The Role of Social Capital on Environment and Quality of Life: Survey-based Econometrics Analyses

インブラーナ, アーラチラーゲ, ジャナキ, イブラーナ, アーラチ

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CERTIFICATE

The undersigned hereby certify that they have read and recommended to the Graduate School of Engineering for the acceptance of this thesis entitled, ***"The Role of Social Capital on Environment and Quality of Life: Survey-based Econometrics Analyses"*** by **I.A.Janaki Imbulana Arachchi** in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Engineering.

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ABSTRACT

Quality of life is the product of the interplay among the social, health, economic and environmental conditions that affect human and social development. Since there is a lack of discussion on people's intervention to improve their own quality of life, this thesis presents the relevance of social capital and sociodemographic factors for the contribution of people as a social aspect. Social capital is capital born within society because it is a frequent byproduct of religion, culture and shared historical experiences, and it offers an approach by which the trust and engagement between people and organizations affect collective actions. Social capital is multidimensional and has attracted attention in different fields of social sciences. Previous economics studies have also used this concept to explain differences in economic and government performance. Therefore, this thesis comprises four empirical studies that examine the effect of social capital and sociodemographic factors on reducing the negative impact on the environment and improving quality of life using global survey data.

This thesis consists of six chapters. **Chapter 1** introduces the concept of social capital and key terms of the topic. The discussion about improving quality of life in this thesis is divided into two main parts. The first part contains two chapters that focus on people's intervention through social capital to reduce the negative impact of two types of environmental problems to maintain quality of life. **Chapter 2** investigates the relationship between community-level social capital, household income, and carbon dioxide (CO_2) emissions. Due to the lack of disaggregated data on CO_2 emissions, this study uses satellite-monitored CO_2 emissions data

with survey data of social capital and household income across 30 countries. Furthermore, both the direct and combined impacts of social capital and income on CO_2 emissions are discussed in the environmental Kuznets curve framework. **Chapter 3** explores the impact of social capital-related factors on COVID-19 deaths as a contemporary environmental problem. For this purpose, this study uses open access data for COVID-19 deaths and survey data for social capital-related factors across 37 countries, including severely affected countries.

After focusing on problems related to the environment, the second part of the thesis discusses the link between social capital and sociodemographic factors to improve quality of life in two studies. **Chapter 4** examines the role of social capital in the subjective assessment of the quality of life across countries. For this assessment, data regarding self-reported social capital and three main domains of life, health, life satisfaction, and perceived economic inequality are used across 37 countries to compare the effect between low-income and high-income country groups. **Chapter 5** investigates the link between gender and energy sustainability. To do so, this study considers self-reported knowledge and concern about energy sustainability in terms of gender across and within 37 countries. Finally, the key findings of the four studies are summarized in **Chapter 6**.

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Chapter 1: Introduction

1.1 Social capital

1.1.1 Definitions

The concept of social capital originally grew out of sociology and proliferated through economics, education, political science, and health and social sciences in the past several decades (Engbers, Thompson and Slaper 2017). Given the several definitions of the term "social capital" by its principal theorists (Bourdie, 1986; Coleman, 1988; Putnam et al., 1993), it is important to provide conceptual clarity in our use of this term. Bourdieu (1986) established the foundation of social capital, and it was given a clear theoretical framework by Coleman (1988), who was the first to subject the concept to empirical analysis and develop ways of operationalizing it for research purposes. According to Coleman (1988), social capital is defined by its function. It is not a single entity but a variety of different entities with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors whether persons or corporate actors within the structure. However, the most commonly used definition is "… features of social life-networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives" by Putnam et al. (1993). Grootaert (1999) stated that social capital in society includes the institutions, the relationships, the attitudes, and values that govern interactions among people and contribute to economic and social development. Therefore, social capital is a capital that born within the society because it is frequently a byproduct of religion, culture, and shared experience but it is an intangible. Simply, this concept explains that trust and engagement between people and organizations are associated with success

collective actions (Fukuyama, 1995). It also describes the effects these interactions have on individual incentives and behavior and the resulting economic, political, and other possible changes.

Quality of life is an individual's perception of their position in life in the context of the culture and values in which they live and in relation to their goals and expectations (World Health Organization). The quality of good life can be assessed either from an objective or subjective point of views (Alatartseva and Barysheva, 2015; Felce and Perry, 1995; Western and Tomaszewski, 2016). The subjective quality of life is personal evaluations of peoples' lives by themselves whereas the objective approach examines the objective components of a good life and is measured by national and international social statistics independent from personal evaluations. Thesis refers to the subjective approach which measures the quality of various dimensions of life indicators covering physical wellbeing, such as health, material wellbeing, such as economic equality which means equal distribution of income and opportunity between different groups in society, and emotional wellbeing such as life satisfaction.

1.1.2 How to measure social capital

Empirical studies on social capital mainly attempt to quantify social capital and its contribution to economic development. At the level of operationalization, social capital can be measured in several ways. It is decomposed into cognitive and structural dimensions (Putnam, 2000). The cognitive component refers to the predisposition of individuals to act in a way that is beneficial for society, while the structural aspect refers to the interaction among individuals (Kaasa and Parts, 2008). Different constructs of trust (e.g., social and

institutional) are often used to measure the cognitive part, while the density of networks (formal and informal) and civic engagement are applied to construct the structural component. Concerning measures of social capital, one weakness of the social capital concept is the absence of consensus on how to measure it. However, two broad approaches have been taken: the first, to conduct a census of groups and group memberships in a given society, and the second, to use survey data on levels of trust and civic engagement (Fukuyama, 2001). Trust is defined by trust between people and organizations and helps to promote the development and progress of community relations (Moscardo et al.,2017), and engagement is peoples' contribution to different societies and associations for some common objectives. Thus, previous studies have measured social capital using these two approaches depending on the research purpose. Thus, this thesis used cross-sectional survey data on levels of trust and civic engagement to measure social capital.

1.1.3 Social capital development

When considering how the social capital can develop in a society, it is related to policy implications. Although social capital basically comes from religion, culture, and shared historical experiences, the government can do some positive things to create social capital. One direct ability to generate social capital is education. Educational institutions not only transmit human capital, but also pass social capital in the form of social rules and norms. This is the case not only in primary and secondary education, but also in higher and professional education. For instance, doctors learn not only medicine but also the Hippocratic oath. Furthermore, promoting voluntary associations and globalization are ways to develop social capital in a country. As an example, globalization has been the bearer not just of capital but also of ideas and culture. Therefore, developed ideas and culture can

increase social capital in less-developed societies. In addition, according to definitions of social capital, it mainly comprises trust and networks between people and organizations associated with collective action. Policy makers can make opportunities to frequently develop networks and trust though social activities based on age and educational level, which can be a better way to develop social capital in society.

1.1.4 Link between social capital and quality of life

Social capital has been recognized as an asset between people that brought many positive consequences for societal wellbeing. A good relationship among the community is not only improving the quality of life, but also leads to happier, and healthier lives, feel safer and greater belonging, effective governance even enhanced economic achievement (Fukuyama, 1995). Thus, in a simple way social capital can be concluded as network, interaction, and connection of people around. Besides, it also consists of the norms, relationships, values, and informal sanctions that shape the quantity and cooperative quality of society's social interactions (Aldridge, 2002). Neighborhoods or homogeneous groups can create and use the network, interaction, and connection to improve the quality of life as well as help get information, ideas, influences, and resources.

1.1.5 Link between social capital and environment

When considering the relationship between social capital, pro-environmental behavior, environmental sacrifice efforts, and environmental activities, (Macias and Williams, 2016) found that social capital has become an important driving factor for encouraging pro-environmental behavior among residents. Scholars have addressed the relationship between social capital and the environment in several dimensions such as recycling behavior, waste

management, and energy conservation (Nigbur et al., 2010; Ferraro et al., 2011; Fornara et al., 2011). Moreover, a few studies have examined how social capital affect to emissions reduction at aggregate level (Ibrahim, 2014), but lack of studies with disaggregate data. Thus, as an intangible resource, social capital will guide residents to take responsibility for the environment (Cho and Kang, 2017; Li et al. 2019). In addition, concerning contemporary environmental problems that cause to human health, most scholars have found positive relationship between social capital and health (Herian et al., 2014; Karimi and Brazier, 2016) but there is a lack of studies regarding the role of social capital in contemporary environmental problems, such as COVID-19 pandemic.

1.2 The outline of the thesis

The discussion about the role of social capital on environmental problems and quality of life in this Thesis is divided into two main parts. The first part contains two chapters to discuss social capital and environmental problems nexus (Chapter 2 and 3) and the second part comprises two chapters to discuss social capital, socio-demographic factors and quality of life (Chapter 4 and 5).

Chapter 2 investigates relationship between community level social capital and carbon dioxide (CO_2) emissions reduction. Furthermore, both the separate and combined impacts of social capital and income on CO_2 emissions are also discussed within countries and regions. In terms of these aims, two types of data were used in this chapter. For the CO_2 emissions as a main source of climate change, used monthly CO_2 emissions data that monitored by satellite and rest of the variables were measured by a multinational survey data. Then, this chapter was estimated how individual social capital and income influence to the CO_2

emissions reduction. The results of separate impact reveal that social capital was correlated with less CO_2 emissions whereas income correlate with more CO_2 emissions. The combined effect of social capital and income is associated to increase negative correlation of social capital and decrease positive correlation of income on CO_2 emissions. Moreover, when inclusion of social capital with income the turning point of household income is approximately 4,934 USD at country level whereas 3,285 USD at region level. However, the results confirm that increasing social capital would be an effective way to emissions reduction with behavioral change at community level.

Chapter 3 explore the impact of social capital-related factors on Covid-19 deaths as a contemporary environmental problem that contributing to the existing literature on the health and social capital nexus. To investigate the link between social capital and Covid-19 deaths, both open access databases and a survey data were employed. Self-reported level of community attachment, social trust, family bond, and security were included as the social capital-related factors. The main findings of this chapter shows that Covid-19 deaths were associated with social capital-related factors both positively and negatively. It means that community attachment and social trust were associated with more Covid-19 deaths whereas family bond and security, suggesting a dynamic role of social capital-related factors in the pandemic situation.

Chapter 4 examines the role of social capital on subjective assessment of quality of life across countries. The quality of good life which can be assessed either from objective or subjective point of views (Felce and Perry 1995, Alatartseva and Barysheva 2015, Western and Tomanzewski 2016). This chapter investigates the relationship between subjective approach which measure the quality of various dimensions of life indicators covering

physical, material, and emotional well-being with social capital. For this purpose, multi-level logistic models were employed to analysis each component of subjective assessment of quality of life with social capital across 37 countries, controlling for socio-economic profiles of the survey respondents. The results of this chapter show that higher social capital associate good health and higher satisfaction in developing countries than developed countries. Moreover, despite developing countries showing a decreasing trend in economic inequality at the community level with higher social capital, developed countries presented an increasing trend. Also, higher educational attainment in countries with social capital associate with less perceived economic gap. Enhancing social capital might lead to improved quality of life in most low-income countries and lifestyle and cultural factors also play a crucial role. These findings indicate that non-economic factors underpin with better lives and need for further research to address the social aspects of life.

Chapter 5 investigates the gender difference between knowledge and concern about energy sustainability across and within countries. Energy is an integral component for quality of life and energy sustainability is necessary to continue and stable economic development process as a main input of the economic growth. Previous studies have been discussed about economic and technological suggestion for energy sustainability including renewable energy sources as well. Therefore, this chapter examine whether the gender difference between knowledge and concern about energy sustainability, concerning people's contribution for this matter. Further, this study was used two concepts which are holistic association and cause-effect logic to compare people's decision-making patter with respect to gender. Both binary and ordered logistic models were performed with combining self-reported responses regarding people's knowledge and concern about energy sustainability rely on

aforementioned concepts, controlling socio-economic factors of the respondents. The results show that males report having more knowledge about energy sustainability than females, while females are more concerned about the importance of energy sustainability than females in most of countries. These results are consistent with the evidence that males are stronger in cause-effect logic and females are strong in holistic association. Therefore, there findings suggest that integrating both thinking styles would be beneficial for the decision-making process concerning energy sustainability and energy conservation practices.

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Chapter 2: Social capital, household income and carbon dioxide emissions: A multicountry analysis

2.1. Introduction

Finding low-emissions paths is necessary to mitigate climate change due to carbon dioxide (CO_2) emissions from human activities (Antonakakis et al., 2017; Barrett et al., 2013). It is reflected in the thirteenth Sustainable Development Goal (climate action) of the United Nations (UN)(Nations, 2015), which refers to taking rapid action to mitigate climate change and its impacts, emphasizing the importance of addressing this issue. Many scholars have focused on the policy perspective and consider mitigating climate change under the concepts of a low-carbon economy (Kaufmann and Hines, 2018; Lin and Jia, 2018) and low-carbon technology (Fridahl, 2017; Selosse and Ricci, 2017), but those climate policies take decades to develop and penetrate through overcoming various technological, social and economic barriers (Dietz et al., 2009). However, there is a lack of research on the relationship between economic development and environmental performance considering social factors (Wang et al., 2022). Potential behavioral change can reduce emissions more quickly than other changes and deserve consideration as part of climate policy (Pacala and Socolow, 2018).

The energy demand is influenced by people's behavior, lifestyle, and culture (Khanna et al., 2021). Cultural norms guide human behavior (Manfredo et al., 2021), and since the evolution of cultures is a general process, it must change in a positive direction if the processes of sustaining life on the planet are to be preserved (Ehrlich and Kennedy, 2005). The sharing of values between groups, can support the environment and guide the way we treat our environment to promote the development of a sustainable, peaceful, and equitable global society (Bruskotter et al., 2019). Since social capital is a byproduct of education, cultural

norms, religion, and shared historical experience (Fukuyama, 2001), it can organize the community to support collective efficacy through networks and trust between individuals and organizations to achieve common goals (Sampson, 2001). Therefore, we can assume that social capital can be used as an important tool in changing human behavior for the collective objective.

The relation between economic growth and environmental performance is commonly estimated using the environmental Kuznets curve (EKC) framework, which developed from the empirical study by Grossman and Kreuger (1995). The EKC hypothesizes that emissions increase as income increases at low-income levels but then decline at higher income levels (Renzhi and Baek, 2020; Stern, 2017). However, some scholars do not support the EKC hypothesis and argue that the relationship between income and emissions is not uniform (Xu et al., 2020). Moreover, there are few studies on the nexus of social capital, economic growth, and CO_2 emissions at the aggregate level (Carattini et al., 2015; Grafton and Knowles, 2004; Ibrahim and Law, 2014; Keene and Deller, 2015; Paudel et al., 2011).

In this context, the traditional EKC hypothesis is expanded in this study by focusing on the separate and combined effects of social capital on the relationship between income and CO_2 emissions at the household level. The present study addresses three questions based on cross-sectional data across 37 countries: (1) Is there a difference between self-reported social capital and the level of concern about the global warming issue with the income level of countries? (2) Is social capital associated with the less CO_2 emissions internationally? (3) How do the individual income turning points differ with and without social capital in terms of country fixed effects and region fixed effects in the EKC framework? To answer these questions, first, bivariate analysis is employed to examine the relationship between self-

reported social capital and the level of concern about the global warming issue in terms of low-and high-income countries. Binary logistic regression is used to confirm the country-level relationship. Then, the separate and combined effects of social capital on CO_2 emissions are investigated with a linear logarithmic quadratic form function. The results imply that increasing social capital is an effective path to reduce CO_2 emissions at the household level.

This article consists of five sections, which are organized as follows: Section 2 reviews the relevant literature. Section 3 provides methods and data descriptions. Section 4 presents the results and discussion, and Section 5 provides both conclusions and implications.

2.2. Literature review

2.2.1. Mechanism of social capital

Given the many definitions of the term 'social capital' by its principal theorists (Coleman, 1988; Bourdieu, 1986; Putnam et al., 1993), it is important to provide conceptual clarity in our use of this term. The commonly used definition is 'those features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions' (Putnam et al., 1993). From this perspective, social capital is born from within a society, describes the social environment in which people live, and is a collective resource to which individuals, families, neighborhoods, and communities have access. Irrespective of definition, the use and measurement of social capital usually include cognitive and structural dimensions (Putnam, 2000). The cognitive aspect refers to the predilection of individuals to act in a way that is salutary for society, and the structural aspect to the interaction among individuals (Kaasa and Parts, 2008). Although social capital has

several definitions, the separate and combined effects of social capital on CO_2 emissions are presented in **Figure 2-1**.

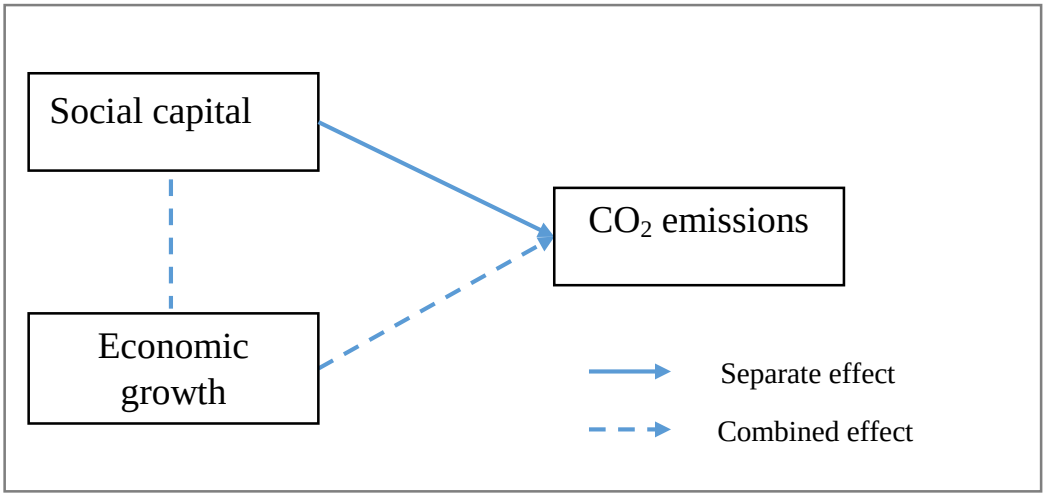


Figure 2-1 Separate and combined relationship between social capital and CO_2 emissions

Social capital has both a direct effect on CO_2 emissions and a combined effect through its impact on economic growth. Concerning direct effect of social capital on the environment, many studies have shown that social capital affects pro-environmental behavior and reduces emissions (for a review, see Farrow et al., 2017). Therefore, one mechanism is that an expectation of reciprocity in environmental actions can foster pro-environmental behavior at the individual level. For instance, at the individual level, our behavior is affected by what other people do or think (Abrahamse and Steg, 2013), and trust generates reciprocity, which leads people to invest in collaborative action, as they are confident that other people will do the same (Ferraro et al., 2011; Fornara et al., 2011; Pretty and Ward, 2001). Another method is that social networks might influence collective action by bonding, bridging, and linking in homogeneous groups (Healy and Hampshire, 2002). For instance, sharing information regarding energy policies or less carbon intensive items within groups tends to support adoption of those behaviors. Furthermore, Pretty and Smith (2004) found that relationships

of trust, reciprocity and exchange, common rules and norms, and engagement in communities are all necessary for shaping individual action to achieve positive biodiversity outcomes. The third channel social capital, which may influence collective action and policy-making and implementation (Ostrom and Economist, 2009). Owen and Videras (2008) found that a high level of trust is significantly associated with the implementation of local Agenda 21 programs in 66 countries involved in the Earth Summit. Furthermore, Uphoff and Wijayaratna (2000) found that the norms and values of farmer organizations are significantly associated with changing irrigation policies for water-use efficiency in paddy fields in Sri Lanka.

With respect to the combined effect of social capital on the environment, there is a large body of literature on social capital and economic growth (Knack and Keefer, 1997; for a review, see Westlund and Adam, 2010), and most of the studies on regions within countries are cross-country studies. Regarding the linkage between social capital and economic growth, there are two effects: positive effects and negative effects. A common issue in the argument for a positive relationship between social capital and economic growth concerns the social capital measurement. Social capital is measured by the two broad approaches of conducting a census of groups and group membership, and using survey data on levels of trust and civic engagement (Fukuyama, 2001). In general, trust and civic engagement facilitate low transaction costs and communication within and between groups and lead to economic growth (Knack and Keefer, 1997; Roth, 2009). In contrast, while a number of studies have found a positive relationship between social capital and economic growth, social capital can be negatively associated with economic growth when there are strong ties within groups that

hinder transactions and reduce communication among groups (Casey and Christ, 2005; Sabatini, 2008).

2.2.2 Review of social capital, income, and CO2 emissions nexus

The literature on economic growth and environmental performance in the (EKC) framework is rich. Related studies build on an empirical study by Grossman and Kreuger (1995), who found an inverted U-shaped relation where pollutant emissions increase as income increases but reach a turning point at which emissions start to decrease as income increases. The reduced-form econometrics model is the model most commonly used to examine the EKC hypothesis (Dinda, 2004; Kaika and Zervas, 2013), and has been applied to aggregate level cross-sectional panel data. The existing research in the EKC framework can be divided into three categories. The first category is the direct effect of income on emissions (Belaïd and Zrelli, 2019; Ben Cheikh et al., 2021; Kaika and Zervas, 2013), and the second category is the direct effect of social capital in an EKC framework (Grafton and Knowles, 2004; Carattini et al., 2015; Keene and Deller, 2015; Paudel et al., 2011). The third category is the combined effect of social capital with income in an EKC framework (Ibrahim and Law, 2014).

The current study mainly considers the combined effect of income and social capital on CO_2 emissions covering the direct effects of income and social capital on CO_2 emissions at the household level. Although household-level empirical studies are few, a detailed analysis of previous findings on the nexus of social capital, income, and environmental impact at the aggregate level is provided as follows. Grafton and Knowles (2004) used a cross-sectional data set covering low-, middle-, and high-income countries and tested the impacts of income and national measures of social capital such as civic engagement and trust on environmental

sustainability, air quality, water quality and SO_2 quality. The authors found little significant evidence of income or social capital on the considered pollutants. In addition, Paudel et al. (2011) conducted an econometric analysis on a cross-country panel data set, and constructed a social capital index with the elements of trust and civic engagement. Although the results show a significant effect of income in the EKC framework on CO_2, SO_2, and NO_2 emissions, the impact of social capital was not significant for any of pollutants. Carattini et al. (2015) examined the direct impacts of income and trust on greenhouse gas emissions across 29 European countries, and although they found a considerable impact of trust on emission reduction the effect of income on emissions was significant and mixed. Furthermore, the results of Keene and Deller (2015) supported that income and social capital reduce emissions. Ibrahim and Law (2014) estimated the combined impact of social capital, measured as an index of trust and network, and income on CO_2 emissions for 69 countries. They considered the separate effects of income in an EKC framework but not the separate effects of social capital. In contrast to our study, theirs used a panel data set and applied GMM estimation. The results showed significant negative and positive effects of the linear and quadratic terms of income with social capital respectively. The negative interaction term implies that emissions are low at a certain level of income because of a high level of social capital, but the positive impact of the squared interaction term contradicts that effect. However, the results of these studies are supported by the EKC hypothesis, and the inclusion of social capital reduces CO_2 emissions at each income level and speeds the turning point at which emissions start to decrease with an increase in income. Since the empirical studies on the nexus of social capital, income, and pollutant emissions offer unclear conclusions, the

relationships between social capital and income and between income and carbon emissions still merit further investigation.

While the existing literature discusses the separate effects and combined effects of social capital and income emissions at the national level in the EKC framework, this study address household-level social capital, income, and CO_2 emissions in the EKC framework. Therefore, this study contributes to the literature in notable aspects. First, this study extends the literature by incorporating household-level income and social capital into the existing income-CO_2 emissions research in the EKC framework. Since there is a lack of disaggregated CO_2 emissions data, this study uses satellite-monitored high-resolution (1×1 km) CO_2 emissions data corresponding with a survey across 30 countries. Second, this study considers not only the separate effects of income and social capital but also the combined effect of social capital through income on CO_2 emissions with both country and region fixed effects. Such an analysis can support effective policy-making to mitigate CO_2 emissions at the household level.

2.3. Methodology

2.3.1 Model

2.3.1.1 Bivariate analysis and binary logistic regression

This study focuses on the impact of social capital on CO_2 emissions by combining survey and satellite-monitored data. We first examined whether there is a difference between self-reported social capital and the level of concern about the global warming issue with income level in terms of the level of community attachment and social trust as a component of social capital using bivariate analysis for each country. We focused on CO_2 emissions because they are the principal cause of the global warming issue. In terms of the first question, for this

comparative analysis, we segmented respondents into two groups based on their responses. We categorized respondents who stated that they were completely attached or slightly attached to the local community inti the high community attachment group. Similarly, we categorized the respondents who stated that they were completely detached, slightly detached or neither to the local community into the low community attachment group. Furthermore, for social trust groups, we named the high social trust group and the low social trust group using the same method that we used in community attachment groups. In the high social trust group, we included respondents who stated that they thought that trusting people or organizations is very important or somewhat important, while in the low social trust group, we included respondents who stated that they thought that trusting people or organizations is not at all important, not very important or neither (for more information, see **Appendix Table 2-3**). Moreover, we considered the income level of the countries and divided them into two groups: low-income countries and high-income countries. Furthermore, in the responses of concern about the global warming issue, we considered only the 'very important' responses and the 'not at all important' responses. Finally, the responses regarding the three variables of community attachment, social trust, and global warming issue were used as percentages of each country sample size.

