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Article

Environmental perspectives and pollutants: Assessing their impact on subjective well-being across 118 countries

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Abstract: Using individual- and panel country-level data from 118 countries for the period 1981–2020, this study investigates the effects of national- and individual-level economic and environmental factors on subjective well-being (SWB). Two individual SWB indicators are selected: the feeling of happiness and life satisfaction. Additionally, two environmental factors are also considered: CO_2 emissions by country level and personal perspective on environmental protection. The ordered probit estimation results show that CO_2 emissions have a significant negative effect on SWB, and a higher perspective on environmental protection has a significant and positive effect. Compared with the average marginal effect of national income, CO_2 emissions are a more important determinant of SWB when considering a personal perspective on protecting the environment. The estimation results are robust to various estimation model specifications: inclusion of additional air pollutants (CH_4 and N_2O), PM 2.5 and various sample groupings. This study makes a novel contribution by providing comprehensive insights into how both individual environmental attitudes and national pollution levels jointly influence subjective well-being.

Keywords: subjective well-being; happiness; life satisfaction; environmental attitudes; ordered probit model
JEL: D60; I31; Q53

1. Introduction

Numerous studies have delved into the nexus between happiness and income, particularly concerning material well-being. The conventional rationale for augmenting income per capita as an economic development strategy posits that well-being or happiness, as an indicator of welfare, is directly proportional to income per capita. Contrary to this, Easterlin (1974) introduced the 'Easterlin Paradox', arguing that happiness is not linearly proportional to per capita income. This paradox, while acknowledging the role of per capita income, proposes that it should not be viewed as the sole comprehensive indicator of happiness. Given the ultimate objective of maximizing happiness in both individual aspirations and government policies, there exists a rich body of theoretical and empirical research exploring the determinants of happiness (Frey and Stutzer, 2010).

Well-being has been expressed in both objective and subjective dimensions. According to Conceição and Bandura (2008), objective well-being (OWB) is measured by various observable economic, social, and environmental factors. The most popular index to measure OWB is the Human Development Index (HDI) developed by the United Nations Development Programme (UNDP). It considers

health- and education-related indicators in addition to GDP per capita. The Organisation for Economic Co-operation and Development (OECD) releases the Better Life Index (BLI), integrating 11 indicators: income, jobs, housing, education, health, environment, safety, civic engagement and governance, access to services, community, and life satisfaction (OECD, 2016).

Subjective well-being (SWB) is a more comprehensive aspect of a person's subjective status, including personal life satisfaction, experienced well-being, and proper psychological functioning (Diener et al., 1999; Kahneman and Krueger, 2006; Huppert et al., 2009). Diener and Seligman (2004) defined SWB as people's positive evaluations of their lives, encompassing positive emotions, engagement, satisfaction, and meaning. Kahneman and Riis (2005) stated that SWB consists of experienced and evaluated well-being. The former is related to short period states, while the latter covers a prolonged period. Diener (2006) characterizes SWB as a broad term for the different valuations made by individuals about their lives, events, physical and mental states, and living circumstances. Similarly**,** OECD (2013) defines SWB as "a good mental state, including all of the various evaluations, positive and negative, that people make of their lives and the affective reactions of people to their experiences."

There are several SWB indicators providing cross-country data, including the World Value Survey (WVS), the World Happiness Report (WHR), and the Gallup World Poll (GWP). In addition, certain countries, such as the United Kingdom, Germany, Italy, the United States, Australia, Canada, and Bhutan, also release country-level indicators; however, the problem with such indices is that they cannot be compared between countries.

This study used both the European Values Study (EVS) and the World Values Survey (WVS) for the period 1981–2022, which reports two SWB indicators (happiness and life satisfaction) and various OWB indicators (Royo and Velazco, 2005). This study aims to investigate the impacts of personal environmental perspective and country-level environmental factors on SWB.

The relationship between environmental factors and SWB is intricate. Air and water pollution personal diseases and thus health (Cohen et al., 2005; Darçın, 2014; Henschel et al., 2012; van Erp et al., 2012), which, in turn, the quality of individual well-being and the regional SWB (Luechinger, 2010; Zheng et al., 2019). And it is necessary to examine the implications of climate change on the SWB since the costs of global warming affect future generations' abilities and welfare (Aronsson and Schöb, 2018).

Many empirical studies have assessed the influence of environmental factors, including water and air pollution, on SWB at both the country- and regional-levels (Behera et al., 2024; Bonasia et al., 2022; Kang and Kim, 2012; Kim and Kang, 2016; Li et al., 2014; Luechinger, 2010; Rehdanz and Maddisson, 2008; Welsch, 2002, 2006; Yuan et al., 2024; Zhang et al., 2017a, 2017b). Most of the studies consider individual SWB for one country or utilize national level SWB for multi countries. However, Ferreira et al. (2013) and Silva et al. (2012), are among the few that examined the combined effects of individual perceptions and national environmental factors on SWB.

This study enhances existing literature by providing further evidence of the effect of environmental factors on SWB. First, this study selects two different environmental

indicators: national-level air pollution, measured by CO_2 emissions a major source of greenhouse gas (GHG) emissions and personal perspective on the environment estimated by the EVS and WVS.

Second, this study leverages comprehensive data covering individual and country characteristics from 118 countries from 1981 to 2020. Two SWB indicators are considered: the feeling of happiness and life satisfaction. Third, ordered property of the SWB is considered in the estimation. The ordered probit model, incorporating country and year fixed effects, is employed alongside the traditional Ordinary Least Squares (OLS) estimation model. Lastly, the robustness of the estimation results is examined through various model specifications, including the inclusion of other air pollutants (CH_4, N_2O, and PM 2.5) and sample regrouping based on environmental or economic growth preferences, income, education, health status, age group, and gender group.

The estimation results demonstrate statistically significant impact of both national- and individual environmental indicators on SWB. Moreover, the estimated coefficient for the personal perspective on the environment is shown to be positive and significant. The results for these two environmental indicators are consistent with robustness tests. In addition, various national environmental indicators exhibit negative and significant impacts on SWB across various model specifications. Notably, the SWB of the respondents prioritizing environmental protection over economic growth is more affected by the degree of environmental pollution. The estimation results of other individual- and country-level characteristics align with findings from previous studies.

The remainder of this study is organized as follows. Section 2 provides a comprehensive review of recent literature on the environmental impacts on life satisfaction. Section 3 details the data sources and outlines the estimation model specification, along with the descriptive statistics of the main variables. Section 4 presents an in-depth discussion of the estimation results. Section 5 reports the robustness check results, disaggregating the main model by explanatory variables. Finally, Section 6 concludes the study, summarizing key findings and their broader implications.

2. Literature review

Extensive research has been conducted on the relation between environmental factors and life satisfaction. However, the majority of these studies primarily focus on the impact of national-level environmental factors for cross-country studies. There are limited studies which consider both individual environmental perspectives and national environmental factors as determinants of SWB.

A common approach in these studies involves the use of air and water pollution as key country-level indicators. Air pollution is typically measured by NO_2, SO_2, PM_{10}, or CO_2, while water pollution is often proxied by organic water pollutants, access to safe water supplies, dissatisfaction with water quality, wastewater discharge, etc. Ferrer-i-Carbonell and Gowdy (2007), utilizing the British Household Panel Survey, found a negative association between public concern over ozone pollution and SWB. Similarly, Rehdanz and Maddison (2008) observed a significant decrease in

SWB with increased local air pollution and noise levels, based on German socio-economic panel data. Smyth et al. (2008), examining 30 cities in urban China through the China Mainland Marketing Research Company (CMMRC) survey, noted lower well-being levels in cities with heightened atmospheric pollution, particularly SO_2, and environmental disasters.

