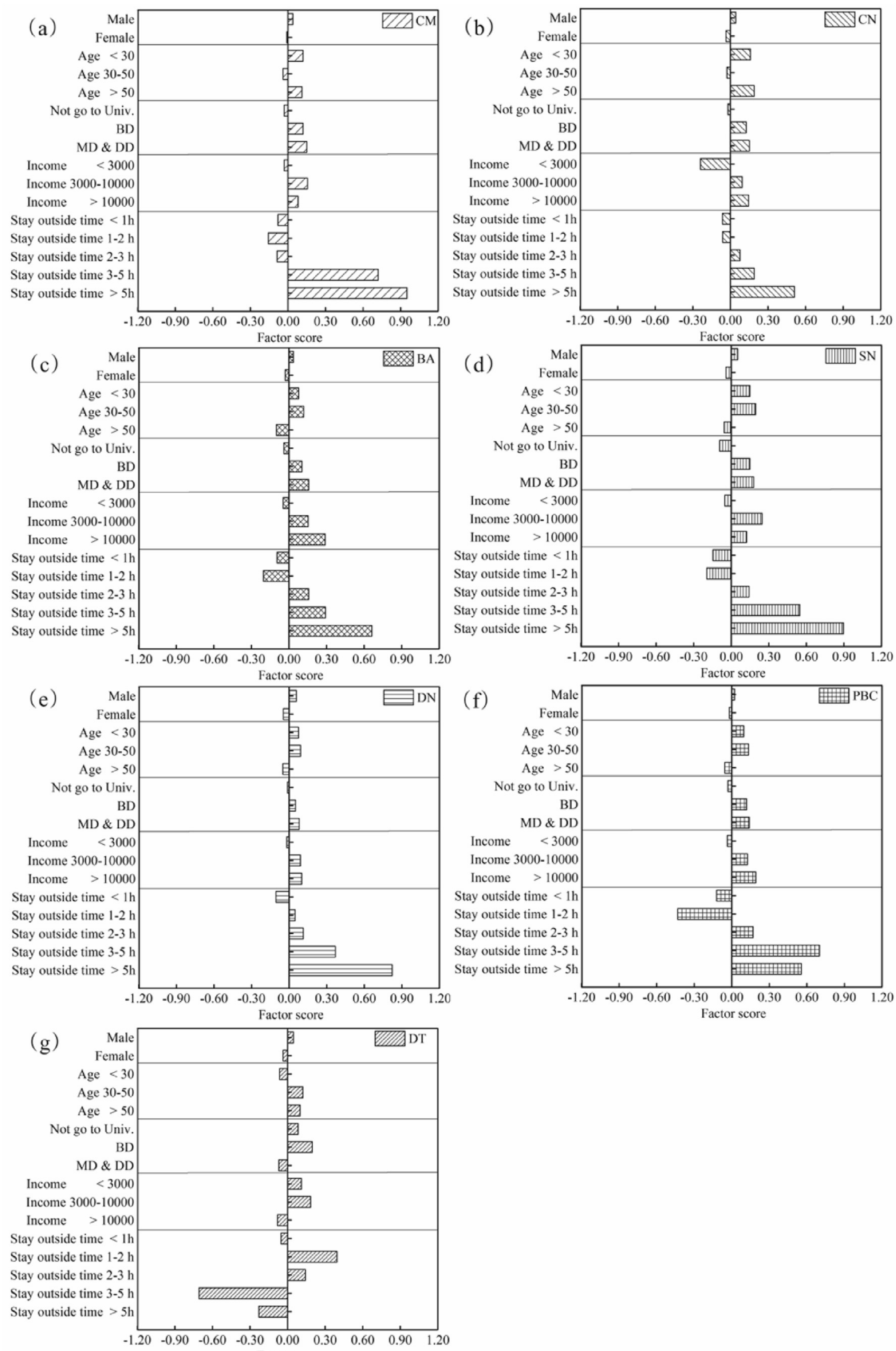


Fig. 6. Different sociodemographic effects on CM, WL, BA, SN, DN, PBC, DT.

behavioral attitude (0.622) are the most influential psychological factors for public WTP intention; (4) all environmental concern factors, such as complaints, concerns and knowledge, have significant effects on public payment intention, i.e., sufficient environmental awareness has a positive effect on public intention for air quality improvement; (5) residents in the areas with fast-growing economic development trends have stronger attitudes about protecting air environment with intense subjective norms, environmental awareness and perceived control; (6) people with different sociodemographic attributes have different WTP intentions. Males, middle-aged men, highly educated people, high-income earners and people who stay outdoors longer have a stronger WTP for air quality improvement; and (7) mean WTP intention has a relative relationship with individuals' local income level.

The practical value of this paper includes the following aspects: (1) Public community leaders, public figures, males, highly educated and high-income people can be focused on training environmental awareness. Public community leaders can launch green welfare environmental activities for residents; public figures can join green advertising and lead fans to prefer pro-environmental behavior; males can encourage their wives and the entire family to join environmental protection activities; highly educated and high-income people can guide others to engage in better environmental education. Pro-environmental attitudes deserve to be carried forward during those public participation activities; (2) Environmental dissemination and education should be promoted and reinforced by the government, mass media and networks. Establishing an environmental education museum and providing environmental-protection optional courses from primary school to university will promote the individual cultivation of pro-environmental awareness and greener values from childhood, which will also prompt governments and related institutions as well as the public to work together to increase the publicity of pro-environmental knowledge and behavior for air pollution reduction; (3) Local governments should consider fast-growing cities when strengthening their air environmental management measures.

Despite the meaningful findings for the determinants of people's air quality improvement paying intentions in China, certain limitations in the current study and suggestions for intensive research for future studies need to be considered. First, because social surveys about air/environmental protection behavior are still in a preliminary stage and acquiring face-to-face data on protest rates is difficult, the present study focused on BI rather than actual behavior. The advantage of using BI is that we can generate realistic intentions by using the monetary scale. Although BI can lead to actual behavior, future studies should attempt to measure subsequent behavior because of the uncertainty of whether behavior can be influenced by pure intention or income level. Second, this study mainly focused on the air quality improvement payment intention in six cities (five rapidly growing cities and Kunming); other cities, such as cities in the middle region of China, can be further studied to verify our results in future research. Third, it may exist the possible bias in the face-to- face questionnaire survey because some selected respondents might not represent other family members who were not selected in. Future studies will reflect a more comprehensive individual awareness of current air quality and the surrounding environment with a more accurate questionnaire survey.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2018.10.192.

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