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Interest in the Biosphere and Environmental Awareness and Optimism among Students: A Seemingly Unrelated Bivariate Weighted Ordered Probit Modeling with Country Fixed Effects

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Abstract

This study inscribes itself in the global discussion on the nurturing of pro-environmental behaviors among young people for a sustainable future. Here we focus on students' interest in Ecosystem Services and Sustainability to explain their awareness and optimism about the environmental issues of air pollution, water shortage and green gas emission in 50 countries around the world. To this end, we use the cross-sectional survey data of the OECD's Program for International Student Assessment (PISA) 2015, along with seemingly unrelated bi-variate weighted ordered Probit modeling with country specific effects.

The results show that in addition to factors such as age, gender, immigration status, and economic, social and cultural status, interest in the biosphere is a significant determinant of students' environmental awareness and optimism. In fact, a one level increase in students' interest in ecosystem services and sustainability raises on average their awareness level by 15.3% for the issue of air pollution, 15.7% for the issue of water shortage, and 24.6% for the issue of green gas emission. Although students' interest in the biosphere seems to not have a significant effect on their expectations about the issue of green gas emission, it does however raise their level of optimism by 0.8% for the issue of air pollution, and 0.2% for the issue of water shortage. Furthermore, every one level increase in students' environmental awareness leads to 17.3% more optimism about the issue of air pollution, 15.8% more optimism about the issue of water shortage, and 17.4% more optimism about the issue of green gas emission. Therefore, relying on the Theory of Planned Behavior (TPB), our results imply that governments and policy makers can successfully leverage young people interests in the biosphere to effectively achieve their goals for sustainability.

Keywords: Air Pollution, Environmental Awareness, Environmental Education, Green Gas Emission, Sustainable Development, Water Shortage
JEL: D83, D84, P5, Q01, Q5

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1. Introduction

It was at the first United Nations Conference on the Human Environment held in Stockholm in 1972 that a call was made for the development of a collective consciousness of environmental problems. This conference was held after the publication of the Meadows report on "the limits to the growth" which identified the risks to ecological balances (Meadows et al., 1972). From 1972 to the present day, the international community has continued to address the major environmental concerns(Harper et al., 2017), with the Conferences of the Parties (COPs) successively drawing the world's attention to the impacts of human activities on the planet(Watson et al., 1998; Wirth, 2002; Bodansky, 2010). As the bearers of the burden of past and current negligence towards the environment, young people have been identified as critical stakeholders in sustainability initiatives such as those embraced under the UN 2030 Agenda (De Leeuw et al., 2015). Understanding what motivates pro-environmental behavior (PEB) among this group is therefore of the utmost interest to policy makers and governments alike, in their quest for a sustainable economic development.

Some of the major environmental issues resulting from direct and indirect anthropogenic perturbation of the biosphere include air pollution (Akimoto, 2003) caused by emissions of carbon dioxide, carbon monoxide, oxides of nitrogen and sulfur, and results in soil acidification and the development of cancerous diseases(Anenberg et al., 2010; Lelieveld et al., 2015; Cohen et al., 2017).The most visible consequences of the greenhouse gas emissions are global warming and climate change (Buchspies and Kaltschmitt, 2018; Quam et al., 2017). Indeed, the atmospheric concentration of well-mixed greenhouse gases such as carbone dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), has increased respectively to a global abundances of 400 ppm, 1845 ppb and 328.1 ppb for CO_2, CH_4, and N_2O in 2015, from their respective pre-industrial revolution concentrations of 278 ppm, 700 ppb, and 270 ppb(Ussiri and Lal, 2017).

Added to this issue is that of water pollution (Mekonnen and Hoekstra, 2018), which comes from numerous human activities including agriculture, industrial activity, fishing and mismanagement of plastic waste (Hounslow, 2018); And soils pollution caused by the practice of intensive agriculture, mono-culture, deep plowing, and the massive use of pesticides and fertilizers which destroy the soil micro-biology (Saha et al., 2017). In addition, there is over-exploitation of non-renewable resources and the clearing of forest areas whose major ecological role is carbon sequestration (Ussiri and Lal, 2017).

These environmental issues are, by nature, problems that call for interdisciplinary approaches(Howarth and Monasterolo, 2017). By their often complex nature, they summon not only the natural and physical sciences for their explanation, but also the social sciences for the description of their interactions with human activities (Kollmuss and Agyeman, 2002; Wells et al., 2016). The use of complementary disciplines makes it possible to explain the various facets of these problems using different theories and methods (De Leeuw et al., 2015; Stern, 2000). For example, using an integrated cross-cultural ecologic-economic approach Niankara (2018) reports on the role that

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scientific media consumption play in students' awareness and expectations about the environmental issues of deforestation and species extinction in the Middle East and North America. Our current paper inscribes itself in the same dynamic of students' environmental awareness and optimism, but now extends the analysis to a worldwide scope, and covering the environmental issues of air pollution, water shortage and green gas emission, which to the best of our knowledge have not yet been specifically addressed in the scientific discourse. To this end, we use the cross-sectional survey data of the OECD's Program for International Student Assessment (PISA) 2015, along with seemingly unrelated bi-variate weighted ordered probit modeling techniques. The general question we seek to answer is:

How do students' interests in the biosphere affect their environmental awareness and expectation worldwide?

More specifically,

How do students' interests in ecosystem services and sustainability affect their awareness and optimism about the environmental issues of air pollution, water shortage and green gas emission worldwide?

In order to answer this question, we organize the rest of the paper as follows; section 2 provides a background discussion on environmental awareness and attitude; section 3 presents the methods used to answer the questions, by first describing the data, then the variables used in the analysis, and ending with the econometric model; section 4 presents the results, while section 5 discusses and concludes the analysis.

2. Background

2.1. United Nations system-wide vision on the environment

The global vision on the environment is based primarily on the Sustainable Development Goals (SDGs), which are 17 in number. Goal 6 focuses on water resource management, taking into account the quality and sustainability of water resources, which are essential for the survival of people and the planet. The 2030 Agenda recognizes the centrality of water resources for sustainable development and the vital role of improved drinking water, sanitation and hygiene in advancing progress in other areas, including health, education and poverty reduction. Goal 7 focuses on access to reliable, sustainable and modern energy services for all at an affordable cost. Goal 9 highlights the need to build a resilient infrastructure, promote sustainable industrialization that benefits everyone and encourages innovation. Added to this is the need for sustainable consumption and production patterns (Goal 12). In fact, sustainable growth and development require minimizing the use of natural resources and toxic materials, as well as the waste and pollutants generated, throughout the production and consumption process. Finally, Goals 13, 14 and 15 address climate change and its impacts, sustainable ocean conservation and sustainable management of terrestrial ecosystems, forests, soils and biodiversity, respectively.

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2.2. Environmental Awareness, Attitude and Behavior

In recent decades, much research has been done to identify factors that positively or negatively influence environmental behavior (Stern, 2000; Kollmuss and Agyeman, 2002; Bamberg and Möser, 2007; Osbaldiston and Schott, 2012; Gifford and Nilsson, 2014; De Leeuw et al., 2015). Factors other than environmental knowledge have gradually been introduced to explain the changing behavior of individuals in relation to the environment. Hwang et al. (2000) classify these factors into three categories: cognitive, affective and situational factors. Cognitive factors are related to a person's level of awareness of the environment, their knowledge of key environmental concepts and actions, and their personal abilities to perform actions. Gifford and Nilsson (2014); Hwang et al. (2000) report that knowledge alone does not guarantee the adoption of environmental behavior, since such a change generally emerges as a result of the expression of an intention to act. This is indeed confirmed by Kempton et al. (1996) which shows that individuals with little environmental knowledge could still engage in an environmental cause, and Ajzen et al. (2011) which shows that having accurate information about an issue can sometimes be irrelevant for decision making. Thus, knowledge would only be one of the determinants of environmental action and other cognitive factors would contribute to the adoption of the right attitude and pro-environmental behavior (De Leeuw et al., 2015). Among those determinant factors identified by Hines et al. (1987), and further updated by Bamberg and Möser (2007) are the degree of environmental awareness (or the degree of familiarity with environmental problems and their causes), knowledge of the environment and ecological concepts, knowledge of action strategies in response to environmental problems and personal skills or abilities that facilitate the application of action strategies. Pruneau et al. (2006)identified the following examples of such skills: the ability to solve problems, prospective thinking, decision-making, and mathematical skills. SimilarlyJensen (2002) believes that knowledge can play a role in behavioral change, but for that to happen it must be action-focused.

