Can Environment Quality Improve Subjective well-being? Cross-country evidence from survey data

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Abstract

Using the World Values Survey (WVS) 112 cross-country data from 1981 to 2014, this paper estimates the impacts of economic and environmental factors on subjective well-being. We use an ordered probit as a model specification taking into account possible endogeneity issues. In addition to the individual- and country-level characteristics in conventional empirical studies, this study incorporates environmental factors of CO2 emissions gathered from various sources as additional determinants. Furthermore, the estimation results are divided into the respondents' tendency, those prioritizing environment protection over economic growth and those with reverse preferences. The estimation results show consistencies with the previous studies; Environmental factors such as CO2 emissions have significantly negative effects on life satisfaction and there is a positive relationship between national or personal income and personal life satisfaction. In addition, the impact of environmental pollution on subjective well-being is also influenced by individual beliefs that whether respondents are focusing on 'Economic Growth' or 'Protecting Environment'.

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1. Introduction

The Easterlin paradox indicates that income in the US was shown to be negatively related to happiness over some period which is in contrast with the traditional belief that happiness might increase proportionately with the level of income per capita as an indicator of welfare level. However, the paradox does not ignore the role of income per capita. Esterlin (1974) indicates that income per capita is not the only comprehensive indicator of the level of happiness. Since maximization of happiness is the final target individuals and government policies want to achieve, there are various theoretical and empirical studies on the determinants of happiness (Frey and Stutzer, 2010).

Happiness means lexically 'the state of being happy and well-being, contentment', and the difficult

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thing is that the degree of happiness is quite abstract and subjective. In general, happiness is analogous to the state of well-being, and it can be expressed in two different ways; objective or subjective. According to Conceição, P. and Bandura, R. (2008), objective well-being is measured from certain observable facts such as economic, social and environmental factors. On the other hand, OECD (2013) stated that subjective well-being is captured from personal feelings or mental conditions: good mental states, including all the various evaluations, positive and negative, that people make of their lives and the affective reactions of people to their experiences. There are various indicators with different measurement methods by individual or country level.

Objective well-being is defined at the national level as the degree of social, economic and environmental conditions. The most popular index to measure objective well-being is the Human Development Index (HDI) reported by UNDP. The HDI considers the health- and education- related variables in addition to GDP per capita as a traditional indicator. Other sources include the Social Progress Index (SPI) of the Social Progress Imperative, and the Better Life Index of the Organization for Economic Cooperation and Development (OECD). While Objective well-being comprises measurable and comparable data, indices such as the World Value Survey, The Sustainable Development Solutions Network (SDSN) World Happiness Report from the Gallup World Poll (GWP) measure personal emotional states. The World Value Survey which is used in this study reported by Ronald Inglehart of Michigan University considers subjective variables. The data is collected by the answers on subjective questions which reflect quality of life for individuals across countries (Royo and Velazco, 2005). In addition, the following countries have measured national well-being; United Kingdom, Germany, Italy, United States, Australia, Canada, Bhutan, etc.

In a line, as happiness is related to the life quality and subjective well-being is available as its indicator. Therefore, this study defines happiness as subjective well-being and for the convenience of analysis. And empirical estimations that have been undertaken to find determinants of happiness assumed individual- and country characteristics as determinants. The most important indicator is income per capita. Other individual -characteristics are various country- and individual-characteristics such as age, number of household members, occupation and education, etc. Country-level characteristics are unemployment, inflation, and income inequality, etc.

In addition to various country- and individual-level characteristics, this study investigates environmental impacts on happiness. By country-level, the environmental indicators which are main concern of this study are not much diverse mainly due to measurement and country coverage problems. The indicators covered in many related literatures are those that reflect the degree of air pollution. Water pollution can be used as an indicator of environmental factors. But the effects of water pollution on life satisfaction is quite regional even though the data of degree of life satisfaction covers broader regions. For example, OECD releases the Better Life Index which is calculated by a combination of 11 indicators

of income, jobs, housing, education, health, environment, safety, civic engagement and governance, access to services, community, and life satisfaction (OECD, 2016, p.13). Here environmental factors include the degree of air and water pollution. There are various studies on the impacts of environmental factors on happiness or life satisfaction (Welsch, 2006; Rehdanz and Maddisson, 2008; Luechinger, 2010; Lew and Arvin, 2012; Kang and Kim. 2012; Li et al., 2014; Kim and Kang, 2016). Since the data used in this study covers individual- and country-level information together, this study focuses on the effect of air pollution rather than water pollution due to data coverage. The degree of air pollution is used by CO2 emissions of various energy sources (coal, oil and natural gas, etc.).

Even though the negative effect of air pollution on life satisfaction has been shown in the previous studies, the data covers only a specific country or small range of countries only. Since the data of life satisfaction includes individual- and country-level information, it is quite useful to consider both characteristics in the same model specification with broader coverage of countries.

The estimation results are quite consistent with those of former studies. However, it is markable that CO2 emissions, which is the main cause of greenhouse gas emissions, are divided into detailed items in selecting environmental indicators. This is different from previous researches in that it considers the marginal effect together with the regression analysis.

This study is organized as follows. After introduction, section 2 summarizes recent studies on environmental effects on life satisfaction. Section 3 introduces data and estimation model specification with descriptive statistics of main variables. After estimation results are discussed in section 4, section 5 concludes.

2. Literature Review

Since Easterlin (1974), various empirical studies on the relationship between well-being and environmental quality with various indicators of air or water pollution have been undertaken with controlling for a range of various individual and/or socio-economic factors.

Using the 54 cross-national data of NOx emissions, Welsch (2002, 2006), for 54 cross-countries and 10 European countries, respectively, finds that self-reported subjective well-being tends to improve as urban air pollution by NOx, emissions decreases. Ferrer-i-Carbonell and Gowdy (2007) with the data of the British Household Panel Survey show that concern on the ozone pollution was negatively related with the subjective well-being while concern on species extinction was positively related. Rehdanz and Maddison (2008) with the German socio-economic panel data find that higher local air pollution and noise levels significantly diminish subjective well-being. Goetzke and Rave (2015), with the German 2004 socio-economic panel data, show that SO2, NOX, and PM10 are negatively related with the life satisfaction. By using the life satisfaction data of South Korea for 1998-2009, Kang and Kim (2012) show that air pollution indicators of SO2, NO2, CO, and PM10 are negatively related with the level of

life satisfactions.

Water pollution indicators even though the specific indicators are different are used even though the finding are quite similar to those for air pollution (Israel and Levinson, 2003; Smyth et al., 2009; Rahaman et al., 2011; Silva et al., 2012; Kim and Kang, 2016). For example, Rahman et al. (2011) use access to safe water supplier as an indicator of water pollution.

