

Research Paper

## Analysis on Socio-cultural Aspect of Willingness to Pay for Air Quality (PM<sub>10</sub>, PM<sub>2.5</sub>) Improvement in Seoul\*

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### 서울지역 미세먼지 문제 개선을 위한 사회문화적 지불의사액 추정

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**Abstract :** Over the last few years, air pollution (PM<sub>10</sub>, PM<sub>2.5</sub>) in the Seoul metropolitan area (SMA) has emerged as one of the most concerned and threatening environmental issues among the residents. It brings about various harmful effects on human health, as well as ecosystem and industrial activities. Governments and individuals pay various costs to mitigate the level of air pollutants. This study aims to empirically find the willingness to pay (WTP) among the parents from different socio-cultural groups - international and domestic groups to mitigate air pollution (PM<sub>10</sub>, PM<sub>2.5</sub>) in their residential area. Contingent Valuation Methods (CVM) is used with employing single-bounded dichotomous choice technique to elicit the respondent's WTP. Using tobit (censored regression) and probit models, the monthly mean WTP of the pooled sample for green electricity which contributes to improve air quality in the region was estimated as 3,993 KRW (3.58 USD). However, the mean WTP between the international group and domestic group through a sub-sample analysis shows broad distinction as 3,325KRW (2.98 USD) and 4,449 KRW (3.98 USD) respectively. This is because that socio-cultural characteristics of each group such as socio-economic status, personal experience, trust in institutions and worldview are differently associated with the WTP. Based on the results, the society needs to raise awareness of lay people to find a strong linkage between the current PM issue and green electricity. Also, it needs to improve trust in the government's pollution abatement policy to mobilize more assertive participation of the people from different socio-cultural background.

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Received: 18 November, 2018. Revised: 19 February, 2019. Accepted: 8 March, 2019.

Keywords : Particulate Matters (PM), Seoul metropolitan area, socio-cultural characteristics, Contingent Valuation Method (CVM), Willingness to Pay (WTP)

**요약:** 서울 및 수도권 지역의 미세먼지 문제는 지역 주민의 건강, 생태계 및 산업활동에 다양한 영향을 미치며 최근 가장 심각한 환경문제의 하나로 대두되고 있다. 정부와 개인은 미세먼지 문제에 대응하기 위해 다양한 비용을 지불하고 있다. 따라서, 본 연구는 동지역에 거주하고 있는 사회문화적 특성이 다른 두 집단(서울 및 수도권 지역의 외국인학교와 일반학교)의 학부모들을 대상으로 미세먼지 문제 해결을 위한 두 집단 간의 지불의사액이 어떻게 다른지를 추정하고자 한다. 응답자들의 지불의사액을 도출하기 위해 단일양분선택형(single-bounded dichotomous choice) 질문기법을 이용한 조건부가치추정법(contingent valuation model: CVM)을 사용하였다. 토빗과 프로빗모형을 이용한 지불의사액 추정 결과, 서울 및 수도권 지역에 거주하는 전체 학부모들은 지역 내 미세먼지 문제 개선을 위한 청정 전기(green electricity) 사용료를 가구당 월평균 3,993원 가량 더 지불할 의사가 있는 것으로 추정되었다. 두 집단 간의 지불의사액 비교 시 비내국인 그룹(international group)은 월 3,325원, 내국인 그룹(domestic group)은 월 4,449원으로 다소 큰 차이를 보였는데, 이는 각 집단이 속한 사회문화적 배경의 차이에 따라 사회경제적 지위, 개인적 경험, 정부정책에 대한 신뢰 및 가치관 등이 개인의 지불의사를 결정하는데 다르게 작용한 것으로 보인다. 본 연구의 결과, 현재 수도권지역의 미세먼지 문제 해결을 위해서는 무엇보다 시민들이 미세먼지 문제를 청정 에너지 사용과 연결 지어 생각할 수 있도록 환경의식을 고취하는 것이 필요하며, 특히 사회문화적 배경이 다른 계층에 대한 정부 오염 저감 정책의 신뢰도 향상에 초점을 맞출 필요가 있다.