Next, the binary logistic regression model presented below was used to examine the statistical correlation between community attachment and social trust on concern about the global warming issue, with some sociodemographic factors as control variables to complement the bivariate analysis of the responses. Concern about the climate change issue was also considered in the binary logistic regression analysis because excessive CO_2 emissions cause these two issues.

$$\Pr(Y<|G, X) = \alpha_0 + \beta_1 CA_i + \beta_2 ST_i + \beta_k X_{ik} + \varepsilon_i \quad (1)$$

where Y is the dependent variable, which concerns the global warming and climate change issues. *CA* is the level of community attachment, and *ST* is the level of social trust. *X* is sociodemographic factors (education levels, income groups, economic gap, gender, and age) that affect self-reported outcomes.

2.3.1.2 Regression model for EKC hypothesis

Grossman and Krueger, (1991) developed the EKC hypothesis based on the Kuznets curve, proposed by Kuznets, (1955), which is relationship between per capita income and income inequality is an inverted U-shaped curve. Empirical evidence for the existence of the EKC has been found in various studies. Most of the data used in these studies are cross-sectional panel data and support a standard quadratic relation between income and CO_2 emissions (Apergis and Payne, 2009; Lean and Smyth, 2010; Pao and Tsai, 2011). Therefore, the general equation is formulated as follows:

$$Y_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_2 Z_{it} + \in_{it} \quad (2)$$

where Y is environmental indicators, X is income and Z relates to other variables that influence on environmental degradation. The subscripts i and t represent the country and years, respectively. α is constant, and β is the coefficient of the explanatory variables. ε is the error term. The presence of the EKC is verified by income parameters that are significantly different from zero, where β_1 is positive and β_2 is negative. Based on (2), the income turning point can be estimated as ($-\beta_1/2\beta_2$).

This part of the study focuses on the impact of household income and self-reported social capital on disaggregated CO_2 emissions. Following the empirical study of (Keene and Deller, 2015), the relationship between income and CO_2 emissions may present a linear logarithm quadratic form, and cross-sectional analysis can be undertaken to test the EKC hypothesis. Therefore, an empirical model with social capital is developed, as shown in equation (3).

$$lnCO_{2i} = \beta_0 + \beta_1 lnY_i + \beta_2\, lnY_i^2 + \beta_3 SC_i + \beta_4 SC_i^2 + \beta_5 lnYSC_i + \gamma Z_i + \delta D_c + \alpha D_r + \in_i \qquad (3)$$

In this setting, CO_{2i} is the dependent variable and refers to the mean CO_2 emissions square kilometer corresponding to respondent i. Likewise, Y_i represents the household income of respondent i. SC_i is the social capital score of respondent i. The term YSC_i is introduced as an interaction term of income with social capital. The term Z_i picks up a set of climate variables closely linked with climate change, which include minimum and maximum temperature, and wind speed. The terms D_c and D_r are country and region dummy variables, respectively. The regression error term is represented by $\in_i$. The variables CO_2 emissions and household income are in logarithmic form. Based on (2), the EKC is supported when $\beta_1 + (\beta_5 * SC_i)$ is positive and β_2 is negative, and the income turning point is $-[\beta_1 + (\beta_5 * SC_i] / 2\beta_2$. Social capital has a significant influence on the shape of the EKC if β_5 is statistically significant.

For the robustness of the results, we used robust standard errors to detect the heteroscedasticity problem, and the Breusch-Pagan test confirmed (Prob>Chi2=0.362) that there was no heteroscedasticity problem in the model. Furthermore, all statistical tests used an alpha level of P<0.05 for significance. Multicollinearity was investigated using the variable inflation factor (VIF). Multicollinearity was not found due to the mean VIF of all

variables was less than 10 (VIF= 2.13). Furthermore, the normality test confirmed that CO_2 emissions approximately follow a normal distribution in **Appendix Figure 2-4.**

2.3.2 Data

This study uses survey data on individual-level social capital, individual socioeconomic factors, and self-reported concern about the global warming and climate change issues covering 30 developed and developing countries across all continents and including 86,764 respondents (for more information on the survey, see (Chapman et al., 2019)). We used a quota sampling method based on each country's population, respondent age and gender. The web-based survey approach was used in this survey, which can prevent interviewer bias caused by arbitrary factors, such as the appearance or gender of interviewer, in responses to sensitive questions such as those regarding household income, employment and marriage status (Welsch and Kühling, 2009). We derived questions in the questionnaire based on the sociology and psychology literature. Additionally, we contacted a survey company in each country to translate the questionnaire into the native language and conduct the survey. When the questionnaire was translated into the native language, some responses to the questions were not matched with country characteristics (for an example: income ranges). Therefore, we had to change some response options considering the country context. Then, the survey questionnaires were collected via the services of Nikkei Research Inc., which is the most well-known survey company in Japan. The company ensured the validity of the answers of respondents by checking, for instance, the time the respondents took to complete the survey, and by translating and checking the questions and answers several times across countries before sending the respondents' answers to the department. In each country, the survey was

conducted online for a month between June 2015 and March 2017. The summary information of the survey is displayed at the country level in **Appendix Table 2-5**.

Social capital is measured by the two broad approaches of conducting a census of groups and group memberships, and using survey data on the levels of trust and civic engagement (Fukuyama, 2001). In this study, as a proxy for social capital measurement, we measured social capital using relevant questions validated in previous research to represent core dimensions of social capital, such as networks and norms. Networks can be divided into two groups (Portes, 2009): informal (family, friends, neighbors) and formal (associations, institutional). Likewise, norms can be segmented into two groups: norms of trust (social trust and institutional trust) and norms of reciprocity (Fukuyama, 1996). We then measured only two factors by asking related questions (see **Appendix Table 2-6**) that mainly concern effectively shared collective objectives and awareness-raising in the formal network and norms of trust. Finally, to compute a score, we computed the mean of those factors. Although this is an imperfect proxy for the social capital score, there is some evidence that these factors can be used to measure social capital (ref. Imbulana Arachchi and Managi, 2021; Knack and Keefer, 1997).

We then measured age and gender as binary dummy variables. The respondents between 18 and 40 years old were classified as young, and those over 40 years old were classified as old. The remaining variables are respondents' education level, income group, economic gap, concern about global warming, and concern about climate change, measured as categorical variables (for more information, see **Appendix Table 2-4**). With regard to respondents' household income collected as income ranges, we transform the categorical ranges of income into real values by taking the midpoint of the corresponding range and dividing this

midpoint by the purchasing power parity relative to USD, to account for transnational differences in currency and life cost (Jebb et al., 2018; Levinson, 2012).

Due to a lack of disaggregated data on CO_2 emissions, many scholars use satellite-monitored data (Chen et al., 2020). Therefore, CO_2 emissions data come from the Open-source Data Inventory for Anthropogenic CO_2 (ODIAC) across countries in this study. The ODIAC reports the monthly average of CO_2 emissions data at a 1×1 km resolution and comprises fossil-fuel combustion, cement production and gas flaring (Oda and Maksyutov, 2011; Umezawa et al., 2020). For the climate variables, the monthly average data of wind speed, and minimum and maximum temperatures, come from global maps of the TerraClimate data set at a 4-km resolution (Abatzoglou et al., 2018). Although we consider only 30 countries, they are responsible for 76% of CO_2 emissions worldwide in 2016, as estimated by World Bank data.

Finally, we pair the address of the respondents of our survey with monthly satellite data providing data regarding CO_2 emissions, and other climate variables. In addition, when we collected satellite data, we considered the corresponding months of the survey conducted in each country.

2.4. Results and discussion

In terms of research questions, first, we interpret our results on the level of people's concern about global warming with respect to levels of community attachment and social trust separately according to bivariate analysis. Then, we interpret the logistic regression results in complement with the bivariate analysis. Finally, the separate and combined effects of

household-level social capital and income on CO_2 emissions are presented in the EKC framework. The descriptive statistics of the variables are presented in **Table 2-1**.

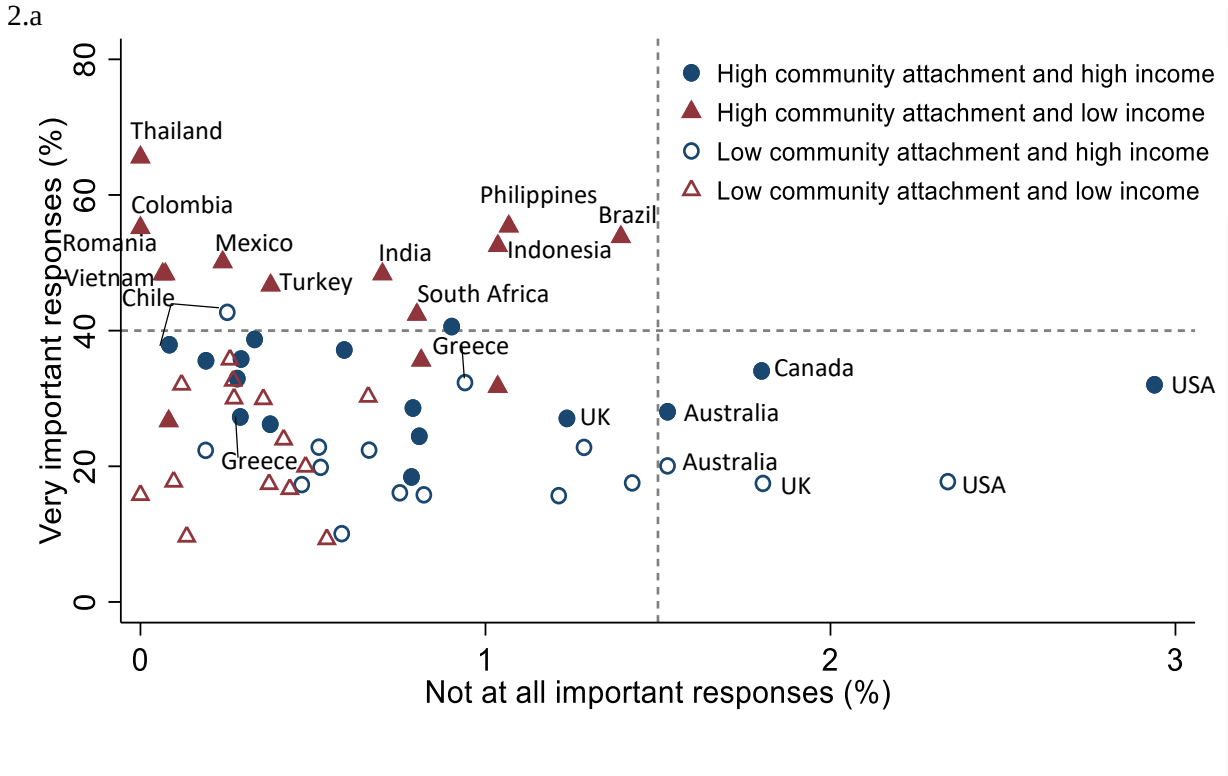
Table 2-1 Descriptive statistics of variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Variables of logistic regression					
Gender (Female =1, Male=0)	86,764	0.503	0.499	0	1
Age (Younger =1, Older =0)	86,764	0.365	0.481	0	1
Global warming	86,764	0.819	0.384	0	1
Climate change	86,764	0.806	0.395	0	1
Income groups	86,764	2.775	0.904	1	5
Education levels	86,764	3.405	0.701	1	4
Economic gap	86,764	2.977	1.574	0	1
Social trust	86,764	0.909	0.286	0	1
Community attachment	86,764	0.609	0.487	0	1
Variables of OLS regression					
Average level of Carbon dioxide emissions (tons)	86,764	2101.947	20228.54	0. 049	752589.8
Income (in USD PPP)	86,764	3649.29	3553.48	13.02	49638.57
Social capital	86,764	0.051	0.483	-2.08	1.23
Minimum temperature (^oC)	86,704	4.72539	12.31628	-33	30
Maximum temperature (^oC)	86,704	7.72375	8.346895	-22	43
Average wind speed (m/s)	86,704	0.9431	1.456557	0	8

2.4.1 Bivariate analysis

Figures 2-2a and **2-2b** present the self-reported outcomes of levels of community attachment and social trust on levels of people's concern about global warming. For both figures, countries that have a high average national income are represented by circles, and countries with a low average national income are represented by triangles. The data points of all 30 countries are named in **Appendix Figure 2-5**.

2.a



2.b

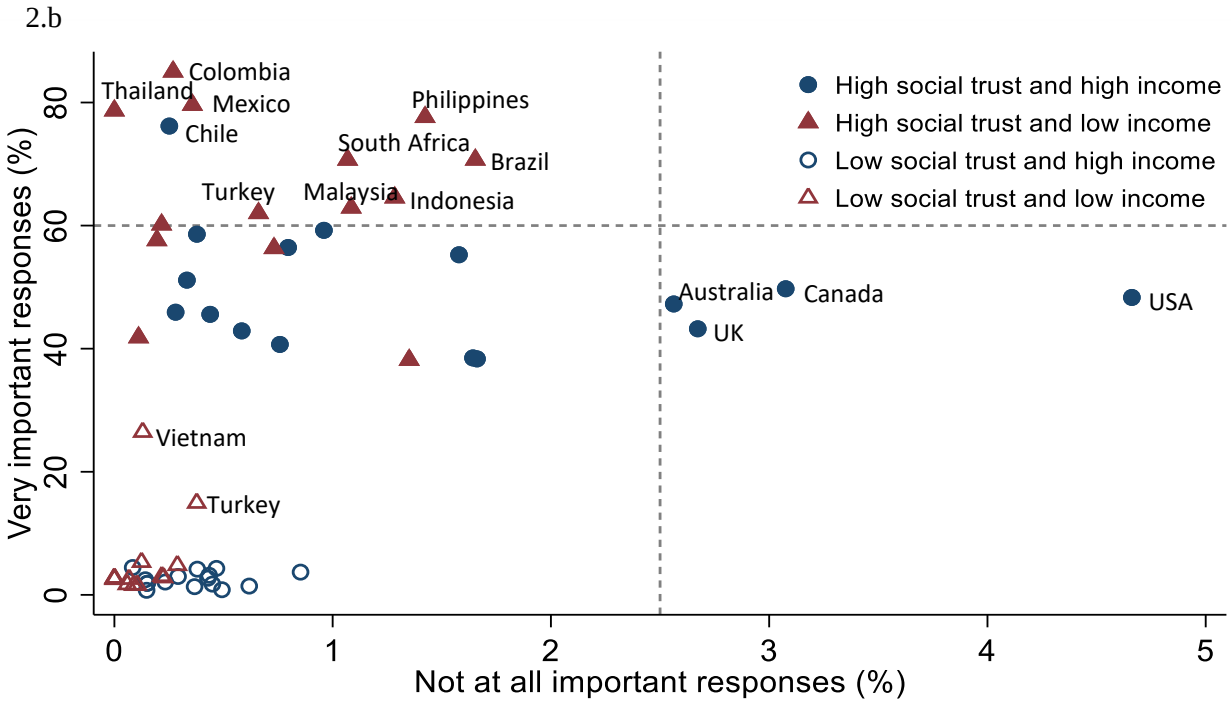


Figure 2-2 Individual level global warming concern outcomes

Note: a and **b** bivariate analysis of self-reported global warming concern level in terms of (**a**) levels of community attachment and (**b**) levels of social trust

Figure 2-2a illustrates the percentages of respondents who reported that 'having concern about global warming is very important' and 'having concern about global warming is not at all important'. Most countries with a high-income and high level of community attachment, tend to cluster between approximately 20% and 40%, while all countries with a low-income and a high level of community attachment tend to spread between 25% and 65% with regard to 'very important' responses. Interestingly, countries with a low income and a high level of community attachment, such as Thailand and Colombia tend to show a disproportionately high level of concern regarding the global warming problem with a very low level of 'not at all important' responses compared with the other countries in this group and the high-income group. More than 50% of respondents in Thailand, Colombia, Mexico, the Philippines, Indonesia, and Brazil reported that concern about global warming is very important.

Furthermore, the high-income country of the USA shows a disproportionately high level of 'not at all important' responses regarding concern about the global warming issue among both groups of high and low levels of community attachment when compared to other countries. In addition, Australia, Canada, and the UK show comparatively high levels of 'not at all important' responses compared to other high-income countries with high community attachment.

In addition, we note that the percentage of respondents who are reported that concern about the global warming issue is very important is higher in the high community attachment group than in the low community attachment group in both low-income and high-income countries, with the exception of two high-income countries which are the Czech Republic and Greece. This result is consistent with previous research, which has found that community attachment allows access to a higher flow of information about environmental issues and leads to

increased environmental awareness (Cramb, 2005; Wakefield et al., 2006). Furthermore, Cho and Kang (2017) found that locally-specific information through neighborly community attachment may play an important role in influencing environmentally beneficial practices.

Next, we discuss the results of the self-reported levels of social trust and concern on global warming issue (**Figure 2-2b**). In contrast to the data shown in **Figure 2-2a**, we observe a large difference between low and high levels of social trust in all the low-income and high-income countries. Compared to the groups with a high level of social trust in both low-income and high-income countries, all groups with a low level of social trust were located in the bottom left of **Figure 2-2b** and were almost close to zero, with the exceptions of Turkey and Vietnam. This implies that the respondents in the group with a low level of social trust did not express much concern about global warming as being either something very important or not important.

In addition, countries with low income and high social trust, such as Thailand, Colombia, and Mexico, tend to show a disproportionately high level of concern about the global warming problem compared with both other countries in this group and the high-income group. Interestingly, Thailand, Colombia, and Mexico are located in the top-left corner of both **Figure 2-2a** and **Figure 2-2b,** showing the highest outcomes. One special case that appeared in the **Figure 2-2b** was high-income country that is Chile, located in the top-left corner but below to above mentioned three low-income countries. In addition, similar to the data shown in **Figure 2-2a**, we observed in the **Figure 2-2b** also Thailand, Colombia, Mexico, Philippines, Brazil, and Indonesia show that highest outcomes. Furthermore, responses of the high level of social trust group of high-income countries spread between 40% to 60% whereas low-income countries cluster between around 40% to 85%.

Countries with a high income and high level of social trust, such as Australia, UK, Canada, and USA tend to show a high level of 'not at all important' responses than all other countries. Interestingly, both **Figure 2-2a** and **Figure 2-2b** show that both high social trust and high community attachment groups in the USA show the highest percentage of 'not at all important' responses. The other three countries, Australia, the UK, and Canada, display similar trends for the two groups in both figures. Overall, the results of **Figure 2-2b** also show that groups with higher social trust show a higher concern about the global warming issue. According to Pretty (2003), the mechanism of social trust is trusting fellow citizens with the perception that other members of the community will act similarly for the protection of the common good.

Finally, through this analysis, we noted that countries with high levels of community attachment and social trust show that higher level of concern about the global warming issue than do countries with low levels. Both the social trust and community attachment of residents can improve the sense of common responsibility (Hua et al., 2021; Song and Soopramanien, 2019). This means that higher social capital is associated with organizing the community for common objectives by trust and information. Analyses further indicated that although we used the national average income to group countries into the low-income or high-income group assuming that income level is correlated with self-reported responses, prior research suggests that income level is correlated with a number of outcomes, including well-being, health, socioeconomic status (Jebb et al., 2018; Kahneman and Deaton, 2010b), which was not supported by our analysis.

Although social capital plays a role in different socioeconomic contexts, this analysis of community attachment and social trust and its relationship with the self-reported concern

regarding the global warming issue within the local community, offers different conclusions. This is because we demonstrate novel evidence of features of social capital regarding the global warming issue in this study.

2.4.2 Regression analysis

Table 2-2 Results of the logistic regression analysis

Country	Marginal effects on global warming concern		Marginal effects on climate change concern	
	Community attachment	Social trust	Community attachment	Social trust
Overall	0.055***	0.205***	0.053***	0.175***
	(0.003)	(0.005)	(0.003)	(0.006)
Australia	0.021	0.377***	0.032	0.408***
	(0.024)	(0.069)	(0.024)	(0.073)
Brazil	0.065***	0.082**	0.069***	0.141***
	(0.019)	(0.039)	(0.022)	(0.044)
Canada	0.052*	0.254***	0.043	0.249***
	(0.031)	(0.063)	(0.031)	(0.064)
Chile	0.002	0.139***	0.019	0.153***
	(0.023)	(0.038)	(0.026)	(0.045)
China	0.014**	0.243***	0.002	0.198***
	(0.006)	(0.013)	(0.007)	(0.013)
Colombia	0.031*	0.040	0.039*	0.035
	(0.018)	(0.042)	(0.023)	(0.056)
Czech	0.055**	0.120***	0.035	0.114**
	(0.027)	(0.038)	(0.027)	(0.052)
France	0.067***	0.251***	0.031	0.215***
	(0.016)	(0.034)	(0.023)	(0.034)
Germany	0.062***	0.234***	0.077***	0.238***
	(0.019)	(0.028)	(0.019)	(0.028)
Greece	0.006	0.281***	0.041	0.229***
	(0.016)	(0.048)	(0.028)	(0.047)
Hungary	0.065**	0.176*	0.071**	0.121
	(0.028)	(0.101)	(0.028)	(0.102)
India	0.124***	0.261***	0.094***	0.145***
	(0.016)	(0.029)	(0.015)	(0.027)
Indonesia	0.069***	0.144***	0.089***	0.049
	(0.021)	(0.029)	(0.023)	(0.034)
Italy	0.036***	0.185***	0.041*	0.180***
	(0.012)	(0.014)	(0.023)	(0.036)
Japan	0.069***	0.237***	0.056***	0.196***
	(0.010)	(0.017)	(0.009)	(0.017)
Malaysia	0.048	0.141***	0.009	0.157**
	(0.030)	(0.061)	(0.031)	(0.066)

Continued				
Mexico	0.058***	0.135***	0.054***	0.149***
	(0.018)	(0.037)	(0.020)	(0.043)
Netherlands	0.095***	0.327***	0.071**	0.258***
	(0.032)	(0.046)	(0.032)	(0.044)
Philippines	0.045**	0.101**	0.060***	0.105*
	(0.021)	(0.051)	(0.022)	(0.057)
Poland	0.072***	0.243***	0.031	0.211***
	(0.017)	(0.045)	(0.021)	(0.043)
Romania	0.081***	0.182***	0.089***	0.117**
	(0.029)	(0.043)	(0.030)	(0.045)
Russia	0.002	0.084**	0.029	0.153***
	(0.025)	(0.039)	(0.026)	(0.041)
South Africa	0.058**	0.151**	0.056*	0.142*
	(0.027)	(0.072)	(0.029)	(0.082)
Spain	0.071***	0.215***	0.051**	0.220***
	(0.022)	(0.044)	(0.022)	(0.044)
Sweden	0.129***	0.259***	0.051**	0.242***
	(0.031)	(0.071)	(0.031)	(0.071)
Thailand	0.032	0.177***	0.004	0.198***
	(0.027)	(0.043)	(0.036)	(0.065)
Turkey	0.022*	0.058***	0.008	0.059**
	(0.012)	(0.011)	(0.020)	(0.011)
UK	0.082***	0.301***	0.067***	0.298***
	(0.019)	(0.045)	(0.019)	(0.044)
USA	0.057***	0.278***	0.049***	0.243***
	(0.011)	(0.024)	(0.011)	(0.024)
Vietnam	0.013	0.025	0.021	0.001
	(0.021)	(0.022)	(0.022)	(0.023)

Note: ***, ** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Robust standard errors in parentheses.

Table 2-2 complements the bivariate analysis of survey responses in **Figure 2-1**, predicting probabilities (marginal effects) of the logistic regression with levels of community attachment and social trust. For this, we estimated the country-level marginal effect while controlling relevant variables, identified country-level marginal effects in terms of the levels of community attachment and social trust on concern for the global warming problem, and then compared the across countries/overall marginal effects with each country results.

First, for community attachment, countries such as Brazil, France, Germany, Hungary, India, Indonesia, Japan, the Netherlands, Poland, Romania, Spain, Sweden, and the UK reported that probability of concerning the global warming issue would be higher among people with a high level of community attachment than the overall probability among people with a high level of community attachment. In contrast, Canada, China, Colombia, Italy, the Philippines, and Turkey presented a lower probability among people with high community attachment than the overall probability concerning the global warming issue. Furthermore, the Czech Republic, Mexico, South Africa, and the USA showed a probability among people with a high level of community attachment almost equal to the overall probability. In these three groups, which present higher, lower, and equal probabilities with respect to the overall probability, both low-income and high-income countries are represented.

Second, for social trust, in Australia, Canada, China, France, Germany, Greece, India, Japan, Malaysia, the Netherlands, Poland, Spain, Sweden, the UK, and the USA, the probability that people with a high level of social trust would express concern for the global warming issue is higher than the overall probability among people with a high level of social trust. This finding is interesting because all these countries are in the high-income category, and they represent four regions: North America, Europe, Australia and East Asia. Lower probabilities than the overall probability are reported in Brazil, Chile, Czech, Hungary, Indonesia, Italy, Mexico, the Philippines, Romania, Russia, South Africa, Thailand, and Turkey, which include both low-income and high-income countries.