Furthermore emotional factors such as attitudes and emotions associated with environmental issues, also play a key role. For example, the intention of an individual to behave in a pro-environmental way appears as a determining factor that adds to the knowledge to promote environmental action (Bamberg and Möser, 2007). The intention to act varies according to other affective factors, such as the impression of the ease of the task at hand (Pruneau et al., 2006) and the feeling of responsibility towards the environment (Hines et al., 1987; Ajzen and Fishbein, 1980) . Indeed, many researchers have found that individuals who prioritize altruistic values often have stronger environmental beliefs and are more likely to act in a way that is beneficial to the environment than those with individualistic or egocentric values (Cameron et al., 1998; Joireman et al., 2001). For their part, De Groot and Steg (2008) recognize three types of ethical postures that have more or less an impact on environmental behavior: the orientation towards egocentric values (where individuals consider the costs and benefits of environmental actions according to their personal well-being) ; orientation towards altruistic values (where individuals consider the

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costs and benefits of environmental actions based on their impact on other humans); and orientation towards biospheric values (where individuals assess the costs and benefits of environmental actions based on the well-being of ecosystems or the biosphere). Still other researchers have shown that individuals with altruistic and biospheric values exhibits more environmental behaviors

Situational factors, which relate to the physical environment in which people live, play a key role in reinforcing or inhibiting cognitive and affective factors. For example Chawla and Cushing (2007) note that significant contact with nature or having already been involved in environmental actions can be important situational factors. In particular, Rickinson (2001) identifies the following experiences as significant factors: in-kind experiences in youth as an individual or with a small group of people, parental influence, participation in environmental clubs, and observation of action of destruction of the natural environment.

3. Methods

3.1. Data and Variables Description

This paper relies on data from the student questionnaire file of the Programme for International Student assessment (PISA) 2015 (OECD, 2016). PISA is the triennial survey of 15-year-old students around the world lunched by the Organization for Economic Co-operation and Development (OECD), to assess the extent to which the students near the end of their compulsory education, have acquired key knowledge and skills essential for full participation in modern societies. A full detail description of the current sampling design is found in the PISA report(OECD, 2017, 67-91). Our analysis is based on the 2015 publicly released student questionnaire data file, which includes estimates of student performance and parent-questionnaire data from the 35 OECD countries and 37 partner countries, for a total sample size of 519334 observations. After variables selection, data treatment, and accounting for missing information, our final analysis used data on a total of 187821 students from 50 countries worldwide. Table (1) provides definitions and summary statistics for all the explanatory variables used in the analysis.

3.1.1. Dependents Variables

The dependent variables in our analysis represent students' levels of awareness and expectations about each of the three environmental issues of air pollution, water shortage, green gas emission:

- SEA: Self-Expressed-Awareness : ordered multinomial variable taking the values (1-Never heard, 2-Heard but can't explain, 3-Know and can provide general explanation 4-Familiar and can provide detail explanation) for each of the following environmental issues
  1. air pollution: SEAAP; with mean value = 3.29 , and standard deviation = 0.73
  2. water shortage: SEAWS; with mean value = 3.04 , and standard deviation = 0.84
  3. green gas emission: SEAGG; with mean value = 2.90 , and standard deviation = 0.88

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- SEE: Self-Expressed-Expectation: also ordered multinomial variable taking the values (1-worse, 2-same, 3-Improve) for each of the following environmental issue
    1. air pollution: SEEAP; with mean value = 2.44 , and standard deviation = 0.79
    2. water shortage: SEEWS; with mean value = 2.33 , and standard deviation = 0.78
    3. green gas emission: SEEGG; with mean value = 2.43 , and standard deviation = 0.76

3.2. Econometric Model Specification

The seemingly unrelated bivariate weighted ordered probit model of awareness and expectation with country specific effects implemented here follows closely the exposition in Niankara (2018) and is derived from the latent variable framework described in (Sajaia, 2008). For this we assume that the awareness (A^*) and Expectation (E^*) for individual student i in country j about the environmental issue k are determined by the following two equations:

$$\begin{aligned} A^*_{ijk} &= \alpha_{1jk} + \mathbf{x'}_{1i}\beta_{1k} + \epsilon_{1ijk} \\ E^*_{jik} &= \alpha_{2jk} + \mathbf{x'}_{2i}\beta_{2k} + \gamma_k A^*_{ijk} + \epsilon_{2ijk} \end{aligned} \tag{1}$$

Where β_{1k} and β_{2k} are vectors of unknown parameters to be estimated for each environmental issue k, γ_k is an unknown scalar capturing the effect of students' awareness on their expectations and estimated for each environmental issue k , ϵ_{1ijk} and ϵ_{2ijk} are the error terms of the awareness and expectation equations respectively. α_{1jk} and α_{2jk} denote the country specific effects in the awareness and expectation equations respectively. The explanatory variables in the model are assumed exogenous such that $E(\mathbf{x'}_{1i}\epsilon_{1ijk}) = E(\mathbf{x'}_{2i}\epsilon_{2ijk}) = 0$.

The model system as presented in equation (1) assumes that there are unobserved heterogeneity in students' awareness (A^*_{ijk}) and expectations (E^*_{ijk}) across countries j for each environmental issue k, which are captured by the non-constant model intercepts α_{ijk}. These country-specific effects are the leftover sources of variation in students' environmental awareness and expectation that cannot be explained by their interest in the Biosphere and other included regressors in the models. They capture the effects of factors such as the unique local culture, and/or educational system within each country, which might help explain observed variations in student's environmental awareness and expectations. Given the potential correlation between these country-specific effects and the included regressors (such as students' interest in ecosystem services and sustainability), the fixed effect estimator as implemented here using the Rchoice package(Sarrias, 2016) from the R statistical software(R Core Team, 2015) would be more appropriate for valid coefficient estimates.

Because we have 50 countries in our data sample, this approach implies that we would have 50-1 = 49 country fixed effects representing the average levels of students' awareness and expectation in each of the 49 non-reference countries for each of the three environmental issues (air pollution, water shortage, and green gas emission), while the overall model constant (intercept)

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would represent the average levels of students' awareness and expectation for the reference country (which is Australia in this analysis) for each environmental issue. We recover these country specific effects as shown in tables (4) , (6) and (8) after estimation using the following equations:

$$\begin{aligned} \hat{\alpha}_{1j} &= \bar{A}^*_{ijk} - \bar{\mathbf{x}}_i' \hat{\beta}_{1k} \\ \hat{\alpha}_{2j} &= \bar{E}^*_{ijk} - \bar{\mathbf{x}}_i' \hat{\beta}_{2k} - \bar{A}^*_{ijk} \hat{\gamma}_k \end{aligned} \tag{2}$$

Abstracting from the subscripts for country j and environmental issue k, the observed variables for student's self-expressed awareness (SEA) and self-expressed Expectation (SAE) about any of the three environmental issues (air pollution, water shortage, green gas emission) are related to their corresponding latent variables in equation (1) as:

$$SEA_i = \begin{cases} 1 - Never\ Heard & \text{if } A_i^* \leq \mu_1 \\ 2 - Heard,\ but\ Unable\ to\ Explain & \text{if } \mu_1 \leq A_i^* \leq \mu_2 \\ 3 - Know,\ can\ provide\ General\ Explanation & \text{if } \mu_2 \leq A_i^* \leq \mu_3 \\ 4 - Familiar,\ can\ provide\ Detailed\ Explanation & \text{if } \mu_3 < A_i^* \end{cases} \tag{3}$$

$$SAE_i = \begin{cases} 1 - Worse & \text{if } E_i^* \leq \delta_1 \\ 2 - Same & \text{if } \delta_1 \leq E_i^* \leq \delta_2 \\ 3 - Improve & \text{if } \delta_2 < E_i^* \end{cases} \tag{4}$$

Where the unknown cutoffs satisfy the condition that $\mu_1 < \mu_2 < \mu_3$ and $\delta_1 < \delta_2$. For identification purposes, the first threshold values are "anchored" a priori, such that $\mu_1 = \delta_1 = 0$. Following (Jackman, 2000; McKelvey and Zavoina, 1975), we also define $\mu_0 = \delta_0 = -\infty$ and $\mu_4 = \delta_3 = +\infty$ in order to avoid handling the boundary cases separately.