**주요어:** 미세먼지, 서울 수도권지역, 사회문화적 특성, 조건부가치추정법, 지불의사

## I. Introduction

Despite enormous efforts by the local as well as the central government to mitigate the concentration of fine particles in the Seoul metropolitan area (SMA), the air quality in the country's capital area has rapidly deteriorated. Above all, particulate matter (PM) 2.5 which is known as ultra-fine particles so that it can be more fatal to human health have increased exponentially in the air. Unlike a prevalent view that sees China as a main attributor for the fine particulate matters, this environmental calamity in the area is not purely stemmed from the external source. According to the recent study by the city authority, as well as a joint research 'KORUS-AQ', majority of the PM in the SMA - 45% for the former and 52% for the latter generated from internal source although there exist seasonal variations for the source of the pollutant (The Seoul Institute

2016; KORUS-AQ 2017). Thus, more assertive actions should be taken from the domestic side along with the international cooperation to settle this problem (Kim 2018).

The international society reached an agreement at the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015 that keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase even further to 1.5 degrees Celsius (United Nations 2015). In this context, Korea must find its own way to mitigate the air pollution issue by transforming its fossil fuel-based energy supply system to more environmentally friendly structure such as an LNG or renewable-based system. Therefore, controlling a large emission source like coal-fired power plants is one of the easiest and the most effective ways to mitigate the PM concentration in the area (Kim 2018).

In addition, unlike some other sources of PM<sub>2.5</sub>, coal-fired power generation brings about much higher social cost according to an International Monetary Fund (IMF) research paper. The report emphasizes that among different energy sources for the power generation, coal-fired power generation caused much higher social cost compared to gas-based power generation system (Parry et al. 2014).

Nevertheless, shifting from the existing system requires high cost and often faces severe opposition due to the inertia effect. Thus, it is worthy to measure willingness to pay for better air quality through changing cleaner energy sources. This study aims to investigate how socio-culturally different groups of parents in the SMA – international and domestic groups cope with this possible transition of the energy supply system differently to mitigate PM concentration in the region through the contingent valuation method (CVM).

To meet this research purpose, we investigate different parent groups' willingness to pay. We expect that different socio-economic conditions, the degree of trust toward government's air quality policy, perception on air quality, and worldviews may have varying impact on the WTP. The result will provide the government a basis for mapping out more inclusive environmental plans for the current PM issue and a possible funding source to mobilize. Next section as literature review is going to introduce extant studies on the WTP and CVM for air quality issues. Section 3 is discussing the methodology and data, followed by Section 4 which will present the results and the analysis. Finally, the conclusion will be examined in Section 5.

## II. Literature review

### 1. Determinants of the WTP

Several studies have paid attention to how socio-cultural factors can influence on public preference for preserving environmental goods or services through CVM. For example, Ressurreição et al. (2012) investigated the role of cultural variation in Portugal, Poland and UK by comparing their WTPs for conserving marine species in each culture. Another study by Hoyos et al. (2009) showed cultural identity could significantly affect the WTP to protect natural resources through the case study of the Basque country. The result revealed that whose cultural identity is Basque has 28-33% higher WTP. Therefore, to find the correlation how different socio-cultural background affects the WTP for the same environmental issue, our study highlights four categories of determinants of the WTP for air quality improvement in the SMA: (1) socio-demographic characteristics; (2) health related experience and perception; (3) trust and awareness of the governmental policy; and (4) eco-friendly worldview/ value orientation.

Regarding socio-demographic characteristics, first, the WTP is associated with gender, size of family, income, and respondent's nationality. Many literatures suggest that women tend to be more concerned about environmental protection than men (Diez et al. 1998; Loewenstein et al. 2001; McCright 2010). Similarly, Dupont (2004) found that individuals with children care more about the environment than those who have no children. When it comes to income factor, higher income bracket individuals exhibit higher WTP as they have fewer economic problems to be anxious about, thus there are higher demanding of public goods (Franzen & Meyer 2010; Jones et al.

2010). Last, respondent's nationality is related to trust about the society, which decide their commitment to protect common goods of the society through social networks and civic participation (Putnam 2000).

For individual's health related experience or perception, after the Great East Japan Earthquake of March 11, 2011 which severely damaged Fukushima Daiichi nuclear powerplants, people in Japan, especially those who experienced the disaster directly showed negative willingness to pay for electricity produced by nuclear power (Morita & Managi 2015). Also, those who believe air pollution as a threat to their health are more likely to use public transportation to mitigate negative impact of air pollution (Whitmarsh 2008).