Interestingly, countries with a high income, such as France, Germany, India, Japan, the Netherlands, Poland, Spain, Sweden, and the UK, show a higher probability of concern for the global warming issue than the overall probability, while the Philippines, Italy and Turkey

are reported to have a lower probability, considering both a high level of community attachment and a high level of social trust. In addition, we estimated the country-level marginal effect for climate change with the same variables as global warming (**Table 2-2**), and both analyses report similar trends, confirming the robustness of the results.

Furthermore, although compared to low-income countries, high-income countries have shown higher concern for global warming and climate change considering the two aspects separately, **Figure 2-3** shows the average social capital scores of 30 countries and how they differ from the overall average scores. We find that compared to high-income countries, low-income countries have higher average social capital scores than the overall average scores with a 95% confidence interval. Furthermore, **Figure 2-3** confirms the significant variation in the social capital score across countries compared to within countries. This suggests that behavioral advice is important, because human adaptation to climate change is a heterogeneous process influenced by more than just economic and technological development, as cultural norms play a key role (Adger et al., 2009; Kahneman and Deaton, 2010b).

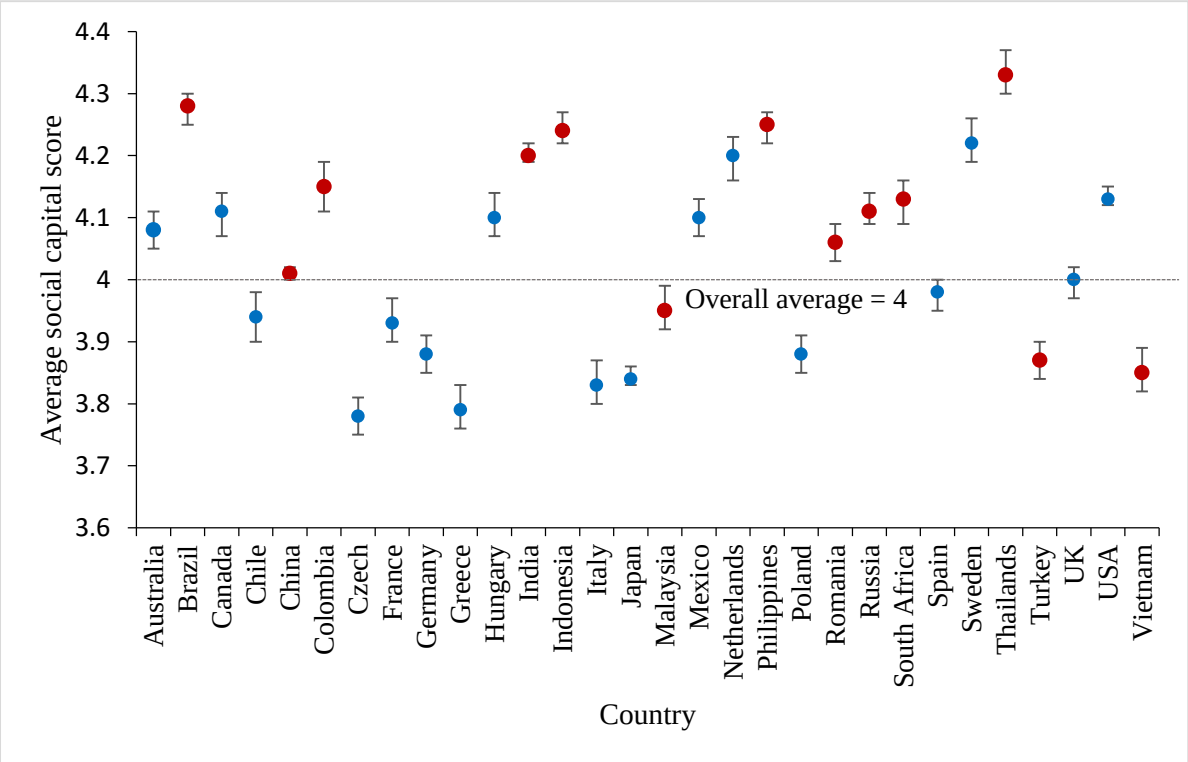


Figure 2-3 Significant difference in social capital score by country

Note: Solid blue and maroon circles denote high-income countries and low-income countries respectively with the corresponding 95% confidence interval.

Table 2-3 OLS regression estimates for CO_2 emissions

Variables	1.a	1.b	2.a	2.b	3.a	3.b	4.a	4.b	5.a	5.b
Log(Income)	0.271*** (0.046)	0.113** (0.115)	0.077*** (0.005)	0.019*** (0.005)	0.077*** (0.004)	0.020*** (0.005)	0.271*** (0.046)	0.115*** (0.014)	0.258*** (0.047)	0.102*** (0.047)
Log(Income)^2	-0.077*** (0.003)	-0.028*** (0.003)					-0.024*** (0.003)	-0.009*** (0.003)	-0.071*** (0.003)	-0.019*** (0.003)
Social capital (SC)			-0.074*** (0.011)	-0.037*** (0.011)	-0.296*** (0.077)	-0.478*** (0.080)	-0.078*** (0.011)	-0.042*** (0.011)	-0.321*** (0.079)	-0.483*** (0.081)
Social capital^2							0.019 (0.013)	-0.044*** (0.014)	-0.022 (0.013)	-0.044*** (0.014)
Log(Income)*SC					0.025*** (0.008)	-0.056*** (0.010)			-0.031*** (0.009)	-0.056*** (0.010)
Constant	6.495*** (0.174)	5.249*** (0.174)	5.238*** (0.047)	4.775*** (0.045)	5.292*** (0.044)	4.765*** (0.045)	6.472*** (0.174)	5.264*** (0.174)	6.427*** (0.175)	5.177*** (0.175)
Observations	79,567	79,567	79,567	79,567	79,567	79,567	79,567	79,567	79,567	77,997
R-squared	0.392	0.340	0.392	0.340	0.392	0.34	0.393	0.34	0.393	0.34
Weather variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country dummy	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Regional dummy	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Income turning point	5,891	7,062					5,645	6,388	4,934	3,285

Note: *** denote statistical significance at the 1%. Robust standard errors in parentheses.

In addition to the self-reported outcomes and country-level trends described above, we estimated ordinary least squares regression, adding complementary secondary data to investigate the separate and combined effects of social capital score and income on CO_2 emissions. Turning to the results of **Table 2-3**, we present the linear and quadratic ordinary least square regression results with two specifications: country fixed effects and region fixed effects. The coefficient of the social capital score shows a negative and significant correlation with CO_2 emissions in all models, and these effects are increased by the negative and significant effect of the interaction term, except in linear model 3.a. The quadratic term of social capital shows both positive and negative correlations, but only the negative correlation is significant. The negative correlation of social capital is in contrast with the findings of Grafton and Knowles (2004), but it is consistent with the finding of Carattini et al. (2015), that social capital significantly reduces GHG emissions.

The correlation coefficient of income on CO_2 emissions is positive and significant for the linear term, and the coefficient of the quadratic term is negative and significant in all models. This result shows a similar trend to the EKC relationship in CO_2 emissions and household income. The turning point of income varies between approximately USD 3200 and USD 7000, where the lower level is below and the upper level is above the average income of approximately USD 3600 but within the range of the minimum and maximum income levels (see **Table 2-1**). When comparing the turning points in models 1.a and 1.b without the inclusion of social capital, it is noticed that the inclusion of social capital can be decreased with two model specifications (models 4.a and 4.b, and 5.a and 5.b). This result is in line with a prior study of Ibrahim and Law (2014), who

found a positive impact of social capital on the income turning point at the aggregate level. Furthermore, the income turning point of region-level model 5.b is the lowest level, and it is below the average income level. Overall, social capital has mechanism to mitigate CO_2 emissions at household level through behavioral intervention. Mi et al. (2020) found that the urban carbon footprint is higher than the carbon footprint of rural households, but rich households contribute to consumption decarbonized items in China. Given the negative effect of social capital on emissions, when income increases with social capital, behavioral intervention can be achieved: for example, social capital can influence higher income households to consume more decarbonized goods.

2.5. Conclusion

This study investigates the impact of social capital and income on CO_2 emissions. Based on the cross-sectional data of 30 countries including 86,764 respondents, linear and quadratic household-level income and social capital models are estimated in the EKC framework. Several interesting facts can be found, as follows.

First, countries with high levels of community attachment and social trust are associated with higher concern about the global warming issue than countries with low levels. Second, respondents in low-income countries who have higher community attachment and social trust show a higher level of concern about the global warming issue than such respondents in high-income countries. Third, within-country individual differences between groups with low and high levels of community attachment and social trust are much larger in high-income countries than in low-income countries. Fourth, the separate effect of income is associated with increased CO_2 emissions, while social

capital is associated with decreased CO_2 emissions. Finally, the combined effects of income and social capital are correlated to reduce the positive impact of income on CO_2 emissions. The empirical results prove that social capital is a mechanism to address climate change mitigation actions by reducing CO2 emissions.

This study has some implications. (1) Higher community attachment and social trust are associated with higher concern about the global warming issue. This inference is in line with people who are highly attached to the community being more likely to work together to achieve a desired outcome, such as protecting the environment (Brown et al., 2002), and social trust promotes cooperation in the form of pro-environmental behaviors (Gupta and Ogden, 2009; Van Lange et al., 1998). Therefore, it is necessary to consider the opportunities for development engagement and trust in society for emissions reduction. It is worthwhile for policy makers to develop customized policies to enhance social capital at the community level. For instance, such policies could involve organizing environmental activities or facilitating meeting opportunities that can be influential trust and engagement at the community level.

(2) Low-income countries show a higher level of concern about the global warming issue than high-income countries. This is because although high-income and productive countries are larger CO_2 emitters than low-income countries (Solaymani, 2019), it might be that most developing countries are more vulnerable to climate change (Mertz et al., 2009). Therefore, high-income countries can learn from low-income countries in terms of the important factors that underpin concern about global warming, and take a role reducing the negative impact of excessive CO_2 emissions, such as providing compensation or engaging in less emissions-intensive economic activities.

(3) Within-country individual differences between groups with low and high levels of community attachment and social trust are much larger in high-income countries than in low-income countries. When formulating social capital development opportunities, it is necessary to consider the geographical differences (rural and urban) that can considerably influence individual outcomes. Because more rural communities exhibited lower levels of community attachment than communities in most urban area (Kyle et al., 2010), people who live in urban areas may have more social relationships and be more socially active (Sampson, 2016).

(4) The separate effect of income is associated with increased CO_2 emissions, while social capital is associated with decreased CO_2 emissions, and the combined effect of income and social capital is correlated with a reduced positive impact of income on CO_2 emissions. This result is in line with a prior study by Ibrahim and Law (2014), who found a positive impact of social capital on the income turning point at the aggregate level. Empirical evidence suggests that civic engagement and trust are positively correlated with social internet use (Pénard and Poussing, 2010). Therefore, online platforms can be used as a potential channel for sharing information and promoting public policies and regulations to reduce CO_2 emissions. Furthermore, power groups of environmental organizations at the community level can be involved in the aforementioned sharing process across the nation and region wide. However, to increase the stock of social capital in society, rational thinking and policy expertise are required, with the understanding that social capital can produce both positive and negative externalities in different contexts (Fukuyama, 2001; Imbulana Arachchi and Managi, 2021).

There are some limitations of this study that need to be addressed in the future. First, this study considers social capital as the main independent variable. Social capital is a multidimensional concept, and it can be measured using several core dimensions. We used those core dimensions and measured their characteristics. Ideally, several questions would be used to capture each characteristic, but we used single questions to measure formal network and norm of trust. This limitation means that our results do not captured all the aspects that can be measured to show respondents' levels of formal networking and social trust. However, although this is an imperfect proxy for the social capital score, there is evidence that a single question can be used to assesses these variables (Werner et al., 2013).

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Appendix 2

Table 2-4 Logistic regression model parameters

Dependent variables	Measurements	Independent variable	Measurements
Global warming	Very important=1, Other=0	Community attachment	5. Completely attached 4. Slightly attached } =1
			3. Neither 2. Slightly detached 1. Completely detached } =0
		Social trust	5. Very important 4. Somewhat important } =1
			3. Neither 2. Not very important 1. Not at all important } =0
		Gender	Female =1, Male =0
		Age	Younger =1, Older =0
Climate change	Very important=1, Other=0	Income groups	1.Lower 2.Lower middle 3.Middle 4.Upper middle 5.Upper
		Education levels	1.Not attended 2.Primary 3.Secondary 4.Tertiary
		Economic gap	0.Do not know 1.Does not exist 2.Not so large 3.Average 4.Slightly large 5.Very large

Table 2-5 Survey information

Country	Survey method	Survey period		Observation	Income level*
Australia	Internet	10/02/2016	22/02/2016	2,029	High
Brazil	Internet	23/07/2015	26/07/2015	2,298	Low
Canada	Internet	01/09/2016	13/09/2016	1,333	High
Chile	Internet	24/07/2015	28/07/2015	1,192	High
China	Internet	12/01/2016	29/02/2016	20,744	Low
Colombia	Internet	07/24/2015	27/07/2015	1,115	Low
Czech	Internet	08/03/2017	16/03/2017	1,400	High
France	Internet	26/08/2016	07/09/2016	2,138	High
Germany	Internet	26/08/2016	07/09/2016	3,165	High
Greece	Internet	31/08/2016	12/09/2016	1,382	High
Hungary	Internet	08/03/2017	15/03/2017	1,354	High
India	Internet	25/07/2015	11/08/2015	6,700	Low
Indonesia	Internet	18/07/2015	23/07/2015	2,413	Low
Italy	Internet	29/08/2016	10/09/2016	2,106	High
Japan	Internet	14/07/2015	05/08/2015	11,167	High
Malaysia	Internet	23/07/2015	29/07/2015	1,106	Low
Mexico	Internet	24/07/2015	27/07/2015	1,678	Low
Netherlands	Internet	29/08/2016	10/09/2016	1,371	High
Philippines	Internet	15/07/2015	22/07/2015	1,686	Low
Poland	Internet	08/03/2017	17/03/2017	2,227	High
Romania	Internet	08/03/2017	18/03/2017	1,386	Low
Russia	Internet	31/08/2015	14/09/2015	2,221	Low
South Africa	Internet	15/07/2015	23/07/2015	1,123	Low
Spain	Internet	26/08/2016	07/09/2016	2,116	High

Continued					
Sweden	Internet	31/08/2016	12/09/2016	1,330	High
Thailand	Internet	18/07/2015	23/07/2015	1,127	Low
Turkey	Internet	07/03/2017	20/03/2017	2,120	Low
UK	Internet	16/08/2016	28/08/2016	2,993	High
USA	Internet	16/08/2016	28/08/2016	10,683	High
Vietnam	Internet	18/07/2015	28/07/2015	1,541	Low

Note:* World Bank new country classifications by income level: 2019-2020

Table 2-6 Description of questionnaire and variables

Variables	Questions and responses
Global warming	Please select an option that appropriately describes the level of importance for global warming problem. 1. Not at all important, 2. Not very important, 3. Neither, 4. Somewhat important, 5. Very important
Climate change	Please select an option that appropriately describes the level of importance for climate change problem. 1. Not at all important, 2. Not very important, 3. Neither, 4. Somewhat important, 5. Very important
Community attachment	How attached are you to your local community? 1. Completely detached, 2. Slightly detached, 3. Neither, 4. Slightly attached, 5. Completely attached
Social trust	To be able to believe people/organizations is 1. Not at all important, 2. Not very important, 3. Neither, 4. Somewhat important, 5. Very important
Income level	Which income group do you feel that you belong within your country? 1. Lower, 2. Lower middle, 3. Middle, 4. Upper middle, 5. Upper
Economic gap	Please select an item that appropriately describes your point of view about inequality in local community 0. Do not know, 1. Does not exist, 2. Not so large, 3. Average, 4.Slightly large, 5. Very large
Income	Household monthly income

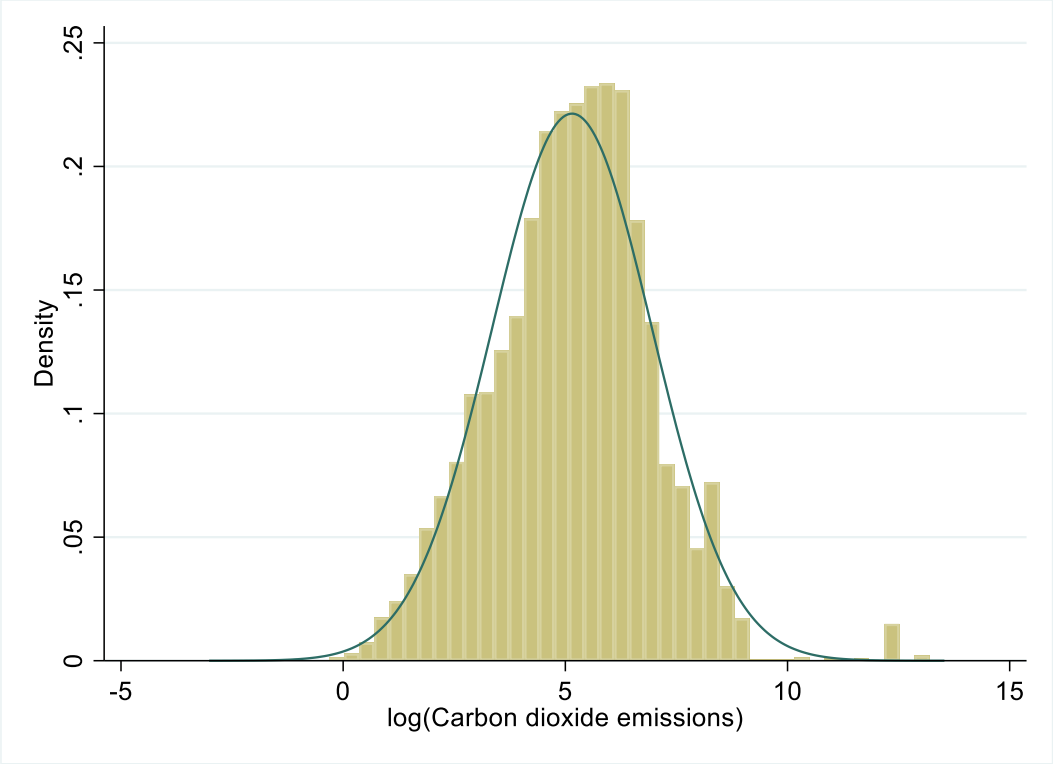

Figure 2-4 Histogram of CO_2 emissions

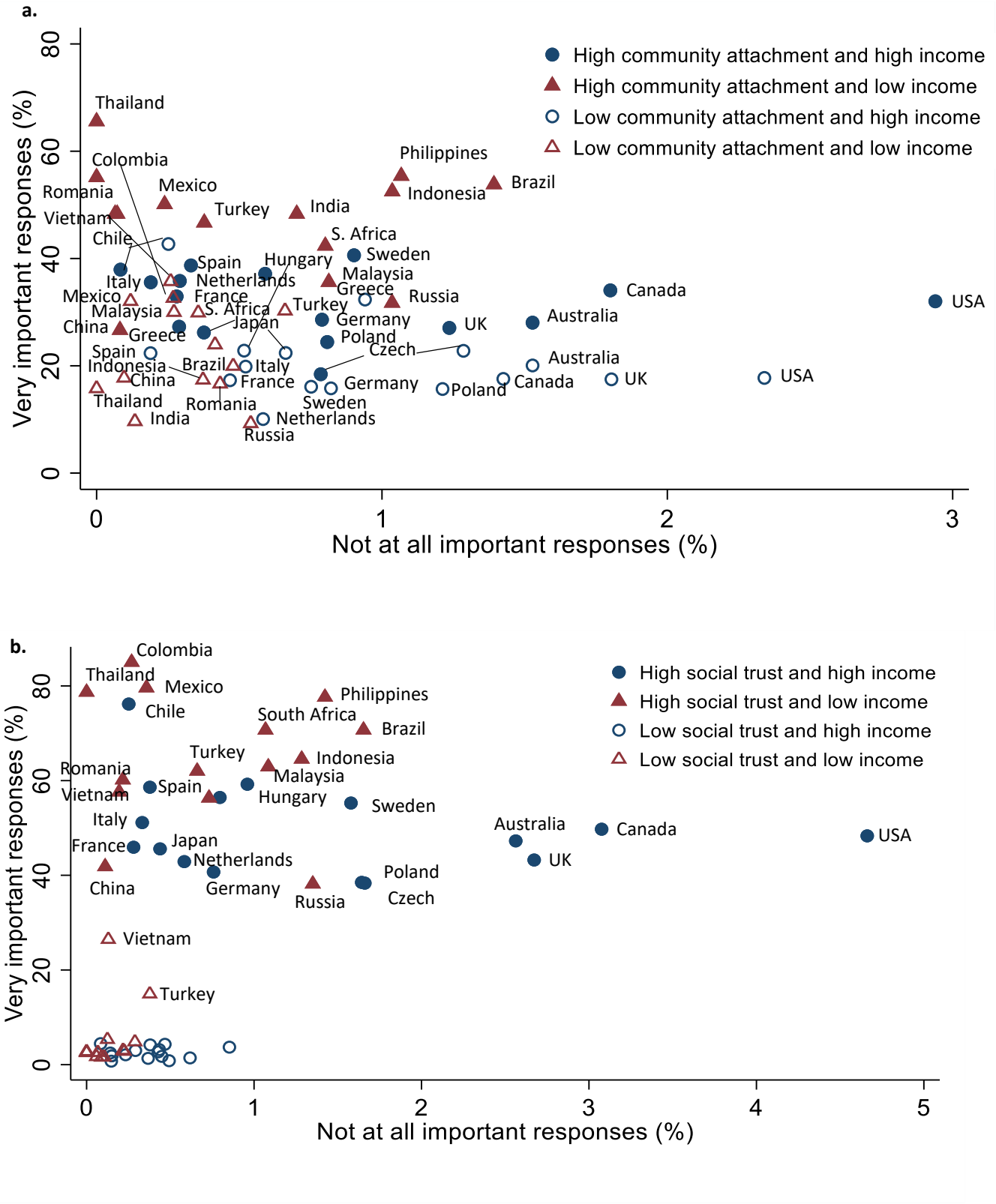

Figure 2-5 Individual level global warming concern outcomes

Note: a and **b** bivariate analysis of self-reported global warming concern level in terms of (**a**) levels of community attachment and (**b**) levels of social trust

Chapter 3: The role of social capital in Covid-19 deaths

3.1. Introduction

Since the first report of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in China, the coronavirus disease 2019 (Covid-19) (Zhu et al., 2020) spread as a pandemic affecting the whole world. More than 35 million people have been infected while more than 1 million deaths were reported by October 5,2020. The Covid-19 pandemic shows a continuously increasing trend with a huge variation in the infections and deaths across countries. Compared with the other countries, most of the American and European countries experienced a large number of Covid-19 cases and deaths(ESRI, 2016). In response to the rising numbers of cases and deaths, many countries have implemented non-pharmaceutical methods of interventions, such as social distancing, case isolation and quarantine, contact tracing, and lockdowns (Flaxman et al., 2020; Hellewell et al., 2020; Mattioli et al., 2020; Nicola et al., 2020; Pulla, 2020). Although many studies were conducted, we know little the ways of permanently controlling this pandemic and the reasons behind the variation in cases and deaths across countries. This kind of differences implicit that not only clinical characteristics but also other factors such as social capital determine Covid-19 deaths.

The concept of social capital was initially defined by sociologists in the 1980s as the aggregated value of connections between individuals and the norms of mutuality developed from the network (Coleman, 1988). Social capital is the commonly identified traits of social organization, such as trust between individuals, standards of

correspondence and interpersonal connections that could increase the efficiency of society creating platforms which could be beneficial to many parties (Kawachi et al., 1999). Previous studies have examined relationships between social capital and health outcomes (Ehsan et al., 2019; Harpham et al., 2002; Hawe and Shiell, 2000; Kabayama et al., 2017; Moore et al., 2009; Murayama et al., 2012; Takakura, 2015; Villalonga-Olives and Kawachi, 2017). Although most of social capital and health studies have provided the positive side of social capital (Ehsan et al., 2019; Harpham et al., 2002; Hawe and Shiell, 2000; Murayama et al., 2012), studies related to negative side of social capital on health have been growing (Moore et al., 2009; Takakura, 2015; Villalonga-Olives and Kawachi, 2017). Therefore, the relationship between social capital and health is a double-edged phenomenon (Villalonga-Olives and Kawachi, 2017). An important problem that needs to be addressed is the connection between social capital and the prevalence of Covid-19 related deaths, based on existing studies on the relationship between social capital and health.

In the pandemic context, some clinical studies have shown that Covid-19 mortality can occur due to by age, smoking, obesity, lack of immunity, hospital care, and it also can be commonly observed among patients with some other diseases such as diabetes and heart diseases (Chen et al., 2020; Wang et al., 2020; Yin et al., 2020; Zhou et al., 2020). However, only this clinical evidence is insufficient to propel the implementation of policies to reduce the number of Covid-19 related deaths. However, certain studies related to social capital have attempted to fill the gap left by the lack of research on Covid-19. Several studies have concluded that the development and the maintenance of different types of social ties leads to response Covid-19 pandemic (Pitas and Ehmer,

2020). Furthermore, high social capital areas show lower additional Covid-19 mortality compared to low social capital areas (Bartscher et al., 2020). Others have discussed that bridging and linking social ties were associated with spread of Covid-19 directly (Fraser and Aldrich, 2020). A recent study has analyzed the positive association for Covid-19 deaths with social trust (Elgar et al., 2020). However, the results of previous studies related to Covid-19 have not shown a similar conclusion on social capital and Covid-19 related deaths.