For any two index j and k on the two latent scales, and different from the previously used subscripts, the probability that $SEA_i = j$ and $SAE_i = k$, for any of the three environmental issues is given by:

$$\begin{aligned} Pr(SEA_i = j\ ,\ SAE_i = k) &= Pr(\mu_{j-1} < A_i^* \leq \mu_j\ ,\ \delta_{k-1} < E_i^* \leq \delta_k) \\ &= Pr(A_i^* \leq \mu_j\ ,\ E_i^* \leq \delta_k) \\ &- Pr(A_i^* \leq \mu_{j-1}\ ,\ E_i^* \leq \delta_k) \\ &- Pr(A_i^* \leq \mu_j\ ,\ E_i^* \leq \delta_{k-1}) \\ &+ Pr(A_i^* \leq \mu_{j-1}\ ,\ E_i^* \leq \delta_{k-1}) \end{aligned} \tag{5}$$

If ϵ_{1i} and ϵ_{2i} are distributed as bivariate standard normal with correlation ρ the individual contribution to the likelihood function could be expressed as:

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$$\begin{aligned} Pr(SEA_i = j\ ,\ SAE_i = k) = {} & \Phi_2(\mu_j - \alpha_j - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_k - \alpha_k - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ & - \Phi_2(\mu_{j-1} - \alpha_{j-1} - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_k - \alpha_k - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ & - \Phi_2(\mu_j - \alpha_j - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_{k-1} - \alpha_{k-1} - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ & + \Phi_2(\mu_{j-1} - \alpha_{j-1} - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_{k-1} - \alpha_{k-1} - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \end{aligned} \tag{6}$$

where Φ_2 is the bivariate standard normal cumulative distribution function, $\zeta = \frac{1}{\sqrt{1+2\gamma\rho+\gamma^2}}$ and $\tilde{\rho} = \zeta(\gamma+\rho)$. This specification is referred to as simultaneous bivariate ordered probit model. When $\rho = 0$ then the model simplifies to a seemingly unrelated specification with $\zeta = 1$ and $\tilde{\rho} = \rho$. The general closed form solutions of the likelihood function are described in the appendix of Niankara (2018). The model is estimated here under weighted seemingly unrelated specification($\rho = 0$), with country fixed effects using the package(Sarrias, 2016) from the R statistical software(R Core Team, 2015).

4. Results

4.1. Descriptive Results

4.1.1. Summary Statistics of the Explanatory Variables

The descriptive results in table (1) suggest that 48% of the students respondent are males, with an average student age of 15.79 years. The mean value of the standard normalized scale of the index of economic, social and cultural status (ESCS)[1], suggests that the average student in our studied sample is 0.04 standard deviation below the mean index value across all PISA 2015 students. The average student is interested (3.37) in the biosphere (ecosystem services and sustainability), but highly interested (3.95) in how science can help prevent disease. Table (1) also suggests that the average student in the sample regularly visit ecological website (3.40), and blogs (3.28) for news; In addition students sometimes watch television programs (2.90) on broad science, but regularly visit websites (3.06) and read books (3.35) on broad science. Furthermore the average student regularly attend a science club (3.60), and regularly read magazines and science articles in newspapers (3.19).

[1]Estimated across all OECD countries and partner countries on the basis of the following variables: the International Socio-Economic Index of Occupational Status (ISEI); the highest level of education of the student's parents in years of schooling; the PISA index of family wealth; the PISA index of home educational resources; and the PISA index of possessions related to "classical" culture in the family home. See (OECD, 2017, pp. 339-340) for more details

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4.1.2. Relative Frequency Distributions of Awareness and Expectations

The relative frequency distributions of students awareness and expectations about the three environmental issues of air pollution, water shortage, green gas emission are presented in table (2), and also graphically summarized in figure (1).

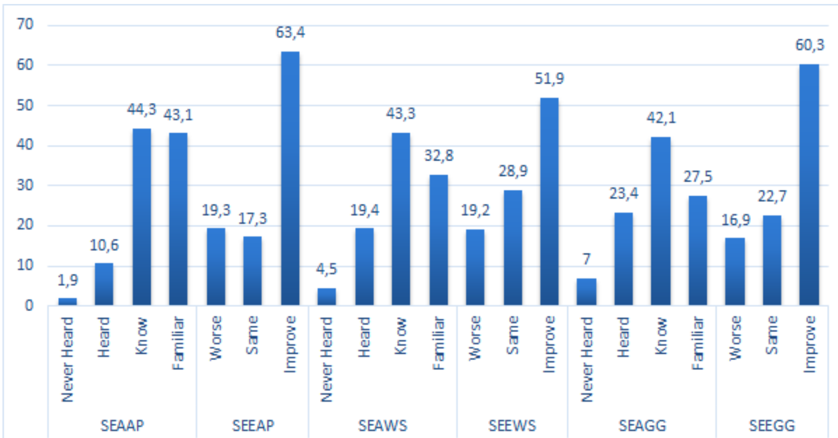

Figure 1: Relative Frequencies of Awareness and Expectations about the three Environmental Issues

With regards to the problem of air pollution, SEAAP and SEEAP in figure (1) suggest that the greatest share (44.3%) of students know about this issue, and able to provide general explanation, followed by 43.1% reporting being familiar and able to provide detailed explanation, and then 10.6% reporting having heard about the issue but unable to explain it, while the remaining students (1.9%) report having never heard about the issue. With regards to students' expectations about the evolution of this issue for the next 20 years (SEEAP), the greater majority of students (63.4%) are optimistic, and believe the issue will improve, while 19.3% feel pessimistic, believing it will get worse, and the remaining 17.3% believe it will remain the same.

A similar pattern as described above is observed with regards to the issue of water shortage. SEAWS and SEEWS in figure (1) suggest that the greatest share (44.3%) of students know about this issue, and able to provide general explanation, followed by 32.8% reporting being familiar and able to provide detailed explanation, and then 19.4% reporting having heard about the issue but unable to explain it, while the remaining students (4.5%) report having never heard about the issue. With regards to students' expectations about the evolution of this issue for the next 20 years (SEEWS), the greater majority of students (51.9%) are optimistic, and believe the issue will improve, while 28.9% believe it will remain the same, and the remaining 19.2% feel pessimistic, believing it will get worse.

Finally, for the issue of green gas emission, SEAGG and SEEGG in figure (1) suggest that the greatest share (42.1%) of students know about this issue, and able to provide general explanation,

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followed by 27.5% reporting being familiar and able to provide detailed explanation, and then 23.4% reporting having heard about the issue but unable to explain it, while the remaining students (7%) report having never heard about the issue. With regards to students' expectations about the evolution of this issue for the next 20 years (SEEGG), the greater majority of students (60.3%) are optimistic, and believe the issue will improve, while 22.7% believe it will remain the same, and the remaining 16.9% feel pessimistic, believing it will get worse.

4.1.3. Conditional Frequency Distributions of Awareness and Expectations

Breaking down the relative frequencies described in the previous section by the levels of students interest in the Biosphere (IntBiosph), we can understand the variations in students' awareness and expectations about the three environmental issues (air pollution, water shortage, green gas emission), based on their level of interest in ecosystem services and sustainability. Table (2) presents the results of this break down, which is further summarized in figure (2). The results show significant variations in cell frequencies as interest level in the Biosphere rises from 0 to 4, at every level of awareness and expectation for the three environmental issues. This result is further confirmed by the chi-square test results shown in the last column of table Table (2).