As for the trust in the governmental policy, Jones et al. (2009) explained the effects of institutional trust on WTP for the environmental protection. As people have higher trust about institutions that will implement the declared environmental policy, they are more willing to contribute for the environmental goods (Jones et al. 2009).

Lastly, individual's eco-friendly worldview/value orientation, in other words, people's pro-environmental attitudes enhance the level of the WTP. The environmental domain has three value orientations such as (1) egoistic values maximizing individual outcomes, (2) socio-altruistic values caring about other people, and (3) bio-spheric values focusing on non-human nature (Stern 2000). These value structures are prioritized differently according to individual's worldview (Stern et al. 1993).

## 2. Relevant CVM studies

To estimate WTP values for non-market goods/services, the CVM, a survey-based elicitat-

ion technique has been widely used by the Western countries in the beginning. For example, Carsson and Johannsson (2000) measured WTP of improved air quality in Sweden through the open-ended format of CVM questions. The mean WTP value to reduce harmful pollutant in the air by 50% was about 225 USD/year per. Recently, environmental degradation in developing countries arises as more severe problem, thus CVM is also frequently used on the other side of the world. For example, Zoric and Hrovatin (2012) investigated WTP among the households in Slovenia for participating in green electricity programs. Green electricity can be defined as electricity generated from renewable or cleaner energy source in general. Based on the data obtained through dichotomous choice and open-ended questions, this study ran tobit and double-hurdle model to obtain mean WTP value 4.18 Euro. In China where the air pollution issues have been chronic problems, Wei and Wu (2017) estimated individual's WTP to mitigate PM<sub>2.5</sub> pollution in the Jing-Jin-Ji by using a payment card format. Employing a two-part model, and the mean WTP for an 80% reduction of PM<sub>2.5</sub> polluting days in the region was 602 CNY per year which approximately accounted for 1% of the GDP per capita. In Korea, Yoo and Kwak (2009) used single-bounded dichotomous choice method to find the WTP for introducing the policy that raises percentage of green electricity consumption from 0.2% to 7% out of the total electricity supply by the year of 2011. The mean WTP estimated was 1,681 KRW for parametric method and 2,072 KRW for non-parametric method. For the parametric approach, conventional model is used whereas for the non-parametric approach, the spike model is adopted.

### III. Methodology

#### 1. Research design and data

The target population corresponds to the young parents who have children aged between 0 to 18 years old and living in the SMA. In order to estimate the relationship between socio-cultural variations and the WTP, the survey included a group of parents whose children attended foreign/international schools in the area and named it as international group and the rest as domestic group. The current study expected the international group to have different level of the WTP for the green electricity to mitigate PM concentration. The online survey was available from October 26, 2017 to December 12, 2017 at the Survey Monkey website. The online links which transferred respondents to the questionnaire were distributed through convenience sampling method using snowballing approach, thus it was difficult to know the response rate. After discarding incomplete responses, the final sample was comprised of 171 participants, and 72 samples out of 171 were obtained from the international group. The data was analyzed in pooled sample, as well as in sub-samples through tobit and probit models using STATA ©12.0 (Kim 2018).

The survey questionnaire used in this study consisted of 4 sections – overall questions about PM/air pollution in the SMA, the government's new environment-friendly electricity supply policy, valuation questions to measure the WTP, and socio-demographic characteristics of the respondents. The respondents were asked whether they would pay more for green electricity contributing to air pollution (including PM<sub>10</sub> and PM<sub>2.5</sub>) reduction in the SMA. To help the respondents understand about the situation, a hypothetical market close to actual market transaction was given.

Dichotomous choice question was used to elicit the respondent's WTP. If a respondent picked "No" to a bid amount provided, the individual had no intention to contribute, or he was less willing to pay (Kim 2018).