This study aims to investigate the relationship between social capital related factors which are community attachment, social trust, family bond, and security with several control variables on Covid-19 deaths, hypothesizing Covid-19 deaths can be explained more through social capital. Social capital can be measured by different dimensions and in this study, the four factors of community attachment (Clark et al., 2019; Tsurumi et al., 2019), social trust (Bjørnskov, 2008; Clark et al., 2019; Ram, 2010; Rodríguez-pose and Berlepsch, 2012), family bond (Helliwell and Putnam, 2004), and security (Helliwell and Putnam, 2004) were used to measure social capital based on some previous studies. Moreover, we assume that rely on rely on both prior pandemic and health studies of positive relationship between social capital and health (Chuang et al., 2015; Jung et al., 2013; Rönnerstrand, 2013), all these four factors may associate negatively on Covid-19 related deaths. Linear regression analyses were performed, and eight different linear regression models were regressed with social capital related factors and by adding other explanatory variables one by one (**Table 3-2**). We analyzed data on Covid-19 deaths in 37 countries until 5 October 2020. We examined how social capital associate with Covid-19 deaths as well as association of social capital with aged

population on Covid-19 deaths. Finally, this study analyzed the relationship of Covid-19 deaths with population density, aged population, number of hospital beds, and country lockdown, as a proxy for governments' policy.

3.2. Methods

3.2.1 Study design and data sources

For this study, we used data from open access databases and our survey data. We collected Covid-19 related data from the website "COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University" (CSSE,2020). This website has complied data from several important sources, such as the World Health Organization (WHO), European Centre for Disease Prevention and Control (ECDC), and WorldoMeters which had documented Covid-19 case numbers, death numbers, recovered numbers, active case numbers, testing rate, case-fatality ratio and incidence rate from 188 countries by country, provinces/states. We identified 35,157,350 Covid-19 cases with 1,037,075 deaths at 11.00 AM on October 05,2020 from the CSSE database.

Social capital data was collected from a large-scale survey of 100,956 respondents across 37 countries that including web-based and face-to-face surveys covering all regions/provinces/states of 37 countries in 2017. Data regarding population density, hospital beds numbers, and population age 65 or older, was retrieved from the World Development Indicators (WDIs) (The World Bank, 2020). Data on country lockdown was obtained from the website "National responses to the 2019-20 coronavirus pandemic" (National responses to the COVID-19 pandemic, 2020).

The most recent year for WDI country data was available in 2018. After merging our survey data with Covid-19 data and WDI country- level data, the study sample consisted of totally 765,875 deaths in 37 countries. Among 37 countries, 8 countries which are China, India, USA, Indonesia, Brazil, Russia, Mexico, and Japan were separated into provinces/states due to highest population countries in the sample. Therefore, total number of observations was 294. The sample countries are described in **Appendix Table 3-3.**

3.2.2 Variables

Covid-19 death was measured as number of deaths per square km^2. The deaths per km^2 were calculated by dividing the number of deaths by the land area km^2 of 29 countries and land area km^2 of provinces of 8 largest population countries.

The social capital was measured by four factors which were constructed from previous studies in different dimensions. For instance, community attachment, social trust, family bond, and security. Therefore, those four factors were used to measure social capital in this study. All those four variables are dummy variables and community attachment, social trust, and security were measured by Likert scale whereas family bond was measured as binary dummy variable. Then, the average values of all four variables for 29 countries and for 8 countries by provinces, were calculated. The questions for measure to social capital related factors are described in **Appendix Table 3-4.**

Rest of other explanatory variables are population density, population age 65 or older, interactions terms between population age 65 or older and social capital related factors.

Number of hospital beds, and country lockdown. Population density was measured by dividing total population of each country by land area km^2 of 29 countries and land area km^2 of provinces of 8 largest population countries. Population aged 65 or older was measured by dividing total population of each country by land area km^2 of 29 countries and total population of provinces of 8 highest population countries. The number of beds was measured per 1,000 people. Country lockdown was a dummy variable and it was measured by the number of days that were spent to take the decision to shut down/lockdown or imposed stay at home order of considered countries after report the first covid-19 case in China. If a country was locked down or imposed stay at home order after 50 days, it was called an early lockdown, if it was locked down after 100 days, it was called a late lockdown and if a country was not locked down, it was referred to as no lockdown. We used all the variables in log-form except number of beds and country lockdown to make the data conform more closely to the normal distribution and to improve the model fit.

3.2.3 Multiple regression analyses

First, we investigated the correlation between Covid-19 deaths per km^2 and four factors which used to measure social capital, because the social capital is the main explanatory predictor than other predictors in our model.

In the multiple regression analyses, Covid-19 deaths per km^2 is the dependent variable and the main explanatory variable is social capital. Therefore, we regressed eight different linear regression models with social capital related variables and the other explanatory variables were added one by one. All analyses were performed using the Stata 16 software.

3.3. Results

3.3.1 Descriptive statistics

Table 3-1 Descriptive statistics of model variables

Variables	N	Mean	SE	95% CI
Death per km^2	293	0.08	0.029	0.03-0.14
Social Capital related factors				
Community attachment [a]	293	3.71	0.03	3.65-3.77
Social trust [b]	293	4.55	0.01	4.52-4.57
Family bond [c]	293	0.90	0.01	0.88-0.93
Security [d]	293	2.95	0.02	2.91-2.98
Other explanatory variables				
Population density	293	466.78	83.53	302.37-631.19
Population aged 65 or older per km^2	293	42.77	8.67	25.69-59.84
Community attachment*Population aged 65 or older per km^2 (Aged65CA)	291	2.79	0.15	2.48-3.09
Social trust* Population aged 65 or older per km^2 (Aged65ST)	291	3.00	0.15	2.69-3.31
Family bond* Population aged 65 or older per km^2 (Aged65FB)	290	1.34	0.16	1.03-1.66
Security* Population aged 65 or older per km^2 (Aged65S)	291	2.56	0.15	2.26-2.87
Bed number per 1,000 people	293	4.28	0.25	3.79-4.77
Country lockdown [e]	293	2.04	0.06	1.93-2.16

Note: [a,b,d] Range of data: from 1 to 5. [c] Range of data: from 0 to 1. [e] Range of data: from 1 to 3.

Social capital data were collected from a large-scale survey of 100,956 respondents across 37 countries that including web-based and face-to-face surveys covering all regions/provinces/states of 37 countries. However, most of countries which are reported highest Covid-19 infections and deaths were included in our sample such as USA, India, Brazil, Russia, and Spain.

Table 3-1 summarizes the Covid-19 deaths per square kilometer (km^2) and regression covariates. For the 294 observations (29 countries and 264 provinces of 8 countries), the mean Covid-19 deaths per km^2 was 0.09 (95% CI 0.03 to 0.14). The mean community attachment was 3.71 (95% CI 3.65 to 3.77); the mean social trust was 4.53

(95% CI 4.52 to 4.57); the mean family bond was 0.90 (95% CI 0.88 to 0.93); and the mean security was 2.95 (95% CI 2.91-2.98). Furthermore, the mean population density was 466.78 (95% CI 302.37 to 631.19); the mean population aged 65 or older per km^2 was 42.77 (95% CI 25.69 to 59.84); the mean population aged 65 or older with community attachment was 2.79 (95% CI 2.48 to 3.09); the mean population aged 65 or older with social trust was 3.00 (95% CI 2.69 to 3.31); the mean population aged 65 or older with family bond was 1.34 (95% CI 1.03 to 1.66) the mean population aged 65 or older with security was 2.56 (95% CI 2.26 to 2.87) ; the mean bed number per 1,000 people was 4.28 (95% CI 3.79 to 4.77), and the mean country lockdown policy was 2.04 (95% CI 1.93 to 2.16).

3.3.2 Simple regression analyses: relationships between Covid-19 deaths per km^2 and social capital

Relationships between Covid-19 deaths per km^2 and social capital related factors are illustrated in **Figure 1**. **Figure 1a**, and **1b** demonstrates that Covid-19 deaths per km^2 was positively and significantly associated with community attachment for all countries ($r = 0.27$, $P = 0.000$) and provinces of 8 countries ($r = 0.24$, $P = 0.000$). Figure 1c and 1d also displays that the positive correlation between Covid-19 deaths per km^2 and social trust was significant for all countries ($r = 0.29$, $P = 0.000$) and provinces of 8 countries ($r = 0.32$, $P = 0.000$). In contrast, Figure 1e and 1f exhibits that the negative and significant correlation between Covid-19 deaths per km^2 and family bond for all countries ($r = 0.15$, $P = 0.014$) and provinces of 8 countries ($r = 0.21$, $P = 0.001$). Finally, **Figure 1g** and **1h** reveals that the negative correlation between Covid-19 deaths per km^2 and security for all countries ($r = 0.07$, $P = 0.231$) and provinces of 8 countries ($r = 0.06$, $P = 0.307$).

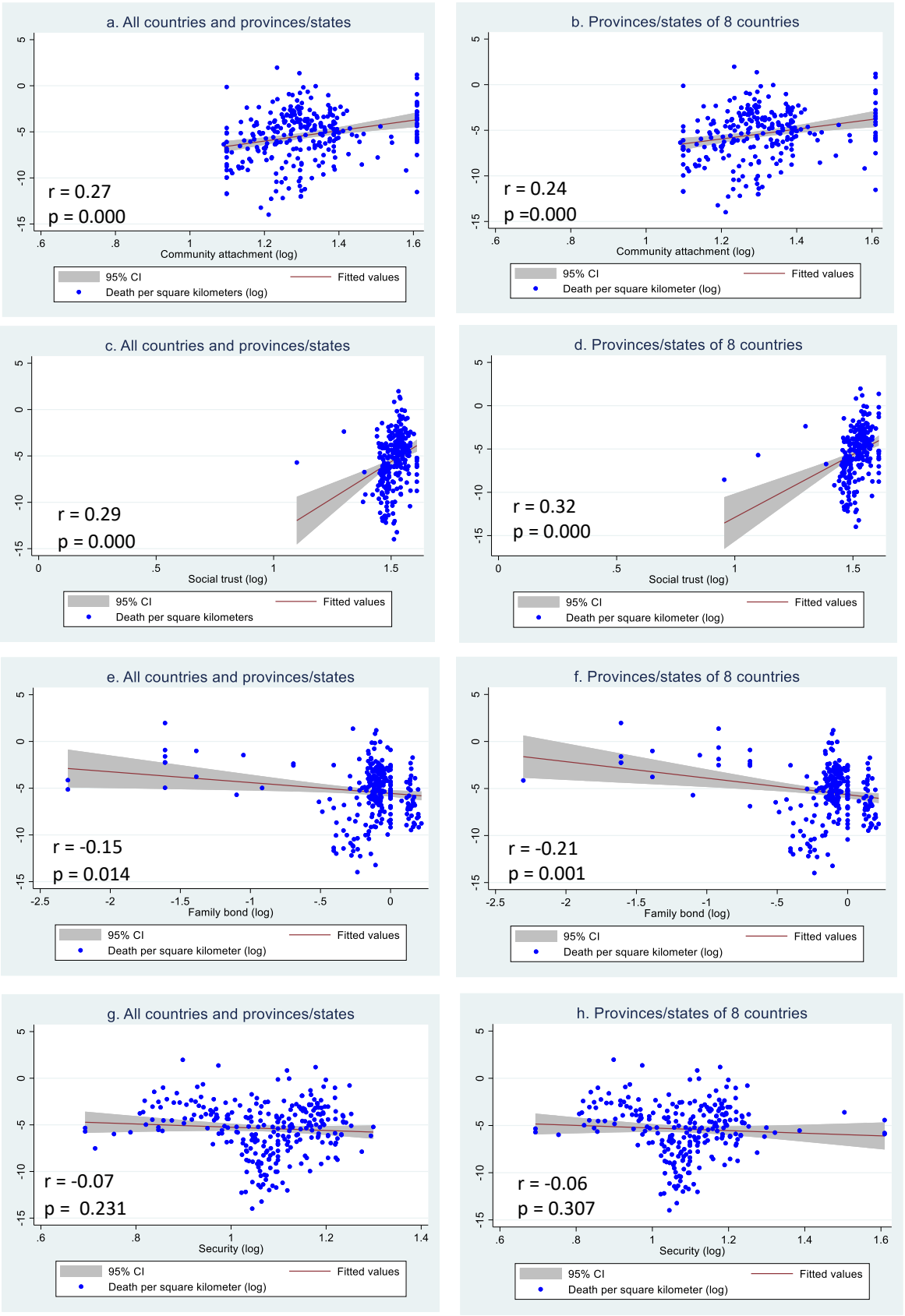

Figure 3-1 Correlation between Covid-19 deaths per km^2 and social capital related factors

Note: Sample was categorized by two groups such as **a**, **c**, **e** and **g** were considered 29 countries and 8 largest population countries by provinces/states together (N=294) and **b**, **d**, **f** and **h** were considered only 8 largest population countries by provinces/states (N=265). Red lines are linear predictions of Covid-19 deaths per km^2 on each factor of social capital. The 95% confidence intervals of the fitted values are shown by gray areas (r: correlation coefficient, p: probability value).

3.3.3 Multiple regression analyses

Results of multiple regressions for predicting Covid-19 deaths per km^2 are shown in **Table 3-2**. According to our aim, we included the social capital related factors for all specifications (1-8) to check robustness of the predictions of social capital related factors. In column 1-7, we included one by one other explanatory variables with social capital related factors. In column 3-6, we included social capital related factors with population aged 65 or older as interaction terms. In column 8, we included all of explanatory variables simultaneously in the regression model.

Table 3-2 Multiple regressions result for Covid-19 deaths

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Intercept	-41.974***	-33.473***	-33.473***	-33.473***	-33.473***	-33.473***	-19.645***	-21.416***
	(6.606)	(6.216)	(3.552)	(6.216)	(6.216)	(6.215)	(5.431)	(4.623)
Log (Community	3.767***	4.862***	4.181***	4.862***	4.862***	4.862***	3.581***	2.273**
attachment)	(1.139)	(1.019)	(1.026)	(1.019)	(1.019)	(1.019)	(1.188)	(0.997)
Log (Social trust)	21.007***	15.859***	15.859***	15.178***	15.859***	15.859***	8.285**	10.769***
	(4.216)	(3.869)	(3.869)	(3.855)	(3.869)	(3.869)	(3.351)	(2.831)
Log (Family bond)	-0.858***	-1.485***	-1.485***	-1.485***	-2.166***	-1.485***	-0.570*	-0.345*
	(0.308)	(0.326)	(0.326)	(0.326)	(0.329)	(0.326)	(0.342)	(0.191)
Log (Security)	-2.983***	-3.384***	-3.384***	-3.384***	-3.384***	-4.065***	-3.586***	-5.096***
	(0.961)	(0.882)	(1.035)	(0.882)	(0.882)	(0.882)	(1.096)	(0.849)
Log (population density)	0.623***							0.357***
	(0.075)							(0.101)
Log (Age65 or older)		0.681***						0.612***
		(0.049)						(0.087)
Log (Aged65CA)			0.681***					
			(0.049)					
Log (Aged65ST)				0.681***				
				(0.049)				
Log (Aged65FB)					0.681***			
					(0.049)			
Log (Aged65S)						0.681***		
						(0.049)		
Bed number per 1,000							-0.013	-0.228***
people							(0.752)	((0.036)
Country lockdown								
2 Early lockdowns							-3.843***	-1.241
							(0.583)	(0.763)
3 Late lockdowns							1.712***	0.947***
							(0.331)	(0.259)
R^2	0.29	0.52	0.52	0.52	0.52	0.52	0.37	0.67
Adj. R^2	0.28	0.51	0.51	0.51	0.51	0.51	0.36	0.66
Observations	278	276	276	276	276	276	278	277

Note: The dependent variable was Covid-19 deaths per km^2 (log). Robust standard error in parentheses. ***, ** and * denote statistical significance at the 1%,5% and 10% level, respectively.

Among the social capital related factors, two factors which are community attachment and social trust were associated to increase Covid-19 deaths per km^2. In contrast, two other factors which are family bond and security were associated to decrease Covid-19 deaths per km^2 in all specifications. Other explanatory variables, population density and population aged 65 or older per km^2 were associated to increase Covid-19 deaths per km^2; social capital related factors with population aged 65 or older were associated to increase Covid-19 deaths per km^2. One additional bed per 1,000 people was associated to reduce Covid-19 deaths per km^2. Although no lockdown policy was associated to reduce Covid-19 deaths, early lockdown policy was associated to reduce Covid-19 deaths more than no lockdown policy and also late lockdown policy was associated to reduce Covid-19 deaths less than no lockdown policy.

3.3.4 Robustness analyses

As robustness checks, although we included other explanatory variables with social capital related factors in several multiple regressions, main results did not change. Furthermore, robust standard error implies that no heteroscedasticity and diagnostic tests confirmed that normality and no multicollinearity in the regressions. In addition, we tested the correlation between Covid-19 deaths per km^2 and social capital related factors by 8 highest population countries separately which are included in our sample. Most of the results were similar to **Figure 3-1** results. The results are presented in **Appendix Figure 3-2, 3-3, 3-4,** and **3-5**.

3.4. Discussion

To the best of our knowledge, this is the first systematical study to examine the social capital impact on Covid-19 deaths. The multiple regressions revealed that Covid-19 deaths are associated with social capital related factors in two dimensions. As we hypothesized, Covid-19 deaths can be explained by social capital whereas it shows in two dimensions. The community attachment and social trust were associated to increase Covid-19 deaths. Two other factors which are family bond and security were associated to reduce Covid-19 deaths in this study. The key findings of the study are discussed below.

In this study, we found that a percentage point increase in average community attachment and social trust are associated with a 4% and a 14% (on average) increase in Covid-19 deaths respectively. In contrast, a percentage point increase in average family bond and security are associated with a 1% and a 4% (on average) reduce in Covid-19 deaths respectively. Therefore, positive impact of social capital related factors was larger than negative impact on Covid-19 deaths in all specifications. Especially, in terms of correlation coefficients indicated that the similar conclusions of social capital related factors with Covid-19 deaths by country level as well as provinces of 8 countries (**Figure 3-1**). Although we expected to find negative associations according to prior evidence of positive link between social capital and health (Ehsan et al., 2019; Harpham et al., 2002; Hawe and Shiell, 2000; Kabayama et al., 2017; Kristin, 2020), community attachment and social trust were positively associated on Covid-19 deaths. These findings consist with, high social trust societies might be more vulnerable to deception about the severity of Covid-19, counterfeit treatments, and contemptuous perspectives

towards physical distancing (Zmerli, 2010), and trust impedes with endeavors to contain transmission through physical distancing (Dezecache et al., 2020). These results suggest that social capital has double-edged phenomenon (Villalonga-Olives and Kawachi, 2017). It implies that social capital does not always positively or negatively on affect health (Elgar et al., 2020).

Population density was found in this study to be associated with more Covid-19 deaths per km^2. This finding consists with population density associate with Covid-19 outbreak and related deaths (Bhadra et al., 2020; Coşkun et al., 2021; Rocklöv and Sjödin, 2020). Recent clinical studies have discussed that old age people have high Covid-19 mortality risk (Chen et al., 2020; Yin et al., 2020; Zhou et al., 2020). Our study also confirmed that a high population aged 65 or older significantly associated high Covid-19 deaths. In addition, interaction terms of social capital related factors with aged 65 or older population appeared to have more deaths of Covid-19. The number of hospital beds was negatively and significantly associated with Covid-19 deaths. This finding implies that hospital bed is a critical input in treating Covid-19 infected patients (Remuzzi and Remuzzi, 2020). In addition, country lockdown as a dummy variable which appeared early lockdown was a more effective response to reduce Covid-19 deaths than no lockdown and late lockdown policies (Iacobucci, 2020; Pulla, 2020).

There are some limitations in this study. Firstly, this study included only 37 countries based on our survey data. However, countries including USA, India, Brazil, Russia, and Spain which reported the highest Covid-19 infections and deaths were included in our sample. Secondly, we selected only a limited number of factors that potentially determine the Covid-19 deaths in a country. In order to improve the prediction accuracy,

other factors also may be included in studies conducted in the future. Finally, although Covid-19 data were available by country level as well as provinces level, there was a lack of public data for other demographic variable in certain countries. However, the results of this study can still contribute to future pandemic-related policymaking at the country level.

In conclusion, we found that social capital related factors were associated in two dimensions with Covid-19 deaths. Moreover, community attachment and social trust were associated to increase Covid-19 related deaths whereas family bond and security were associated to decrease Covid-19 related deaths. In addition, higher Covid-19 deaths are associated with higher population density, aging population, fewer hospital beds, and lower government effectiveness. However, social capital related factors show that both positive and negative effect on Covid-19 deaths, showing dynamic evolution of social capital. This study shows important factors of role of social capital to in a situation similar to the current Covid-19 pandemic.

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Appendix 3

Table 3-3 Sample countries

Country	**Covid-19 deaths**	**Country**	**Covid-19 deaths**	**Country**	**Covid-19 deaths**
Thailand	58	Hungary	642	Maine	138
Malaysia	128	Poland	2203	Maryland	3861
Singapore	27	Czech	465	Massachusetts	9260
Vietnam	35	Romania	4185	Michigan	6955
Philippines	4630	Sri Lanka	13	Minnesota	1994
Venezuela	494	**USA**	**197001**	Mississippi	2780
Chile	12013	Alabama	2401	Missouri	1782
Colombia	22924	Alaska	44	Montana	143
South Africa	15499	Arizona	5409	Nebraska	442
Myanmar	32	Arkansas	1166	Nevada	1506
Kazakhstan	1634	California	14812	New Hampshire	438
Mongolia	0	Colorado	2006	New Jersey	16057
Egypt	5661	Connecticut	4488	New Mexico	836
Australia	816	Delaware	619	New York	33070
Germany	9356	Florida	13086	North Carolina	3180
UK	41726	Georgia	6474	North Dakota	184
France	30958	Hawaii	107	Ohio	4580
Spain	29848	Iowa	1250	Oklahoma	930
Italy	35624	Idaho	434	Oregon	521
Sweden	5846	Illinois	8624	Pennsylvania	7893
Netherland	6296	Indiana	3478	Rhode Island	1085
Greece	310	Kansas	582	South Carolina	3158
Canada	9217	Kentucky	1093	South Dakota	193
Turkey	7119	Louisiana	5313	Tennessee	2164

Continued					
Texas	14826	Gansu	2	Goa	327
Utah	437	Tibet	0	Gujarat	3270
Vermont	58	Macao	0	Haryana	1069
Virginia	2918	Jiangxi	1	Himachal Pradesh	98
Washington	2031	Jiangsu	0	Jammu & Kashmir	951
West Virginia	297	Guangxi Zhuang	2	Jharkhand	590
Wisconsin	1230	Shanghai	7	Karnataka	7629
Wyoming	49	Liaoning	2	Kerala	489
Washington, D.C.	619	Hebei	6	Madhya Pradesh	1877
China	**4737**	Shanxi	0	Maharashtra	31351
Beijing	9	Tianjin	3	Manipur	51
Jilin	2	Xinjiang Uygur	3	Meghalaya	31
Hunan	4	Hubei	4512	Mizoram	0
Sichuan	3	Shaanxi	3	Nagaland	15
Chongqing	6	Qinghai	0	Odisha	669
Fujian	1	Ningxia Hui	0	Puducherry	431
Guangdong	8	Henan	22	Punjab	2646
Guizhou	2	**India**	**83236**	Rajasthan	1293
Hainan	6	Andhra Pradesh	5177	Tamil Nadu	8618
Zhejiang	1	Arunachal Pradesh	13	Tripura	228
Heilongjiang	13	Assam	528	Uttar Pradesh	4771
Anhui	6	Bihar	855	Uttarak hand	460
Inner Mongolia	1	Chandigarh	109	West Bengal	4183
Hong Kong	103	Chhattisgarh	628	**Indonesia**	**9460**
Shandong	7	Dadra & Nagar Havel	2	Aceh	130
Yunnan	2	Delhi	4877	Bali	206

Continued

Bangka-Belitung	4	South Sumatera	322	Santa Catarina	2609
Banten	124	North Sumatera	394	Sergipe	1968
Bengkulu	31	Yogyakarta	54	São Paulo	33472
Gorontalo	69	**Brazil**	**134935**	Tocantins	840
Jakarta	1527	Acre	646	**Russia**	**19489**
Jambi	8	Alagoas	2002	Volga	872
West Java	311	Amazonas	3931	Central	7669
Central Java	1243	Amapa	688	Ural	1146
East Java	2942	Bahia	6132	North Caucasus	2062
West Kalimantan	7	Ceara	8774	East Siberian	1057
South Kalimantan	396	Distrito Federal	3022	West Siberian	1332
Central Kalimantan	127	Espírito Santo	3399	Volga-Vyatka	840
East Kalimantan	265	Goias	3995	Northwestern	3019
South Sulawesi	389	Maranhao	3622	Central Black Earth	350
Riau Island	96	Minas Gerais	6500	Far Eastern	462
Lampung	28	Mato Grosso do Sul	1133	Northern	612
Maluku	38	Mato Grosso	3178	Northern	68
North Maluku	72	Para	6421	Kaliningrad	872
West Nusa Tenggara	182	Paraiba	2670	**Mexico**	**66329**
East Nusa Tenggara	5	Pernambuco	7954	Aguascalientes	432
Papua	72	Piaui	2007	Baja California	3196
Riau	96	Paraná	4018	Baja California Sur	368
West Sulawesi	7	Rio de Janeiro	17453	Campeche	775
Central Sulawesi	12	Rio Grande do Norte	2333	Coahuila de Zaragoza	1452
South east Sulawesi	46	Rondo Nia	1289	Colima	447
North Sulawesi	167	Roraima	611	Chiapas	1005

Continued

West Sumatera	90	Rio Grande do Sul	4268	Chihuahua	1169
Distrito Federal	10725	Hokkaido	106	Shiga	7
Durango	462	Aomori	1	Kyoto	25
Guanajuato	2231	Iwate	0	Osaka	187
Guerrero	1681	Miyagi	2	Hyogo	55
Hidalgo	1658	Akita	0	Nara	9
México	8170	Yamagata	1	Wakayama	4
Michoacán de Acampo	1243	Fukushima	0	Tottori	0
Morelos	987	Ibaraki	16	Shimane	0
Nayarit	610	Tochigi	1	Okayama	1
Nuevo León	2362	Gunma	19	Hiroshima	3
Oaxaca	1260	Saitama	97	Yamaguchi	1
Puebla	3620	Chiba	67	Tokushima	6
Querétaro Arteaga	765	Tokyo	389	Kagawa	2
Quintana Roo	1416	Kanagawa	131	Ehime	6
San Luis Potosí	1227	Niigata	0	Kochi	3
Sinaloa	2840	Toyama	25	Fukuoka	88
Sonora	2678	Ishikawa	44	Saga	0
Tabasco	2620	Fukui	8	Nagasaki	3
Tamaulipas	1850	Yamanashi	5	Kumamoto	8
Tlaxcala	928	Nagano	1	Oita	2
Veracruz Llave	3739	Gifu	10	Miyazaki	1
Yucatán	1350	Shizuoka	2	Kagoshima	12
Zacatecas	521	Aichi	77	Okinawa	45
Japan	**1474**	Mie	4		

Note: Total number of countries are 37 and China, India, USA, Indonesia, Brazil, Russia, Mexico, and Japan were separated by provinces. Data for Covid-19 death collected from the Coronavirus COVID-19 global cases by the Johns Hopkins university website.