MacKerron and Mourato (2009) presented a significant negative effect of NO_2 on life satisfaction, quantifying a 1% increase in NO_2 level as equivalent to a 5.3% decrease in income in the terms of life satisfaction. Moreover, Rahman et al. (2011) used air and noise pollution indicators and revealed a negative impact on indices of quality of life. Using the General Social Survey of residents of the United States, Levinson (2012) observed a more pronounced effect of PM_{10} on happiness compared to SO_2 and CO. Kang and Kim (2012), using the life satisfaction data of South Korea during 1998–2009, reported that pollutants such as SO_2, NO_2, CO, and PM_{10} are negatively related to the level of life satisfaction. Through examining the German 2004 socio-economic panel data, Goetzke and Rave (2015) also found similar negative relationships between life satisfaction ("happiness") and pollutants including SO_2, NO_X, and PM_{10}. In Korea, Kim and Kang (2016) highlighted that water pollutants measured by biochemical oxygen demand (BOD) and total phosphorus (TP) adversely and significantly affect SWB.

In addition, Yuan et al. (2024) found a negative impact of air pollution on happiness, indicating the residents' happiness decrease by about 1.8 units when annual air quality index increases by 50 units in China. Similarly, Dolan and Laffan (2016) presented lower life satisfaction among 165,000 individuals in the U.K. exposed to higher levels of air pollution. Using the Canadian Community Health Survey (CCHS) from 2005 to 2011, Barrington-Leigh and Behzadnejad (2017) disclosed that SO_2, a daily variation of air pollution, influences self-reported life satisfaction. Zhang et al. (2017a) examined the effect of air pollution on happiness and mental health in China and find that although daily air quality does not significantly effect overall life satisfaction, it lowers hedonic happiness and raises depressive symptoms. For China, Zhang et al. (2017b) exhibited a significant negative effect of $PM_{2.5}$ on hedonic happiness and that, on average, people are willing to pay 3.8% of annual household per capita income for a 1μg/m3 reduction in $PM_{2.5}$.

Several studies have conducted comparative cross-country analysis using country-level environmental variables. For example, using the cross-national data of NO_X for 54 cross-countries and 10 European countries, Welsch (2002, 2006) observed improvements in self-reported SWB with reductions in urban air pollution. Luechinger (2010) presented a negative effect of SO_2 on life satisfaction in 13 European countries from 1979 to 1994. Orru et al. (2016) found that PM_{10} tends to reduce the SWB in their study covering 30 European countries based on the 2010 and 2012 European Social Survey (ESS). Similarly, Bonasia et al. (2022) found strong connections between happiness and environmental protection expenditure in the long run in 19 European countries between 1997 and 2019. Through investigating the socioeconomic determinants of happiness across 166 countries, Behera et al. (2024) suggested that exposure to air pollution negatively affects happiness in both developed and developed countries.

Fewer studies have examined the combined effects of individual perceptions and

national environmental factors on life satisfaction. Employing the individual- and country-level data, Silva et al. (2012) and Ferreira et al. (2013) explored the impact of individual perceptions on the environment and observed a negative and significant influence of environmental conditions on life satisfaction. However, their analyses were confined to a limited number of countries (50 and 23, respectively) and employed diverse environmental quality factors. Silva et al. (2012) used binary variables for residential satisfaction with air quality from the GWP surveys, while Ferreira et al. (2013) utilized discrete indicators measuring the importance of caring for nature and the environment from ESS data.

3. Data and model specification

Because of limited availability of SWB and environmental quality data, previous studies often restrict their analyses to country-level data from a small set of nations. Instead, this study uses the Integrated Values Surveys (IVS), which comprises both EVS and WVS for the period 1981–2022. IVS data contains SWB at both the individual- and the country-level. Further, the data also includes various individual socio-economic indicators: income by scale, income inequality, number of children, personal activities, gender, age, education, and employment status, etc.

This study encompasses data across seven waves, from Wave 1 (1981–1984) to Wave 7 (2017–2022). The initial Wave covered 25 countries with 29,685 respondents, whereas the latest Wave expanded to include 90 countries and 153,716 respondents. **Table 1** summarizes the number of countries and respondents for each Wave (For a detailed list of countries included in each Wave, refer to the Appendix).

Table 1. Respondents of the IVS.

	Wave1 (81-84)	**Wave2 (90-94)**	**Wave3 (95-98)**	**Wave4 (99-04)**	**Wave5 (05-09)**	**Wave6 (10-14)**	**Wave7 (17-22)**	**Total**
Country	25	44	56	71	83	60	90	118
Respondent	29,685	62,771	77,818	100,155	150,255	89,565	153,716	663,965

Source: Authors' calculation based on EVS and WVS Database.

The SWB indicators are obtained from the IVS questions. There are as follows:

1) (Feeling of happiness) Taking all things together, would you say you are "Very happy", "Quite happy", "Not very happy", or "Not at all happy", which is a 4-point scale.
2) (Satisfaction with your life) All things considered, how satisfied are you with your life as a whole these days? Please use this card to help with your answer on a 10-point scale, with 1 representing "dissatisfied" and 10 indicating "satisfied."

Tables 2 and **3** summarize the trends in happiness and life satisfaction, respectively, over Waves. On average, approximately 82.2% responded that they were "Quite happy" or "Very happy." Regarding life satisfaction, 71.3% of respondents in Wave 1 (1981–1984) and 61.5% in the latest Wave rated their satisfaction between 7 and 10.

Table 2. Trends of happiness by waves (%).

	Not at all happy	Not very happy	Quite happy	Very Happy
Wave1 (81–84)	1.3	10.0	62.2	26.6
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
Wave7 (17–22)	2.0	12.1	56.9	29.0
Average	2.7	15.2	55.4	26.8

Source: Authors' calculation based on EVS and WVS Database.

Table 3. Trends of life satisfaction by waves (%).

	Dissatisfied----------									----------Satisfied
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Wave1 (81–84)	1.6	1.2	2.6	4.0	9.5	9.9	16.2	24.9	14.8	15.3
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	21.4	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
Wave7 (17–22)	2.4	1.4	3.0	4.2	10.8	10.5	16.9	22.1	12.4	16.3
Average	3.5	2.3	4.4	5.2	12.6	10.5	15.2	20.4	11.7	14.2

Source: Authors' calculation based on EVS and WVS Database.

Table 4 presents the sources and statistics of variables used in the empirical estimation from 1981 to 2020. The variables are classified into four groups. First, there are two SWB indicators: happiness (Feelings of happiness) and life satisfaction (Satisfaction with your life). The data are obtained from the IVS. Second, individual-level characteristics: state of health, importance in life (friend; community), gender, age, marital status, and number of children. Prior studies suggest that better health, social connections, having more children, greater personal freedom, and being female are generally associated with higher SWB (Choi, 2024; Ferreira et al., 2013; Fleche et al., 2011; Kang, 2010; Luechinger, 2010; Tella et al., 2003). The effect of education on SWB can be ambiguous, as higher education often raises expectations for future employment and income, which, if unmet, may lead to diminished happiness (Clark and Oswald, 1996; Green, 2011; Nikolaev and Rusakov, 2015; Powdthavee, 2010; Shields et al., 2009). All data are from the IVS.

Third, there is a personal perspective on the environment and economic growth. Dummy = 1 gives the value on the environment if the respondent replied yes for the question "Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs." As Bonasia et al. (2022) highlighted a strong connection between happiness and environmental protection expenditure, individuals who prioritize environmental protection over economic growth are expected to positively influence SWB. Similar to the other two cases, they are obtained from the

IVS.