#### 2. Estimation for the WTP

To measure non-use values or non-market values of environmental resources, the contingent valuation method (CVM) has been widely used in cost-benefit analysis and environmental impact assessment (Cummings et al. 1986; Mitchell & Carlson 1989). Especially, dichotomous choice (DC) contingent valuation approach conducts surveys based on utility difference model (Yoo & Kwak 2009; Hong & Um 2011). Hence, the indirect utility function,  $v$ , indicates that each respondent will pay the increased portion of bid amount to accept the proposed program if:

$$\begin{aligned} v(1 - w - A; S) + \varepsilon_1 &\geq v(0, w; S) + \varepsilon_0, \text{ or} \\ v(A) &\equiv v(1 - w - A; S) - v(0, w; S) \geq \varepsilon_1 - \varepsilon_0 \end{aligned}$$

Where '0' denotes no existence of the proposed program and '1' means existence of the program which the respondents should pay stated bid amount  $A$ .  $w$  represents an individual's income.  $\varepsilon_i$  is a random error independently and normally distributed with a mean of zero and variance of  $\sigma^2$ . Also,  $S$  represents other observable attributes that affect the preference of each individual (Yoo & Kwak 2009; Kim 2018).

To estimate WTP for improving PM<sub>2.5</sub> in the SMA, this study employs tobit and probit models. A tobit model is usually adopted if a dependent variable is censored data with a significant fraction zero value which results in OLS technique biased and inconsistent (Tobin 1958; Zoric & Hrovatin 2012). Likewise, this study includes 34 observations of zero answer out of 171 the

dependent variable – the WTP for the air quality improvement. The survey question format is single bounded dichotomous choice; thus, the data is treated as discrete value. However, for tobit analysis the data is processed into continuous format and the econometric model can be specified as follows (Greene 2000; Zoric & Hrovatin 2012; Kim 2018).

$$y_i^* = \chi_i' \beta + u_i \\ \text{if } y_i^* > 0, y_i = y_i^* \text{ otherwise, } y_i = 0$$

While variable  $y_i$  represents the observed or stated willingness to pay by each individual  $i$  ( $i=1, 2, 3 \dots n$ ),  $y_i^*$  is a not observed latent variable. In addition,  $x_i$  indicates a vector of independent variables,  $\beta$  is a vector of regression coefficients and  $u_i$  means a random error independently and normally distributed. Since the survey used dichotomous choice format, probit model also used as follows. Cameron and James (1987) suggested innovative method overcoming the limitation of conventional ML probit model. Based on their argument, when a respondent is willing to pay for the air quality improvement,  $y_i$  equals 1, yet if he/she is not this will be 0.

$$\begin{aligned} Pr(y_i = 1 | \chi_i) &= Pr(y_i^* > t_i) \\ &= Pr(\chi_i' \beta + u_i > t_i) \\ &= Pr(u_i > t_i - \chi_i' \beta) \\ &= Pr(z_i > (t_i - \chi_i' \beta) / \sigma) \end{aligned}$$

$z_i$  is the standard normal random variable. Therefore,

$$\begin{aligned} Pr(y_i = 1 | \chi_i) &= 1 - \Phi(t_i - \chi_i' \beta / \sigma) \\ Pr(y_i = 0 | \chi_i) &= \Phi(t_i - \chi_i' \beta / \sigma) \end{aligned}$$

Based on the literature review, several independent variables under  $x_i$  is considered in the equation below. The basic model for the WTP estimation can be drawn as follows (Kim 2018):

$$\begin{aligned} WTP_i^* &= b_0 + b_1 \text{ visit\_doc} + b_2 \text{ aware\_pol} + b_3 \text{ env\_con} \\ &+ b_4 \text{ health\_threat} + b_5 \text{ belief\_pol} \\ &+ b_6 \text{ abrd10\_nation} + b_7 \text{ env\_eco} + b_8 \text{ eva\_pol} \\ &+ b_9 \text{ family} + b_{10} \text{ sex} + b_{11} \text{ elec\_bill} \end{aligned}$$

The selected variables used in the analysis are summarized in Table 1. *wtp\_value* indicates the amount that respondent is willing to pay. Independent variables included in the model are categorized into four groups. The first group relates to socio-demographic characteristics: *family*, *sex*, *abrd10\_nation* and *elec\_bill*. *family* is the number of family member in each household and measured in numbers. *sex* is represented as number 1 for female and 2 for male respondents. *abrd10\_nation* is a dummy variable. If a respondent spent more than 10 years abroad or hold foreign nationality other than the republic of Korea, it bears value 1, otherwise 0. *elec\_bill* used as a proxy for a household income measures average monthly electricity bill of each household in Likert scale. The second category is about individual's direct experience and perception related to health. *visit\_doc* denotes how often the respondent and his/her family member visit doctor's office due to PM borne illness per year in Likert scale. Also, *health\_threat* indicates how threatening a respondent feels about PM to harm his health condition. Third group represents awareness and trust in the governmental policy. *aware\_pol* measures respondent's awareness of the government's new policy for eco-friendly electricity supply. *eva\_pol* is used to see how respondent evaluates the government's new eco-friendly energy policy using points from 0 being the worst and 100 being the best. The last group of variables is about an individual's pro-environmental worldview/value orientation. *env\_con* represents how concerned a respondent is about current air pollution issue including PM in Korea. The other