Table 3-4 Questions and answers to measures social capital related factors

Variables	Questions	Answers
Community attachment	How attached are you to your local community?	5.Completely attached 4.Slightly attached 3.Neither 2.Slightly detached 1.Completely detached
Social trust	To be believed by people/organizations is	5.Very important 4.Somewhat important 3.Neither 2.Not very important 1.Not at all important
Family bond	Relationship with family is important or not in your life?	1.Important 0.Not important
Security	Please tell us about safety of your neighborhood.	5.Very safe 4.Moderately safe 3.Slightly dangerous 2.Very dangerous 1.Do not know

Note: Part of survey questions in 2017

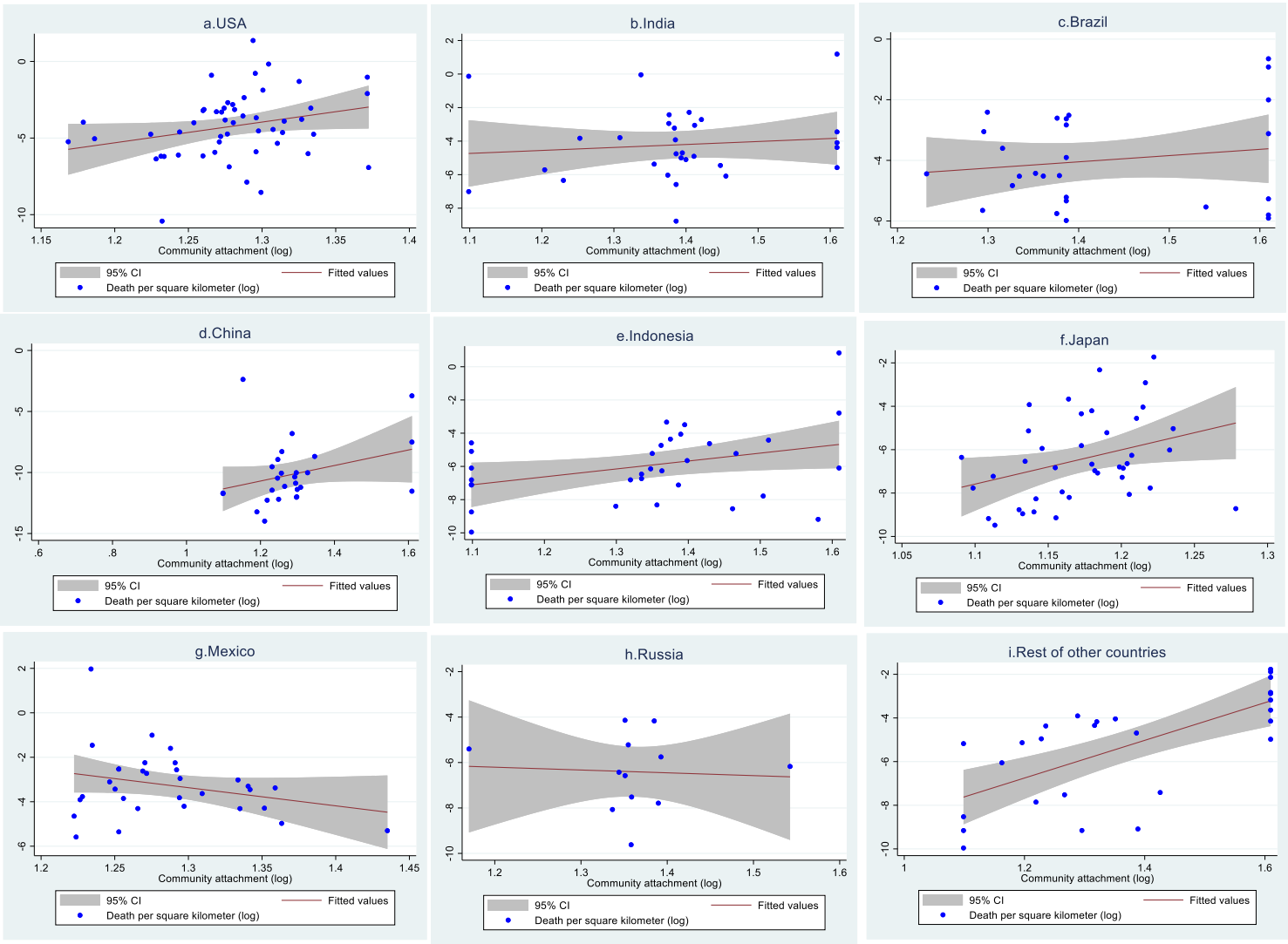


Figure 3-2 Correlations between community attachment and Covid-19 deaths per km^2 of 8 counties by provinces and rest of other 29 countries

Note: Red lines are linear predictions of Covid-19 deaths per km^2 on average community attachment. The 95% confidence intervals of the fitted values are shown by grey areas

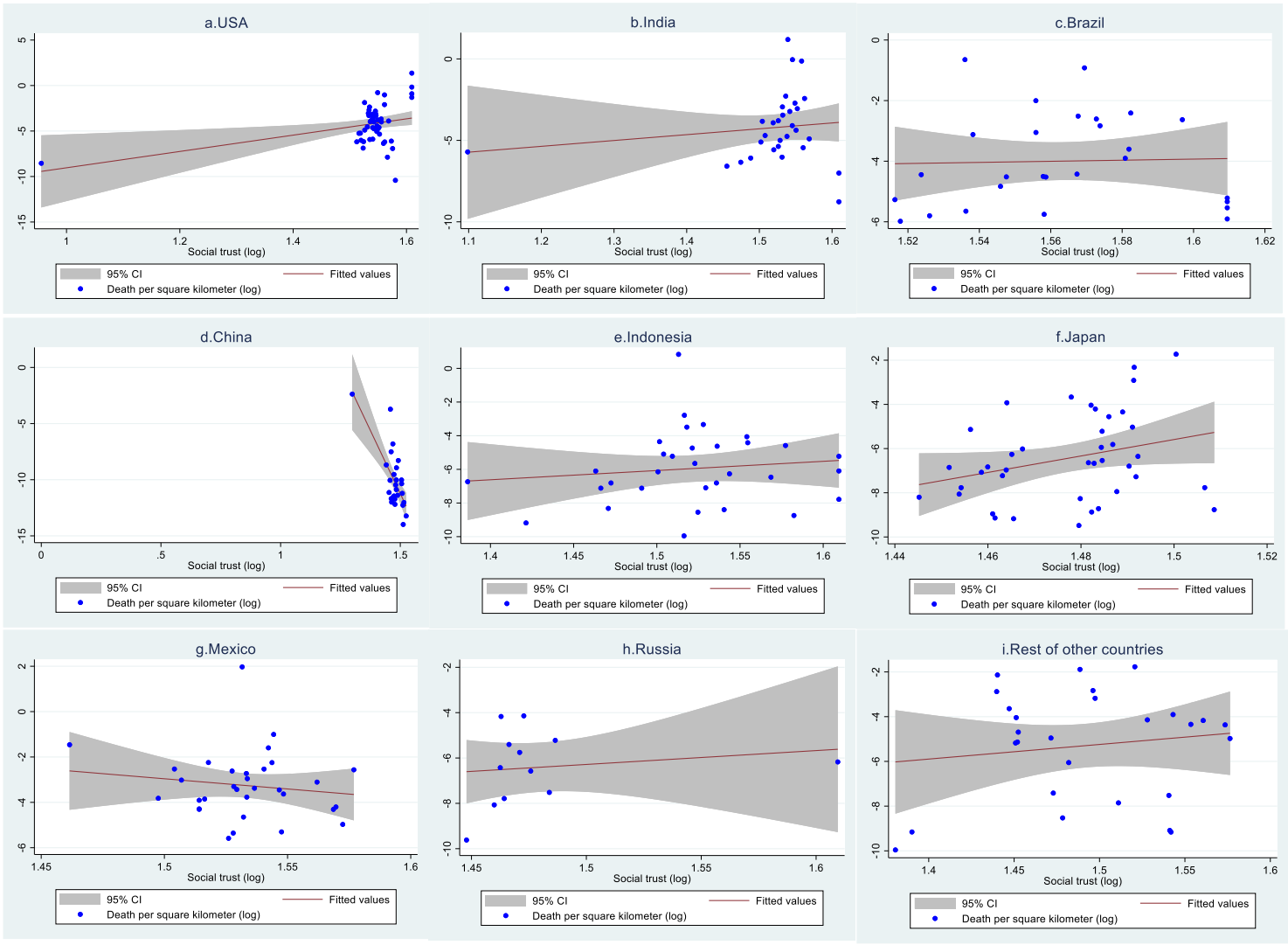


Figure 3-3 Correlations between social trust and Covid-19 deaths per km2 of 8 counties by provinces and rest of other 29 countries

Note: Red lines are linear predictions of Covid-19 deaths per km^2 on average social trust. The 95% confidence intervals of the fitted values are shown by grey areas

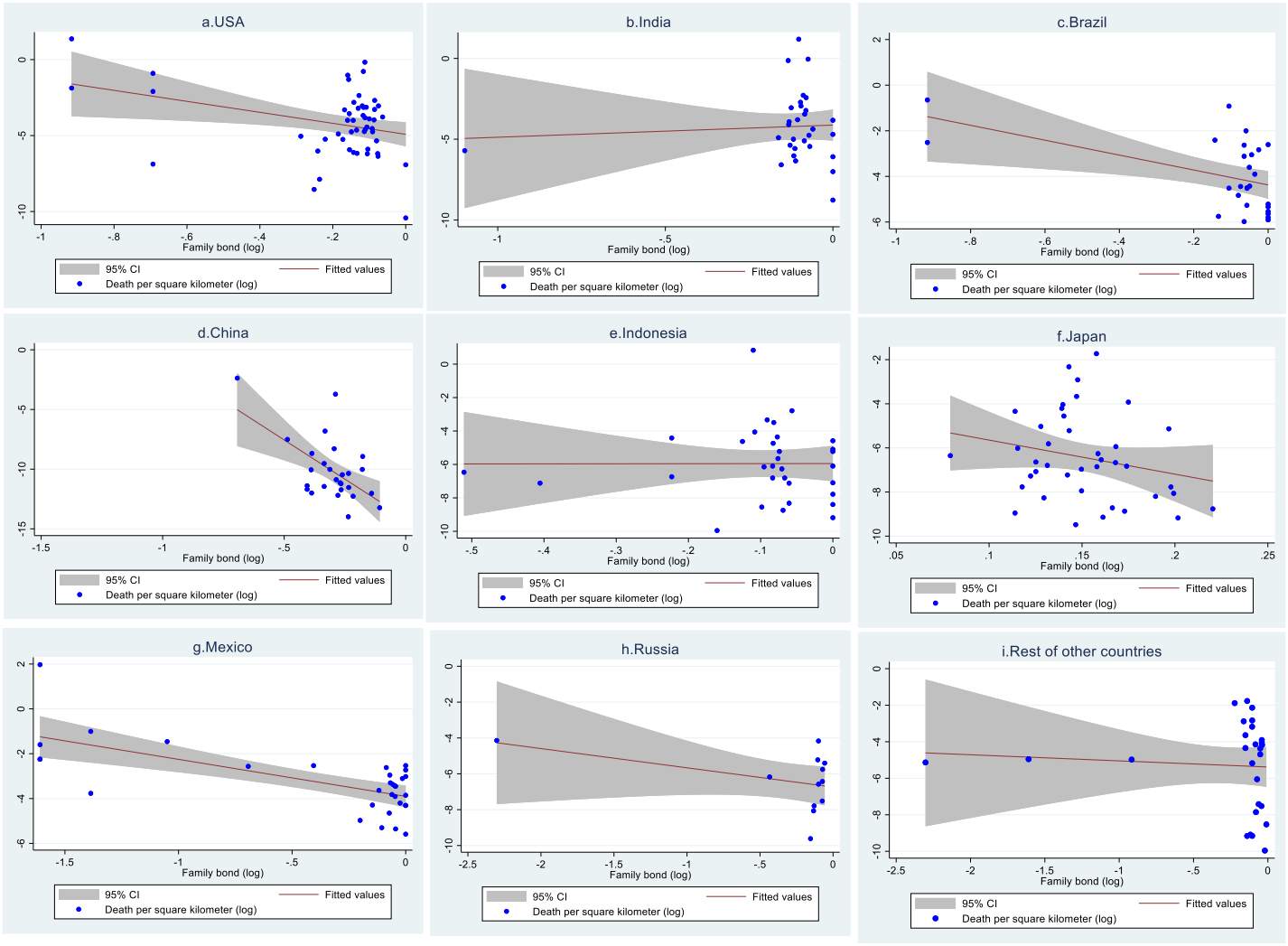


Figure 3-4 Correlations between Family bond and Covid-19 deaths per km^2 of 8 counties by provinces and rest of other 29 countries

Note: Red lines are linear predictions of Covid-19 deaths per km^2 on average family bond. The 95% confidence intervals of the fitted values are shown by grey areas

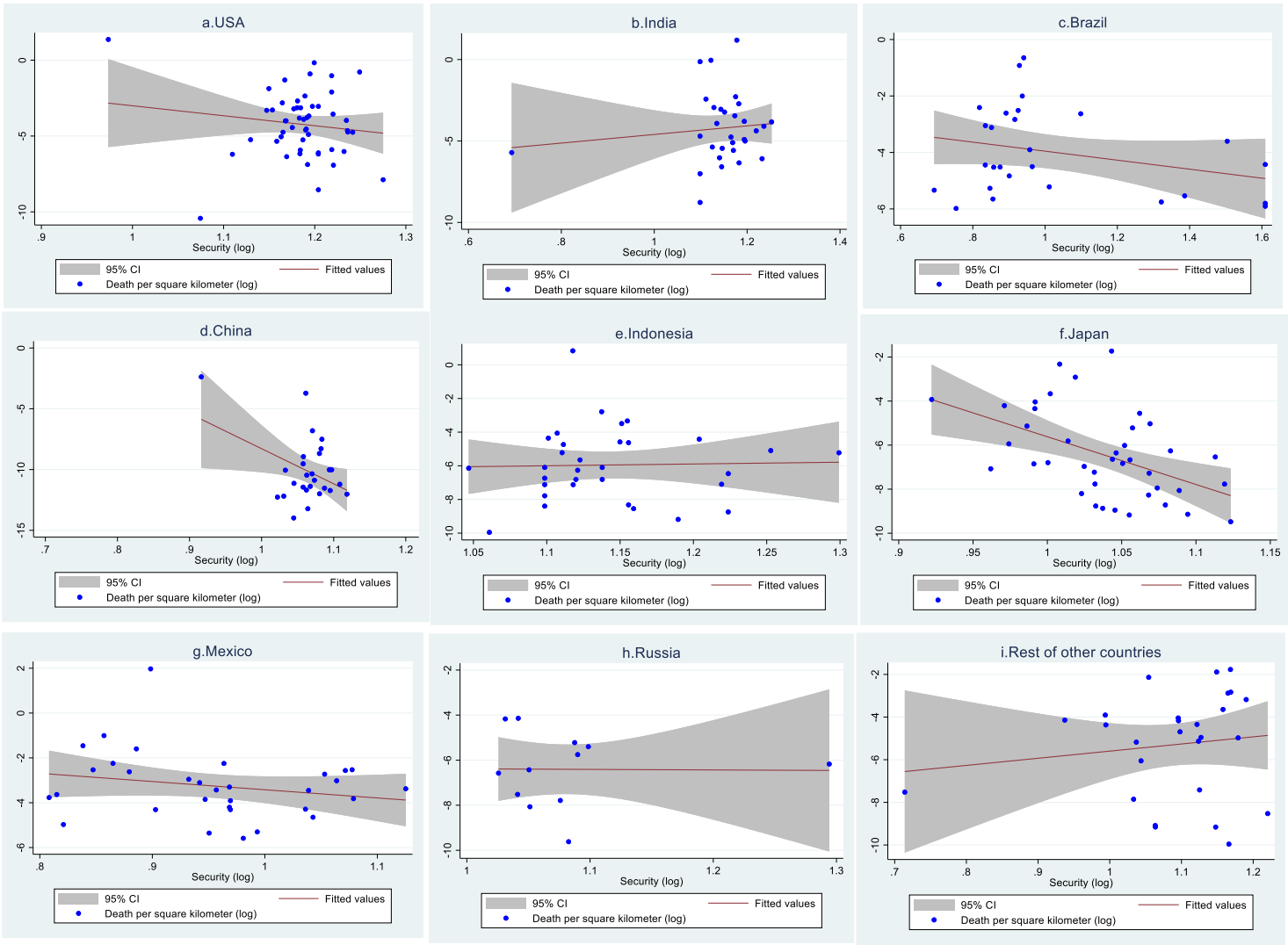


Figure 3-5 Correlations between Security and Covid-19 deaths per km^2 of 8 counties by provinces and rest of other 29 countries

Note: Red lines are linear predictions of Covid-19 deaths per km^2 on average security. The 95% confidence intervals of the fitted values are shown by grey areas

Chapter 4: Quality of good life with social capital

4.1. Introduction

The concept of quality of life has a variety of definitions, but most scholars agree with a subjective assessment of the concept as the individual's perception of their own life in terms of physical, material, and emotional wellbeing (Felce and Perry, 1995). With the development of social determinants, the role of social capital in human quality of life has been recognized (Christian et al., 2020). As a concept, social capital has several definitions and is commonly defined as "the features of social organization, such as civic participation, norms of reciprocity, and trust in others, that facilitate cooperation for mutual benefit" (Putnam et al., 1993). The relationship between social capital and factors that are related to the quality of life has been examined considering a single factor in different dimensions (Carpiano and Fitterer, 2014; Diener et al., 2003; Herian et al., 2014; Hoogerbrugge and Burger, 2018; Hooghe et al., 2009; Knack and Keefer, 1997; Sen, 2004); however, few studies consider the role of social capital as a combination of the necessary aspects for improving quality of life. To provide evidence for the link between social capital and quality of life, we undertake household responses through a multinational lifestyle satisfaction survey. We examine how social capital has affected people's lives using the three main indicators of wellbeing to measure the quality of life in subjective aspects: self-rated life satisfaction, health, and perceived economic inequality. To address this relation, we use a large-scale survey of 100,956 respondents across 37 nations by applying multilevel logistic models.

Concerning life satisfaction, as one of the important indicators to measure the quality of life, life satisfaction is a subjective assessment that indicates not only physical and mental health but also social adaptability, which can comprehensively evaluate people's lives (Diener et al., 2003). In line with these dimensions, several studies report a relationship between social capital and life satisfaction. A Netherlands study has showed neighborhood-based social capital is positively associated with individual life satisfaction (Hoogerbrugge and Burger, 2018). Social trust and networks show a higher correlation with life satisfaction (Portela et al., 2013). Likewise, a study using cross-country data found that high general trust leads to a high level of life satisfaction in most western Asian countries (Yamaoka, 2008).

Health condition is also a measure of quality of life, and better health improves people's lives (Karimi and Brazier, 2016). A study with 45 countries found that higher social participation and trust are associated with higher average health perception (Mansyur et al., 2008). Interpersonal trust, as a component of social capital, also affects better health (Herian et al., 2014). Moreover, a Canadian study found that trust is positively associated with mental health (Carpiano and Fitterer, 2014). In contrast, a multinational study found that social capital positively and negatively affected health diseases, such as the COVID-19 pandemic (Morales and Pilati, 2011).

Economic inequality relates to individual well-being (Sen, 2004). Empirical evidence supports a negative relationship between economic inequality and social capital (Robison and Siles, 1997; Uslaner and Brown, 2005). A key study of 29 market economies found that countries with greater economic equality have higher levels of trust and civic engagement (Knack and Keefer, 1997). Likewise, a study of 20 European

countries indicated that higher levels of trust lead to more equal incomes (Hooghe et al., 2009).

In summary, it is important to study how social capital relates to key aspects of quality of life with a large-scale international survey to provide a basis for the improvement in people's lives concerning social adaptability. Using a multinational survey comprising 100,956 respondents across 37 countries, we evaluated social capital and the factors related to quality of life (satisfaction, health, and inequality) at the individual and country levels. Moreover, we examined how individual-level social capital varies between developed and less-developed countries to enhance the quality of life.

4.2. Methods

4.2.1 Sample

The present study used data from a multinational survey designed to collect people's self-reported wellbeing and socioeconomic factors, covering 37 developed and developing countries across all continents and including 100,956 respondents (Chapman et al., 2019). We used a quota sampling method based on each country's population age and gender. In each country, the survey was conducted for a month between June 2015 and March 2017 using both internet and interview survey approaches. The internet survey approach was used in 32 countries and rest of 5 countries a face-to-face survey was used for those countries. A summary of the survey method and survey period for each country are displayed in **Appendix Table 4-5**.

4.2.2 Measures

Self-reported life satisfaction, health condition, and economic inequality are the dependent variables in this study. Life satisfaction was assessed by one item asking, "Overall, how satisfied are you with your life?". Health condition and economic inequality were also assessed by one item, that asked, "All in all, how would you describe your state of health? Please select an item that appropriately describes your point of view about economic inequality in local community. All three items were measured by a five-point scale ranging from "completely dissatisfied" to "completely satisfied" (for life satisfaction), "very poor" to "very good" (for health), and "does not exist" to "very large" (for economic inequality). For comparability with previous studies(Jen et al., 2010; Meng and Chen, 2014), we reclassified these three categorical variables to form dichotomous outcomes, where 1 represented life satisfaction (slightly satisfied or completely satisfied), good health (good or very good) and large inequality (slightly large or very large), and 0 represented dissatisfied (completely dissatisfied, slightly dissatisfied or neither), poor health (very poor, poor or neither) and not large inequality (does not exist, not very large or average) of life satisfaction, health condition and social inequality.

In terms of the independent variables, social capital is the key variable of interest. Social capital was assessed by multiple items because a variety of definitions and measures have been used for social capital in the literature. However, most scholars measure social capital in terms of cognitive and structural dimensions (Murayama et al., 2012; Putnam, 2000), using the two broad approaches of conducting a census of groups and group memberships and using survey data on the level of trust and civic engagement

(Fukuyama, 2001). Therefore, social capital was assessed based on the two dimensions of trust and civic engagement in this study. Social trust was assessed by asking two questions “To be able to believe people/organization is”, with five response options ranging from “not at all important” to “very important” and “Please tell us about safety of your neighborhood”, with five response options ranging from “very safe” to “very dangerous”. Then, considering civic engagement, it was assessed by asking four questions including both formal and informal engagement. Formal engagement was assessed by asking “How attached are you to your local community?”, on scale ranging from “completely detached” to “completely attached”, “How often do you participate in community activities”, on a scale ranging from 0 (“do not participate at all”) to 6 (“more than four days a week”), and informal engagement was assessed by asking “Relationship with family that you feel important in your life” and “Relationships with friends and acquaintances that you feel important in your life”, with response options “important” and “not important”. To compute a social capital score at the individual level, we calculated the individual arithmetic average of those factors. Moreover, we aggregated the social capital score at the country level by taking the arithmetic average of the weighted individual responses. Although this is an imperfect proxy for social capital, previous studies have supported the reliability of those factors (Elgar et al., 2011; Knack and Keefer, 1997; Murayama et al., 2012).