Fourth, country-level characteristics are air pollutants, GDP per capita in constant 2015 USD, degree of urbanization, and unemployment rate. The logarithm of GDP is used to capture proportional changes in income, while its squared term is included to assess potential non-linear effects, suggesting a possible U-shaped or quadratic relationship between economic growth and well-being. This approach facilitates the examination of whether SWB initially moves in one direction and then reverses as income levels rise, analogous to the Environmental Kuznets hypothesis, which proposes a similar pattern between economic growth and environmental impact. Moreover, we consider additional air pollutants such as CH_4 (Methane), N_2O (Nitrous oxide), and PM 2.5 (Particulate Matter)~~,~~, all of which are expected to negatively impact SWB (Ferrer-i-Carbonell and Gowdy, 2007; Luechinger, 2010; Rehdanz and Maddison, 2008; Yuan et al., 2024). The data are sourced from the World Bank (WD) World Development Indicators (WDI).

Table 4. Summary statistics.

Variables		Description	Obs.	Mean	SD	Min	Max
Happiness		Feeling of happiness (Scale 1–4)	650,091	3.07	0.73	1	4
Life satisfaction		Satisfaction with your life (Scale 1–10)	656,352	6.83	2.36	1	10
Log of CO_2		Log of carbon dioxide emissions (kt)	597,158	11.46	1.84	6.21	16.17
Log of CH_4		Log of methane emissions (kt of CO_2 equivalent)	597,158	10.16	1.74	3.76	13.95
Log of N2O		Log of nitrous oxide emissions (thousand metric tons of CO_2 equivalent)	597,158	9.27	1.67	1.01	13.21
Log of PM2.5		Log of PM2.5 air pollution, mean annual exposure (micrograms per cubic meter)	292,165	3.07	0.60	1.83	4.47
Log of GDP		Log of GDP per capita (constant 2015US$)	643,025	9.12	1.25	5.88	11.61
Squared log of GDP		Squared log of GDP per capita (constant 2015US$)	643,025	84.82	22.55	34.58	134.77
Urban population		Urban population (% of total)	654,833	66.88	17.82	15.20	100
Unemployment rate		Unemployment, total (% of total labor force)	572,503	8.42	5.38	0.25	34.5
Healthy		State of health (subjective)	610,810	3.78	0.91	1	5
Income inequality		We need larger income differences as incentives for individual effort	598,194	5.21	2.99	1	10
Income scale		Income group (low to high)	403,414	4.66	2.27	1	10
Community		Important in life, friends (very important to not at all important)	625,006	3.31	0.72	1	4
Children		Number of children	643,059	1.73	1.52	0	8
Personal activities		How much freedom of choice and control	637,267	6.90	2.34	1	10
Gender		Dummy: 1 = Female	659,023	0.53	0.50	0	1
Marital status	Divorce	Dummy: 1 = Divorced, widowed, and separated	657,185	0.13	0.34	0	1
	Single	Dummy: 1 = Single	657,185	0.24	0.43	0	1
Age		Age	658,299	42.96	16.91	13	108
Unemployment status		Dummy: 1 = Unemployment	648,927	0.09	0.28	0	1

Table 4. (*Continued*).

Variables		Description	Obs.	Mean	SD	Min	Max
Education level	Primary	Dummy: 1 = Primary school completed	464,734	0.33	0.47	0	1
	Secondary	Dummy: 1 = Secondary school completed	464,734	0.36	0.48	0	1
	University	Dummy: 1 = University completed	464,734	0.25	0.43	0	1
Protecting the Environment		Dummy: 1 = 'Protecting Environment'	416,913	0.54	0.50	0	1

The estimation model specification extends the model in previous studies (Blanchflower and Oswald, 2004; Ferrer-i-Carbonell and Gowdy, 2007; Ferreira et al., 2013; Fleche et al., 2012; Kang, 2010; Kang and Kim, 2012; Luechinger, 2010; Orru et al., 2016; Tella et al., 2003; Zhang et al., 2017a, 2017b). Equation (1) represents the individual utility assumption, which is based on personal and national factors. The following defines the SWB in terms of the feeling of happiness or life satisfaction for individual i and country j in year t.

$$SWB^*_{ijt} = W[U(X_{it}, E_{ijt}, E_{jt}, Z_{jt})] \quad (1)$$

where SWB^*_{ijt} is defined as a continuous latent variable that measures the level of the SWB, ranging from $-\infty$ to ∞. $U(\cdot)$ is a utility function and $W(\cdot)$ reflects SWB, which is converted from the utility function. X_{it} and Z_{jt} indicate the individual and country characteristics, respectively. Two environmental factors (E_{ijt}, E_{jt}) are considered where E_{ijt} is the individual perspective on the environment, and E_{jt} is the degree of environmental quality of country *j* where individual *i* lives.

Then, the estimation model specification is as follows.

$$SWB^*_{ijt} = \beta_0 + \beta_1 X_{it} + \beta_2 E_{ijt} + \beta_3 E_{jt} + \beta_4 Z_{jt} + w_i + w_j + w_t + \varepsilon_{ijt} \quad (2)$$

where β_0 is a constant and β_1, β_2, β_3 and β_4 are vectors of the parameters to be estimated. w_i, w_j and w_t are the individual-, country-, and time-specific dummy variables, respectively. Furthermore, ε_{ijt} is a stochastic error term. For simplicity, this study assumes that X and β are vectors of the explanatory variables and parameters, respectively, and $\omega = w_i + w_j + w_t$. Then, Equation (2) can be expressed as $SWB^*_{ijt} = X\beta + \omega + \varepsilon_{ijt}$.

The data are released through the index by ordinal categories, as shown in Equation (3).

$$SWB_{ijt} = k \; if \; \alpha_{k-1} < SWB^*_{ijt} \leq \alpha_k; \; k = 1,2,..M \quad (3)$$

where the cut-off points α_k from α_1 to α_{M-1} are estimated, and ks are discrete rank categories relevant to the SWB. Then the probability of observing $SWB_{ijt} = k$ can be measured by Equation (4).

$$\Pr(SWB_{ijt} = k) = F[\alpha_k - X\beta - \omega] - F[\alpha_{k-1} - X\beta - \omega] \quad (4)$$

Equation (4) measures the probability of $SWB_{ijt} = k$ when SWB^*_{ijt} lies between α_{k-1} and α_k, given other explanatory variables. $F(\bullet)$ means the cumulative distribution function of error terms.

Because of an ordinal discrete property of the dependent variable, an ordered probit model is estimated. The ordered probit model is well-suited as it accounts for the ordered nature of the dependent variable without assuming equal spacing between the categories. This model allows for a more precise estimation of how independent variables influence the probability of an observation falling into each ordered category. By using this model, we can capture the subtle variations in SWB that might be lost if a simpler linear regression or binary response model were used. Furthermore, The assumption of standard normal distributed error leads to the ordered probit model, which might be more flexible than the ordered logit model (Mahasuweerachai and Pangjai, 2017). Then, the marginal effect of an explanatory variable (X_{it}) is calculated by Equation (5).

$$\frac{\partial \Pr(SWB_{ijt}=k)}{\partial X_{it}} = \beta_i[f(\alpha_{k-1} - X\beta - \omega) - f(\alpha_k - X\beta - \omega)] \quad (5)$$

where $f(\bullet)$ is a probability density function.

To assess the model specification, Variance Inflation Factor (VIF), Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), and Likelihood Ratio Test (LR Test) were employed. To check for multicollinearity among the explanatory variables, VIF values were calculated (Marquardt, 1970). And AIC and BIC evaluate the goodness of fit and model complexity, respectively, and were utilized to confirm the appropriate model. Additionally, this study determined the best model between two nested models according to the LR test results.

4. Estimation results

Tables 5 and **6** present the estimation results for the feeling of happiness and life satisfaction, respectively. The models vary based on the combination of explanatory variables: national environmental factor (CO_2), individual characteristics, national characteristics, and personal perspectives on the environment and economic growth.