Even though the number of countries is quite limited, cross-country analysis also show how environmental quality indicators are related with the subjective well-being. Luechinger (2010), Levinson (2012), Lew and Arvin (2012), and Silva et al. (2012) show that air pollution indicators such as emissions of NO2, SO2, PM10, or CO2 are negatively related with the life-satisfaction. With the General Social Survey of residents of the United States, Levinson (2012) finds that PM10 rather ozone, SO2, and CO affects more seriously happiness even though the areas without ozone and SO2 are included in the estimation. For European countries, Ferreira et al. (2013) show a robust negative impact of SO2 concentrations on self-reported life satisfaction.

Recently there are extended empirical studies on the determinants of life-satisfaction to willingness-to-pay values of improvement of environmental quality through impacts on life-satisfaction. Luechinger (2010) with the 19 years of individual-level data for 13 European countries and national-level SO2 data find negative impact of air pollution on life satisfaction and significant willingness-to-pay by showing the higher costs of air pollution. And MacKerron and Mourato (2009) estimate the willingness-to-pay of NOx for the quality of air pollution in London by showing negative effect.

Von Mollendorff and Welsch (2017) with the 1994-2012 SOEP individual survey data in Germany finds that the monetary equivalent of 1MW capacity expansion of wind power and biomass installations by controlling for health status, employment status, partner status is estimated to be 0.35% and 1.25% of monthly per capita income, respectively.

The studies reviewed above use the data with very limited information on country or individual characteristics or coverage of regions or countries. For example, the studies which uses individual-level life satisfaction cover a specific country therefore broader range of countries are not considered in empirical estimation. The studies with national-level countries do not cover individual-level characteristics as well.

3. Data and Model specification

Due to limited availability of subjective well-being and environmental quality data, most of the studies on the relation between subjective well-being and environmental quality use cross-country level data with limited number of countries. In this paper, to cover the maximum number of countries into our analysis, we use the World Value Survey (WVS) which includes data of both individual- and country-level subjective well-being. And the advantage of the data is that individual socio-economic indicators

are included and thus the analysis can control for the individual- and country-level characteristics. The variables related to individual characteristics are income scale, income inequality, the number of children, personal activities, gender state of employment, etc.

The subjective well-being data consists of six Waves from Wave 1(1981-84) to Wave 6(2010-14), each of which include 8 and 14 questionnaires and corresponding responses. Starting from 24 countries with 32,964 respondents in Wave 1, the latest Wave includes 60 countries with 89,565 respondents. Table 1 summarizes the number of countries and respondents for each Wave.

Table 1. WVS Longitudinal Data Respondent

	Wave1 (81-84)	Wave2 (90-94)	Wave3 (95-98)	Wave4 (99-04)	Wave5 (05-09)	Wave6 (10-14)	Total
Country	24	43	56	71	82	60	112
Respondent	32,964	62,771	77,818	100,155	150,256	89,565	513,529

Source: authors' calculation by using the WVS longitudinal data.

Table 2 and Table 3 summarize the trends of happiness and life satisfaction respectively over Waves. On average, about 81.6% responded 'Quite happy' or 'Very happy'. Respondents whose scale of life satisfaction were between 7 to 10 accounted for 72.1% in Wave1(81-84) and 60.9% in the latest Wave. However, it cannot be interpreted as increasing trends of happiness of the same respondents since the countries and respondents covered in respective Wave are different.

Table 2. Trends of Happiness by Waves (%)

	Not at all happy	Not very happy	Quite happy	Very Happy
Wave1 (81-84)	1.2	9.6	62.2	27.0
Wave2 (90-94)	2.9	19.2	55.3	22.7
Wave3 (95-98)	3.3	20.2	52.3	24.2
Wave4(99-04)	3.5	16.8	53.3	26.4
Wave5(05-09)	2.8	15.2	56.0	26.1
Wave6(10-14)	2.9	12.6	51.6	32.9
Average	2.8	15.6	55.1	26.5

Source: authors' calculation by using the WVS longitudinal data.

Table 3. Trends of Life Satisfaction by Waves (%)

	Dissatisfied----------									----------Satisfied
	1	2	3	4	5	6	7	8	9	10
Wave1 (81-84)	1.5	1.2	2.5	3.9	9.3	9.5	16.0	24.9	15.5	15.6
Wave2 (90-94)	2.6	1.7	3.9	4.7	12.6	10.7	15.1	21.9	12.0	14.9
Wave3 (95-98)	6.1	3.6	6.7	7.2	15.2	10.0	12.2	16.0	9.5	13.7
Wave4(99-04)	5.5	4.2	5.9	5.8	14.8	10.2	13.5	16.7	10.9	12.5
Wave5(05-09)	3.4	2.3	4.6	5.3	12.3	10.3	15.6	21.3	11.9	13.0
Wave6(10-14)	3.2	2.1	3.9	5.1	13.0	11.9	17.0	20.0	10.3	13.6
Average	3.7	2.5	4.6	5.3	12.9	10.4	14.9	20.1	11.7	13.9

Source: authors' calculation by using the WVS longitudinal data.

Table 4 summarizes the sources and summary statistics of the data used in empirical estimation. We use two dependent variables, happiness and life satisfaction, as a measure for the degree of subjective well-being. The independent variables related to individual characteristics are state of health, importance in life (friend; community), gender, age, marital status, and the number of children. Other explanatory variables to represent country-level characteristics are GDP per capita, the share of trade to GDP, degree of urbanization, all of which are considered to be the determinants of lifer satisfactions from previous studies. Environmental factors are also included as one of the explanatory variables which are measured by the level of national CO2 emission.