Independent variables comprise two levels: the individual level and the country level. Individual-level variables are age, gender, SC score, household income, and educational attainment. Yearly household income was collected as income ranges in local currency. We transformed the categorical ranges of income into real values by taking the midpoint

of the corresponding range and dividing this midpoint by the purchasing power parity relative to USD to account for transnational differences in currency (Jebb et al., 2018). Average SC and country groups are independent variables at country level. The country groups, which are low-income and high-income, were determined using the gross national income of each country.

4.2.3 Analyses

Since the responses of self-reported life satisfaction, health, and economic inequality are binary variables and the hierarchical structure of the data, we used multilevel logistical regression models based on a logit-link function. This technique can analyze the effects of individual characteristics (SC score) and country characteristics (average SC) on each dependent variable simultaneously (Jones and Duncan, 1995; Maas and Hox, 2004).

A simple multilevel logistic model is shown as follows:

$$Y_{ij} = \beta_0 + \beta_1 X_{1ij} + \beta_2 X_{2j} + u_{0j}$$

$$\left[u_{0j}\right] \sim N(0, \sigma_{u0}^2)$$

where Y_{ij} is dependent variable, and it refers to binary responses regarding life satisfaction, health, and economic inequality for individual i in country j. X_{1ij} represents individual-level variables (age, gender, social capital score, household income, and educational attainment), and X_{2j} is country-level variables (average social capital score and country groups). The u_{0j} terms are the random differences, which represent country-level residual differences after taking into account both the individual level and country

level. These are shown on the logit scale and are assumed to be normally distributed with a mean of 0 and variance of σ_{u0}^2. To examine whether social capital affected particular variables, we included interaction terms of social capital (country-level) with the individual-level predictors of educational attainment and household income, and social capital (individual level) with the country groups. We used MLwiN software for all analyses. All multilevel regressions were conducted using the version MLwiN 2.36 software (Rasbash et al., 2016).

4.3. Results

We describe our results for social capital, life satisfaction, health, and economic inequality using multilevel regression of the survey results. **Table 4-1** displays the descriptive statistics for individual and country-level study variables. Approximately 74.1% and 72.7% of the sample population reported high life satisfaction and good health, respectively, while 52.2% of the sample reported a smaller economic gap within society. However, the difference between less and more perceived economic gap responses is small. This implies that compared to the other two variables, perceived economic inequality is high in society.

Table 4-1 Descriptive statistics for individual and country-level variables

Variables	Statistics
Dependent variables	
Self-rated life satisfaction	Slightly satisfied or completely satisfied (74.1%), Completely dissatisfied, slightly dissatisfied or neither (25.9%)
Self-rated health	Good or very good (72.7%), Very poor, poor or neither (27.3%)
Self-rated economic inequality	Slightly large or very large (47.8%), Does not exist, not so large or average (52.2%)
Independent variables *Level 1*	
Age	18-99, mean = 42
Gender	Male (51%), Female (49%)
Education attainment	None (3.9%), Primary (1.8%), Secondary (44.6%), Tertiary (49.5%)
Personal monthly income (in 10,000 USD)	0-2058, mean = 6.12
Social capital (SC) score (individual level)	1-5, mean = 4.04
Level 2	
Average SC (country level)	3.4-4.3, mean = 4.03
Country groups	Low-income (53%), High-income (47%)

Tables 4-2, **4-3**, and **4-4** present the results of the multilevel logit models for life satisfaction, health, and economic inequality, respectively. The model strategy remains the same for all three analyses. The models are increasingly more complex using the Deviance Information Criterion (DIC) comparison. Models 1 to 4 are established from the null model, where individuals are nested within countries with no predictor variables, extending to a model including individual-level and country-level variables.

The results of model 4 in **Table 4-2** show that the SC score (individual-level) is associated with higher odds of reporting satisfaction with one's life (ORs=2.33). For other control variables, younger people, women, those with higher educational attainment and higher incomes in general report greater life satisfaction than older people, men, those with lower educational attainment and those with low incomes.

Model 5 shows further estimation for cross-level interactions between each individual characteristic and the country-level variables. The interactions between average SC and educational attainment, average SC and income, and SC score and country groups are represented in models 5A, 5B, and 5C, respectively. To better understand each cross-level interaction on life satisfaction, **Figure 4-1a** presents the results graphically. In terms of educational attainment, the odds of reporting life satisfaction for all the education groups increase with increasing social capital at the country level. Individuals with a tertiary education level are more likely to report satisfaction than those with the other three levels, and there is a large gap between the tertiary education level and the other three levels. Interestingly, individuals in the no formal education group are more likely to report satisfaction with their life than those in the primary-level education group. Moreover, different income groups are represented by the low quartile (LQ=25%), the median quartile (MQ=50%), and high quartile (HQ=75%). Individuals in the high quartile are more likely to report satisfaction than individuals in the other two income groups from a low social capital country, and the gap between them is wide, increasing with social capital at the country level. In contrast, divergent trends are found for low-income and high-income country groups. Although there is a small difference between low-income and high-income countries in terms of reported satisfaction among

individuals with low SC scores, the gap gradually widens with higher SC scores, and the increase is most notable for low-income countries.

Table 4-2 Logit multi-level regression estimates for Life satisfaction

Variable	Model 1	Model 2	Model 3	Model 4	Model 5A	Model 5B	Model 5C
Fixed part							
Constant	1.086***	-5.257***	-7.909***	-6.630***	-6.806*	-6.099**	-6.368*
	(0.082)	(0.162)	(3.350)	(2.420)	(3.722)	(4.318)	(3.570)
Age		0.001	0.003***	0.001	-0.002**	-0.004***	-0.002**
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female (ref. Male)		0.080***	0.095***	0.073***	0.075***	0.074***	0.074***
		(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Education attainment (ref. None)							
Primary		0.013	-0.117	-0.101	-1.415***	-0.115*	-0.120*
		(0.070)	(0.070)	(0.069)	(0.001)	(0.070)	(0.070)
Secondary		-0.134***	-0.145***	-0.036	-0.283	-0.102***	-0.104***
		(0.041)	(0.040)	(0.042)	(1.182)	(0.042)	(0.042)
Tertiary		0.015	0.201***	0.302***	0.814***	0.101***	0.097***
		(0.042)	(0.041)	(0.042)	(0.182)	(0.043)	(0.043)
Log personal income		0.301***	0.347***	0.316***	0.317***	1.064***	0.317***
		(0.008)	(0.008)	(0.008)	(0.008)	(0.234)	(0.008)
Social capital (SC) score		0.816***	0.848***	0.849***	0.849***	0.848***	0.808***
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.017)
Average SC			0.128***	0.277	0.317**	2.125**	0.249***
			(0.069)	(0.888)	(0.129)	(1.076)	(0.093)
Low-income country (ref. high-income)				0.317***	0.318***	0.326***	-0.220
				(0.104)	(0.108)	(0.096)	(0.330)
Interactions							
Average SC*Primary					0.222***		
					(0.194)		
Average SC*Secondary					0.290***		
					(0.045)		
Average SC*Tertiary					0.378***		
					(0.094)		
Average SC*Log personal income						0.185***	
						(0.058)	
Low-income country * SC score							0.085***
							(0.024)
Random part							
Between Countries	0.242***	0.902***	0.882***	0.922***	0.926***	0.975***	0.932***
	(0.057)	(0.205)	(0.200)	(0.207)	(0.207)	(0.219)	(0.209)

Note: ***, **and* denote statistical significance at the 1%,5%, and 10%, respectively. Standard errors in parentheses.

In terms of the results of health in **Table 4-3**, the results of model 4 show that the SC score is associated with higher odds of reporting good health (ORs=2.06) than the average SC, while both are positively associated with reporting good health. The interactions between average SC and educational attainment, average SC and income, and SC score and country groups are represented in models 5A, 5B, and 5C, respectively. Considering **Figure 4-1b**, we identified a similar trend for different income groups on health to that found in **Figure 4-1a** on life satisfaction. Moreover, educational attainment showed a similar trend on health, with increasing social capital at the country level except for primary-level education. Interestingly, country groups show a divergent trend in good health when individuals' social capital scores increase. There is a small difference between low-income and high-income countries in terms of reported good health among individuals with a low social capital score, while the gap is wide among individuals with a higher social capital score, and the increase is most marked for low-income countries.

Table 4-3 Logit multi-level regression estimates for health

Variable	Model 1	Model 2	Model 3	Model 4	Model 5A	Model 5B	Model 5C
Fixed part							
Constant	1.049***	-3.478***	-5.107*	-4.629*	-2.884	-0.175	8.280***
	(0.102)	(0.152)	(2.650)	(2.754)	(2.918)	(5.304)	(3.535)
Age		-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female (ref. Male)		-0.035***	-0.034***	-0.035***	-0.037***	-0.034***	-3.035***
		(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Education attainment (ref. None)							
Primary		-0.354***	-0.351***	-0.360***	0.499***	-0.362***	-0.364***
		(0.065)	(0.065)	(0.065)	(0.092)	(0.065)	(0.065)
Secondary		0.153***	0.153***	0.155***	-1.810	0.156***	0.151***
		(0.040)	(0.040)	(0.040)	(1.141)	(0.040)	(0.040)
Tertiary		0.324***	0.324***	0.327***	-2.363***	0.327***	0.321***
		(0.041)	(0.041)	(0.041)	(1.157)	(0.041)	(0.041)
Log personal income		0.232***	0.233***	0.234***	0.234***	0.233***	-1.060***
		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.231)
Social capital (SC) score		0.713***	0.716***	0.723***	0.723***	0.719***	0.724***
		(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Average SC			0.655***	0. 689***	0. 728***	0. 705 ***	2.974***
			(0.400)	(0.223)	(0.202)	(0.105)	(0.879)
Low-income country (ref. High-income)				0.338***	0.326*	1.078***	0.349*
				(0.204)	(0.196)	(0.267)	(0.204)
Interactions							
Average SC*Primary					-2.561***		
					(0.465)		
Average SC*Secondary					0.484*		
					(0.280)		
Average SC*Tertiary					0.665***		
					(0.284)		
Average SC*Log personal income						0.321***	
						(0.057)	
Low-income country * SC score							0.367***
							(0.023)
Random part							
Between Countries	0.410***	0.537***	0.530***	0.552***	0.539***	0.533***	0.529***
	(0.093)	(0.121)	(0.119)	(0.125)	(0.122)	(0.120)	(0.119)

Note: ***, **and* denote statistical significance at the 1%,5%, and 10%, respectively. Standard errors in parentheses.

Next, we discuss the results for self-reported economic inequality and social capital. The interactions between social capital and educational attainment, income, and country groups are shown in **Table 4-4** (model 5A, 5B, and 5C). In contrast to the results shown in **Figure 4-1a** and **Figure 4-1b**, we did not observe a large difference between income

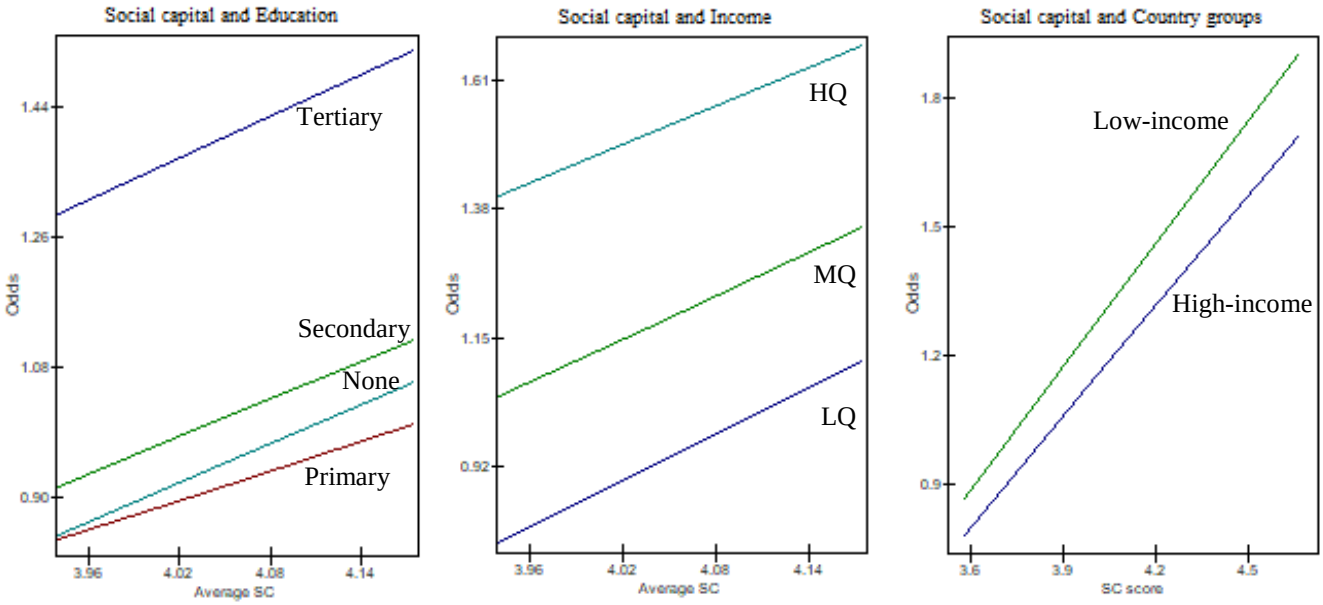
groups with increased social capital at the country level in **Figure 4-1c,** but individuals in all three income groups are likely to report a large economic gap in their local community. In terms of educational attainment, the odds of reporting a large economic gap for all the education groups decrease with increasing social capital at the country level. Individuals with a secondary level of education show a higher negative trend than other levels of education with low and high average social capital. Furthermore, we observed an interesting result for the interaction of country groups with social capital; low- and high-income countries show a negative and positive relationship with increased individual social capital, respectively. This means that when individuals' social capital increases, economic inequality in the local community decreases in low-income countries and increases in high-income countries.

Table 4-4 Logit multi-level regression estimates for Economic gap

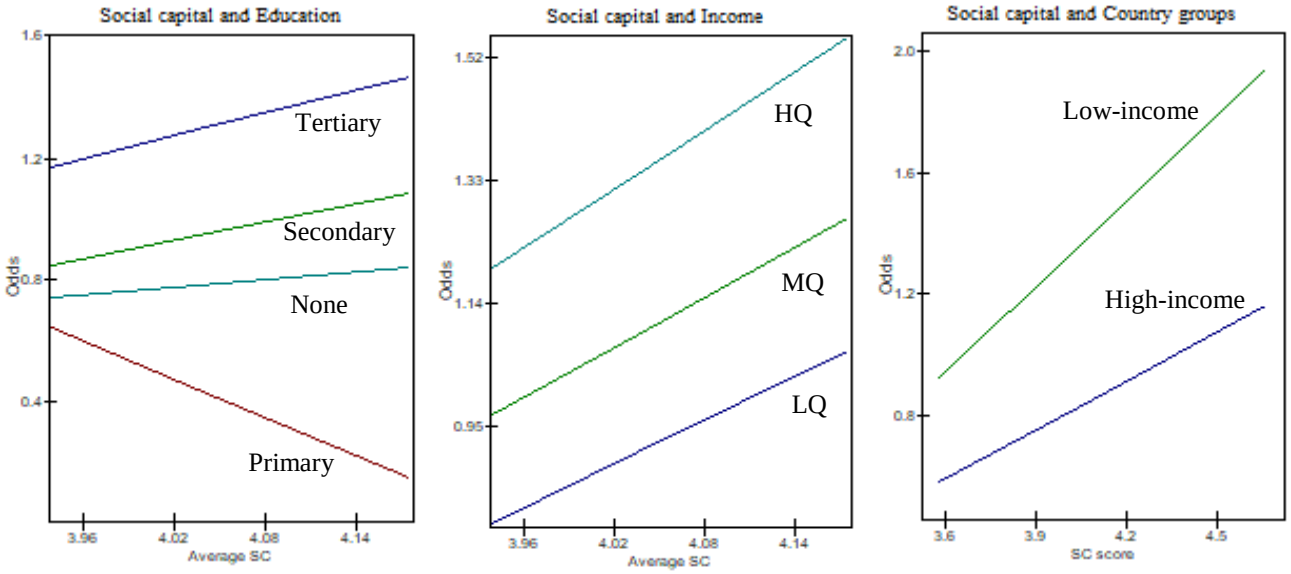
Variable	Model 1	Model 2	Model 3	Model 4	Model 5A	Model 5B	Model 5C
Fixed part							
Constant	-0.521***	-0.636***	-3.141	-2.686***	-1.980***	3.046***	-3.159***
	(0.088)	(0.122)	(1.932)	(0.918)	(0.153)	(0.795)	(0.931)
Age		-0.002***	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female (ref. Male)		-0.017*	-0.015	-0.017*	-0.008	-0.018*	-0.016*
		(0.010)	(0.014)	(0.010)	(0.014)	(0.010)	(0.009)
Education attainment (ref. None)							
Primary		0.086	-0.086	-0.086	-0.008	-0.087	-0.082
		(0.063)	(0.063)	(0.063)	(0.010)	(0.063)	(0.063)
Secondary		0.013	0.013	0.013	0.163	0.012	0.168
		(0.037)	(0.037)	(0.037)	(1.053)	(0.037)	(1.054)
Tertiary		0.155***	0.156	0.157***	-1.603	0.156***	-0.168
		(0.037)	(0.037)	(0.037)	(1.038)	(0.037)	(1.054)
Log personal income		0.017**	0.018**	0.018**	0.016**	-0.554***	0.016**
		(0.007)	(0.007)	(0.007)	(0.007)	(0.203)	(0.007)
Social capital (SC) score		-0.028*	-0.030*	-0.030*	-0.028*	-0.098***	-0.074***
		(0.016)	(0.016)	(0.016)	(0.016)	(0.021)	(0.010)
Average SC			-0.620***	-0.476	-0.536*	-0.437	-0.513*
			(0.037)	(0.479)	(0.309)	(0.482)	(0.282)
Low-income country (ref. high-income)				0.214*	0.207*	0.213*	0.817***
				(0.123)	(0.121)	(0.111)	(0.191)
Interactions							
Average SC*Primary					-0. 258***		
					(0. 039)		
Average SC*Secondary					-0. 448***		
					(0. 104)		
Average SC*Tertiary					-0.434*		
					(0.259)		
Average SC*Log personal income						0.153***	
						(0.050)	
Low-income country * SC score							-0.152***
							(0.021)
Random part							
Between Countries	0.304***	0.289***	0.279***	0.265***	0.265***	0.269***	0.268***
	(0.069)	(0.066)	(0.063)	(0.060)	(0.060)	(0.061)	(0.061)

Note: ***, **and* denote statistical significance at the 1%,5%, and 10%, respectively. Standard errors in parentheses.

1.a


Social capital and Education
Tertiary
Secondary
None
Primary
Odds
1.44
1.26
1.08
0.90
3.96
4.02
4.08
4.14
Average SC
Social capital and Income
HQ
MQ
LQ
1.61
1.38
1.15
0.92
Social capital and Country groups
Low-income
High-income
1.8
1.5
1.2
0.9
3.6
3.9
4.2
4.5
SC score

1.b


Social capital and Education
Tertiary
Secondary
None
Primary
Odds
1.6
1.2
0.8
0.4
3.96
4.02
4.08
4.14
Average SC
Social capital and Income
HQ
MQ
LQ
1.52
1.33
1.14
0.95
Social capital and Country groups
Low-income
High-income
2.0
1.6
1.2
0.8
3.6
3.9
4.2
4.5
SC score

1.c

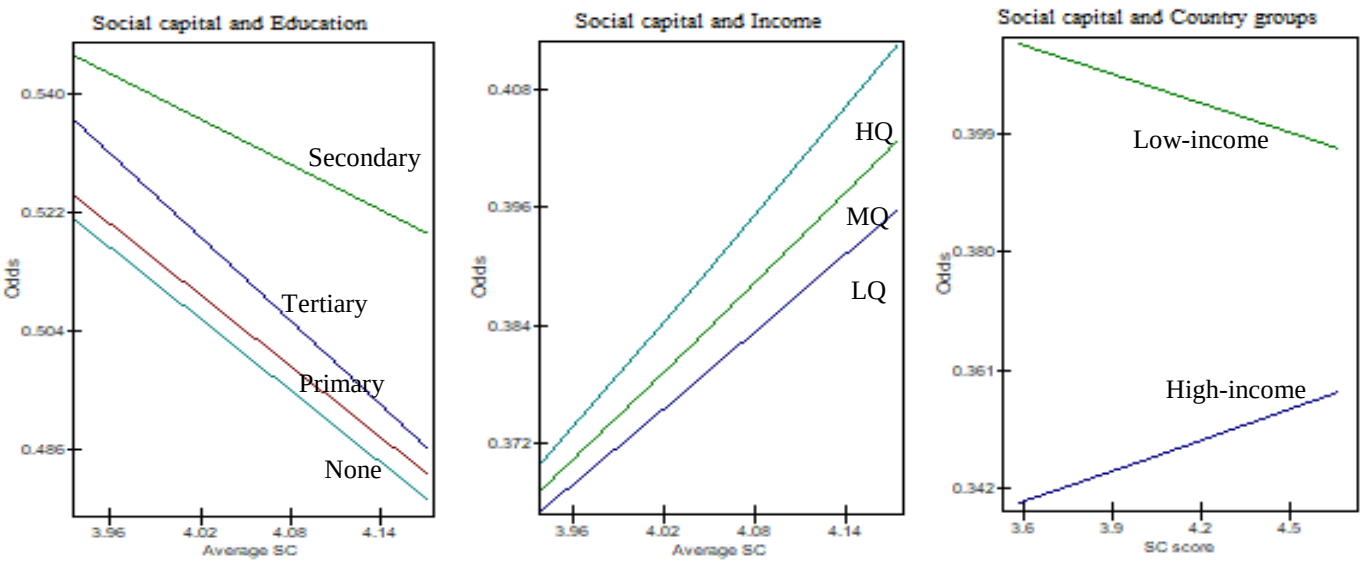


Figure 4-1 Cross-level interactions with social capital

Note: **a-c,** each plot derived from Model 5A, 5B, and 5C of Table 4-1,4-2, and 4-3. Odds of reporting education, income and country groups with social capital are presented for life satisfaction (**a**), health (**b**) and economic gap (**c**). Average SC (country-level) and SC score (individual-level).

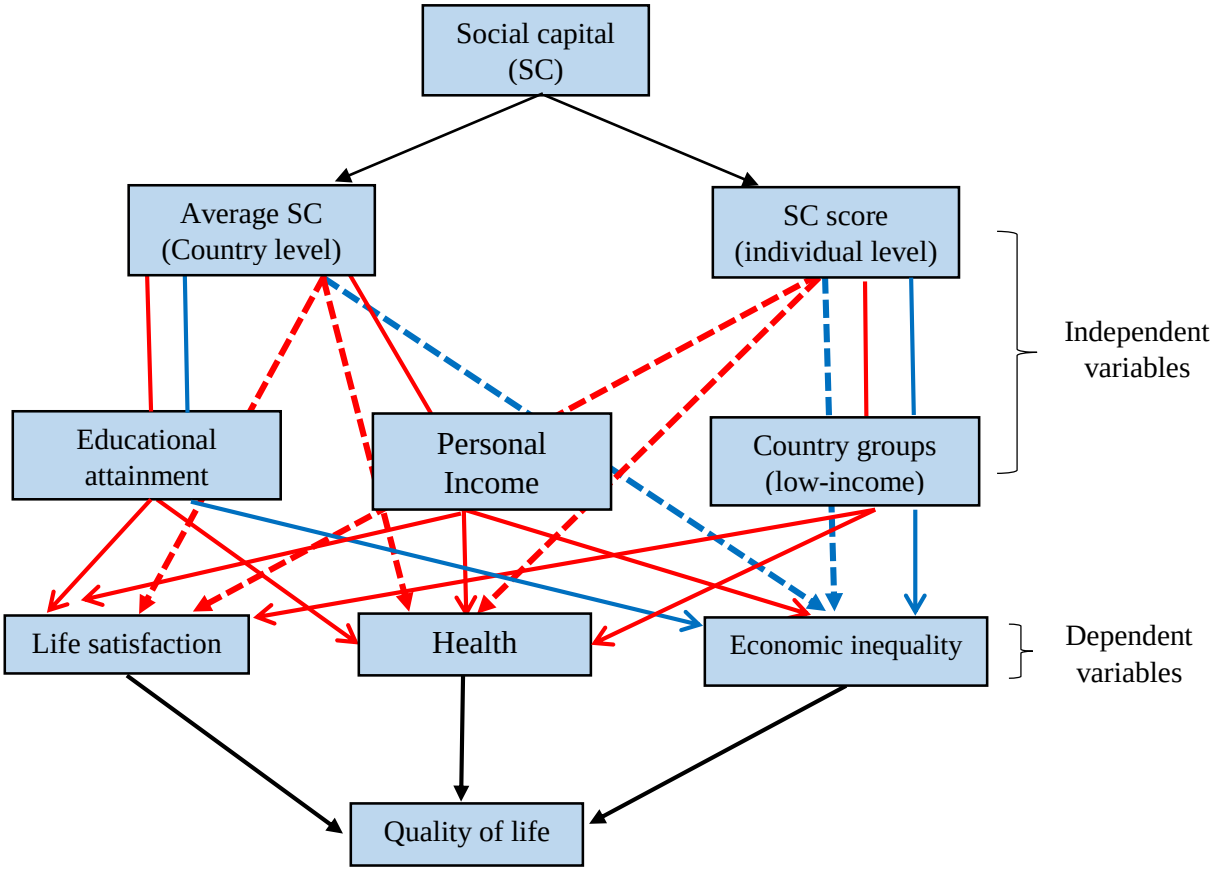


Figure 4-2 Summary of the main results

Note: The red and blue dotted arrows indicate the direct positive and negative relationship respectively. The red and blue line arrows indicate the indirect positive and negative relationship respectively.