Table 1. Definition and descriptive statistics of the variables (Reorganized based on Kim, 2018)

Variables	Definitions	International group (72 Obs.)		Domestic group (99 Obs.)	
		Mean (S.D.)	Min Max	Mean (S.D.)	Min Max
wtp_value	Willingness to pay amount	4027.778 (3348.206)	0 10000	4767.677 (3245.082)	0 10000
family	No. of family member	4.361 (1.755)	2 10	4.303 (1.265)	3 8
sex	Female:1, Male:2	1.264 (0.444)	1 2	1.192 (0.396)	1 2
abrd10_nation	Lived abroad more than 10 years or foreign nationality: yes 1, no 0	0.694 (0.464)	0 1	0 (0)	0 0
elec_bill	Average monthly electricity bill in each household	6.208 (2.226)	2 9	3.808 (1.550)	1 9
visit_doc	No. of visit doctor due to PM borne illness per year	2.278 (1.270)	1 5	2.162 (1.226)	1 5
health_threat	How threatening PM is to health	6.625 (0.759)	4 7	6.182 (1.232)	1 7
aware_pol	Awareness of the governmental policy	2.7222 (1.646)	1 7	2.930 (1.624)	1 7
eva_pol	How evaluates government's new energy policy	49.167 (25.660)	10 100	65.556 (20.811)	10 100
env_con	Environmental concern	6.472 (0.804)	3 7	6.172 (1.457)	1 7
env_eco	Environment first or economy first for electricity supply	5.264 (1.839)	1 7	5.758 (1.546)	1 7

variable in the same category is *env\_eco* which means a respondent's preferred value between environmental protection and economic prosperity for governmental policy to supply electricity. In Likert scale, 1 indicates respondent's economy first worldview for the electricity supply, whereas 7 represents environment first value (Kim 2018).

#### IV. Results and Analysis

Table 2 represents estimated results of the sub-sample analysis using tobit and probit model. The notable characteristics of the international group in comparison with the domestic group can be summarized as follows.

First, in terms of socio-demographic aspect, WTP of the international group of parents are affected by their sexes. Female respondents in

this group tend to pay more for the air quality improvement than their opposite sex as tobit and probit analysis shows. Women are more attentive to the environmental issues thus, this leads them being more aware of the problem which induces more assertive actions (Diez et al. 1998; Loewenstein et al. 2001). In terms of the variable *abrd10\_nation* measuring whether a respondent has been exposed to a foreign culture/society is negatively related with the WTP in both tobit and probit analysis. In accordance with Polyzou et al. (2011), trust leads to stronger social cohesion, therefore support for the environmental protection is stronger among people who have ownership about the society where they belong to (Kim 2018). When it comes to the income, the international group is not affected by the income factor in deciding the level of WTP, whereas

Table 2. Tobit and Probit estimation of sub-groups for PM improvement in the SMA (Reorganized based on Kim, 2018)