Table 4. Summary statistics of variables included in the model

Variables	Variables Definitions	Sources	Obs.	Mean	Std. Dev.	Min	Max
Dependent variable (Subjective well-being)							
Happiness	Felling of happiness (Scale 1-4)	WVS	500,965	3.049	0.735	1	4
Life satisfaction	Satisfaction with your life (Scale 1-10)	WVS	506,626	6.732	2.403	1	10
Independent variable (country level)							
Log of total CO2	Log of total CO2 emissions from fuel combustion (Total CO2 = Coal + Oil + Natural gas + Others)	IEA	490,214	4.694	1.704	0.678	9.103
Log of GDP	Log of GDP per capita (current US$)	WDI	494,668	8.749	1.401	5.464	11.647
Square of log of GDP	Square of log of GDP per capita (current US$)	WDI	494,668	78.516	24.149	29.853	135.642
Inflation consumption price/1000	Inflation, consumer prices (annual %)	WDI	471,916	0.018	0.069	-0.002	1.058
Trade/1000	Trade (% of GDP)	WDI	488,182	0.075	0.052	0.012	0.426
Urban population	Urban population (% of total)	WDI	499,655	66.239	17.857	15.201	100.000
Unemployment rate	Unemployment, total (% of total labor force)	WDI	415,050	8.807	5.843	0.450	34.500
Gini	Log of Gini index of inequality in equivalized household disposable income	SWIID	476,843	3.530	0.248	2.851	4.096
Independent variable (individual level)							
Unhealthy	State of health (subjective)	WVS	460,750	2.209	0.910	1	5
Income inequality	We need larger income differences as incentives for individual effort	WVS	447,106	5.708	2.998	1	10
Income scale	Income group (low to high)	WVS	397,459	4.709	2.383	1	11
Community	Important in life, Friends (Very important to Not at all important)	WVS	471,815	1.700	0.724	1	4
Children	Number of children	WVS	431,813	1.858	1.766	0	8
Personal activities	How much freedom of choice and control	WVS	488,505	6.807	2.375	1	10
Gender	Dummy =1 if Female	WVS	508,707	0.525	0.499	0	1
Marital	Dummy=1 if respondent is divorced and widowed	WVS	508,685	0.110	0.313	0	1
	Dummy=1 if respondent is separated	WVS	508,685	0.016	0.127	0	1

	Dummy=1 if respondent is single	WVS	508,685	0.245	0.430	0	1
Age	Age	WVS	508,672	42.099	16.715	13	108
Square of age/1000	Square of age / 1000	WVS	508,672	2.052	1.571	0.169	11.664
State of employment	Dummy =1 if respondent is Fulltime	WVS	501,667	0.369	0.482	0	1
	Dummy =1 if respondent is Part time	WVS	501,667	0.075	0.263	0	1
	Dummy =1 if respondent is Self-employed	WVS	501,667	0.094	0.291	0	1
	Dummy =1 if respondent is Retired	WVS	501,667	0.145	0.352	0	1
	Dummy =1 if respondent is Housewife	WVS	501,667	0.139	0.346	0	1
	Dummy =1 if respondent is Student	WVS	501,667	0.070	0.254	0	1
Education level	Dummy =1 if respondent is Primary	WVS	482,689	0.179	0.383	0	1
	Dummy =1 if respondent is Secondary	WVS	482,689	0.466	0.499	0	1
	Dummy =1 if respondent is University	WVS	482,689	0.196	0.397	0	1
Protecting Environment vs Economic Growth							
Protecting Environment	Dummy =1 if response is 'Protecting Environment'	WVS	436,448	0.320	0.467	0	1
Economic Growth	Dummy =1 if response is 'Economic Growth'	WVS	513,529	0.230	0.421	0	1

This study estimates determinants of subjective well-being of individual *i* and country *j* of air pollution by controlling for their individual and counties characteristics (see. Tella et al., 2005; Fleche et al., 2012; Luechinger, 2010; von Mollendorff and Welsch, 2017).

Basic model specification is based on the Paradox of Easterlin which means that happiness does not increase even if income increases above a certain income (Esterlin, 1974) and the modified version of Blanchflower and Oswald (2004) by Kang (2010) and Kang and Kim (2012). Since the data includes individual- and country-characteristics, the following model is estimated.

(1) $H_{ijt}^{*} = W[U(X_{it}, E_{jt}, Z_{jt})]$
(2) $H_{ijt}^{*} = \beta_0 + \beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t + \varepsilon_{ijt}$

Equation 1 implies the Utility of subjective well-being defined happiness and life satisfaction indexes and it can be expressed as linear form like equation 2. H_{ijt}^{*} implies the degree of subjective well-being of individual *i* in country *j* at year *t*. As independent variables, individual characteristics ($\boldsymbol{X_{it}}$) and country characteristics ($\boldsymbol{Z_{jt}}$) are included. In addition, the degree of environmental quality of country j ($\boldsymbol{E_{jt}}$) is considered. β_0 is constant and $\beta_1, \beta_2, \beta_3$ are vectors of parameters to be estimated. ε_{ijt} is a stochastic error term. w_i, w_j and w_t are individual-, country- and time-specific dummy variables, respectively.

(3) $\alpha_{k-1} < H_{ijt}^{*} \leq \alpha_k;\ H_{ijt} = k_m;\ m = 1,2;\ k_1 = 1, \dots, 4;\ k_2 = 1, \dots, 10$

(4) $\Pr(H_{ijt} = k_m) = \Pr(\alpha_{k-1} < H^*_{ijt} \leq \alpha_k)$

$= \Pr(\alpha_{k-1} < \beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t + \varepsilon_{ijt} \leq \alpha_k)$

$= \Pr[\alpha_{k-1} - (\beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t) < \varepsilon_{ijt} \leq \alpha_k - (\beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t)]$

$= F[\alpha_k - (\beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t)] - F[\alpha_{k-1} - (\beta_1 X_{it} + \beta_2 E_{jt} + \beta_3 Z_{jt} + w_i + w_j + w_t)]$

Here, $F(\bullet)$ means cumulative distribution function of error term and α_{k-1}, α_k : parameter of cutoff point. And happiness and life satisfaction is an ordinal discrete variable with a scale of 1-4 and 1-10, having the cut-off point at 3 and 9. Due to the properties of ordinal discrete variables of index, this study uses an ordered probit model specification. The assumption of standard normal distributed error leads us to the ordered probit model, which maybe more flexible than the ordered logit model (Mahasuweerachai, P. and S. Pangjai, 2017, p.6).

In the above equation, $F(\bullet)$ denotes the cumulative distribution function of error term, and α_{k-1} and α_k denote the parameter of cutoff point. For the ordered probit model, $f(\bullet)$ is probability density function and first difference function for $F(\bullet)$. Since the error term follows the standard normal distribution, $F(\bullet) = \Phi(\bullet)$, that is, c.d.f of the standard normal distribution.

(5) $\frac{\partial \Pr(H_{ijt}=k_m)}{\partial X_{it}} = \frac{\partial \Pr(\alpha_k - \beta_1 X_{it})}{\partial X_{it}} - \frac{\partial \Pr(\alpha_{k-1} - \beta_1 X_{it})}{\partial X_{it}} = \beta[f(\alpha_{k-1} - \beta_1 X_{it}) - f(\alpha_k - \beta_1 X_{it})]$

The sign of the estimation factor can be interpreted as determining whether the potential variable H^*_{ijt} increases as the explanatory variable increases or decreases. The marginal effect of the change in the explanatory variable on the selection probability of the dependent variable is defined as. In other words, this study expresses the probability of belonging to the category of subjective well-being index (Scale 1-4 of happiness and 1-10 of life satisfaction) as individual and national characteristics and degree of air pollution increase. If the estimation coefficient is positive, it means that the probability of becoming the lowest category of subjective well-being is decreased and the probability of belonging to the highest category (happiness =4, life satisfaction= 10) is increased.