4.4. Discussion

By using a multinational sample of 100,956 respondents, this study provides insight into the subjective experiences of life with a link between self-reported social capital and life satisfaction, health, and perceived economic inequality. To do so, we used multilevel logistic models to observe the effects of social capital at the individual- and country-levels. Furthermore, we separated countries into low-and high-income groups, assuming that income level is correlated with a number of outcomes. A summary of the main results is presented in **Figure 4-2**.

The results reveal that individual-level social capital is positively associated with life satisfaction and health but negatively associated with perceived economic inequality within the local community. These results thus suggest that social capital can play a role in a better life. The results are in line with research showing that trust as a component of social capital is positively associated with health and life satisfaction (Elgar et al., 2011) and economic inequality (Hooghe et al., 2009; Paarlberg et al., 2018).

In terms of cross-level interactions on life satisfaction, health, and economic inequality (**Figure 4-1a, 4-1b**, and **4-1c**), the present study suggests that higher educational attainment can enhance life satisfaction and health while associating less economic inequality with increased social capital. This finding is also in line with research showing that educational attainment not only develops human capital but can improve social capital by passing social rules and norms (Fukuyama, 2001); in contrast, educational attainment is not directly associated with less economic inequality (Solga, 2014). This implies that when education interacts with social capital, it can indirectly reduce economic inequality in society.

Concerning country groups, low-income countries show better outcomes of satisfaction, health, and economic gap than high-income countries, in contrast to research suggesting that those outcomes would be superior in high-income countries (Jebb et al., 2018; Kahneman and Deaton, 2010). On the other hand, some low-income countries with limited resources and facilities reported better health and satisfaction with increased social capital, indicating noneconomic factors that influence self-reported responses. Furthermore, this result suggests that developing social capital can improve quality of life, especially through health improvements in developing countries (Story, 2013). This is in line with the finding from a Sub-Saharan African study that social capital can be used to improve health identifying possible channels for health improvement (Hollard and Sene, 2016). Concerning income groups, different levels of personal income are also positively associated with a considerable gap between them in terms of good health and life satisfaction (Diener et al., 2010; Luhmann et al., 2011). Although income groups are positively related to economic inequality, the difference between groups becomes smaller as country-level social capital increases.

Moreover, the results suggest that sociodemographic factors, such as gender and age, may be sources of the difference in how health, life satisfaction, and economic inequality affect the improvement in quality of life. Older people report life dissatisfaction and poorer health than younger people, in line with a study that found an inverse relationship between life satisfaction and age beyond 65 years (Chen, 2001); in contrast, aging and life satisfaction show a positive relationship among the European elderly population (Gaymu and Springer, 2010), and life satisfaction has a U-shaped relationship with age profile (Stone et al., 2010). In addition, our study finds that

compared to men, women show higher life satisfaction and less perceived economic inequality but poor health. Men are more satisfied with their lifestyle than women (Goldbeck et al., 2007). Our results are also in line with a few studies demonstrating that women are more satisfied with their lives than men (Jovanović and Lazić, 2020; Knight et al., 2009).

Our results need to be interpreted considering several limitations. Even though our analyses provide sound knowledge about the link between social capital and quality of life, we assessed some of the variables with only one item. Concerning measurement of the variables, it is better to use multiple items to improve validity and coverage (for example, social capital and perceived economic inequality). Additionally, we used only three main factors as a proxy for quality of life, but we can consider it broadly in future studies because it is a highly subjective assessment. Moreover, our results mainly describe the individual level and do not account for each country's situation separately.

In conclusion, this study provides evidence that social capital positively correlates with life satisfaction and health at the individual and country levels while negatively affecting the perceived economic gap within the local community. When we turn to the interaction terms of country groups with individual social capital, less-developed or low-income countries have higher life satisfaction and good health than developed and high-income countries with higher social capital. Moreover, low-income countries show a negative trend in perceived economic inequality when social capital increases, while high-income countries show a positive relation. This finding suggests that social capital has the potential to improve quality of life, especially in low-income countries. Based on our results, we propose several suggestions to improve quality of life in both

country groups. First, high-income countries can learn from low-income countries about the important factors that improve their level of social capital. Low-income countries have higher life satisfaction, and good health than high-income countries with increased individual-level social capital. Second, at the community level, social contact between income groups seems to have a strong link with reducing economic inequality between the rich and the poor, suggesting that organizing community participation opportunities may be beneficial. Additionally, higher educational attainment of the country associated with smaller economic gap, suggesting that educational institutes not only develop human capital but also improve social capital by passing social rules and norms. Finally, policy expertise is required for rational thinking about how to increase the social capital stock in society considering age groups and educational level because higher social capital seems to have a strong link to quality of life at the community level.

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Appendix 4

Table 4-5 Survey information

Country	Survey method	Survey period		Observation	Income level
Australia	Internet	10/02/2016	22/02/2016	2029	High
Brazil	Internet	23/07/2015	26/07/2015	2298	Low
Canada	Internet	01/09/2016	13/09/2016	1333	High
Chile	Internet	24/07/2015	28/07/2015	1192	High
China	Internet	12/01/2016	29/02/2016	20744	Low
Colombia	Internet	07/24/2015	27/07/2015	1115	Low
Czech	Internet	08/03/2017	16/03/2017	1400	High
France	Internet	26/08/2016	07/09/2016	2138	High
Germany	Internet	26/08/2016	07/09/2016	3165	High
Greece	Internet	31/08/2016	12/09/2016	1382	High
Hungary	Internet	08/03/2017	15/03/2017	1354	High
India	Internet	25/07/2015	11/08/2015	6700	Low
Indonesia	Internet	18/07/2015	23/07/2015	2413	Low
Italy	Internet	29/08/2016	10/09/2016	2106	High
Japan	Internet	14/07/2015	05/08/2015	11167	High
Malaysia	Internet	23/07/2015	29/07/2015	1106	Low
Mexico	Internet	24/07/2015	27/07/2015	1678	Low
Netherlands	Internet	29/08/2016	10/09/2016	1371	High
Philippines	Internet	15/07/2015	22/07/2015	1686	Low
Poland	Internet	08/03/2017	17/03/2017	2227	High
Romania	Internet	08/03/2017	18/03/2017	1386	Low
Russia	Internet	31/08/2015	14/09/2015	2221	Low
South Africa	Internet	15/07/2015	23/07/2015	1123	Low
Spain	Internet	26/08/2016	07/09/2016	2116	High
Sweden	Internet	31/08/2016	12/09/2016	1330	High
Thailand	Internet	18/07/2015	23/07/2015	1127	Low
Turkey	Internet	07/03/2017	20/03/2017	2120	Low
UK	Internet	16/08/2016	28/08/2016	2993	High
USA	Internet	16/08/2016	28/08/2016	10683	High
Vietnam	Internet	18/07/2015	28/07/2015	1541	Low

Chapter 5: Preferences for energy sustainability: Different effects of gender on knowledge and importance

5.1. Introduction

Both energy and energy sustainability are necessary for human survival on earth. Globally, energy consumption and quality of life have shown a continuous increase for several decades (Pasten and Santamarina, 2012). As a result, for many years, energy sources have consistently captured the attention of humankind and have caused many conflicts leading to wars. The sustainable development goals (SDGs) agenda sets seventeen goals to enhance basic human development. Among those goals, the seventh goal refers to ensuring access to affordable, reliable, sustainable, and modern energy services. in particular, target 7.2 provides a timeline to substantially increase the proportion of renewable energy (RE) in the global energy mix by 2030. The progress of the seventh goal in 2018 indicates that the share of RE out of the total final energy consumption has gradually increased. Meanwhile, international financial flows to developing countries to assist in clean and RE usage almost doubled from 2010 to 2016 (SDGs, 2020).

A critical challenge of global energy and environmental policy for the last twenty years has been climate change mitigation. A widely recognized reason for this challenge is carbon dioxide (CO_2) emissions mainly resulting from the use of fossil fuels, including coal, oil, and gas. While energy is essential for accelerating economic growth, a higher level of energy consumption leads to significantly increased CO_2 emission (Antonakakis et al., 2017). Therefore, energy consumption and economic growth can

be recognized as two main contributors to CO_2 emission (Kaika and Zervas, 2013; Tiba and Omri, 2017). As a result of the strong interrelationship among economic development, energy consumption and CO_2 emissions, the mitigation of CO_2 emissions has faced major challenges (Zaman and Moemen, 2017). Although nonrenewable energy consumption positively affects CO_2 emissions, RE consumption negatively affects CO_2 emissions (Shafiei and Salim, 2014). Although the share of RE sources is increasing, the role played by fossil fuels as primary energy sources is unlikely to be replaced in the near future (REN21, 2018). Additionally, non-technological economic aspects, such as political, institutional, and cultural aspects, can serve as barriers to the use of RE sources. Focusing on public awareness of the increasing consequences of climate change, the competitive economics of renewable electricity, and the positive ideologies of a cleaner, healthier and more sustainable future, can encourage people to adapt to changes (Diesendorf and Elliston, 2018).

Investigating knowledge, ideas, and public attitudes that are relevant to various aspects of environmental issues is highly important (Liarakou et al., 2009). Information about the reasons and solutions for the energy crisis and climate change problem plays an important role, as consumer knowledge is expected to translate into attitudes and intentional behavior (Qin and Brown, 2007; Roberts, 1996). Additionally, individualized audits and consultation are comparatively more effective in promoting energy conservation behavior (Delmas et al., 2013), while knowledge about greenhouse gas emissions, energy savings, and actions can help reduce energy use (Pothitou et al., 2016). Increasing energy literacy among young people can transform them into sustainable energy-friendly consumers and citizens when they grow up, and this can

influence their peers and other people in their environments (Zografakis et al., 2008). Non-price incentives such as health and environment-based information (Asensio and Delmas, 2015) and education levels (Mills and Schleich, 2012) can effectively persuade people to use household energy-efficient technology and adopt household energy conservation practices (Brandon and Lewis, 1999; Choong et al., 2006; Ueno et al., 2006; Wen et al., 2018). Moreover, experience, attitudes, and subjective norms motivate people to contemplate the importance of energy conservation practices (Macey et al., 1983) . Moral obligation regarding one's conduct can serve as a significant arbitrator of the impact of social standards on individuals' pro-environmental behavior (Dwyer et al., 2015).

The concepts of intuition and rationality are different ways to connect with intellectual processes while the inconsistencies between the two can never be completely eliminated (Epstein, 1994; Evans, 2003). Decision makers would benefit from utilizing both holistic associations and cause-effect logic (Calabretta et al., 2017). Therefore, it is important to identify what kinds of social groups are stronger in making holistic associations and using cause-effect logic. Previous studies show that holistic associations is a characteristic of intuition and connects with an intuitive-experiential thinking style, and that cause-effect logic is a characteristic of rationality and is related to a rational thinking style. Intuition can be conceptualized as a dynamic instrument that depends on fast, unconscious acknowledgement of patterns and holistic associations to infer affectively charged decisions (Dane and Pratt, 2007), just as the experiential framework is thought to be programmed, preconscious, holistic, associations, basically nonverbal and personally connected with the effect. Heuristic preparation addresses the

normal method of the experiential framework. Natural reasoning may have various ramifications for people, and intuitive feeling-based thinking is related to femininity (Epstein et al., 1996). Intuitive – affective techniques can outperform deliberation techniques in terms of integrating values as an active technique that is essential in complex decision-making situations (Usher et al., 2011). Furthermore, according to neuroscience studies, female brains are composited to accommodate connections between analytical and intuitive preparation modes (Ingalhalikar et al., 2014). On the other hand, rational decision-making outcomes basically rely on a logical order of cause-effect relationships (Epstein et al., 1996). Male brains are organized to accommodate connections between perception and coordinated action (Ingalhalikar et al., 2014), and perception is a source of knowledge; information stored in memory based on past experience (stored knowledge) can influence observation itself (Rock, 1985). Essential standards of theory and practice are problem solving, which is increasingly compelling and dependent on the information base and use of that information (Carson, 2007). Moreover, rationality begins with logical reasoning (Moshman, 2004),and rational thinking is related to masculinity (Epstein et al., 1996).

Additionally, some empirical studies have discussed analytical and intuitive decision making in different disciplines, such as business administration and medicine. For instance, senior managers use both rational analysis and intuitive judgment to make effective managerial decisions (Agor, 1986), and senior managers of some companies, such as bank and utility industries, often use intuitive processes to make organizational decisions (Khatri, 2000).Lank and Lank (1995) argued that traditional management

approaches need to be supported by intuitive thinking due to make sense of the complexity that managers face. Furthermore, nurses also use both analytical and intuitive processes in decision-making, and nurses who were more working experience tend to analytical and less working experience tend to intuitive orient (Lauri et al., 2001). Hence, we suppose that females' decision making/ thinking tends to involve holistic associations and that males' decision making/ thinking relies on cause-effect logic. Furthermore, by citing the above multidiscipline studies, we attempt to identify the different roles of gender with both holistic associations and cause-effect logic as human behavior factors in the energy sustainable decision-making. Therefore, gender is a crucial factor in our study.

The vast majority of the existing literature has focused on energy consumption and CO_2 emissions, energy conservation, and RE in different dimensions (e.g.,(Ding et al., 2017; Steg, 2008; Sugiawan et al., 2019; Wang and Ye, 2017)). As we mentioned above, some studies have attempted to identify the impact of knowledge of energy on energy conservation, and only a few studies have focused on people's knowledge of energy and energy conservation practices (e.g., (Brounen et al., 2013; Halder et al., 2010; Mills and Schleich, 2012; Zyadin et al., 2014)). Very few studies have focused on male and female differences in energy conservation in households (e.g., (Lee et al., 2013)). In fact, we contribute to the existing literature by studying the context of energy, examining how people's decisions regarding their knowledge and concern about energy sustainability are based on gender. Therefore, we consider existing literature that is focused on both environmental and energy knowledge and concerns based on male and female differences because of the lack of previous studies on energy. For instance,

females show more environmentally friendly behavior than males (e.g., (Eisler et al., 2003; Michel Laroche et al., 2001; Olli et al., 2001; Tindall et al., 2011; Torgler et al., 2008; Xiao and McCright, 2015, 2014, 2012; Zelezny et al., 2000)), but males have more knowledge of the environment than females (e.g., (Eisler et al., 2003; Mostafa, 2007; Tikka et al., 2000)). Therefore, we hypothesize that males and females differ in knowledge and concerns about the importance of energy sustainability.

This study aims to investigate the linkage between self-reported knowledge of energy sustainability and concerns regarding the importance of energy sustainability in different gender roles with both the concepts of holistic associations (intuition) and cause-effect logic (rationality) and explore how different decision-making/thinking styles affect people's knowledge and concerns about energy sustainability. To address this context, we use international empirical evidence based on data collected from more than 100,000 respondents from 37 nations through online and face-to-face interviews. Additionally, two types of logistic (binary and ordered logistic) regression models are employed in the data analysis. We find that males have more knowledge of energy sustainability than females, while females are more concerned about the importance of energy sustainability. This finding implies that decisions rely on different processes typical of each gender.

The remainder of this article is organized as follows: Section 2 provides background on the environment and energy, focusing on gender differences in knowledge and concerns to develop our hypotheses. Section 3 discusses the research methodology and data used. The results and discussion are presented in section 4, and section 5 offers some conclusions with recommendations.

5.2. Literature review

This article is related to a large body of literature on energy and the environment based on sociodemographic factors. First, the most frequently examined sociodemographic factors that affect energy-saving behaviors and energy consumption include age, gender, household income and education level, with controversial results (e.g., (Abrahamse and Steg, 2009; Brandon and Lewis, 1999; Carlsson-Kanyama and Lindén, 2007; Yang et al., 2016; Yohanis et al., 2008)). Second, several previous studies have focused on environmental knowledge, attitudes, concern and behavior based on sociodemographic factors (e.g.,(Olli et al., 2001; Scott and Willits, 1994; Tindall et al., 2011)). However, this study also considers sociodemographic factors such as gender, occupation, age, household income, education, and having children with energy sustainability in different dimensions. Likewise, gender is a crucial factor for the reasons noted in the introduction, and we examine how people make decisions based on their knowledge of energy sustainability and concerns about the importance of energy sustainability.

According to some studies, both knowledge and concerns about energy and the environment lead to conservation behavior. For instance, some knowledge may lead to initial formation of attitudes and attitudes associate to further obtain of knowledge (Bradley et al., 1999; Ramsey and Rickson, 1976) and environmental attitudes and values influence to improve behavior (Ramsey and Rickson, 1976). Frick et al., (2004) found that action-related environmental knowledge and effectiveness knowledge show behavior orient whereas system knowledge shows more remote from behavior. Further consumers' attitudes toward and faith in the environment might change their environmental and energy-saving behavior (Gadenne et al., 2011). In addition, some

studies have found that environmental concerns are linked with environmentally friendly behavior. Mostafa, (2007) found that environmental concerns were positively related to consumers' behavior to purchase green products. Ellen et al., (2013) indicated that a general attitude of environmental concern leads to purchasing environmentally safe products and recycling. Therefore, it can be concluded both knowledge and concern are associated with the energy and environmental conservation process, and concern is closer to behavior rather than knowledge.

Some empirical studies have explored the differences between males and females in terms of environmental knowledge. According to the majority of the literature, males possess more environmental knowledge than females. For instance, females show less awareness and concern about environmental issues than males do in Egypt (Mostafa, 2007) . People's knowledge of nature and the environment is related to their gender identity (Tikka et al., 2000), and males show greater environmental knowledge than females (Eisler et al., 2003) . However, women have slightly greater scientific knowledge of climate change than men do in the USA (Berenguer et al., 2005). Interestingly, a few studies have focused on environmental concerns and conduct comparisons between genders, concluding that women have stronger environmental perspectives, practices, and concerns about the earth and environmental issues than men do (Xiao and McCright, 2015; Zelezny et al., 2000). Similarly, according to the environmental knowledge hypothesis of Blocker and Eckberg, (1997), and Davidson and Freudenburg, (1996) argued that although men tend to have greater scientific knowledge than women and knowledge is negatively related to environmental concerns, and men tend to exhibit less environmental concern than women. Wehrmeyer and

McNeil, (2000) found that women always tend to be involved in the health care and well-being of family members; hence, they are more concerned about environmental issues, whereas men tend to play a role in economic activities rather than environmental issues. Likewise, both married women and women with children are willing to pay more for environmentally friendly production (Michel Laroche et al., 2001). In most European countries, women are more willing to pay for environmentally friendly products while participating less in environmental activities than men (Torgler et al., 2008) . Further, women exhibit more environmentally friendly behavior than men (Olli et al., 2001; Tindall et al., 2011) . Although women participate more in private environmental behaviors, no significant gender differences in public environmental activities have emerged (Hunter et al., n.d.). However, some studies have found no gender differences in environmental behavior and concerns (e.g., (Berenguer et al., 2005; Xiao and McCright, 2012)).

Although the vast majority of the existing literature has mainly focused on environmental knowledge and behavior, several previous studies have attempted to examine the knowledge of energy sustainability considering differences between males and females. Knowledge of energy can be defined as people's general knowledge about the use of energy, energy conservation, forms of energy, sources of energy, and energy transformation (Mostafa, 2007). *"Sustainable energy is the practice of using energy in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs"*(WCED, 1987). Adult families with young children have the highest level of knowledge of household energy use and energy-saving possibilities (Mills and Schleich, 2012). Males are more likely to have

information about energy consumption and energy literacy than females are (Brounen et al., 2013). However, Halder et al., (2010) found that there are no significant gender differences in the knowledge of RE sources, including bioenergy, among high school students. Only a few studies have focused on concerns about energy conservation on the basis of gender. Women were found to be more likely to engage in energy conservation practices and willing to spend more money on energy-efficient sources of energy for their households (Lee et al., 2013).

However, Pothitou et al., (2016) found that the link between greater environmental knowledge and energy behaviors, attitudes, and habits leads to energy-saving activities. Given this link, we also used the environmental literature to develop our hypotheses. Hence, most of the above gender studies related environmental knowledge, concerns and behavior, and only a few of the studies related to knowledge and concerns about energy. Thus, based on these existing works, we proposed the following hypotheses:

Hypothesis 1: Males are more knowledgeable about energy sustainability than females are.

Hypothesis 2: Females are more concerned about the importance of energy sustainability than males are.

Additionally, we contribute to the existing literature by studying the effects of different factors, the concepts of holistic associations and cause-effect logic, on both males' and females' decisions based on their knowledge and concerns about energy sustainability. To the best of the authors' knowledge, there is no such investigation in the energy-related literature.

5.3. Data and Methodology

5.3.1 Data

To examine whether males and females differ in their decisions based on their knowledge and concerns about the importance of energy sustainability, we obtained data covering 37 developing and developed countries with a sample size of 100,956 respondents. The questionnaire-based survey was conducted from 2015 to2017 using both internet and interview survey approaches. The internet survey approach was used in 32 countries but was not practicable in Egypt, Kazakhstan, Mongolia, Myanmar, and Sri Lanka, where a face-to-face survey approach was used (see **Appendix Table 5-4**). In **Figure 5-1** and **Figure 5-2** show the response rate of each country for their knowledge of energy sustainability and concerns about the importance of energy sustainability based on gender. However, as illustrated in **Figure 5-1**, three types of responses are included and show such a difference in three responses between the male and female respondents. In most countries, males' response rates were higher than those of females, except for a few countries with an average response regarding knowledge.

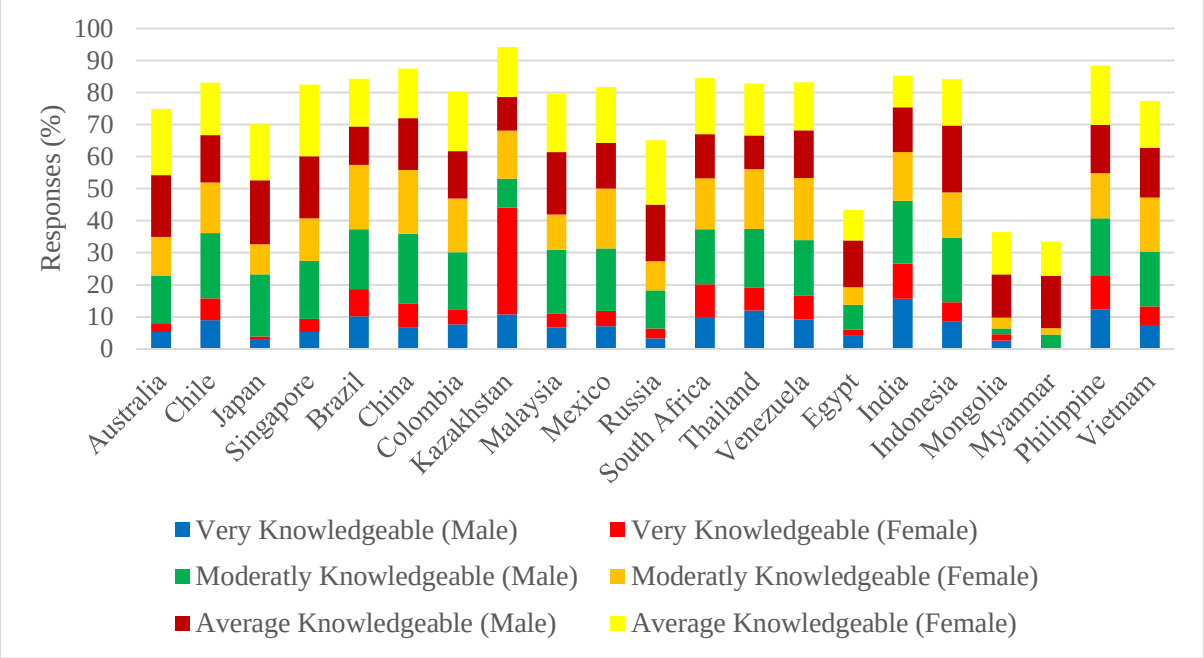

Figure 5-1 The response rate regarding knowledge of energy sustainability very/high, moderate, and average based on gender

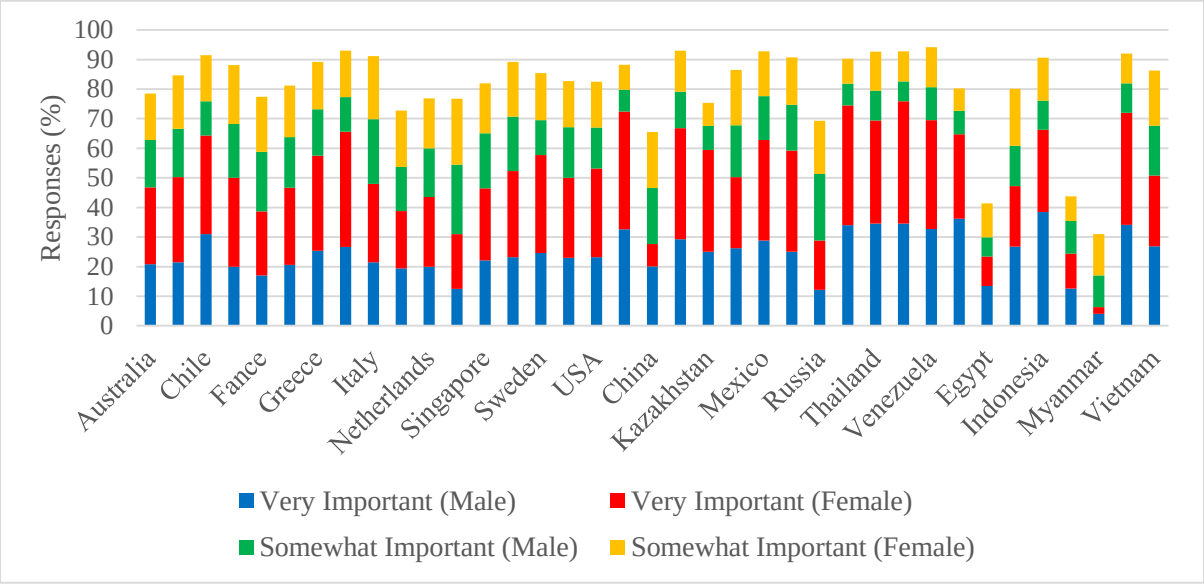

Figure 5-2 The response rate regarding the importance of energy sustainability (very important and somewhat important) based on gender

In **Figure 5-2**, two types of responses are included, shown a difference in two responses between the male and female respondents. In most countries, female response rates were higher than those of males for each category.