In **Table 5**, Models (1) and (2) present the OLS estimation results, while Models (3) and (4) show the ordered probit estimation results. Specifically, Model (1) examines the original Easterlin paradox in conjunction with individual characteristics. Model (2) extends Model (1) by incorporating additional national characteristics. Models (3) and (4) present the ordered probit estimation results, with Model (4) further including personal perspectives on the environment. All models include country and year effects, although these are not reported in the Tables.

First, the log of CO_2 emissions demonstrates a negative and statistically significant coefficient, implying that an increase in environmental pollution, as indicated by higher CO_2 levels, is associated with a decrease in the SWB across all model specifications. In contrast, the log of the GDP positively influences happiness except for Model (4), although the coefficients of the squared log of the GDP for Models (2) to (4) are not significant. Furthermore, the unemployment rate, one of the country-level characteristics, exhibits a statistically significant negative impact in Models (2) to (4). In Model (4), the coefficient for urban population appears positive.

Second, the impact of personal characteristics on happiness aligns with the findings from previous studies (Feleche et al., 2011; Ferreira et al., 2013; Kang, 2010; Laechinger, 2010; Tella et al., 2003; etc.). Positive correlations with happiness include

better health, higher income, making friends, having more children, greater freedom, being female, and employment. Conversely, factors such as income inequality, certain marital statuses (divorced, widowed, separated, and single), age, and higher than secondary school attainment negatively correlate with happiness. In particular, the coefficient for higher secondary education is presented to be significant negative, reflecting the future the uncertain or expectations employment and income (Clark and Oswald, 1996; Green, 2011; Nikolaev and Rusakov, 2015; Powdthavee, 2010; Shields et al., 2009).

Finally, from a personal perspective on the environmental quality in Model (4), there is a positive and significant coefficient related to SWB. This indicates a positive association between perceived environmental quality and SWB.

Table 5. Ordered probit estimation of the SWB and air pollution: The feeling of happiness.

	OLS		**Ordered Probit**	
	(1)	**(2)**	**(3)**	**(4)**
Log of CO_2	−0.092***	−0.055***	−0.075***	−0.154***
	(0.014)	(0.015)	(0.026)	(0.028)
Log of GDP	−0.088	0.165**	0.301**	0.079
	(0.078)	(0.082)	(0.144)	(0.152)
Squared Log of GDP	0.013***	−0.006	−0.014	−0.001
	(0.005)	(0.005)	(0.009)	(0.010)
Urban Population		0.001	0.002	0.009***
		(0.001)	(0.002)	(0.002)
Unemployment rate		−0.011***	−0.018***	−0.019***
		(0.001)	(0.001)	(0.001)
Healthy	0.256***	0.256***	0.447***	0.453***
	(0.002)	(0.002)	(0.004)	(0.004)
Income inequality	−0.005***	−0.006***	−0.010***	−0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
Income scale	0.027***	0.026***	0.046***	0.046***
	(0.001)	(0.001)	(0.001)	(0.001)
Community	0.061***	0.062***	0.110***	0.111***
	(0.002)	(0.002)	(0.004)	(0.004)
Children	0.004***	0.005***	0.008***	0.009***
	(0.001)	(0.001)	(0.002)	(0.002)
Personal activities	0.040***	0.039***	0.067***	0.064***
	(0.001)	(0.001)	(0.001)	(0.001)
Gender	0.067***	0.066***	0.118***	0.116***
(Dummy, Female=1)	(0.003)	(0.003)	(0.005)	(0.005)

Table 5. (*Continued*).

		OLS		Ordered Probit	
		(1)	**(2)**	**(3)**	**(4)**
Marital (Dummy)	Divorced	−0.194***	−0.195***	−0.326***	−0.331***
		(0.005)	(0.005)	(0.009)	(0.009)
	Single	−0.089***	−0.087***	−0.159***	−0.156***
		(0.004)	(0.004)	(0.008)	(0.008)
Age		0.001***	0.001***	0.001***	0.001***
		(0.000)	(0.000)	(0.000)	(0.000)
Unemployment Dummy)	status	−0.099***	−0.094***	−0.156***	−0.152***
		(0.005)	(0.005)	(0.009)	(0.010)
Education level (Dummy)	Primary	0.012*	0.008	0.013	0.007
		(0.006)	(0.006)	(0.011)	(0.012)
	Secondary	0.007	0.002	−0.000	−0.004
		(0.006)	(0.006)	(0.011)	(0.012)
	University	−0.012*	−0.016**	−0.033***	−0.038***
		(0.007)	(0.007)	(0.012)	(0.013)
Protecting the Environment					0.063***
(Dummy)					(0.005)
Observations		225,536	220,226	220,226	197,938
R-squared		0.262	0.265		

Note: 1) Robust standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.
2) Dependent variable is happiness (scale 1–4).
3) Results of constant, cut-off, country and year dummies are not reported.

Table 6 presents the estimation results for the other dependent variable, life satisfaction. The estimation results of most variables are consistent with those in Table 5. First, among national characteristics, the log of CO_2 emission is significantly and negatively related to life satisfaction. The log of GDP exhibits a statistically positive and significant impact across all models. Moreover, diverging from the results in **Table 5**, the squared log of GDP is negatively significant in models except Model (5). This indicates that there is an inverted U-shaped relationship between life satisfaction and income. A distinct national characteristic outcome in this table, compared to **Table 5**, is the negative influence of urban population density on life satisfaction.

At the individual level, Models (7) and (8) exhibit negative statistical significance except for primary-level education. This aligns with several studies which reported negative or insignificant effect of education on SWB (Clark and Oswald, 1996; Green, 2011; Nikolaev and Rusakov, 2015; Shields et al., 2009; Powdthavee, 2010). The underlying reasoning suggests that higher education often comes with elevated expectations regarding future employment and income, which, if unmet, may diminish happiness. Nikolaev and Rusakov (2015) suggested that the relationship between education and SWB depends on one's current age. Regarding environmental indicators, personal perspective on the environment exhibits a positive and significant correlation with life satisfaction in Model (8). Third, the estimation results of Model (8) indicate that respondents who prioritize environmental quality report higher levels

of SWB, and personal awareness related to environmental protection also influences SWB.

Table 6. Ordered probit estimation of SWB and air pollution: Life satisfaction.

		OLS		**Ordered Probit**	
		(5)	**(6)**	**(7)**	**(8)**
Log of CO_2		−0.467***	−0.259***	−0.117***	−0.165***
		(0.043)	(0.045)	(0.023)	(0.025)
Log of GDP		0.749***	1.933***	0.877***	0.777***
		(0.240)	(0.256)	(0.130)	(0.137)
Squared Log of GDP		−0.017	−0.090***	−0.042***	−0.037***
		(0.015)	(0.016)	(0.008)	(0.009)
Urban Population			−0.034***	−0.015***	−0.010***
			(0.003)	(0.002)	(0.002)
Unemployment rate			−0.018***	−0.010***	−0.011***
			(0.002)	(0.001)	(0.001)
Healthy		0.568***	0.567***	0.293***	0.295***
		(0.006)	(0.006)	(0.003)	(0.003)
Income inequality		−0.026***	−0.027***	−0.014***	−0.014***
		(0.002)	(0.002)	(0.001)	(0.001)
Income scale		0.144***	0.145***	0.069***	0.069***
		(0.002)	(0.002)	(0.001)	(0.001)
Community		0.103***	0.098***	0.051***	0.050***
		(0.006)	(0.007)	(0.003)	(0.004)
Children		0.007*	0.028***	0.005**	0.004**
		(0.004)	(0.004)	(0.002)	(0.002)
Personal activities		0.268***	0.266***	0.138***	0.136***
		(0.002)	(0.002)	(0.001)	(0.001)
Gender		0.194***	0.188***	0.101***	0.099***
(Dummy, Female = 1)		(0.009)	(0.009)	(0.004)	(0.005)
Marital (Dummy)	Divorced	−0.351***	−0.404***	−0.178***	-0.182***
		(0.015)	(0.015)	(0.008)	(0.008)
	Single	−0.106***	−0.237***	−0.053***	-0.053***
		(0.013)	(0.014)	(0.007)	(0.007)
Age		0.005***	−0.050***	0.003***	0.003***
		(0.000)	(0.002)	(0.000)	(0.000)
Unemployment status		−0.337***	−0.321***	−0.156***	−0.152***
(Dummy)		(0.016)	(0.016)	(0.008)	(0.009)

Table 6. (*Continued*).