Finally, the model includes the average of explanatory variables that characterize the country in Equation (2) to control for this possible endogeneity between independent variables and error term; the correlated random effect assumes that $w_i = \gamma \overline{X}_i + \theta_i$. this analysis is analogous to Chamberlain's (1979) random effects probit model and includes each country's average values of the independent variables in the estimation.

4. Estimate Results

Regression analysis was conducted to examine the effects of individual, national characteristics and air pollution (CO2 emissions from fuel combustion) on subjective well-being expressed by happiness and

life satisfaction indexes. The results are summarized from Table 5 to Table 9.

First, Table 5 includes only individual- and country-level characteristics with time and country effects.[3] Model 1 and 3 present the results of individual independent variables' effects on subjective well-being. The results conducted with individual- and country-level independent variables are reported in models 2 and 4. As reported in Table 5, the estimation results of the effect of personal characteristics on the subjective well-being index are consistent with the previous studies (Kang, 2010; Laechinger, 2010; Feleche et al., 2011; Ferreira et al., 2013; Tella et al., 2015, etc.). In particular, subjective well-being and age show non-linear relationship; subjective well-being is negatively correlated with age and positively correlated with the age squared term. But compared with the informal education as a default, when level of education was higher, the impact on subjective well-being is differed by each model specification.

Model 2 and Model 4 results of the regression analysis show that the national characteristic effects including national income, the log of GDP. The log of GDP has a positive effect (0.524, 0.668) on happiness and life satisfaction. However, the square of log of GDP shows a negative effect (-0.020, -0.029) and shows U-shaped non-linear relationships.

Table 5. Impact of Individual and Country-level Characteristic on happiness and life Satisfaction

	happiness		life satisfaction	
	(1)	(2)	(3)	(4)
Log of GDP		0.524***		0.668***
		(0.055)		(0.049)
Square of Log of GDP		-0.020***		-0.029***
		(0.004)		(0.003)
Inflation consumption price/1000		0.227***		-0.259***
		(0.048)		(0.045)
Trade/1000		-0.202		-0.726**
		(0.350)		(0.312)
Urban Population		0.006***		-0.012***
		(0.002)		(0.002)
Unemployment rate		-0.029***		-0.020***
		(0.002)		(0.002)
Gini		-1.918***		-0.801***
		(0.093)		(0.084)
Unhealthy	-0.431***	-0.452***	-0.291***	-0.299***
	(0.003)	(0.004)	(0.003)	(0.003)
Income inequality	0.009***	0.012***	0.013***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
Income scale	0.049***	0.051***	0.065***	0.071***
	(0.001)	(0.001)	(0.001)	(0.001)
Community	-0.112***	-0.117***	-0.054***	-0.052***
	(0.003)	(0.004)	(0.003)	(0.003)

[3] In these results, the sign of the variables and the significance are depending on whether time and country effects are included or not. Especially, the dummy indicating the level of education showed significant difference depending on whether time and country dummy was included.

Children		0.013***	0.015***	0.013***	0.013***
		(0.002)	(0.002)	(0.002)	(0.002)
Personal activities		0.070***	0.065***	0.143***	0.136***
		(0.001)	(0.001)	(0.001)	(0.001)
Gender (Dummy, Female=1)		0.092***	0.094***	0.076***	0.075***
		(0.005)	(0.006)	(0.004)	(0.005)
Marital (Dummy)	Divorced and Widowed	-0.339***	-0.345***	-0.187***	-0.186***
		(0.008)	(0.009)	(0.007)	(0.009)
	Separated	-0.383***	-0.375***	-0.270***	-0.257***
		(0.018)	(0.020)	(0.016)	(0.018)
	Single	-0.237***	-0.245***	-0.125***	-0.134***
		(0.007)	(0.008)	(0.006)	(0.007)
Age		-0.023***	-0.022***	-0.020***	-0.021***
		(0.001)	(0.001)	(0.001)	(0.001)
Square of Age/1000		0.255***	0.242***	0.254***	0.250***
		(0.010)	(0.012)	(0.009)	(0.010)
State of employment (Dummy)	Full time	0.089***	0.087***	0.114***	0.115***
		(0.008)	(0.009)	(0.007)	(0.008)
	Part time	0.079***	0.068***	0.100***	0.088***
		(0.011)	(0.012)	(0.010)	(0.011)
	Self employed	0.081***	0.082***	0.096***	0.099***
		(0.010)	(0.012)	(0.009)	(0.010)
	Retired	0.172***	0.173***	0.177***	0.170***
		(0.011)	(0.013)	(0.010)	(0.012)
	Housewife	0.192***	0.183***	0.207***	0.191***
		(0.010)	(0.011)	(0.009)	(0.010)
	Student	0.178***	0.174***	0.190***	0.191***
		(0.012)	(0.014)	(0.011)	(0.012)
Education level (Dummy)	Primary	-0.026**	0.027*	0.041***	0.036***
		(0.012)	(0.014)	(0.011)	(0.013)
	Secondary	-0.014	0.028**	0.039***	0.015
		(0.011)	(0.014)	(0.010)	(0.013)
	University	-0.035***	0.003	0.034***	-0.004
		(0.012)	(0.015)	(0.011)	(0.014)
Observations		275,385	207,861	276,999	208,552

Note: 1. Robust standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1.

2. Dependent variable is happiness (scale 1-4) and life satisfaction level (scale 1-10)

3.Country and Year dummies are included in model.

Table 6 summarizes the estimation results controlling for endogeneity between independent variables and error term by including the average of each country-level independent variables. In other words, Model (6) and (8) are the final base model of this study, which control for the possible endogeneity in Model (5) and (7). In the data of this study, only the average value of the country characteristic data was added as the explanatory variable since the individuals who answered the questionnaire were not repeated. The results were statistically significant, showing that the log of CO2 emissions can reduce subjective well-being. Some national level variables such as inflation rate, consumption price, and trade amount are changed to opposite sign and there are differences in the coefficient values after controlling endogeneity. On the other hand, in the case of the individual characteristics, university dummy showed the same result. These are similar to previous studies and present that it is necessary to control the possible endogeneity in the base model of this study. Therefore, this study analyzes the ordered probit model using the Chamberlain approach.