Indeed the p-values of the chi-square tests suggest highly significant ($\alpha = 0.1\%$) relationship between student's interest in the biosphere (IntBiosph), and their self-expressed-awareness about the issues of air pollution (SEAAP), water shortage (SEAWS), and green gas emission (SEAGG) on one hand, and on the other hand self-expressed-expectation about the issues of air pollution (SEEAP), water shortage (SEEWS), and green gas emission (SEEGG).

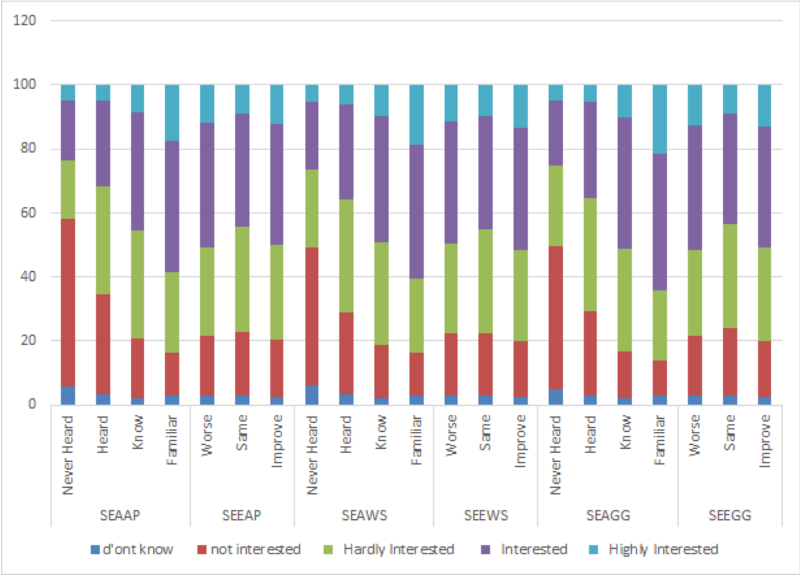

Figure 2: Conditional Relative Frequencies of Awareness and Expectations by Level of Interest in Biosphere

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4.2. Econometric Results

4.2.1. Interest in the Biosphere and Environmental Awareness

Maximum likelihood estimation (MLE) results for the effects of students' interest in the Biosphere on their environmental awareness are summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. Focusing on the issue of air pollution, table (3) shows that on average a one level increase in students' interest in ecosystem services and sustainability raises their awareness about the issue of air pollution by 15.3%. A similar result is recorded for the issue of water shortage as seen in table (5), which shows that students' awareness of this issue increases by 16.7% on average, for each level increase in students' interest in the biosphere. The greatest effect of students' interest in the biosphere is observed however for the issue of green gas emission as seen in table (7), where every level increase in interest raises students' awareness about this later issue by 24.6%.

4.2.2. Interest in the Biosphere and Environmental Expectations

As in the case of environmental awareness in the previous section, MLE results for the effects of students' interest in the Biosphere on their environmental expectations (optimism) are summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. Although students' interest in the biosphere seems to not have a significant effect on their expectations about the issue of green gas emission as seen in table (7), focusing on the issue of air pollution, table (3) shows that on average students become 0.8% more optimistic about the issue of air pollution, for every one level increase in students' interest in ecosystem services and sustainability. A similar result is observed for the issue of water shortage as seen in table (5), which shows that students' become on average 0.2% more optimistic about this issue, for each level increase in their interest in the biosphere.

4.2.3. Control variables and Environmental Awareness

Maximum likelihood estimation (MLE) results for the effects of students' socio-demographic characteristics on their environmental awareness are also summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. The coefficients of the age variable show that every one year increase in students' age leads to an increase by 4.9%, 6.6% and 10.9% in awareness about the respective issues of air pollution [table(3)], water shortage [table(5)], and green gas emission [table(7)]. The coefficients of the gender variable show that compared to female students, males are 15.5% [table(7)] more aware of the issue of green gas emission, but respectively 8.3% [table(3)], and 4% [table(5)] less aware of the issues of air pollution, and water shortage. Furthermore, a one standard deviation increase in students' normalized index of economic, social, and cultural status is found to increase their awareness of the issue of air pollution by 14.4% [table(3)], water shortage by 12.9% [table(5)], and green gas emission by 18.4% [table(7)]. With regards to immigration status, the results show that compared to native students,

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first generation immigrants (expatriates) students are 9.6% more aware of the issue of air pollution , 11.1% more aware of the issue of water shortage, but 6.5% less aware of the issue of green gas emission. Similarly, compared to native students, second generation expatriates students are 6.7% more aware of the issue of air pollution , 9.3% more aware of the issue of water shortage, but 2.4% less aware of the issue of green gas emission.

The results of the effects of students' media consumption on their environmental awareness are also summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. These results show that every level increase in students frequency of ecological website visits leads to an increased awareness of 1.7% for the issue of air pollution, 6.0% for the issue of green gas emission, but a decreased awareness of 0.9% for the issue of water shortage. With regards to students blogs' visits for news, every one level increase in the frequency of this activity leads unequivocally to a reduced awareness of 8.6% for the issue of air pollution, 7.5% for the issue of water shortage, and 8.2% for the issue of green gas emission. The same thing is true for increased students frequency of broad science viewership on television, which leads to a reduced awareness of 6.9% for the issue of air pollution, 4.7% for the issue of water shortage, and 7.4% for the issue of green gas emission. Similarly for increased students frequency of web browsing for broad science content, which leads to a reduced awareness of 9.0% for the issue of air pollution, 5.8% for the issue of water shortage, and 10.2% for the issue of green gas emission. And also similarly for increased students frequency of magazine, science article and newspaper reading, which lead to reduced awareness of 4.5% for the issue of air pollution, 6.2% for the issue of water shortage, and 9.5% for the issue of green gas emission. On the other hand, increased frequency of broad science reading in books leads however to an increased awareness of 4.3% for the issue of air pollution, 2.5% for the issue of water shortage, but leads to a reduced awareness of 0.3% for the issue of green gas emission. Furthermore, with regards to students' science club attendance, an increase frequency of this activity leads to an increased awareness of 17% for the issue of air pollution, 9% for the issue of water shortage, and 11.6% for the issue of green gas emission. Finally, turning to the effects that students' interest in science as a disease prevention channel, can have in students' environmental awareness, we note that every one level increase in this interest raises students' awareness by 12.3% for the issue of air pollution, 8.9% for the issue of water shortage, and 8.5% for the issue of green gas emission.

4.2.4. Control variables and Environmental Expectations

MLE results for the effects of students' socio-demographic characteristics on their environmental expectations are summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. The coefficients of the age variable show that students are respectively 8.9%, 12.2%, and 11.9% more optimistic about the issues of air pollution [table(3)], water shortage [table(5)], and green gas emission [table(7)]. The coefficients of the gender variable show that compared to female students, males are respectively 18.1% [table(7)] , 9.7%

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[table(3)], and 13.8% [table(5)] less optimistic about the issues of air pollution, water shortage, and green gas emission. Furthermore, a one standard deviation increase in students' normalized index of economic, social, and cultural status is found to increase their optimism by 7.9% for the issues of air pollution [table(3)] and water shortage [table(5)], and 6.8% [table(7)] for the issue of green gas emission. With regards to immigration status, the results show that compared to native students, first generation immigrants (expatriates) students are 3.4% less optimistic about the issue of air pollution , 6.5% less optimistic about the issue of green gas emission, but 0.1% more optimistic about the issue of water shortage. Similarly, compared to native students, second generation expatriates students are 9% less optimistic about the issue of air pollution , 16.8% less optimistic about the issue of green gas emission, but 1.8% more optimistic about the issue of water shortage.