		OLS		Ordered Probit	
		(5)	**(6)**	**(7)**	**(8)**
Education level (Dummy)	Primary	0.020	0.020	−0.003	-0.004
		(0.020)	(0.020)	(0.010)	(0.011)
	Secondary	−0.034*	−0.006	−0.039***	-0.039***
		(0.020)	(0.020)	(0.010)	(0.011)
	University	−0.047**	−0.005	−0.056***	-0.057***
		(0.021)	(0.021)	(0.011)	(0.012)
Protecting the Environment					0.051***
(Dummy)					(0.005)
Observations		226,307	220,988	220,988	198,502
R-squared		0.322	0.327		

Note: 1) Robust standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.
2) Dependent variable is life satisfaction level (scale 1–10).
3) Results of constant, cut-off, country and year dummies are not reported.

Table 7 presents the average marginal effects of country-level air pollutants and income on SWB based on the empirical analyses in columns (4) and (8) of **Tables 5** and **6**, respectively. These values indicate the probability of responding to the SWB category when the explanatory variable increases by one unit. The variables for national and individual characteristics are all considered average except for the variables expressed as air pollution or national income. The models are estimated for two groups: all respondents and those respondents who emphasize "protecting the environment."

The following results in **Table 7** display the marginal probability effects (MPE) of the log of CO_2 and the log of GDP on the feeling of happiness as the SWB. For respondents who consider environmental protection crucial, a negative coefficient is observed for the log of CO_2. This suggests a positive marginal effect for the first three respondents and a negative effect for the final group "Very happy." For example, the interpretation of the SWB in full dataset, $MPE_{1,\log(CO_2)} = 0.004$ implies that the probability of happiness = 1 (Not at all happy) increases as CO_2 level rises. Conversely, $MPE_{4,\log(CO_2)} = -0.050$ indicates a decreased probability of happiness = 4 (Very happy) as CO_2 level rises. Furthermore, the coefficient of "protecting the environment" is −0.078, surpassing the −0.050 observed across all respondents. In contrast, the marginal effects of the log of GDP are predominantly positive. For instance, among all respondents, the coefficient of approximately 0.026, although not statistically significant, when $H_{ijt} = 4$ (Very happy) suggests that higher GDP per capita is associated with an increased probability of this highest happiness level. Interestingly, the results for the group prioritizing environmental protection demonstrate contrary results.

Moreover, the marginal effects on SWB and life satisfaction are as follows. Focusing on the group that prioritizes environmental concerns, we observe notable trends. Specifically, a one-unit increase in the log of CO_2 leads to a 0.009 increase in the probability of belonging to the group reporting complete dissatisfaction with life

(i.e., both group 1). However, the sign of marginal probability reverses for higher satisfaction groups. Notably, for groups 7 and 8, where the switching point is $H_{ijt} \geq 7$ and $H_{ijt} \geq 8$, respectively, the marginal probability turns negative. This shift results in the probability of being "completely satisfied ($H_{ijt} = 10$)" decreasing by -0.036 and -0.041. Furthermore, the marginal effects of the log of GDP exhibit an intriguing pattern. For groups indicating lower levels of life satisfaction ($1 \leq H_{ijt} \leq 6$ and $1 \leq H_{ijt} \leq 7$), the marginal effects are negative, however, these effects become positive at and beyond the switching points of $H_{ijt} \geq 7$ and $H_{ijt} \geq 8$. For the group expressing complete satisfaction ($H_{ijt} = 10$), the ratio of the log of CO_2 to the log GDP is 0.480 among all respondents. This ratio increases to 0.760 for respondents who prioritize "Protecting the Environment." This suggests that the ratio of the marginal effect of CO_2 and GDP is more pronounced among those who emphasize environmental protection.

Table 7. Marginal probability effects of CO_2 and GDP.

		Happiness										
		1 Not at all happy			**2 Not very happy**			**3 Quite happy**			**4 Very happy**	**Obs.**
Full	Log CO_2	0.004***			0.029***			0.017***			−0.050***	197,938
	Log GDP	−0.002			−0.015			−0.009			0.026	
Environment	Log CO_2	0.005***			0.040***			0.033***			−0.078***	101,065
	Log GDP	0.008*			0.069*			0.057*			−0.074*	
		Life Satisfaction										
		1	2	3	4	5	6	7	8	9	10	Obs.
		Dissatisfied----------									Satisfied	
Full	Log CO_2	0.009***	0.009***	0.015***	0.017***	0.030***	0.012***	−0.002***	−0.029***	−0.026***	−0.036***	199,423
	Log GDP	−0.020***	−0.018***	−0.031***	−0.035***	−0.064***	−0.026***	0.004***	0.060***	0.054***	0.075***	
Environment	Log CO_2	0.009***	0.008***	0.014***	0.017***	0.033***	0.016***	0.002***	−0.028***	−0.029***	−0.041***	102,078
	Log GDP	−0.011*	−0.011*	−0.019*	−0.022*	−0.043*	−0.020*	−0.003*	0.037*	0.037*	0.054*	

Note: 1) Robust standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.
2) Independent variables include all independent variables of Models 4 and 8.

5. Robustness tests of the estimation results

Tables 8 and **9** present robustness test results, benchmarking against the model specifications of Models (4) and (8) for further analysis. The robustness of the estimation results is investigated by considering additional air pollutants (**Table 8**) and various grouping of samples (**Table 9**). **Table 8** demonstrates the estimation results that include disaggregated components of air pollutants. In addition to CO_2, other GHG emissions (CH_4, N_2O) and PM 2.5 are considered. The estimation results show

that other non-CO_2 air pollutants such as CH4 and PM 2.5 also have a negative effect on the SWB.

Notably, most air pollutants negatively affect the SWB, and the log of GDP displays a U-shaped non-linear relationship with SWB. Regarding happiness, the coefficients for all environmental indicators, except for the log of N_2O, are statistically significant and negative. Furthermore, for life satisfaction, all environmental indicators show negative and significant coefficients. Moreover, personal perspective on "protecting the environment" is statistically significant and positive across all models in **Table 8**. This implies that individuals who prioritize environment protection tend to have a higher SWB compared to those who answered, "economic growth is more important."

Table 8. Ordered probit estimation of SWB and air pollution: different air pollutants.