Table 6. Impact of Environmental Quality on happiness and life Satisfaction

		happiness		life satisfaction	
		(5)	(6)	(7)	(8)
Log of CO2		-0.226***	-0.183***	-0.221***	-0.315***
		(0.028)	(0.021)	(0.026)	(0.020)
Log of GDP		0.639***	0.246***	0.783***	0.532***
		(0.058)	(0.044)	(0.051)	(0.040)
Square of Log of GDP		-0.025***	-0.008***	-0.034***	-0.014***
		(0.004)	(0.003)	(0.003)	(0.002)
Inflation consumption price/1000		0.244***	-0.091**	-0.238***	-0.306***
		(0.048)	(0.042)	(0.045)	(0.041)
Trade/1000		-0.259	5.721***	-0.761**	4.416***
		(0.350)	(0.269)	(0.311)	(0.240)
Urban Population		0.012***	0.013***	-0.006***	0.008***
		(0.002)	(0.001)	(0.002)	(0.001)
Unemployment rate		-0.025***	-0.023***	-0.016***	-0.006***
		(0.002)	(0.001)	(0.002)	(0.001)
Gini		-1.986***	-2.355***	-0.866***	-1.745***
		(0.093)	(0.074)	(0.084)	(0.066)
Unhealthy		-0.447***	-0.441***	-0.296***	-0.291***
		(0.004)	(0.004)	(0.003)	(0.003)
Income inequality		0.012***	0.014***	0.015***	0.014***
		(0.001)	(0.001)	(0.001)	(0.001)
Income scale		0.050***	0.045***	0.069***	0.064***
		(0.001)	(0.001)	(0.001)	(0.001)
Community		-0.116***	-0.122***	-0.051***	-0.049***
		(0.004)	(0.004)	(0.004)	(0.003)
Children		0.015***	0.025***	0.013***	0.017***
		(0.002)	(0.002)	(0.002)	(0.002)
Personal activities		0.066***	0.069***	0.137***	0.143***
		(0.001)	(0.001)	(0.001)	(0.001)
Gender (Dummy, Female=1)		0.095***	0.103***	0.075***	0.070***
		(0.006)	(0.006)	(0.005)	(0.005)
Marital (Dummy)	Divorced and Widowed	-0.347***	-0.343***	-0.191***	-0.203***
		(0.010)	(0.009)	(0.009)	(0.009)
	Separated	-0.378***	-0.335***	-0.269***	-0.227***
		(0.021)	(0.020)	(0.019)	(0.019)
	Single	-0.248***	-0.218***	-0.138***	-0.133***
		(0.009)	(0.008)	(0.008)	(0.007)
Age		-0.022***	-0.022***	-0.021***	-0.021***
		(0.001)	(0.001)	(0.001)	(0.001)
Square of Age/1000		0.247***	0.247***	0.253***	0.255***
		(0.012)	(0.012)	(0.011)	(0.011)
State of employment (Dummy)	Full time	0.087***	0.068***	0.116***	0.102***
		(0.010)	(0.009)	(0.009)	(0.009)
	Part time	0.063***	0.057***	0.088***	0.092***
		(0.012)	(0.012)	(0.011)	(0.011)
	Self employed	0.081***	0.107***	0.104***	0.095***
		(0.012)	(0.012)	(0.011)	(0.011)
	Retired	0.168***	0.139***	0.168***	0.142***
		(0.013)	(0.013)	(0.012)	(0.012)
	Housewife	0.180***	0.126***	0.195***	0.184***
		(0.012)	(0.011)	(0.011)	(0.010)
	Student	0.171***	0.154***	0.191***	0.171***
		(0.014)	(0.014)	(0.012)	(0.012)
Education level (Dummy)	Primary	0.022	0.059***	0.024*	0.101***
		(0.015)	(0.014)	(0.014)	(0.013)
	Secondary	0.024*	0.054***	0.003	0.058***
		(0.015)	(0.013)	(0.014)	(0.012)
	University	-0.002	0.029**	-0.017	0.034***
		(0.015)	(0.014)	(0.014)	(0.013)
Average of Log of CO2			0.180***		0.311***

		(0.022)		(0.020)
Average of Log of GDP		-0.876***		-0.191***
		(0.063)		(0.058)
Average of Square of Log of GDP		0.054***		0.007*
		(0.004)		(0.003)
Average of Inflation consumption price		-0.936***		-0.372***
		(0.092)		(0.087)
Average of Trade		-6.447***		-5.989***
		(0.264)		(0.238)
Average of Urban Population		-0.017***		-0.012***
		(0.001)		(0.001)
Average of Unemployment rate		0.005***		-0.017***
		(0.002)		(0.001)
Average of Gini		3.158***		2.423***
		(0.073)		(0.066)
Observations	201,865	201,865	202,596	202,596

Note: 1. Robust standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1.
2. Dependent variable is happiness (scale 1-4) and life satisfaction level (scale 1-10)
3.Country and Year dummies are included in model (5), (7) and Year dummy is included in model (6), (8).

In this section, we present the estimate results based on the respondents of 'Economic Growth vs. Protecting Environment' surveyed by WVS. The percentages of responses by country and individual income are as follows. By the income groups presented in the WDI, the data suggest that the higher the income, the tendency to 'Protect Environment' increases. This is the same for personal income scales in response to WVS. In addition, the gap that responded to environmental protection against economic growth within the same income groups or scales increases as the income increases.

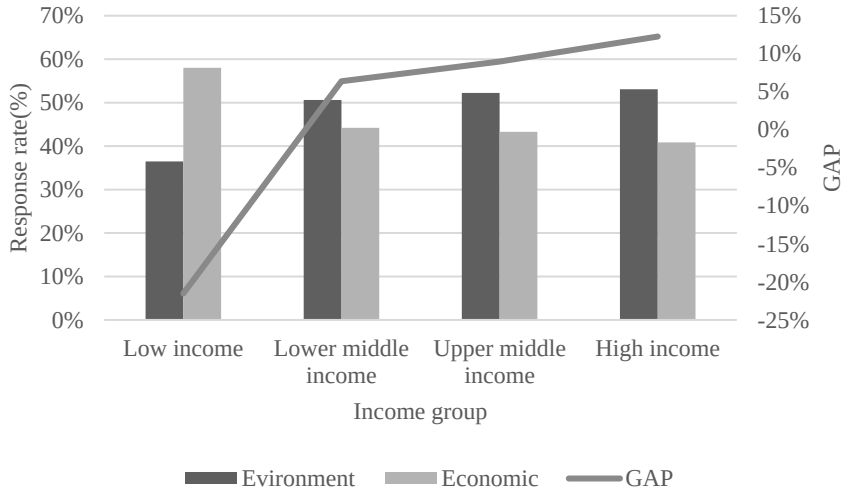

Figure 1. Response rates by Income group

Source: authors' calculation by using the WVS longitudinal data.