The results of the effects of students' media consumption on their environmental expectations are also summarized in tables (3) , (5), and (7) respectively for the issues of air pollution, water shortage, and green gas emission. These results show that every level increase in students frequency of ecological website visits leads to an increased optimism of 3.4% for the issue of air pollution, 4.2% for the issue of water shortage, and 5.1% for the issue of green gas emission. Similarly with regards to students blogs' visits for news, where every one level increase in the frequency of this activity leads unequivocally to an increased optimism of 2.1% for the issue of air pollution, 1.9% for the issue of water shortage, and 1% for the issue of green gas emission. With regards to students' broad science viewership on television, the results show that increased frequency of this activity leads to an increased students' optimism of 0.6% for the issue of air pollution, but reduces students' optimism by 0.2% for the issue of water shortage, and 0.9% for the issue of green gas emission.

Similarly for increased frequency of broad science reading in books, which increases students optimism about the issue of air pollution by 6.6%, the issue of water shortage by 5.1%, and the issue of green gas emission by 7.5%. And also similarly for increased frequency of science club attendance, which increases students optimism about the issue of air pollution by 10.1%, the issue of water shortage by 10.2%, and the issue of green gas emission by 9.2%. Conversely however, students increased frequency of web browsing for broad science content, seems to reduce their level of optimism about the issue of air pollution by 1.7%, water shortage by 3.1%, and green gas emission by 1.3%. Furthermore, students' increased frequency of magazine, science article and newspaper reading, is seen to reduce by 0.2% their level of optimism about the issue of water shortage, but raises their optimism level by 0.3% for the issue of air pollution, and 0.8% for the issue of green gas emission.

Now turning to the effects that students' interest in science as a disease prevention channel, can have in their environmental expectations, we note that every one level increase in this interest raises students optimism by 4% for the issue of air pollution, 3.1% for the issue of water shortage, and 3.6% for the issue of green gas emission. Finally looking at how students' increased awareness of these three issues affect their expectations about their evolution for the next 20 years, the results in tables (3) , (5), and (7) suggest that every one level increased awareness leads to improved expectations, or 17.3% more optimism about the issue of air pollution, 15.8% more optimism about the issue of water shortage, and 17.4% more optimism about the issue of green gas emission.

4.2.5. Country specific effects of Students' Environmental Awareness and Expectations

The country fixed effects results of students' awareness and expectations about the issues of air pollution, water shortage, and green gas emission are reported in tables (4) , (6), and (8) respectively.

These estimated effects are showing how factors specific to each country are contributing to variations in students environmental awareness and expectation/optimism. Given that our studied sample contains 187821 students distributed across 50 countries, these fixed country effects control for the variations in awareness and expectations that are linked to factors unique to each country. These factors include the type of educational system, the local culture, the physical, social, and economic environment that affect students' level of awareness and expectation about the three environmental issues under considerations. This procedure allows us to capture the true effect of our main independent variable "Student's interest in the Biosphere" along with the effects of the other included co-variates. It implicitly assumes between country heterogeneity, but within country homogeneity in students' environmental awareness and expectation.

For alphabetical convenience, Australia is chosen as our reference country in the data, such that all other country specific effects are interpreted relative to this reference country. The value of the country specific effect for Australia is captured by the overall estimated constant/intercept in the model, while the intercept for the other countries are obtained relative to that of Australia, by adding the overall constant to the estimated country fixed effects. As such a country with a positive estimated fixed effect on awareness or expectation will have an intercept, or minimum awareness or expectation above that of Australia, while a country with negative estimated fixed effect will have an intercept or minimum awareness or expectation below that of Australia.

Starting with students' country level awareness, table (4) shows that except for Luxembourg and Uruguay, all country specific effects on students' awareness of the issue of air pollution are statistically significant. In fact, students' from countries such as Belgium, Denmark, France, Iceland, Netherlands, New Zealand, Sweden, and Switzerland show relatively less awareness of the issue of air pollution, compared to Australian students, while students from the remaining countries show on average relatively more awareness of this issue compared to Australian students. Moving to the issue of water shortage, table (6) shows that except for Australia itself, all other country specific effects are statistically significant. In fact, compared to students from Australia, those from Belgium, Denmark, France, Netherlands, New Zealand, Russian Federation, Switzerland, and United Kingdom show relatively less awareness, while those from the remaining countries show relatively more awareness of the issue of water shortage. Now turning to the issue of green

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gas emission, table (8) shows that all country specific effects are statistically significant except for Denmark, Greece, Hungary, and Macao. Furthermore, compared to Australian students, those from most countries show relatively less awareness about the issue of green gas emission, while students from countries such as Canada, Finland, Ireland, Korea, Portugal, Singapore, Spain, Sweden, United Kingdom, China, and Spain show relatively more awareness of the issue of water shortage.

Now considering country level expectations about the three environmental issues, table (4) shows that all country specific effects on students' expectation about the issue of air pollution are statistically significant. In fact, compared to Australian students, those from Belgium, Chinese Taipai, Croatia, Czeck Republic, France, New Zealand, and Turkey are relatively more optimistic about the issue of air pollution, while student's from the remaining countries are relatively pessimistic about this issue compared to their Australian counterparts. With regards to the issue of water shortage, table (6) shows that except for Hong kong and Macao, all other countries have statistically significant fixed effects on students' expectations about this issue. Indeed students' from countries such as Austria, Canada and Uruguay, just to name a few are relatively more optimistic about the issue of water shortage compared to Australian students, while students' from countries such as the United Arab Emirates, the United Kingdom, and the United States among others are relatively less optimistic about the issue of water shortage compared to their Australian counterparts. The fixed effects results for the issue of green gas emission are summarized in table (8), and suggest that except for Austria, Belgium, Macao, and the Slovak Republic, all other countries have statistically significant fixed effects on students' expectations about this issue. Indeed compared to Australian students, those from countries such as Bulgaria, Canada, and the Dominican Republic are relatively less optimistic, while those from countries such as Costa Rica, Peru, and Turkey are relatively more optimistic about the issue of green gas emission.

5. Conclusion and Discussions

This study relied on seemingly unrelated bi-variate weighted ordered probit modeling to look at how 15 year old students' interest in ecosystem services and sustainability affect their environmental awareness and optimism in relation to the three environmental issues of air pollution, water shortage, and green gas emission worldwide. The study is carried out in times of immense challenges to the natural environment arising from high demographic growth, increased demand for energy and water resources coupled with high level of global green gas emissions; but most importantly in times of global commitments to the 2030 agenda for sustainable economic development, adopted by United Nations country members in 2015. It aimed at identifying not only durable solutions to some of our major contemporary environmental issues, but also providing ways to successfully channel the leaders of tomorrow into adopting pro-environmental behavior.

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We found that along with socio-demographic factors such as age, gender, immigration status, and economic, social and cultural status, interest in the biosphere is a significant determinant of students' environmental awareness and optimism. In fact, a one level increase in students' interest in ecosystem services and sustainability was found to significantly raise on average students' awareness level by 15.3% for the issue of air pollution, 15.7% for the issue of water shortage, and 24.6% for the issue of green gas emission. Although students' interest in the biosphere seemed to not have a significant effect on their expectations about the issue of green gas emission, it did however raise their level of optimism by 0.8% for the issue of air pollution, and 0.2% for the issue of water shortage. Furthermore, we found that every one level increase in students' environmental awareness leads to 17.3% more optimism about the issue of air pollution, 15.8% more optimism about the issue of water shortage, and 17.4% more optimism about the issue of green gas emission. These results are in line with those found in Niankara (2018) with respect to the environmental issues of deforestation and species extinction in the Middle East and North America. Therefore, based on the Theory of Planned Behavior (TPB), they seem to indicate that governments and policy makers worldwide can successfully leverage young people interests in the biosphere to effectively achieve their goals for sustainability. However, for more efficacy, any strategy forward would have to develop some complementarity with technology and social media, given their current popularity among the youth. This will most likely require proper planing, educating, and using innovative ways to make ecosystem services and sustainability more appealing to the younger generation. A couple of suggestions that could be made based on our results include:

- Strengthening global environmental education (in line with Goal 4 of the SDGs: Ensuring access to quality education for all, and promoting opportunities for lifelong learning),
- Introducing modules on environmental responsibility into primary, secondary and higher education curricula worldwide,
- Developing public awareness programs targeted at the general population, and especially young people using social media,
- Increasing youth participation in conferences of parties meetings on major environmental issues,
- Establishing youth partnerships for the environment at the national level within each country and at the global level.