Parameter		Total sample		International		Domestic	
		Tobit	Probit	Tobit	Probit	Tobit	Probit
bidamount		–	-0.00015*** (-2.82)	–	-0.0003** (-2.06)	–	-0.0001 (-1.57)
Socio-demographic	family	-114.435 (-0.62)	-0.089 (-1.00)	-327.771 (-1.56)	-0.135 (-0.61)	9.255 (0.03)	-0.197 (-1.39)
	sex	-1224.378* (-1.75)	-0.579* (-1.83)	-2215.804** (-2.30)	-2.735** (-2.07)	-350.126 (-0.36)	0.072 (0.15)
	abrd10_nation	-944.136 (-1.30)	-0.403 (-1.15)	-532.365 (-0.62)	-0.756 (-0.77)	0 (omitted)	0 (omitted)
	elec_bill	399.398** (2.42)	0.093 (1.46)	184.777 (1.05)	0.118 (0.69)	648.902** (2.50)	0.140 (1.27)
Health related	visit_doc	-425.044* (-1.84)	-0.088 (0.73)	-378.593 (-1.20)	0.155 (0.47)	-457.667 (-1.45)	-0.213 (-1.37)
	health_threat	-494.325* (-1.71)	-0.163 (-1.19)	-297.480 (-0.52)	0.085 (0.13)	-471.238 (-1.36)	-0.160 (-1.00)
Gov't policy	aware_pol	-93.434 (-0.54)	0.010 (0.13)	-244.589 (-1.04)	0.064 (0.29)	-61.833 (-0.25)	0.083 (0.73)
	eva_pol	58.135*** (4.25)	0.018*** (3.03)	87.582*** (4.78)	0.076** (2.37)	21.925 (1.14)	0.009 (1.09)
Eco-first worldview	env_con	736.042*** (2.80)	0.302*** (2.60)	1300.818** (2.23)	1.364** (2.43)	756.841** (2.49)	0.258* (1.92)
	env_eco	500.688*** (2.63)	0.189** (2.26)	400.516 (1.62)	0.255 (1.16)	519.256* (1.89)	0.222* (1.88)
constant		-1846.146 (-0.72)	-0.114 (-0.09)	-3315.737 (-0.78)	-7.401 (-1.48)	-2658.766 (-0.81)	-0.151 (-0.10)
$\sigma$		3418.985	–	2811.613	–	3551.218	–
$\log L$		-1339.146	-59.960	-516.198	-11.766	-813.006	-35.321
$N$		171		72		99	

Note: t(z)-Statistic in brackets, Significant at \*10%, \*\* 5%, \*\*\*1%

domestic group is influenced by the income variable. This may be because that the majority of international group belongs to the higher income bracket. For instance, 52 respondents out of 72 pays in this sample respond that they pay more than 70,000KRW for the monthly electricity bill which is used as a proxy for household income (Francisco et al. 2006).

Second, the health-related variables in this category are statistically significant only with the pooled sample. Nevertheless, it is notable that most of the variables are negatively correlated with the WTP. This can be interpreted when peo-

ple already spend too much medical expenses due to the air-borne illness, they would rather spend additional money to find private remedy instead of contributing to public goods. In addition, people seem to have difficulties to find connection between the PM issue with the green electricity, thus despite the deteriorated health condition, they are not willing to pay for the environmental goods (Kim 2018).

Third, respondent's awareness and evaluation about the governmental policy variables are estimated under the third category. Cognitive aspect of the environmental pollution has no relation

with the WTP in both groups of parents. However, when respondents evaluate the government's new environmental policy positively, a higher level of the WTP is observed both in tobit and probit models. Especially, the international group of parents reacts more sensitively to their trust in government when making contributions. In the same vein, the international group evaluates the governmental policy lower than the domestic group as the mean statistics of the variable in Table 1 shows 49.167 and 65.556 respectively. Likewise, a strong trust in institutions results in a higher tendency of willing to pay for a better environment (Jones et al. 2009). Consequently, people with less trust in government tend to resolve environmental problems through their personal contribution (Kim 2018).

Last, an individual's eco-friendly worldview or value orientation under the last category comes up with meaningful remarks in both tobit and probit analysis. When parents from both groups are more concerned about the environmental value, their WTP for the air quality improvement in the SMA is higher. Nevertheless, the level of the WTP between two groups stands apart as the international group shows higher level of WTP. Furthermore, the variable 'env\_eco' which represents individual's worldview whether he/she values more about environmental protection than

economic prosperity is positively associated with the WTP for air quality improvement in the region with the pooled sample (Kim 2018).

Based on the estimation above, the current paper obtains the mean WTP values for each group of respondents (Table 3). The international group shows lower WTP for the green electricity that improves air quality in the SMA than the domestic group at 3,325 KRW and 4,449KRW, respectively (Kim 2018).

## V. Conclusion

Current air pollution (PM<sub>10</sub>, PM<sub>2.5</sub>) issue in the SMA emerged as one of the most concerned environmental problems in the citizens' lives since it results in a variety of harmful consequences on human health, as well as ecosystem and industrial activities. Individuals, central and local governments put various efforts to mitigate negative impacts of fine dusts. However, more strategic and multi-faceted approach to the issue is required. Therefore, investigating how socio-cultural difference between two groups – international and domestic affect their WTP for the green electricity to mitigate PM concentration should be meaningful findings. To estimate WTP for this non-marketed good – green electricity, a survey-based elicitation technique so called CVM is used. By adopting single bounded dichotomous choice, a hypothetical market close to actual market transaction is given to the respondents. For analysis, tobit (censored regression) and probit models are used (Kim 2018).