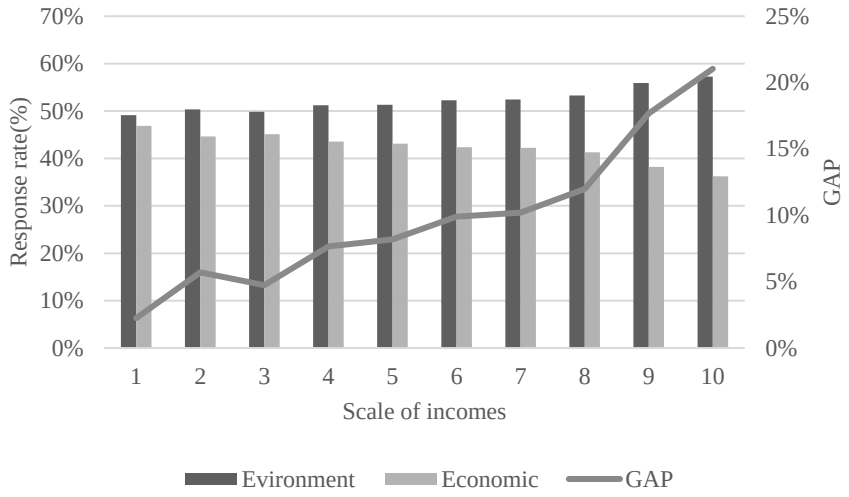

Figure 2. Response rates by Scale of incomes

Source: authors' calculation by using the WVS longitudinal data.

The following is an empirical analysis of how the level of air pollution affects the level of subjective well-being (see Table 7).[4] The CO2 emissions from combustions, which are expressed as air pollution levels, are classified into coal, oil, natural gas, and other items. [5] The selection probability of happiness and life satisfaction index according to CO2 emissions from fuel consumption was measured by 3 types of datasets. That is, all respondents, respondents selected Economic Growth and Respondents who responded to Protecting Environment.

For models considering divided dataset, it is appropriate to compare the effect of CO2 emissions and GDP on subjective well-being defined happiness and life satisfaction. This is to analyze how the effect of the major variables on the dependent variables statistically varies according to the respondent's usual values. From Table 7, different results are statistically significant depending on individual tendency. Basically, as the CO2 emissions (Mt) increased by 1 %, the level of subjective well-being is decreased. And if GDP per capita increased by 1% increase, the level of life satisfaction increased. In addition, comparing those who responded that 'Protecting Environment is more important' with the respondents who answered, 'Economic Growth is more important', the relative increase of CO2 to GDP was about 3.47 times happier and about 1.39 times greater than life satisfaction. The other variables

[4] Independent variables were controlled by country and individual characteristics. In the text, only the results of CO2 emissions are presented, and the appendix shows the results of the overall variables.

[5] IEA (2016) presents CO2 emissions from fuel combustion according to climate change agreement and OECD accession. Therefore, in further research, we try to regress the effect of CO2 emissions from fuel combustion on happiness and life satisfaction.

have different coefficients and significance, but the relationship with the dependent variable has the same direction. In addition, the variables for individual and national characteristics are similar to the previous models.

Table 7. Impact of Environmental Quality on happiness and life satisfaction using divided dataset

		happiness			life satisfaction		
		(9)Full	(10)Econ	(11)Env	(12)Full	(13)Econ	(14)Env
Log of CO2		-0.183***	-0.240***	-0.409***	-0.315***	-0.369***	-0.397***
		(0.021)	(0.035)	(0.033)	(0.020)	(0.034)	(0.030)
Log of GDP		0.246***	0.328***	0.162**	0.532***	0.684***	0.530***
		(0.044)	(0.072)	(0.065)	(0.040)	(0.066)	(0.059)
Square of Log of GDP		-0.008***	-0.014***	-0.0004	-0.014***	-0.024***	-0.016***
		(0.003)	(0.004)	(0.004)	(0.002)	(0.004)	(0.003)
Inflation consumption price/1000		-0.091**	0.164**	0.219***	-0.306***	-0.174***	-0.257***
		(0.042)	(0.069)	(0.073)	(0.041)	(0.067)	(0.070)
Trade/1000		5.721***	8.040***	5.025***	4.416***	3.269***	3.626***
		(0.269)	(0.453)	(0.412)	(0.240)	(0.407)	(0.367)
Urban Population		0.013***	0.010***	0.016***	0.008***	0.013***	0.011***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Unemployment rate		-0.023***	-0.028***	-0.023***	-0.006***	-0.009***	-0.011***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Gini		-2.355***	-2.954***	-2.363***	-1.745***	-2.067***	-1.871***
		(0.074)	(0.118)	(0.110)	(0.066)	(0.108)	(0.099)
Unhealthy		-0.441***	-0.449***	-0.459***	-0.291***	-0.299***	-0.298***
		(0.004)	(0.006)	(0.005)	(0.003)	(0.005)	(0.005)
Income inequality		0.014***	0.016***	0.010***	0.014***	0.014***	0.011***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Income scale		0.045***	0.048***	0.040***	0.064***	0.072***	0.055***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Community		-0.122***	-0.116***	-0.134***	-0.049***	-0.045***	-0.049***
		(0.004)	(0.006)	(0.006)	(0.003)	(0.005)	(0.005)
Children		0.025***	0.027***	0.034***	0.017***	0.014***	0.025***
		(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Personal activities		0.069***	0.066***	0.062***	0.143***	0.139***	0.137***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Gender (Dummy, Female=1)		0.103***	0.107***	0.082***	0.070***	0.084***	0.049***
		(0.006)	(0.009)	(0.008)	(0.005)	(0.008)	(0.007)
Marital (Dummy)	Divorced and Widowed	-0.343***	-0.364***	-0.330***	-0.203***	-0.209***	-0.210***
		(0.009)	(0.015)	(0.014)	(0.009)	(0.014)	(0.012)
	Seperated	-0.335***	-0.322***	-0.374***	-0.227***	-0.281***	-0.232***
		(0.020)	(0.034)	(0.029)	(0.019)	(0.031)	(0.027)
	Single	-0.218***	-0.182***	-0.230***	-0.133***	-0.134***	-0.126***
		(0.008)	(0.014)	(0.012)	(0.007)	(0.012)	(0.011)
Age		-0.022***	-0.023***	-0.024***	-0.021***	-0.022***	-0.023***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Square of Age/1000		0.247***	0.264***	0.249***	0.255***	0.269***	0.271***
		(0.012)	(0.018)	(0.017)	(0.011)	(0.017)	(0.016)
State of employment (Dummy)	Full time	0.068***	0.111***	0.021	0.102***	0.138***	0.062***
		(0.009)	(0.015)	(0.014)	(0.009)	(0.013)	(0.013)
	Part time	0.057***	0.094***	0.024	0.092***	0.116***	0.069***
		(0.012)	(0.020)	(0.018)	(0.011)	(0.018)	(0.016)
	Self employed	0.107***	0.136***	0.072***	0.095***	0.135***	0.053***
		(0.012)	(0.019)	(0.017)	(0.011)	(0.017)	(0.016)
	Retired	0.139***	0.125***	0.124***	0.142***	0.154***	0.107***
		(0.013)	(0.020)	(0.019)	(0.012)	(0.018)	(0.018)
	Housewife	0.126***	0.143***	0.127***	0.184***	0.179***	0.186***
		(0.011)	(0.018)	(0.017)	(0.010)	(0.016)	(0.016)
	Student	0.154***	0.173***	0.120***	0.171***	0.198***	0.129***
		(0.014)	(0.022)	(0.020)	(0.012)	(0.019)	(0.018)
Education	Primary	0.059***	0.091***	0.079***	0.101***	0.087***	0.123***