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6. Appendix

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Table 1: Summary Description of the Variables used in the Econometric Modeling

Variables	N = 187821	Mean	s.d.
IntBiosph	Level of interest in the Biosphere, (Ecosystem services and Sustainability); 0- Don't know what it is, 1- not interested, 2-Hardly interested, 3-Interested, 4-highly interested.	3.37	1.00
Socio-demographics			
AGE	The student's age.	15.79	0.29
Gender	Gender; 0-Female , 1-Male.	0.48	0.50
ESCS	Standardized PISA Index of economic, social and cultural status.	-0.04	1.03
IMMIG	Student Immigration status; 1-Native, 2-Second-generation, 3- First-generation.	1.21	0.56
Other control Variables			
EcoWebVisit	How often visit Ecological Websites; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.40	0.83
BlogsVisit	How often follow news via blogs; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.28	0.91
BroadScTVprog	How often watch TV program on broad science; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	2.90	0.89
BroadScBooks	How often read books on broad science; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.35	0.83
BroadScWeb	How often visit websites on broad science; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.06	0.91
MagScArtNewsp	How often read magazines and science article; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.19	0.88
ScClubAttend	How often attend science club; 1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.	3.60	0.75
IntScPrevDis	Level of Interest in how science can help prevent disease; 0- Don't know what it is, 1- not interested, 2-Hardly interested, 3-Interested, 4-highly interested.	3.95	1.05
WFSTUWT	Student final weight in the Data (used for weighting and correct standard error estimation)	47.51	99.56
CNTRYID	Unique Country Identifier for each of the 50 countries in the Sample (used to capture the country-specific effects with "Australia" representing the reference country)		

Source: Programme for International Student Assessment (PISA 2015) Data set.

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Table 2: Conditional and Relative Frequencies of Awareness and Expectation

		IntBiosph					Rel. Freq.	$\text{Chi}^2 Stat.$
		0	1	2	3	4	(%)	
SEAAP	1	5.7	52.5	18.3	18.5	5.1	01.9	X-squared = 11718***
	2	3.4	31.3	33.6	26.8	4.9	10.6	df = 12 , p-value < 2.2e-16
	3	2.3	18.6	33.6	37.1	8.4	44.3	
	4	2.9	13.6	25.0	41.1	17.4	43.1	- - - - - - - - - - - - - - - - - - - -
SEEAP	1	2.8	19.0	27.3	38.9	12.1	19.3	X-squared = 551.87***
	2	2.8	20.2	32.7	35.2	9.2	17.3	df = 8, p-value < 2.2e-16
	3	2.7	17.9	29.5	37.5	12.5	63.4	- - - - - - - - - - - - - - - - - - - -
SEAWS	1	6.0	43.3	24.2	21.0	5.6	04.5	X-squared = 12681***
	2	3.4	25.7	35.3	29.5	6.1	19.4	df = 12, p-value < 2.2e-16
	3	2.1	16.5	32.3	39.4	9.7	43.3	
	4	2.8	13.4	23.4	41.5	18.9	32.8	- - - - - - - - - - - - - - - - - - - -
SEEWS	1	3.1	19.4	27.8	38.4	11.2	19.2	X-squared = 904.25***
	2	2.8	19.8	32.5	35.2	9.6	28.9	df = 8, p-value < 2.2e-16
	3	2.5	17.4	28.6	38.1	13.3	51.9	- - - - - - - - - - - - - - - - - - - -
SEAGG	1	4.8	44.7	25.3	20.4	4.8	07.0	X-squared = 19252***
	2	2.9	26.3	35.6	29.7	5.5	23.4	df = 12, p-value < 2.2e-16
	3	2.1	14.7	32.0	40.9	10.3	42.1	
	4	2.9	10.9	22.0	42.8	21.4	27.5	- - - - - - - - - - - - - - - - - - - -
SEEGG	1	3.0	18.5	26.9	39.1	12.4	16.9	X-squared = 1056.4***
	2	2.8	21.3	32.6	34.5	8.8	22.7	df = 8, p-value < 2.2e-16
	3	2.6	17.4	29.2	37.9	12.8	60.3	

Source: Author's construction using the PISA 2015 Data set; $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 3: MLE Results for Awareness and Expectation about the issue of Air Pollution

N	Awareness		Expectations	
187821	Coef.	(s.e.)	Coef.	(s.e.)
Cutoff 2	$\mu_2 = 1.008^{***}$	(0.001)	$\delta_2 = 0.538^{***}$	(0.001)
Cutoff 3	$\mu_3 = 2.433^{***}$	(0.001)		
(Intercept)	0.353^{***}	(0.021)	-1.663^{***}	(0.023)
IntBiosph	0.153^{***}	(0.001)	0.008^{***}	(0.001)
Socio-demographics				
AGE	0.049^{***}	(0.001)	0.089^{***}	(0.001)
GenderM	-0.083^{***}	(0.001)	-0.181^{***}	(0.001)
ESCS	0.144^{***}	(0.001)	0.079^{***}	(0.001)
(IMMIG)2	0.096^{***}	(0.002)	-0.034^{***}	(0.002)
(IMMIG)3	0.067^{***}	(0.002)	-0.090^{***}	(0.002)
Other control variables				
EcoWebVisit	0.017^{***}	(0.001)	0.034^{***}	(0.001)
BlogsVisit	-0.086^{***}	(0.001)	0.021^{***}	(0.001)
BroadScTVprog	-0.069^{***}	(0.001)	0.006^{***}	(0.001)
BroadScBooks	0.043^{***}	(0.001)	0.066^{***}	(0.001)
BroadScWeb	-0.090^{***}	(0.001)	-0.017^{***}	(0.001)
MagScArtNewsp	-0.045^{***}	(0.001)	0.003^{***}	(0.001)
ScClubAttend	0.170^{***}	(0.001)	0.101^{***}	(0.001)
IntScPrevDis	0.123^{***}	(0.001)	0.040^{***}	(0.001)
Awareness (SEAAP)			0.173^{***}	(0.001)
Log-likelihood	−8704600.9		−7771884.3	
BIC	17410003.2		15544570.0	
AIC	17409333.7		15543900.5	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 4: Country Fixed Effects Results for the issue of Air Pollution