As results of the estimation, considering socio-demographic aspect, women tend to pay more in the international group, yet higher income households have a higher level of WTP in the domestic

Table 3. Mean WTP of each group based on tobit model (Kim 2018)

	WTP (KRW)	S.E	95% C.I.
Total	3992.7***	273.3	3453.0 4532.4
Int'l group	3325.5***	374.5	2576.9 4074.0
Domestic group	4449.2***	365.5	3723.1 5175.3

Significant at \*10%, \*\* 5%, \*\*\*1%

group due to the income effect. For health-related variables, negative association with the respondent's WTP is observed, and we can assume that people in general cannot relate the health issue directly with their contributions to the green electricity. For people's trust in the governmental policy, the international group reacts more sensitively to make contributions. In other words, the more they are affirmative to the institutions, the more they are willing to pay. Lastly, when people have eco-friendly worldview including their concerns about environment, the WTP are positively affected (Kim 2018).

Based on empirical analysis, the paper draws the following policy implications for the government, as well as for those who pursue further study in the relevant field. First, society needs to raise awareness of lay people to find a strong linkage between the current PM issue and green electricity as a solution for the problem. Although people feel the necessity for the air quality improvement, it doesn't mean that this is directly connected to the people's willingness to pay for the green electricity. It is critical to invest financial resources to abate the causes of fine dusts rather than just for end-use measures such as air filtering masks and machines. This will also enable the government to secure a stable funding stream for cleaner energy sources. Second, society needs to put a lot more emphasis on environmental value through public education. When people adhere to more environmentally friendly attitudes, they tend to make more contribution to the higher quality environment. Third, policy makers need to make efforts to plan more inclusive policy to mobilize participation of the people from different socio-cultural background. People from different socio-cultural background such as

international group of parents in this study are less likely to pay for an environmental service/good due to a low level of trust in the governmental policy as well as their own interests which are different from the majority's. Therefore, policy inducement to such groups is necessary (Kim 2018).

Despite meaningful findings above, the paper also faces inherent limitations. For example, like the most survey-based research retains, non-random sampling derived from the convenience sampling method weakens the generalizability of the research. Reflecting a weighted reciprocal number of probability sampling would have enhanced representativeness of the sample. Also, the survey questionnaire design needs to be enhanced. Other solutions to reduce the PM concentration in the area apart from the green electricity can be considered as a payment vehicle. Lastly, the CVM study in this paper has a design bias by allowing to drive only maximum WTP value instead of the actual WTP amount. Nevertheless, what is novel about this research is highlighting the nexus between socio-cultural aspect of the contributors and their WTP. Furthermore, investigating the distinctive characteristics between the culturally different groups can provide a better picture for improving the PM<sub>10</sub> and PM<sub>2.5</sub> in the SMA (Kim 2018).

## References

- Cameron TA, James MD. 1987. Efficient Estimation Methods for "Closed-Ended" Contingent Valuation Surveys. *The Review of Economics and Statistics*. 69(2): 269-276.
- Carlsson F, Johansson-Stenman O. 2000. Willingness to Pay for Improved Air Quality in Sweden.