level		(0.014)	(0.022)	(0.022)	(0.013)	(0.021)	(0.021)
(Dummy)	Secondary	0.054***	0.063***	0.071***	0.058***	0.044**	0.070***
		(0.013)	(0.022)	(0.021)	(0.012)	(0.021)	(0.020)
	University	0.029**	0.028	0.055**	0.034***	0.003	0.055***
		(0.014)	(0.014)	(0.023)	(0.022)	(0.013)	(0.022)
Average of Log of CO2		0.180***	0.239***	0.409***	0.311***	0.365***	0.394***
		(0.022)	(0.036)	(0.033)	(0.020)	(0.033)	(0.030)
Average of Log of GDP		-0.876***	-0.985***	-0.719***	-0.191***	-0.322***	-0.029
		(0.063)	(0.103)	(0.088)	(0.058)	(0.096)	(0.081)
Average of Square of Log of GDP		0.054***	-0.776***	-1.015***	0.007*	-0.128	-0.380***
		(0.004)	(0.156)	(0.147)	(0.003)	(0.150)	(0.140)
Average of Inflation consumption price		-0.936***	-8.871***	-5.831***	-0.372***	-4.873***	-5.169***
		(0.092)	(0.447)	(0.407)	(0.087)	(0.407)	(0.366)
Average of Trade		-6.447***	-0.011***	-0.021***	-5.989***	-0.016***	-0.016***
		(0.264)	(0.002)	(0.002)	(0.238)	(0.002)	(0.002)
Average of Urban Population		-0.017***	0.010***	0.007***	-0.012***	-0.013***	-0.010***
		(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Average of Unemployment rate		0.005***	3.665***	3.105***	-0.017***	2.573***	2.378***
		(0.002)	(0.116)	(0.108)	(0.001)	(0.107)	(0.096)
Average of Gini		3.158***	0.061***	0.041***	2.423***	0.015***	-0.002
		(0.073)	(0.006)	(0.005)	(0.066)	(0.006)	(0.005)
Observations		201,865	76,599	94,454	202,596	76,808	94,682

Note: 1. Robust standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1.
2. Dependent variable is happiness (scale 1-4) and life satisfaction level (scale 1-10)
3. Year dummy is included.

Table 8 and Table 9 reports the average marginal effects from Model (9) to (14) in Table 7. The measured value presented in tables means the probability of responding to the category of subjective well-being when the explanatory variable expressed in CO2 emissions and GDP is increased by one unit. In this part, the variables for national and individual characteristics standards were all considered to be average except for the variables expressed as air pollution. The interesting parameter of this study is total CO2 emissions sum of coal, oil, natural gas, and other emissions from combustion, which shows that the probability of responding to subjective well-being is generally lower as the level of indexes increases.

In detail, the marginal probability of the log of CO2 under the ordered probit model show a positive coefficient, implying a positive sign of the marginal probability effects for low happiness that switches into a negative sign when $\frac{\partial \Pr(H_{ijt}=4)}{\partial E_{it}}$, coefficient -0.056 means that the probability of happiness = 4 decreases as the log of CO2 rises in Full dataset. Similarly, the marginal effects of the log of GDP switch into a positive when $H_{ijt} = 4$. and 0.078 means that the probability of happiness = 4 decreases as the GDP per capita increases. In this respect, in the 3 data set cases, Marginal effects showed that the relative increase in CO2 to GDP was about 2.51 times in Protecting Environmental dataset, which is greater than when economic growth is important (0.73).

It is similar to in the case of life satisfaction (see Table 9). These results present the average marginal effects of the log of CO2 emissions and log of GDP per capita on life satisfaction using the 3 types of dataset. In Full dataset, for example, the log of CO2 emissions by one unit, the probability of responding to life satisfaction as completely dissatisfied is 0.014, but the probability of responding as

completely satisfied (10) is decreased to -0.049 with switching point $H_{ijt} \geq 7$. On the other hand, we can see that negative sign of marginal effects of the log of GDP for least life satisfaction ($1 \leq H_{ijt} \leq 6$) into a positive sign when $H_{ijt} \geq 7$. The other cases present the same pattern as well. Based on completely satisfied ($H_{ijt} = 10$), the relative increase in the log of Mt of CO2 to the log of GDP per capita is 0.54 when respondents answered, 'Economic Growth' and 0.75 when respondents select the answer 'Protecting Environment'. In other words, the difference between the two data sets is about 1.39 times, indicating that the marginal effect varies with the respondents' values.

Therefore, additional information on the empirical analysis of the impact of CO2 emissions from fuel combustion on happiness and life satisfaction can be confirmed through the marginal effects of CO2 Emissions on subjective well-being.