N 187821	Number of Observations	Awareness Coef.	(s.e.)	Expectations Coef.	(s.e.)
Australia(Intercept)	6613	0.353^{***}	(0.021)	-1.663^{***}	(0.023)
Austria	2763	0.075^{***}	(0.007)	-0.101^{***}	(0.008)
Belgium	1817	-0.162^{***}	(0.008)	0.081^{***}	(0.009)
Brazil	5704	0.180^{***}	(0.003)	-0.079^{***}	(0.004)
Bulgaria	2497	0.283^{***}	(0.008)	-0.615^{***}	(0.009)
Canada	10476	0.259^{***}	(0.004)	-0.038^{***}	(0.005)
Chile	3286	0.144^{***}	(0.005)	-0.100^{***}	(0.006)
Chinese Taipei	4562	0.113^{***}	(0.004)	0.092^{***}	(0.005)
Costa Rica	3190	0.135^{***}	(0.008)	-0.040^{***}	(0.009)
Croatia	3162	0.475^{***}	(0.008)	0.020^{***}	(0.010)
Czeck Republic	3708	0.296^{***}	(0.006)	0.151^{***}	(0.007)
Denmark	2235	-0.082^{***}	(0.008)	-0.208^{***}	(0.009)
Dominican Republic	1594	0.269^{***}	(0.006)	-0.576^{***}	(0.007)
Estonia	3560	0.304^{***}	(0.014)	-0.653^{***}	(0.014)
Finland	3223	0.287^{***}	(0.007)	-0.169^{***}	(0.008)
France	2962	-0.047^{***}	(0.004)	0.051^{***}	(0.004)
Germany	1459	0.049^{***}	(0.004)	-0.268^{***}	(0.005)
Greece	3306	0.690^{***}	(0.006)	-0.416^{***}	(0.006)
Hong Kong	2440	0.285^{***}	(0.008)	-0.170^{***}	(0.008)
Hungary	2438	0.484^{***}	(0.007)	-0.232^{***}	(0.008)
Iceland	1836	-0.145^{***}	(0.024)	-0.201^{***}	(0.027)
Ireland	3169	0.423^{***}	(0.007)	-0.303^{***}	(0.008)
Italy	6388	0.025^{***}	(0.004)	-0.168^{***}	(0.004)
Korea	3978	0.324^{***}	(0.004)	-0.280^{***}	(0.004)
Latvia	2646	0.409^{***}	(0.013)	-0.103^{***}	(0.014)
Lithuania	3435	0.625^{***}	(0.010)	-0.233^{***}	(0.010)
Luxembourg	2338	0.037	(0.023)	-0.115^{***}	(0.026)
Macao	3023	0.276^{***}	(0.021)	-0.219^{***}	(0.023)
Mexico	4308	0.249^{***}	(0.003)	0.055^{***}	(0.004)
Montenegro	2222	0.382^{***}	(0.023)	-0.411^{***}	(0.023)
Netherlands	2649	-0.573^{***}	(0.005)	-0.720^{***}	(0.005)
New Zealand	1980	-0.195^{***}	(0.008)	0.099^{***}	(0.009)
Peru	3589	0.423^{***}	(0.004)	-0.179^{***}	(0.005)
Poland	2939	0.571^{***}	(0.004)	-0.332^{***}	(0.005)
Portugal	2964	0.567^{***}	(0.007)	-0.382^{***}	(0.007)
Qatar	4965	0.381^{***}	(0.017)	-0.704^{***}	(0.017)
Russian Federation	3198	0.507^{***}	(0.004)	-0.579^{***}	(0.004)
Singapore	3997	0.614^{***}	(0.008)	-0.152^{***}	(0.008)
Slovak Republic	3061	0.422^{***}	(0.008)	-0.137^{***}	(0.009)
Spain	3416	0.152^{***}	(0.004)	-0.218^{***}	(0.005)
Sweden	2698	-0.014^{*}	(0.006)	-0.282^{***}	(0.007)
Switzerland	2180	-0.041^{***}	(0.007)	-0.062^{***}	(0.008)
United Arab Emirates	6919	0.427^{***}	(0.009)	-0.748^{***}	(0.009)
Tunisia	1633	0.488^{***}	(0.007)	-0.249^{***}	(0.007)
Turkey	3478	0.918^{***}	(0.004)	0.206^{***}	(0.004)
United Kingdom	6409	0.237^{***}	(0.004)	-0.119^{***}	(0.004)
United States	3197	0.167^{***}	(0.003)	-0.330^{***}	(0.004)
Uruguay	2095	0.009	(0.010)	-0.112^{***}	(0.011)
B-S-J-G (China)	5324	0.497^{***}	(0.004)	-1.045^{***}	(0.004)
Spain (Regions)	16792	0.135^{***}	(0.004)	-0.226^{***}	(0.005)
Log-likelihood		−8704600.9		−7771884.3	
BIC		17410003.2		15544570.0	
AIC		17409333.7		15543900.5	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 5: MLE Results for Awareness and Expectation about the issue of Water Shortage

N	Awareness		Expectations	
187821	Coef.	(s.e.)	Coef.	(s.e.)
Cutoff 2	$\mu_2 = 1.105^{***}$	(0.001)	$\delta_2 = 0.814^{***}$	(0.001)
Cutoff 3	$\mu_3 = 2.345^{***}$	(0.001)		
(Intercept)	-0.027	(0.041)	-2.211^{***}	(0.022)
IntBiosph	0.167^{***}	(0.001)	0.002^{***}	(0.001)
Socio-demographics				
AGE	0.066^{***}	(0.001)	0.122^{***}	(0.001)
GenderM	-0.040^{***}	(0.001)	-0.097^{***}	(0.001)
ESCS	0.129^{***}	(0.001)	0.079^{***}	(0.001)
(IMMIG)2	0.111^{***}	(0.002)	0.001^{***}	(0.002)
(IMMIG)3	0.093^{***}	(0.002)	0.018^{***}	(0.002)
Other control variables				
EcoWebVisit	-0.009^{***}	(0.001)	0.042^{***}	(0.001)
BlogsVisit	-0.075^{***}	(0.001)	0.019^{***}	(0.001)
BroadScTVprog	-0.047^{***}	(0.001)	-0.002^{**}	(0.001)
BroadScBooks	0.025^{***}	(0.001)	0.051^{***}	(0.001)
BroadScWeb	-0.058^{***}	(0.001)	-0.031^{***}	(0.001)
MagScArtNewsp	-0.062^{***}	(0.001)	-0.002^{*}	(0.001)
ScClubAttend	0.090^{***}	(0.001)	0.102^{***}	(0.001)
IntScPrevDis	0.089^{***}	(0.001)	0.031^{***}	(0.001)
Awareness (SEAWS)			0.158^{***}	(0.001)
Log-likelihood	-9935072.1		-8634069.5	
BIC	19870945.7		17268940.4	
AIC	19870276.2		17268270.9	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 6: Country Fixed Effects Results for the issue of Water Shortage

N 187821	Number of Observations	Awareness Coef.	(s.e.)	Expectations Coef.	(s.e.)
Australia(Intercept)	6613	−0.027	(0.021)	−2.211***	(0.022)
Austria	2763	0.055***	(0.007)	0.226***	(0.008)
Belgium	1817	−0.485***	(0.008)	0.158***	(0.008)
Brazil	5704	0.516***	(0.003)	0.255***	(0.004)
Bulgaria	2497	0.317***	(0.008)	−0.319***	(0.008)
Canada	10476	0.033***	(0.004)	0.195***	(0.004)
Chile	3286	0.603***	(0.005)	0.256***	(0.005)
Chinese Taipei	4562	0.456***	(0.004)	0.380***	(0.005)
Costa Rica	3190	0.475***	(0.008)	0.385***	(0.009)
Croatia	3162	0.645***	(0.008)	0.271***	(0.009)
Czeck Republic	3708	0.416***	(0.006)	0.271***	(0.007)
Denmark	2235	−0.032***	(0.008)	−0.258***	(0.008)
Dominican Republic	1594	0.345***	(0.006)	−0.385***	(0.006)
Estonia	3560	0.563***	(0.014)	−0.464***	(0.014)
Finland	3223	0.223***	(0.007)	−0.244***	(0.007)
France	2962	−0.038***	(0.004)	0.212***	(0.004)
Germany	1459	0.046***	(0.004)	0.098***	(0.004)
Greece	3306	0.794***	(0.006)	−0.091***	(0.006)
Hong Kong	2440	0.248***	(0.007)	0.004	(0.008)
Hungary	2438	0.574***	(0.007)	0.051***	(0.007)
Iceland	1836	0.190***	(0.024)	−0.132***	(0.025)
Ireland	3169	0.449***	(0.007)	−0.297***	(0.007)
Italy	6388	0.168***	(0.004)	−0.023***	(0.004)
Korea	3978	0.714***	(0.004)	0.083***	(0.004)
Latvia	2646	0.262***	(0.012)	−0.124***	(0.013)
Lithuania	3435	0.625***	(0.009)	−0.086***	(0.010)
Luxembourg	2338	0.048*	(0.022)	0.100***	(0.024)
Macao	3023	0.408***	(0.020)	−0.024	(0.021)
Mexico	4308	0.562***	(0.003)	0.425***	(0.004)
Montenegro	2222	0.501***	(0.022)	−0.306***	(0.022)
Netherlands	2649	−0.058***	(0.005)	−0.553***	(0.005)
New Zealand	1980	−0.183***	(0.008)	0.164***	(0.008)
Peru	3589	0.672***	(0.004)	0.319***	(0.004)
Poland	2939	0.425***	(0.004)	−0.024***	(0.004)
Portugal	2964	0.798***	(0.007)	0.168***	(0.007)
Qatar	4965	0.253***	(0.016)	−0.485***	(0.016)
Russian Federation	3198	−0.217***	(0.003)	−0.518***	(0.004)
Singapore	3997	0.484***	(0.007)	−0.228***	(0.004)
Slovak Republic	3061	0.586***	(0.008)	0.064***	(0.008)
Spain	3416	0.254***	(0.004)	−0.168***	(0.004)
Sweden	2698	0.300***	(0.006)	−0.260***	(0.006)
Switzerland	2180	−0.082***	(0.007)	0.147***	(0.007)
United Arab Emirates	6919	0.323***	(0.008)	−0.470***	(0.008)
Tunisia	1633	0.486***	(0.007)	0.175***	(0.007)
Turkey	3478	1.049***	(0.004)	0.557***	(0.004)
United Kingdom	6409	−0.023***	(0.004)	−0.127***	(0.004)
United States	3197	0.164***	(0.003)	−0.178***	(0.003)
Uruguay	2095	0.409***	(0.010)	0.217***	(0.011)
B-S-J-G (China)	5324	0.807***	(0.003)	−0.408***	(0.004)
Spain (Regions)	16792	0.270***	(0.004)	−0.173***	(0.004)
Log-likelihood		−9935072.1		−8634069.5	
BIC		19870945.7		17268940.4	
AIC		19870276.2		17268270.9	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 7: MLE Results for Awareness and Expectation about the issue of Green Gas Emission