Feeling of Happiness	**Log of CO_2**	**Log of CH_4**	**Log of N_2O**	**Log of PM2.5**
Air pollution	−0.154***	−0.229***	−0.018	−1.087***
	(0.028)	(0.031)	(0.032)	(0.141)
Log of GDP	0.079	0.028	−0.073	3.273***
	(0.152)	(0.149)	(0.151)	(0.431)
Squared Log of GDP	−0.001	0.001	0.005	−0.223***
	(0.010)	(0.010)	(0.010)	(0.030)
Protecting the Environment	0.063***	0.062***	0.062***	0.023***
(Dummy)	(0.005)	(0.005)	(0.005)	(0.008)
Observations	197,938	197,938	197,938	97,020
Life Satisfaction	**Log of CO_2**	**Log of CH_4**	**Log of N_2O**	**Log of Other**
Air pollution	−0.165***	−0.082***	−0.250***	−1.412***
	(0.025)	(0.028)	(0.028)	(0.131)
Log of GDP	0.777***	0.635***	0.884***	2.524***
	(0.137)	(0.137)	(0.138)	(0.404)
Squared Log of GDP	−0.037***	−0.030***	−0.044***	−0.160***
	(0.009)	(0.009)	(0.009)	(0.028)
Protecting the Environment	0.051***	0.050***	0.050***	0.028***
(Dummy)	(0.005)	(0.005)	(0.005)	(0.007)
Observations	198,502	198,502	198,502	97,283

Note: 1) Robust standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.
2) the results of log of CO_2 are the results of Models (4) and (8), and the results of CH_4, N_2O, and PM2.5 are analyzed by replacing the pollutant variables in Models (4) and (8) with the corresponding pollutants.

As a second robustness test, **Table 9** presents the estimation results categorized by respondents' personal perspectives, income scales, education levels, health statuses, age and gender group. First, in Model A, respondents are divided into two groups based on their personal perspectives: all respondents and respondents prioritizing "protecting the environment." Across all groups, the effect of the log of CO_2 on SWB is consistently negative. However, the impact of the GDP varies according to individual characteristics. The log of CO_2 is negatively associated with both SWB measures for all groups, whereas the log of GDP exhibits a positive

relationship with SWB, except in the context of "feeling of happiness" within the environmental group. In addition, those who responded that "protecting the environment is more important" appear more sensitive to changes in CO_2 emissions.

Second, Model B categorizes households into four income brackets based on the 11 groups in the raw data. These include the lowest income group (combing the first two income levels, 1 and 2), lower-middle (3, 4, 5), upper-middle (6, 7, 8) and high (9, 10, 11) income groups (Due to the non-continuous measure of the income, the willingness to pay (WTP) from the estimation results is not calculated). The log of CO_2 shows a significant negative effect in all groups except for the highest income brackets of "feeling of happiness" and the lowest and highest income brackets of "Life satisfaction". When focusing on environmental prioritization, a positive coefficient is observed across all income groups, albeit with varying magnitudes. Moreover, log of GDP coefficient for the low-income group is negative, contrary to the positive coefficients in the other three income categories.

Third, in Model C, respondents are segmented by education level: those with less than secondary and those with more or equal to secondary education. When the dependent variable is "feeling of happiness", the log of CO_2 coefficients for the less-educated group are significantly negative, possibly reflecting limited access to air quality information (Levinson, 2012; Zhang et al., 2017b). Conversely, when life satisfaction is considered as the dependent variable, the effects of air pollutants are uniformly negative across all educational levels, underscoring that these environmental factors adversely affect life satisfaction regardless of education. This suggests that the impact of air pollutants on SWB can vary significantly along different dimensions of well-being. In addition, a higher education level correlates with an increased SWB when considering environmental protection perspectives.

Fourth, Model D examines the effect of personal health status on SWB. Across most health categories, the log of CO_2 displays a negative coefficient, with the exception of among those in poor health. Conversely, life satisfaction groups exhibit a positive coefficient for the log of GDP except for poor health groups, and the opposite results for the square Log of GDP, indicating a non-linear relationship. From the personal perspective of environmental protection, this study finds that SWB varies by individual health status and perspective toward environmental protection.

Fifth, Model E classifies the age groups such as individuals under 25 years old, between 24 and 65 years, and over 65 years. The log of CO_2 is significantly negative with the exception of the "feeling of happiness" among those 65 years or older. This implies environmental problems were an important factor in happiness for the younger and middle-aged, and life satisfaction for the elderly. In terms of income, it increased the happiness of the elderly, but the effect decreased above a certain level, while income improved the overall life satisfaction of all age groups, and the effect decreased above a certain level. Perception of environmental protection has a positive effect on both happiness and life satisfaction, especially in young and middle-aged people.

Finally, as can be seen from Model F, log CO_2 had a negative effect on both happiness and life satisfaction in the case of gender. Log of GDP had a significant positive effect on life satisfaction, but the effect of economic growth above a certain level on increasing happiness and life satisfaction diminished. Environmental

protection has a positive effect on all groups, showing that environmental awareness is an important factor in promoting well-being in terms of gender. Overall, the results of these robustness tests align with the main estimation findings, confirming their reliability and validity.

Table 9. Ordered probit estimation of SWB and air pollution: Sample regrouping.

Model A: Personal perspectives				
	Feeling of Happiness		**Life satisfaction**	
	Total	**Environment**	**Total**	**Environment**
Log of CO_2	−0.154***	−0.231***	−0.165***	−0.180***
	(0.028)	(0.041)	(0.025)	(0.035)
Log of GDP	0.079	−0.399*	0.777***	0.582***
	(0.152)	(0.221)	(0.137)	(0.198)
Squared Log of GDP	−0.001	0.032**	−0.037***	−0.026**
	(0.010)	(0.014)	(0.009)	(0.013)
Protecting the Environment	0.063***	-	0.051***	-
(Dummy)	(0.005)	-	(0.005)	-
Observation	197,938	101,065	198,502	101,300

Model B: Income scale								
	Feeling of Happiness				**Life satisfaction**			
	Low	**Lower Middle**	**Upper Middle**	**High**	**Low**	**Lower Middle**	**Upper Middle**	**High**
Log of CO_2	0.139**	−0.203***	−0.284***	0.063	−0.012	−0.182***	−0.132***	−0.199
	(0.070)	(0.043)	(0.059)	(0.176)	(0.062)	(0.038)	(0.051)	(0.142)
Log of GDP	−1.604***	0.586***	0.095	1.645*	−0.992***	0.824***	0.735***	3.445***
	(0.362)	(0.222)	(0.305)	(0.957)	(0.340)	(0.202)	(0.273)	(0.816)
Squared Log of GDP	0.110***	−0.027*	−0.002	−0.111*	0.072***	−0.034***	−0.029*	−0.202***
	(0.023)	(0.014)	(0.019)	(0.061)	(0.022)	(0.013)	(0.017)	(0.052)
Protecting the Environment	0.075***	0.061***	0.053***	0.054**	0.084***	0.056***	0.025***	0.037*
(Dummy)	(0.012)	(0.008)	(0.010)	(0.023)	(0.011)	(0.007)	(0.009)	(0.020)
Observation	36,654	88,096	60,992	12,196	36,734	88,432	61,102	12,234

Model C: Education				
	Feeling of Happiness		**Life satisfaction**	
	Less secondary attained	**More secondary attained**	**Less secondary attained**	**More secondary attained**
Log of CO_2	−0.295***	0.039	−0.135***	−0.158***
	(0.048)	(0.037)	(0.042)	(0.032)
Log of GDP	−0.145	−0.120	0.694***	0.492***
	(0.276)	(0.191)	(0.251)	(0.172)
Squared Log of GDP	0.010	0.007	−0.036**	−0.019*
Protecting the Environment	(0.017)	(0.012)	(0.016)	(0.011)
(Dummy)	0.051***	0.070***	0.045***	0.056***
	(0.009)	(0.007)	(0.008)	(0.006)
Observation	73,378	124,560	73,481	125,021

Table 9. (*Continued*).