Table 8. The Marginal Effects CO2 Emissions and GDP on happiness

		$\frac{\partial \Pr(H_{ijt}=1)}{\partial E_{it}}$	$\frac{\partial \Pr(H_{ijt}=2)}{\partial E_{it}}$	$\frac{\partial \Pr(H_{ijt}=3)}{\partial E_{it}}$	$\frac{\partial \Pr(H_{ijt}=4)}{\partial E_{it}}$	Observations
Full	Log of CO2	0.006***	0.037***	0.016***	-0.058***	201,865
	Log of GDP	-0.008***	-0.049***	-0.021***	0.078***	
Economic	Log of CO2	0.009***	0.051***	0.015***	-0.074***	76,599
	Log of GDP	-0.012***	-0.069***	-0.020***	0.102***	
Environment	Log of CO2	0.010***	0.073***	0.055***	-0.138***	94,454
	Log of GDP	-0.004***	-0.029***	-0.022***	0.055***	

Note: 1. marginal probability effect of all independent variables on life satisfaction
2. Dependent variable is subjective well-being measure captured by happiness level (scale 1-4)
3. Year dummy is included

Table 9. The Marginal Effects CO2 Emissions and GDP on life satisfaction

	Full		Economic		Environment	
	Log of CO2	Log of GDP	Log of CO2	Log of GDP	Log of CO2	Log of GDP
$\partial \Pr(H_{ijt}=1)/\partial E_{it}$	0.014***	-0.024***	0.018***	-0.034***	0.015***	-0.020***
$\partial \Pr(H_{ijt}=2)/\partial E_{it}$	0.012***	-0.021***	0.017***	-0.031***	0.014***	-0.019***
$\partial \Pr(H_{ijt}=3)/\partial E_{it}$	0.021***	-0.035***	0.026***	-0.048***	0.022***	-0.030***
$\partial \Pr(H_{ijt}=4)/\partial E_{it}$	0.022***	-0.038***	0.027***	-0.050***	0.026***	-0.034***
$\partial \Pr(H_{ijt}=5)/\partial E_{it}$	0.039***	-0.066***	0.043***	-0.080***	0.051***	-0.068***
$\partial \Pr(H_{ijt}=6)/\partial E_{it}$	0.015***	-0.025***	0.015***	-0.028***	0.023***	-0.031***
$\partial \Pr(H_{ijt}=7)/\partial E_{it}$	-0.003***	0.004***	-0.008***	0.014***	0.004***	-0.006***
$\partial \Pr(H_{ijt}=8)/\partial E_{it}$	-0.037***	0.063***	-0.046***	0.085***	-0.042***	0.057***
$\partial \Pr(H_{ijt}=9)/\partial E_{it}$	-0.034***	0.058***	-0.039***	0.073***	-0.034***	0.061***
$\partial \Pr(H_{ijt}=10)/\partial E_{it}$	-0.049***	0.083***	-0.053***	0.098***	-0.068***	0.091***
Observations	202,596		76,808		94,682	

Note: 1. marginal probability effect of all independent variables on life satisfaction
2. Dependent variable is subjective well-being measure captured by life satisfaction level (scale 1-10)
3. Year dummy is included

5. Conclusion

Greenhouse gas emissions (GHG) are increasing as energy consumption increases. Given the continuing increase in energy consumption due to population growth and economic growth, life satisfaction from GHG emissions may be affected.

The analysis from Sustainable Development Goals (SDGs) Goal 13 adequately exhibits that impact of climate changes, which include weather changing patterns, a rise of sea level, and other extreme weather varieties, gives significant experience to people. In fact, continuous GHG emissions from human activities on Earth have brought up the incessant inclination of climate changes which currently marks the highest level throughout history. [6] Without any resolution taking in place, the rise of surface temperature is predicted to rise over the 21st century and is likely to surpass 3° Celsius within this Century. Such a significant impact is mostly assumed to affect the poor and vulnerable people around the world.[7]

Thus, the quality of the environment affects the individual's health and satisfaction with life. In order to analyze the effects of air pollution on the subjective well-being of the country and individuals, this study conducted ordered probit regression based on the World Values Survey (WVS) 1981-2014 cross-countries data, CO2 emissions from the fuel economy data provided by IEA and the World Bank World Development Indicators data.

In this study, the factors that determine the utility of subjective well-being presented as happiness and life satisfaction index are defined as environment, national (economy, society) and individual characteristics, and they are expressed as a linear function. Prior to the empirical analysis, we checked at subjective well-being trends of the WVS data and found that the average world happiness and life satisfaction was steadily increasing around the world in 6 waves from 1981 to 2014.

In addition, we used the ordered probit model to determine the effect of air pollution, which is an interesting parameter of this study, on subjective well-being. As a result, subjective well-being defined happiness and life satisfaction according to individual characteristics showed similar direction and significance when regression analysis was performed with national and environmental variables, but the level of education showed a different pattern. If the possible endogeneity is not considered, the effects of education level are the opposite according to the dependent variable, and the sign is reversed

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[6] United Nations, Goal 13: Take urgent action to combat climte change and its impacts, http://www.un.org/sustainabledevelopment/climate-change-2/

[7] United Nations, Goal 13: Take urgent action to combat climate change and its impacts, http://www.un.org/sustainable development/climate-change-2/

when the national characteristic variable was added. Following a result of applying the Chamberlain approach, the direction of the sign, magnitude of the coefficient value, and the significant level were adjusted in the base model conducted with individual- and country-level characteristics. And those results seem to be more appropriate because of the similarity of the previous studies.

In the final model, the direction and significance of variables that represent individual and national characteristics are slightly different depending on the personal tendencies. In order to analyze this, data was divided according to respondents' emphasis on whether the Importance of Economic Growth and Protecting Environment. As a result, the increase in CO2 emissions from fuel combustion lower the subjective well-being level, and the higher the level of national income, the higher the level of subjective well-being. However, the respondents who emphasized the environment showed a statistically greater effect of air quality relative to GDP on subjective well-being than those who did not. From this, it was possible to derive that the degree of environmental pollution affects individual's subjective well-being index according to individual beliefs.

For additional explanation of the regression analysis, marginal effects were further considered to examine response probability of happiness (scale 1-4) and life satisfaction (scale 1-10) according to air pollution and national income variables. The marginal effect of the log of total CO2 emissions and GDP have a switching point, and compared with the highest score of the indicator, the relative marginal effect of GDP to CO2 of the respondents who answered ‘Protecting Environment’ is higher than those who did not (Economic Growth). In other words, it means that the incentive to respond to 'Feeling of Happiness' or 'Satisfied with Life' depends on personal values.

This study is meaningful in that it explains the difference of individual happiness as perception and attitude of the environment. With regard to discerning individual differences across nations, environmental indicator, CO2 emissions from fuel combustion, is considered to have statistically significant which is expected to decline in subjective well-being in all types of datasets. In addition, as the recent establishment of sustainable indicators and strategies accelerates, it can be seen that access to the environment is not necessarily only in science fields but also in many aspects of politics, society, and the economy. So, it is a notable trial to attempt to relate the quality of the environment with the response of the individual. In other words, as efforts to improve the environment are increasing, it needs to be analyzed empirically to present the necessity.

There are some limitations to this study. First, it is limited to air pollution in identifying environmental pollution, because it is not based on individual exposure to pollution and can be transferred between countries, so there may be an error in the measurement of the value. And there is a limit in that the index is not correlated with the previous year because the index was not consistently responded by the same respondent. Therefore, in future research, it is necessary to clarify the standard of pollution index and to consider pollution impact based on the national happiness index.

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