- Applied Economics. 32(6): 661-669.
- Cummings RG, Brookshire DS, Schulze WD. (ed.) 1986. Valuing environmental goods: a state of the arts assessment of the contingent valuation method. Totowa, NJ: Rowman and Allanheld.
- Diez T, Stern PC, Guagnano GA. 1998. Social structural and social psychological basis of environmental concern. *Environment and Behavior*. 30(4): 450-471.
- Dupont PD. 2004. Do children matter? An examination of gender differences in environmental valuation. *Ecological Economics*. 49: 273-286.
- Francisco ER, Aranha F, Zambaldi F, Goldszmidt R. 2006. Electricity Consumption as a Predictor of Household Income: a Spatial Statistics Approach. Davis CA, Monteiro AMV.(ed.) *Advanced Geoinformatics*. Berlin, Heidelberg: Springer. pp. 267-282.
- Franzen A, Meyer R. 2010. Environmental attitudes in cross-national perspective: a multilevel analysis of the ISSP 1993 and 2000. *European Sociological Review*. 26: 219-234.
- Greene WH. 2000. *Econometric Analysis*, 4th ed. Prentice Hall International, Inc., New Jersey.
- Hong JH, Eom YS. 2010. Estimating demand for public goods using a survey technique: major issues and application of valuating environmental satellite project. *Korean Economic Analysis*. 17(1): 1-72. [Korean Literature].
- Hoyos D, Mariel P, Fernández-Macho J. 2009. The influence of cultural identity on the WTP to protect natural resources: Some empirical evidence. 68(8-9): 2372-2381.
- Jones N, Evangelinos K, Halvadakis CP, Losifides T, Sophoulis CM. 2010. Social factors influencing perceptions and willingness to pay for market-based policy aiming on solid waste management, *Resources, Conservation and Recycling*. 54: 533-540.
- Jones N, Malesio C, Botetzagias I. 2009. The influence of social capital on willingness to pay for the environment among European citizens. *European Societies*. 11(4): 511-530.
- Kim JW. 2018. Analysis on risk perception and willingness to pay for air quality (PM<sub>10</sub>, PM<sub>2.5</sub>) improvement in the Seoul metropolitan area. MA dissertation. Graduate School of International Studies, Yonsei University, Seoul.
- KORUS-AQ. 2017. KORUS-AQ Rapid Science Synthesis Report. [Cited 2018 Jan 25]. Available from <https://espo.nasa.gov/korus-aq>
- Loewenstein GF, Weber EU, Hsee CK, Welch E. 2001. Risk as feelings. *Psychological Bulletin*. 127(2): 267-286.
- McCright AM. 2010. The effect of gender on climate change knowledge and concern in the American public. *Population and Environment*. 32: 66-87.
- Mitchell RC, Carson RT. 1989. Using surveys to value public goods: the contingent valuation method. Washington, DC: Resources for the Future.
- Morita T, Managi S. 2015. Consumers' willingness to pay for electricity after the Great East Japan Earthquake. *Economic Analysis and Policy*. 48: 82-105.
- Parry IWH, Heine D, Lis E, Li S. 2014. *Getting Energy Prices Right: From Principle to Practice*: Washington DC: International Monetary Fund.
- Polyzou E, Jones N, Evangelinos KI, Halvadakis

- CP. 2011. Willingness to pay for drinking water quality improvement and the influence of social capital. *Journal of Socio-Economic*. 40: 74-80.
- Putnam R. 2000. *Bowling Alone*, New York: Simon and Schuster.
- Ressurreição A, Gibbons J, Kaiser M, Dentinho TP, Zarzycki T, Bentley C, Austen M, Burdon D, Atkins J, Santos RS, Edwards-Jones G. 2012. Different cultures, different values: The role of cultural variation in public's WTP for marine species conservation. *Biological Conservation*. 145(1): 148-159.
- Stern PC. 2000. New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*. 56(3): 407-424.
- Stern PC, Dietz T, Kalof L. 1993. Value orientations, gender and environmental concern, *Environment and Behavior*. 23(5): 322-348.
- The Seoul Institute. 2016. *Research on inventory building for the source of PM<sub>2.5</sub> and detailed monitoring*, Seoul: City of Seoul. [Cited 2018 Feb 3]. Available from <http://opengov.seoul.go.kr/research/11895404> [Korean Literature].
- Tobin J. 1958. Liquidity preference as behavior towards risk. *The Review of Economic Studies*. 25(2):65-86.
- United Nations. 2015. Paris Agreement. [Cited 2018 Jan 25]. Available from <http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>.
- Wei W, Wu Y. 2017. Willingness to pay to control PM<sub>2.5</sub> pollution in Jing-Jin-Ji Region, China. *Applied Economics Letters*. 24(11): 753-761.
- Whitmarsh L. 2008. Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research*. 11(3): 351-374.
- Yoo SH, Kwak SY. 2009. Willingness to pay for green electricity in Korea: A contingent valuation study. *Energy Policy*. 37(12): 5408-5416.
- Zoric J, Hrovatin N. 2012. Household willingness to pay for green electricity in Slovenia. *Energy Policy*. 47: 180-187.