Model D: Health status						
	Feeling of Happiness			**Life satisfaction**		
	Bad	**Fair**	**Good**	**Bad**	**Fair**	**Good**
Log of CO_2	−0.052	−0.212***	−0.126***	0.071	−0.396***	−0.075**
	(0.115)	(0.056)	(0.036)	(0.104)	(0.050)	(0.031)
Log of GDP	−0.273	−0.178	−0.034	1.013*	0.777***	0.733***
	(0.558)	(0.281)	(0.198)	(0.531)	(0.259)	(0.176)
Squared log of GDP	0.032	0.020	0.005	−0.048	−0.034**	−0.035***
	(0.036)	(0.018)	(0.013)	(0.034)	(0.017)	(0.011)
Protecting the Environment	0.058***	0.066***	0.062***	0.052***	0.063***	0.048***
(Dummy)	(0.020)	(0.010)	(0.007)	(0.019)	(0.009)	(0.006)
Observation	12,232	50,129	135,577	12,339	50,472	135,691
Model E: Age group						
	Feeling of Happiness			**Life satisfaction**		
	age < 25	**24 < age< 65**	**65+**	**age < 25**	**24 < age < 65**	**65+**
Log of CO_2	−0.154***	−0.165***	−0.146	−0.165***	−0.169***	−0.256***
	(0.028)	(0.030)	(0.103)	(0.025)	(0.026)	(0.094)
Log of GDP	0.079	−0.074	1.385***	0.777***	0.556***	2.743***
	(0.152)	(0.160)	(0.530)	(0.137)	(0.144)	(0.496)
Squared log of GDP	−0.001	0.009	−0.086**	−0.037***	−0.024**	−0.145***
	(0.010)	(0.010)	(0.035)	(0.009)	(0.009)	(0.033)
Protecting the Environment	0.063***	0.069***	0.031*	0.051***	0.056***	0.024
(Dummy)	(0.005)	(0.006)	(0.017)	(0.005)	(0.005)	(0.016)
Observation	197,938	179,477	18,461	198,502	179,969	18,533
Model F: Gender						
	Feeling of Happiness			**Life satisfaction**		
	Female	**Male**		**Female**	**Male**	
Log of CO_2	−0.174***	−0.127***		−0.150***	−0.177***	
	(0.040)	(0.040)		(0.035)	(0.035)	
Log of GDP	0.230	−0.043		1.040***	0.519***	
	(0.217)	(0.214)		(0.197)	(0.194)	
Squared log of GDP	−0.008	0.003		−0.053***	−0.022*	
	(0.014)	(0.014)		(0.013)	(0.012)	
Protecting the Environment	0.056***	0.069***		0.043***	0.058***	
(Dummy)	(0.007)	(0.007)		(0.007)	(0.007)	
Observation	99,431	98,507		99,675	98,827	

Note: 1) Robust standard errors are in parenthesis *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.
2) The independent variables are the same as those of Models (4) and (8) and are not reported.
3) The results of cut-off, country, and year dummies are not reported.

6. Conclusion

An increase in energy consumption due to the population and economic growth results in substantial GHG emissions, which affect the individual's health and thus

happiness and life satisfaction. This study makes a significant academic contribution by integrating individual-level perceptions and country-level environmental indicators to assess their combined effect on SWB, which is measured in terms of feeling of happiness and life satisfaction. Unlike previous works that primarily focused on either individual perspectives or aggregate national data, this research bridges both dimensions across 118 countries over nearly four decades. Moreover, environmental factors are classified into individual perspectives on the environment and the national level of CO_2 emissions.

The results derived from both OLS and ordered probit estimation results affirm that the effects of most explanatory variables on SWB align with existing literature. Significantly, environmental factors exert a notable influence on SWB. Higher national levels of CO_2 are found to reduce SWB, while a personal inclination towards protecting the environment positively impacts SWB. These results are robust to various estimation model specifications.

Compared to the past, when GDP growth was prioritized as a marker of national progress, there is now a shift towards recognizing the importance of quality of life and well-being. This study makes a substantial contribution to existing literature by elucidating the role of individual perceptions and attitudes towards the environment in shaping personal happiness. Acknowledging variations across different nations, it demonstrates that environmental indicators such as CO_2 emissions negatively and statistically correlate with SWB. This finding points to the urgent need for enhancing environmental protection and advocating for climate action as vital measures to improve individual SWB. Policymakers aiming to enhance public well-being must recognize that environmental quality is an essential determinant of happiness and life satisfaction. Therefore, this study underscores the necessity for integrating environmental protection measures into economic and urban planning policies to mitigate the negative impact of pollution. Moreover, promoting environmental awareness among individuals can play a critical role in shaping sustainable development policies, as the data suggest that those who value environmental protection are more resilient to pollution's detrimental effects on SWB.

The robustness tests involving the reclassification of the sample into four distinct respondent groups—based on views on the environment versus economic growth, income level, education level, health status, age group, and gender—highlight several important policy considerations. First, individuals who prioritize environmental protection over economic growth are shown to be more sensitive to environmental quality. This finding suggests that public policies should not only target pollution reduction but also promote environmental education and awareness to align individual values with sustainable practices. Second, the varying impact of environmental factors across different income and education levels implies that targeted policies are necessary to address disparities. For lower-income or less-educated populations, policies that provide better access to environmental information and support sustainable behaviors could mitigate the adverse effects of pollution. Third, the differences in responses based on health status emphasize the importance of health-centric environmental policies that protect the most vulnerable groups, thereby improving their well-being. Fourth, the environmentalism boosts pleasure and life satisfaction, particularly in young and middle-aged adults. Lastly, Environmental

protection benefits all genders, demonstrating that environmental knowledge promotes gender well-being.

By addressing these findings, this research not only contributes to the broader literature on the intersections between environmental quality and well-being, but also provides actionable insights for policymakers striving to balance economic growth, environmental sustainability, and individual happiness.

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Appendix

This study encompasses data across seven waves, from Wave 1 (1981–1984) to Wave 7 (2017–2022). The initial Wave covered 25 countries with 29,685 respondents, whereas the latest Wave expanded to include 90 countries and 153,716 respondents. **Table A1** presents the list of countries and the corresponding number of respondents for each Wave.

Table A1. Distribution of respondents by country of the IVS.

	Wave1 (81–84)	**Wave2 (90–94)**	**Wave3 (95–98)**	**Wave4 (99–04)**	**Wave5 (05–09)**	**Wave6 (10–14)**	**Wave7 (17–22)**	**Total**
ALB	0	0	999	1,000	1,534	0	1,435	4,968
AND	0	0	0	0	1,003	0	1,004	2,007
ARG	1,005	1,002	1,079	1,280	1,002	1,030	1,003	7,401
ARM	0	0	2,000	0	1,500	1,100	2,723	7,323
AUS	1,228	0	2,048	0	1,421	1,477	1,813	7,987
AUT	0	1,460	0	1,522	1,510	0	1,644	6,136
AZE	0	0	2,002	0	0	1,002	1,800	4,804
BEL	1,145	2,792	0	1,912	1,509	0	0	7,358
BFA	0	0	0	0	1,534	0	0	1,534
BGD	0	0	1,525	1,500	0	0	1,200	4,225
BGR	0	1,034	1,072	1,000	2,501	0	1,558	7,165
BIH	0	0	1,200	1,200	1,512	0	1,724	5,636
BLR	0	1,015	2,092	1,000	1,500	1,535	1,548	8,690
BOL	0	0	0	0	0	0	2,067	2,067
BRA	0	1,782	1,143	0	1,500	1,486	1,762	7,673
CAN	1,254	1,730	0	1,931	2,164	0	4,018	11,097
CHE	0	1,400	1,212	0	2,512	0	3,174	8,298
CHL	0	1,500	1,000	1,200	1,000	1,000	1,000	6,700
CHN	0	1,000	1,500	1,000	1,991	2,300	3,036	10,827
COL	0	0	6,025	0	3,025	1,512	1,520	12,082
CY-TCC	0	0	0	0	500	0	0	500
CYP	0	0	0	0	2,050	1,000	1,000	4,050
CZE	0	3,033	1,147	1,908	1,821	0	3,011	10,920
DEU	1,305	3,437	2,026	2,036	4,139	2,046	3,698	18,687
DNK	1,182	1,030	0	1,023	1,507	0	3,362	8,104
DOM	0	0	417	0	0	0	0	417
DZA	0	0	0	1,282	0	1,200	0	2,482
ECU	0	0	0	0	0	1,202	1,200	2,402
EGY	0	0	0	3,000	3,051	1,523	1,200	8,774
ESP	2,303	4,147	1,211	2,409	2,700	1,189	1,209	15,168
EST	0	1,008	1,021	1,005	1,518	1,533	1,304	7,389
ETH	0	0	0	0	1,500	0	1,230	2,730
FIN	1,003	588	987	1,038	2,148	0	1,199	6,963
FRA	1,200	1,002	0	1,615	2,502	0	1,870	8,189

Table A1. (*Continued*).