N		Awareness		Expectations
187821	Coef.	(s.e.)	Coef.	(s.e.)
Cutoff 2	$\mu_2 = 1.123^{***}$	(0.001)	$\delta_2 = 0.731^{***}$	(0.001)
Cutoff 3	$\mu_3 = 2.413^{***}$	(0.001)		
(Intercept)	-0.659^{***}	(0.021)	-2.037^{***}	(0.023)
IntBiosph	0.246^{***}	(0.001)	-0.001	(0.001)
Socio-demographics				
AGE	0.109^{***}	(0.001)	0.119^{***}	(0.001)
GenderM	0.155^{***}	(0.001)	-0.138^{***}	(0.001)
ESCS	0.184^{***}	(0.001)	0.068^{***}	(0.001)
(IMMIG)2	-0.065^{***}	(0.002)	-0.065^{***}	(0.002)
(IMMIG)3	-0.024^{***}	(0.002)	-0.168^{***}	(0.002)
Other control variables				
EcoWebVisit	0.060^{***}	(0.001)	0.051^{***}	(0.001)
BlogsVisit	-0.082^{***}	(0.001)	0.010^{***}	(0.001)
BroadScTVprog	-0.074^{***}	(0.001)	-0.009^{***}	(0.001)
BroadScBooks	-0.003^{***}	(0.001)	0.075^{***}	(0.001)
BroadScWeb	-0.102^{***}	(0.001)	-0.013^{***}	(0.001)
MagScArtNewsp	-0.095^{***}	(0.001)	0.008^{***}	(0.001)
ScClubAttend	0.116^{***}	(0.001)	0.092^{***}	(0.001)
IntScPrevDis	0.085^{***}	(0.001)	0.036^{***}	(0.001)
Awareness (SEAGG)			0.174^{***}	(0.001)
Log-likelihood	-10249849.5		-8198119.6	
BIC	20500500.4		16397040.7	
AIC	20499830.9		16396371.3	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 8: Country Fixed Effects Results for the issue of Green Gas Emission

N 187821	Number of Observations	Awareness Coef.	(s.e.)	Expectations Coef.	(s.e.)
Australia(Intercept)	6613	−0.659***	(0.021)	−2.037***	(0.023)
Austria	2763	−0.329***	(0.007)	0.001	(0.008)
Belgium	1817	−0.257***	(0.008)	0.014	(0.009)
Brazil	5704	−0.253***	(0.003)	0.014***	(0.004)
Bulgaria	2497	−0.380***	(0.008)	−0.394***	(0.009)
Canada	10476	0.145***	(0.004)	−0.032***	(0.005)
Chile	3286	−0.415***	(0.005)	0.028***	(0.005)
Chinese Taipei	4562	−0.058***	(0.004)	0.231***	(0.005)
Costa Rica	3190	−0.480***	(0.008)	0.092***	(0.009)
Croatia	3162	−0.292***	(0.008)	0.061***	(0.009)
Czeck Republic	3708	−0.390***	(0.006)	0.041***	(0.007)
Denmark	2235	−0.015	(0.008)	−0.237***	(0.009)
Dominican Republic	1594	−0.908***	(0.006)	−0.527***	(0.007)
Estonia	3560	−0.176***	(0.013)	−0.513***	(0.014)
Finland	3223	0.158***	(0.007)	−0.090***	(0.008)
France	2962	−0.114***	(0.004)	0.071***	(0.004)
Germany	1459	−0.188***	(0.004)	−0.198***	(0.005)
Greece	3306	0.005	(0.006)	−0.250***	(0.006)
Hong Kong	2440	−0.022**	(0.007)	0.130***	(0.009)
Hungary	2438	0.005	(0.007)	−0.295***	(0.007)
Iceland	1836	−0.514***	(0.024)	−0.131***	(0.026)
Ireland	3169	0.497***	(0.007)	−0.274***	(0.008)
Italy	6388	−0.109***	(0.004)	−0.126***	(0.004)
Korea	3978	0.097***	(0.004)	−0.089***	(0.004)
Latvia	2646	−0.585***	(0.012)	−0.200***	(0.013)
Lithuania	3435	−0.026**	(0.009)	−0.183***	(0.010)
Luxembourg	2338	−0.409***	(0.022)	−0.118***	(0.024)
Macao	3023	−0.001	(0.020)	−0.006	(0.023)
Mexico	4308	−0.534***	(0.003)	0.203***	(0.004)
Montenegro	2222	−0.323***	(0.021)	−0.340***	(0.023)
Netherlands	2649	−0.072***	(0.005)	−0.571***	(0.005)
New Zealand	1980	−0.189***	(0.008)	0.043***	(0.009)
Peru	3589	−0.315***	(0.004)	0.048***	(0.004)
Poland	2939	−0.126***	(0.004)	−0.273***	(0.004)
Portugal	2964	0.554***	(0.007)	−0.382***	(0.007)
Qatar	3198	−0.113***	(0.016)	−0.483***	(0.016)
Russian Federation	4965	−0.374***	(0.003)	−0.443***	(0.004)
Singapore	3997	0.451***	(0.007)	−0.097***	(0.008)
Slovak Republic	3061	−0.192***	(0.008)	0.001	(0.009)
Spain	3416	0.163***	(0.004)	−0.136***	(0.004)
Sweden	2698	0.587***	(0.006)	−0.193***	(0.007)
Switzerland	2180	−0.259***	(0.007)	−0.022**	(0.008)
United Arab Emirates	6919	−0.479***	(0.008)	−0.523***	(0.008)
Tunisia	1633	−0.808***	(0.007)	−0.154***	(0.007)
Turkey	3478	−0.062***	(0.004)	0.383***	(0.004)
United Kingdom	6409	0.575***	(0.004)	−0.115***	(0.004)
United States	3197	−0.408***	(0.003)	−0.378***	(0.004)
Uruguay	2095	−0.563***	(0.010)	−0.025*	(0.011)
B-S-J-G (China)	5324	0.053***	(0.003)	−0.713***	(0.004)
Spain (Regions)	16792	0.163***	(0.004)	−0.155***	(0.001)
Log-likelihood		−10249849.5		−8198119.6	
BIC		20500500.4		16397040.7	
AIC		20499830.9		16396371.3	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$