	Wave1 (81–84)	Wave2 (90–94)	Wave3 (95–98)	Wave4 (99–04)	Wave5 (05–09)	Wave6 (10–14)	Wave7 (17–22)	Total
GB-NIR	312	304	0	1,000	500	0	447	2,563
GBR	1,167	1,484	1,093	1,000	2,602	0	4,397	11,743
GEO	0	0	2,008	0	3,000	1,202	2,194	8,404
GHA	0	0	0	0	1,534	1,552	0	3,086
GRC	0	0	0	1,142	1,500	0	1,200	3,842
GTM	0	0	0	0	1,000	0	1,229	2,229
HKG	0	0	0	0	1,252	1,000	2,075	4,327
HRV	0	0	1,196	1,003	1,525	0	1,487	5,211
HTI	0	0	0	0	0	1,996	0	1,996
HUN	1,464	999	650	1,000	2,520	0	1,514	8,147
IDN	0	0	0	1,000	2,015	0	3,200	6,215
IND	0	2,500	2,040	2,002	2,001	4,078	0	12,621
IRL	1,217	1,000	0	1,012	1,013	0	0	4,242
IRN	0	0	0	2,532	2,667	0	1,499	6,698
IRQ	0	0	0	2,325	2,701	1,200	1,200	7,426
ISL	927	702	0	968	808	0	1,624	5,029
ISR	0	0	0	1,199	0	0	0	1,199
ITA	1,348	2,018	0	2,000	2,531	0	2,277	10,174
JOR	0	0	0	1,223	1,200	1,200	1,203	4,826
JPN	1,204	1,011	1,054	1,362	1,096	2,443	1,353	9,523
KAZ	0	0	0	0	0	1,500	1,276	2,776
KEN	0	0	0	0	0	0	1,266	1,266
KGZ	0	0	0	1,043	0	1,500	1,200	3,743
KOR	970	1,251	1,249	1,200	1,200	1,200	1,245	8,315
KWT	0	0	0	0	0	1,303	0	1,303
LBN	0	0	0	0	0	1,200	1,200	2,400
LBY	0	0	0	0	0	2,131	1,196	3,327
LTU	0	1,000	1,009	1,018	1,500	0	1,448	5,975
LUX	0	0	0	1,211	1,610	0	0	2,821
LVA	0	903	1,200	1,013	1,506	0	1,335	5,957
MAC	0	0	0	0	0	0	1,023	1,023
MAR	0	0	0	1,251	1,200	1,200	1,200	4,851
MDA	0	0	984	1,008	2,597	0	0	4,589
MDV	0	0	0	0	0	0	1,039	1,039
MEX	1,837	1,531	1,510	1,535	1,560	2,000	1,741	11,714
MKD	0	0	995	1,055	1,500	0	1,117	4,667
MLI	0	0	0	0	1,534	0	0	1,534
MLT	467	393	0	1,002	1,500	0	0	3,362
MMR	0	0	0	0	0	0	1,200	1,200
MNE	0	0	240	1,060	1,516	0	1,003	3,819

Table A1. (*Continued*).

	Wave1 (81–84)	Wave2 (90–94)	Wave3 (95–98)	Wave4 (99–04)	Wave5 (05–09)	Wave6 (10–14)	Wave7 (17–22)	Total
MNG	0	0	0	0	0	0	1,638	1,638
MYS	0	0	0	0	1,201	1,300	1,313	3,814
NGA	0	1,001	1,996	2,022	0	1,759	1,237	8,015
NIC	0	0	0	0	0	0	1,200	1,200
NLD	1,221	1,017	0	1,003	2,604	1,902	4,549	12,296
NOR	1,051	1,239	1,127	0	2,115	0	1,122	6,654
NZL	0	0	1,201	0	954	841	1,057	4,053
PAK	0	0	733	2,000	0	1,200	1,995	5,928
PER	0	0	1,211	1,501	1,500	1,210	1,400	6,822
PHL	0	0	1,200	1,200	0	1,200	1,200	4,800
POL	0	1,920	1,153	1,095	2,510	966	1,352	8,996
PRI	0	0	1,164	720	0	0	1,127	3,011
PRT	0	1,185	0	1,000	1,553	0	1,215	4,953
PSE	0	0	0	0	0	1,000	0	1,000
QAT	0	0	0	0	0	1,060	0	1,060
ROU	0	1,103	1,239	1,146	3,265	1,503	2,870	11,126
RUS	0	1,961	2,040	2,500	3,537	2,500	3,635	16,173
RWA	0	0	0	0	1,507	1,527	0	3,034
SAU	0	0	0	1,502	0	0	0	1,502
SGP	0	0	0	1,512	0	1,972	2,012	5,496
SLV	0	0	1,254	0	0	0	0	1,254
SRB	0	0	1,280	1,200	2,732	0	2,545	7,757
SVK	0	1,602	1,095	1,331	1,509	0	2,632	8,169
SVN	0	1,035	1,007	1,006	2,403	1,069	1,075	7,595
SWE	954	1,047	1,009	1,015	2,190	1,206	1,194	8,615
THA	0	0	0	0	1,534	1,200	1,500	4,234
TJK	0	0	0	0	0	0	1,200	1,200
TTO	0	0	0	0	1,002	999	0	2,001
TUN	0	0	0	0	0	1,205	1,208	2,413
TUR	0	1,030	1,907	4,607	3,730	1,605	2,415	15,294
TWN	0	0	780	0	1,227	1,238	1,223	4,468
TZA	0	0	0	1,171	0	0	0	1,171
UGA	0	0	0	1,002	0	0	0	1,002
UKR	0	0	2,811	1,195	2,507	1,500	2,901	10,914
URY	0	0	1,000	0	1,000	1,000	1,000	4,000
USA	2,325	1,839	1,542	1,200	1,249	2,232	2,596	12,983
UZB	0	0	0	0	0	1,500	0	1,500
VEN	0	0	1,200	1,200	0	0	1,190	3,590
VNM	0	0	0	1,000	1,495	0	1,200	3,695
XKX	0	0	0	0	1,601	0	0	1,601

Table A1. (*Continued*).

	Wave1 (81–84)	Wave2 (90–94)	Wave3 (95–98)	Wave4 (99–04)	Wave5 (05–09)	Wave6 (10–14)	Wave7 (17–22)	Total
YEM	0	0	0	0	0	1,000	0	1,000
ZAF	1,596	2,736	2,935	3,000	2,988	3,531	0	16,786
ZMB	0	0	0	0	1,500	0	0	1,500
ZWE	0	0	0	1,002	0	1,500	1,215	3,717
Total	29,685	62,771	77,818	100,155	150,255	89,565	153,716	663,965

Source: Authors' calculation based on EVS and WVS Database.