The survey questionnaire was designed to collect information on people's self-reported satisfaction levels, income levels, education levels, health conditions, energy use, awareness and concerns about energy, social class, and other quality of life factors. To ensure the accuracy of the responses, one of the authors of this research provided a uniform structure directly to native survey conductors for translations and multiple checks of the online questionnaire. Definitions of the key variables and their descriptive statistics are presented in **Table 5-1.**

Table 5-1 Definitions of the key variables and basic statistics

Variables	Definition	Mean	Standard deviation	Min.	Max.
KE	(*Knowledge of Energy*) Select an option that appropriately describes your level of knowledge of the sustainability of energy supply. 1 (do not have any knowledge) – 5 (very knowledgeable)	3.34	1.06	1	5
IE	(*Importance of Energy*) Select an option that appropriately describes the level of importance of sustainability of energy supply. 1 (not at all important) – 5 (very important)	4.17	1.03	1	5
Gender	Equals 1 if the respondent is male, 2 otherwise	1.48	0.49	1	2
Labor Force	Equals 1 if the respondent is employed, 2 otherwise	1.24	0.42	1	2
Age	Respondents' age	40.71	13.99	18	99

Income Group	What is your income group in your country? 1(lower), 2 (lower middle), 3(middle), 4(upper middle), 5(upper)	2.84	0.87	1	5
Education Level	Select the educational background of you. 1 (not attended), 2 (primary), 3 (secondary), 4 (tertiary)	3.47	0.67	1	4
Children	Number of children in the family	1.89	1.23	0	10

5.3.2 Methodology

As we hypothesized that males are more knowledgeable about energy sustainability than females are and that females are more concerned about the importance of energy sustainability than males are, we used logistic regression models to analyze the marginal effect of independent variables, including gender. Additionally, when the dependent variable of the model is a dummy variable and all variables have equal observations, the logistic model is an appropriate regression model (Bilder and Tebbs, 2008). Furthermore, we employed both binary logistic and ordinal or ordered logistic regression models to investigate the hypotheses in detail and increase the robustness of the results. Furthermore, to ensure the robustness of our models, we needed to test goodness of fit of those models. For this purpose, we conducted the Pearson chi-square test and Hosmer-Leme show test for logistic models (Fagerland and Hosmer, 2017).

5.3.3 The model: Hypothesis 1

The model is based on Hypothesis 1 and analyzes how to decisions-making/thinking processes differ between males and females based on their knowledge of energy sustainability. The estimated functions take the following form.

$$KES_i = \beta_0 + \beta_1 Gender_i + \beta_2 Labor\ Force_i + \beta_3 Age\ Groups_i + \beta_4 Education_i + \beta_5 IncomeGroup_i + \beta_6 GE_i + \varepsilon_i \quad (1)$$

$$KES_i = \beta_0 + \beta_1 Gender_i + \beta_2 Labor\ Force_i + \beta_3 Age\ Groups_i + \beta_4 Education_i + \beta_5 IncomeGroup_i + \beta_6 GE_i + \varepsilon_i \quad (2)$$

In the above specifications, KES_i is the dependent variable (Knowledge of Energy Sustainability) in both equations. Eq. (1) is used for ordered logistic regression analysis, and Eq. (2) is used for binary logistic regression analysis. KES_i is defined as two types: in Eq. (1), KES_i is a dummy variable that is measured by a Likert scale (1 to 5), and in Eq. (2), KES_i is a bivariate (1,0) dummy variable (see **Appendix Table 5-5**), and the key independent variable is gender. Gender and labor force are bivariate dummy variables. Education and income groups were also measured by the Likert scale (categorical variables). GE refers to the interaction of education with gender. β_0 represents a constant term and ε_i is the error term of both equations for the observation *i.*

5.3.4 The model: Hypothesis 2

Additionally, to analyze how gender differs in the decision-making/thinking process regarding concerns about the importance of energy sustainability, the estimated functions take the following form.

$$IES_i = \beta_0 + \beta_1 Gender_i + \beta_2 Labor\ Force_i + \beta_3 Age\ Groups_i + \beta_4 Education_i + \beta_5 IncomeGroup_i + \beta_6 GE_i + \beta_7 GC_I + \varepsilon_i \quad (3)$$

$$IES_i = \beta_0 + \beta_1 Gender_i + \beta_2 Labor\ Force_i + \beta_3 Age\ Groups_i + \beta_4 Education_i + \beta_5 IncomeGroup_i + \beta_6 GE_i + \beta_7 GC_I + \varepsilon_i \quad (4)$$

In these two equations, IES_i is the dependent variable (Importance of Energy Sustainability). The Eq. (3) is used for ordered logistic regression analysis, and Eq. (4) is used for binary logistic regression analysis. IES_i is defined as two types: in the Eq. (3), IES_i is a dummy variable that is measured by a Likert scale (1 to 5), and in Eq. (4), IES_i is a bivariate (1,0) dummy variable (see **Appendix Table 5-5**) and the key independent variable is gender. Gender and labor force are bivariate dummy variables, and education and income groups were also measured by the Likert scale (categorical variables). GE refers to the interaction of education with gender, and GC refers to the interaction of children with gender. β_0 is the constant term, and ε_i is the error term of the equation for observation *i.*

5.4. Results and Discussion

5.4.1 Knowledge with gender: Hypothesis 1

Based on the sample of 21 countries and according to Eq. (1), the results indicate the predicted probabilities (difference in the two probabilities for males and females = marginal effect of gender) of *Gender* (main independent variable) on the knowledge of energy sustainability. Therefore, **Figure 3, Figure 4**, and **Figure 5** illustrate how gender differences affect knowledge of energy in a scale with three different categories (high, moderate knowledgeable, and average level of knowledge).

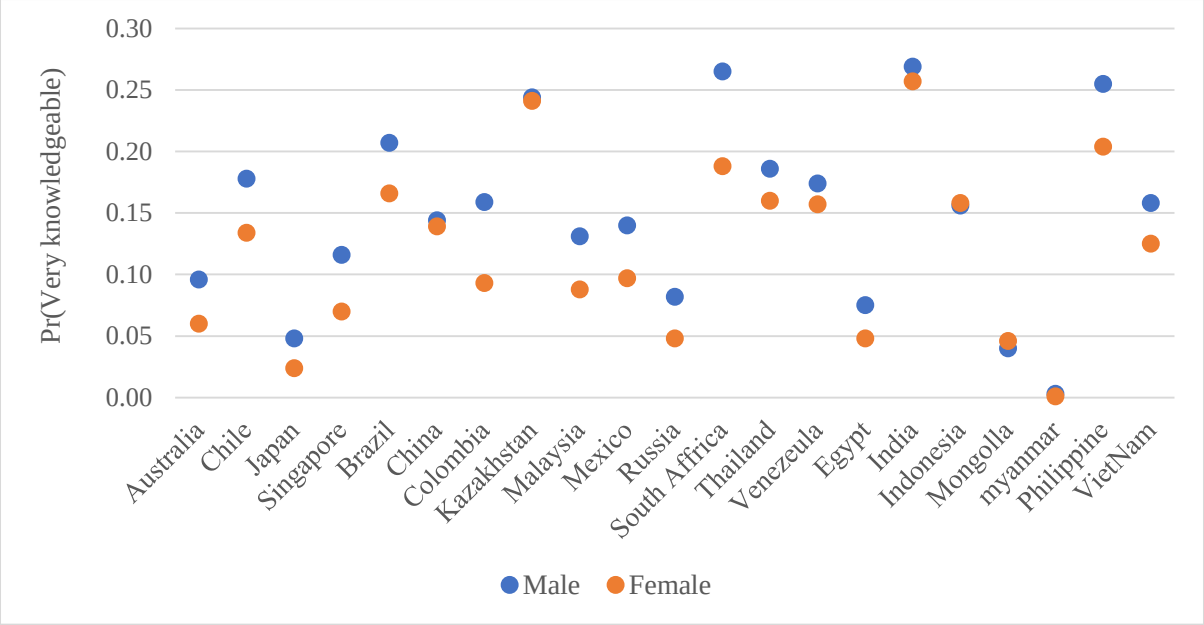

Figure 5-3 Adjusted predictions of very knowledgeable

One special case shown in **Figure 5-3**, Myanmar, shows an almost zero predicted probability for both males and females and their marginal effect of knowledge is also closer to zero in the very knowledgeable category. However, the other countries, including high-income (e.g., Australia, Chile, Japan, and Singapore), upper-middle-income (e.g., Brazil, Colombia, Malaysia, Mexico, Russia, South Africa, and Thailand) and lower-middle-income countries (e.g., India, Philippians and Vietnam), show that males' probability of rating themselves as very knowledgeable about energy sustainability is higher than that of females except in a few countries, such as China, Kazakhstan, Indonesia, and Mongolia.

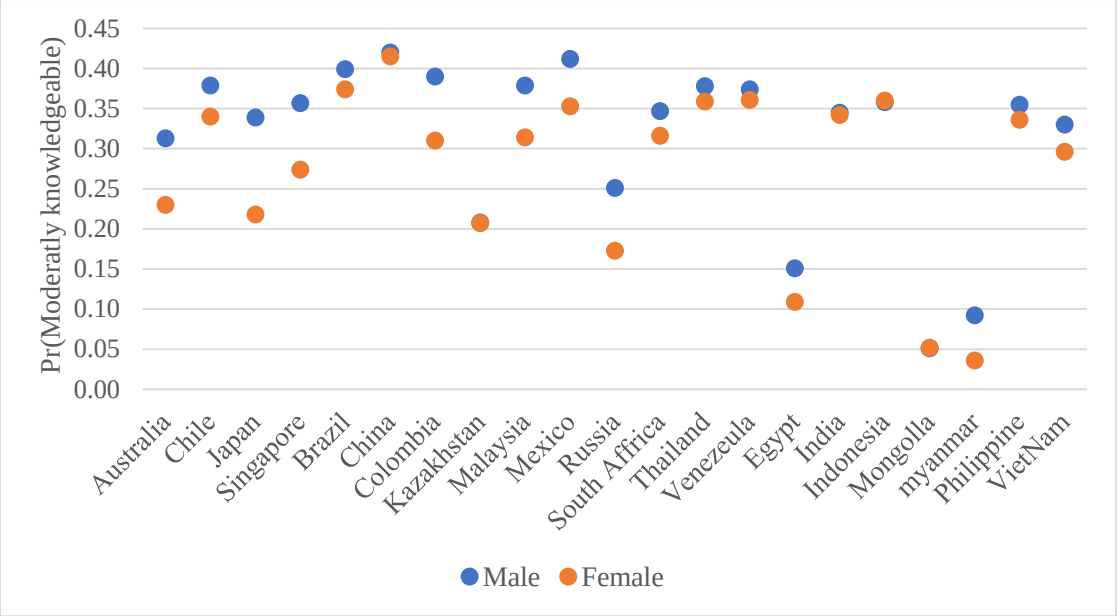

Figure 5-4 Adjusted predictions of moderately knowledgeable

Considering **Figure 5-4**, we identified a trend similar to that found in **Figure 3**: males' probability of rating themselves as moderately knowledgeable about energy sustainability is higher than that of females, including in high-income (e.g., Australia, Chile, Japan, and Singapore), upper-middle-income (e.g., Colombia, Malaysia, Mexico and Russia) and lower-middle-income countries (e.g., Myanmar and Vietnam), but not China, Kazakhstan, Indonesia, and Mongolia. These four countries and India show an almost zero marginal effect between males and females in the moderately knowledgeable category. Thus, those countries show equal effects for both genders in the moderately knowledgeable category.

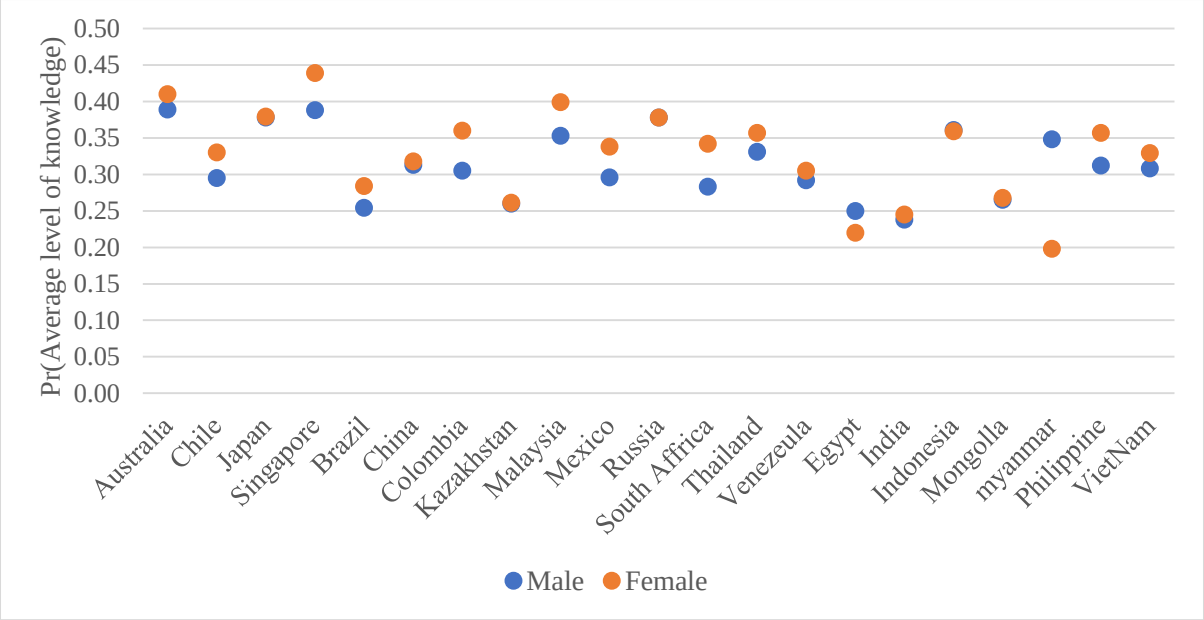

Figure 5-5 Adjusted predictions of average knowledgeable

When comparing both **Figure 5-3** and **Figure 5-4** with **Figure 5-5**, the opposite results are obtained for some countries. Some countries, including high-income (e.g., Australia, Chile and Singapore), upper-middle-income (e.g., Brazil, Colombia, Malaysia, Mexico, South Africa, and Thailand) and lower-middle-income countries (e.g., Philippines and Vietnam), show that females' probability of deciding that they have an average level of knowledge about energy sustainability is higher than that of males except in Myanmar and Egypt. In contrast, Japan, China, Russia, Kazakhstan, Indonesia, and Mongolia show almost no marginal effect between males and females in the average knowledge level category. However, in this part, we observed an interesting result for some countries: China, Kazakhstan, Indonesia, and Mongolia show similar results almost a zero-marginal effect between males and females for all three knowledge levels (high, moderate, and average). This result suggests that there is no gender difference in the knowledge of energy sustainability at each scale for those countries. Furthermore, it that

the marginal effect of gender is different within countries than between countries, and high-income countries show more differences within countries than other countries.

Similarly, the results for Eq. (2) show that in many countries, males' probability of considering themselves knowledgeable about energy sustainability is higher than that of females except in China, Kazakhstan, Vietnam, and Indonesia (see **Appendix Figure 5-8**). Thus, both our binary and ordered logistic analysis confirmed almost similar and statistically significant results regarding gender differences in knowledge of energy sustainability. Likewise, a paired t-test confirmed a statistically significant difference between males and females in their knowledge of energy with respect to the categories of high and moderate levels of knowledge (see **Appendix Table 5-8**). Therefore, the robustness of the results is comparatively higher, and these outcomes support Hypothesis 1.

Table 5-2 Estimation results of Eq. (1) for gender

Countries	**Gender**	**Predicted probability of level of knowledge**		
		Very/high	**Moderate**	**Average**
Overall result	Male	0.147***	0.357***	0.313***
		(0.002)	(0.002)	(0.002)
	Female	0.118***	0.321***	0.333***
		(0.001)	(0.002)	(0.002)
Australia	Male	0.096***	0.313 ***	0.389***
		(0.008)	(0.013)	(0.011)
	Female	0.060***	0.230***	0.410***
		(0.005)	(0.011)	(0.011)
Chile	Male	0.178***	0.379***	0.295***
		(0.013)	(0.015)	(0.014)
	Female	0.134***	0.340***	0.330***

		(0.017)	(0.015)	(0.015)
Japan	Male	0.048***	0.339***	0.378***
		(0.002)	(0.006)	(0.005)
	Female	0.024***	0.218***	0.379***
		(0.001)	(0.005)	(0.005)
Singapore	Male	0.116***	0.357***	0.388***
		(0.016)	(0.023)	(0.021)
	Female	0.070***	0.274***	0.439***
		(0.011)	(0.021)	(0.022)
Brazil	Male	0.207***	0.399***	0.254***
		(0.011)	(0.011)	(0.009)
	Female	0.166***	0.374***	0.284***
		(0.009)	(0.011)	(0.284)
China	Male	0.144***	0.420***	0.313***
		(0.003)	(0.004)	(0.004)
	Female	0.139***	0.415***	0.318***
		(0.003)	(0.004)	(0.004)
Colombia	Male	0.159***	0.390***	0.305***
		(0.014)	(0.017)	(0.015)
	Female	0.093***	0.310***	0.360***
		(0.009)	(0.015)	(0.015)
Kazakhstan	Male	0.244***	0.208***	0.260***
		(0.018)	(0.013)	(0.014)
	Female	0.241***	0.207***	0.261***
		(0.016)	(0.013)	(0.014)
Malaysia	Male	0.131***	0.379***	0.353***
		(0.012)	(0.017)	(0.054)
	Female	0.088***	0.314***	0.399***
		(0.009)	(0.016)	(0.016)
Mexico	Male	0.140***	0.412***	0.296***

		(0.010)	(0.014)	(0.012)
	Female	0.097	0.353***	0.338***
		(0.008)	(0.013)	(0.012)
Russia	Male	0.082***	0.251***	0.378***
		(0.007)	(0.011)	(0.011)
	Female	0.048***	0.173***	0.378***
		(0.004)	(0.009)	(0.010)
Thailand	Male	0.265***	0.347***	0.283***
		(0.014)	(0.015)	(0.016)
	Female	0.188***	0.316***	0.342***
		(0.013)	(0.015)	(0.016)
South Africa	Male	0.186***	0.378***	0.331***
		(0.017)	(0.015)	(0.015)
	Female	0.160***	0.359***	0.357***
		(0.014)	(0.014)	(0.016)
Venezuela	Male	0.174***	0.374***	0.292***
		(0.016)	(0.018)	(0.017)
	Female	0.157***	0.361***	0.305***
		(0.015)	(0.018)	(0.017)
Egypt	Male	0.075***	0.151***	0.250***
		(0.009)	(0.023)	(0.014)
	Female	0.048***	0.109***	0.220***
		(0.008)	(0.010)	(0.013)
India	Male	0.269***	0.345***	0.238***
		(0.007)	(0.006)	(0.006)
	Female	0.257***	0.342***	0.245***
		(0.007)	(0.006)	(0.006)
Indonesia	Male	0.156***	0.358***	0.361***
		(0.008)	(0.011)	(0.011)
	Female	0.158***	0.360***	0.359***

		(0.010)	(0.011)	(0.012)
Mongolia	Male	0.040***	0.051***	0.265***
		(0.010)	(0.010)	(0.023)
	Female	0.046***	0.052***	0.268***
		(0.010)	(0.011)	(0.022)
Myanmar	Male	0.003***	0.092***	0.348
		(0.002)	(0.011)	(0.018)
	Female	0.001***	0.036***	0.198
		(0.001)	(0.005)	(0.014)
Philippine	Male	0.255***	0.355***	0.312***
		(0.014)	(0.012)	(0.013)
	Female	0.204***	0.336***	0.357***
		(0.012)	(0.012)	(0.014)
Vietnam	Male	0.158***	0.330***	0.308***
		(0.011)	(0.013)	(0.012)
	Female	0.125***	0.296***	0.329***
		(0.010)	(0.013)	(0.012)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

Table 5-2 presents the predicted probabilities associated with gender in each country for three different categories and the overall probability (all 21 countries together). Based on these results, the position of each country can be compared to the overall result. According to the overall result in many cases, males' probability of considering themselves knowledgeable about energy sustainability is higher than that of females for all three levels of knowledge. However, when we compare the country results with the overall result, in **Table 5-2**, column 3 (very knowledgeable), countries such as Chile,

Brazil, Kazakhstan, Thailand, South Africa, Venezuela, India, Indonesia, Philippines, and Vietnam show a stronger result than the overall result for both genders. However, the high-income (e.g., Australia, Japan, Singapore), upper-middle-income (e.g., Malaysia, Mexico, Russia) and lower-middle-income countries (e.g., Egypt, Mongolia, and Myanmar) show a predicted probability that is lower than the overall result for both males and females. China and Colombia show mixed results.

According to column 4 (moderately knowledgeable), Chile, Brazil, China, Mexico, South Africa, and Venezuela show a probability higher than the overall probabilities for both genders. In contrast, the effect for Australia, Japan, Kazakhstan, Russia, Egypt, Mongolia, Myanmar, and Vietnam is less than the overall effect. Singapore, India, Indonesia, and Philippines show results similar to the overall result only for males, but the results for females were mixed. Thailand shows an equal probability among both males and females.

However, in column 5 (average level of knowledge), Australia, Japan, Singapore, Malaysia, Russia, South Africa, and Indonesia show a probability higher than the overall probability for both genders. By contrast, Chile, Brazil, China, Kazakhstan, Mexico, Venezuela, Egypt, India, Mongolia, Philippines, and Vietnam show probabilities less than the overall probability. Only Colombia, Thailand, and Myanmar show mixed results.

In addition, according to binary logistic analysis (see **Appendix Table 5-6**), in countries such as Chile, Singapore, Brazil, China, Malaysia, Mexico, Thailand, South Africa, Venezuela, India, Indonesia and Philippines, both males' and females' probabilities of being knowledgeable about energy sustainability are higher than the overall

probabilities. In contrast, Australia, Japan, Kazakhstan, Russia, Egypt, Mongolia, Myanmar, and Vietnam are countries where the knowledge of energy is less than the overall probabilities for both genders. In particular, Egypt, Mongolia, and Myanmar show a very large gap in energy knowledge relative to the overall knowledge level for both males and females'. However, in Colombia, although the effect is greater for males, the effect for females is less than the overall probability. Furthermore, we noted that Chile, Brazil, South Africa, and Venezuela show a greater effect than the overall probabilities, whereas Australia, Japan, Russia, Mongolia, and Myanmar show a lower probability than the overall probability in both models.

5.4.2 Importance based on gender: Hypothesis 2

The results are based on the sample data from 37 countries. According to Eq. (3), the results present the predicted probabilities of *Gender* (main independent variable) affecting the importance of energy sustainability. Hence, **Figure 5-6** and **Figure 5-7** illustrate, how gender differences relate to on the importance of energy sustainability in two different categories (very important and somewhat important).

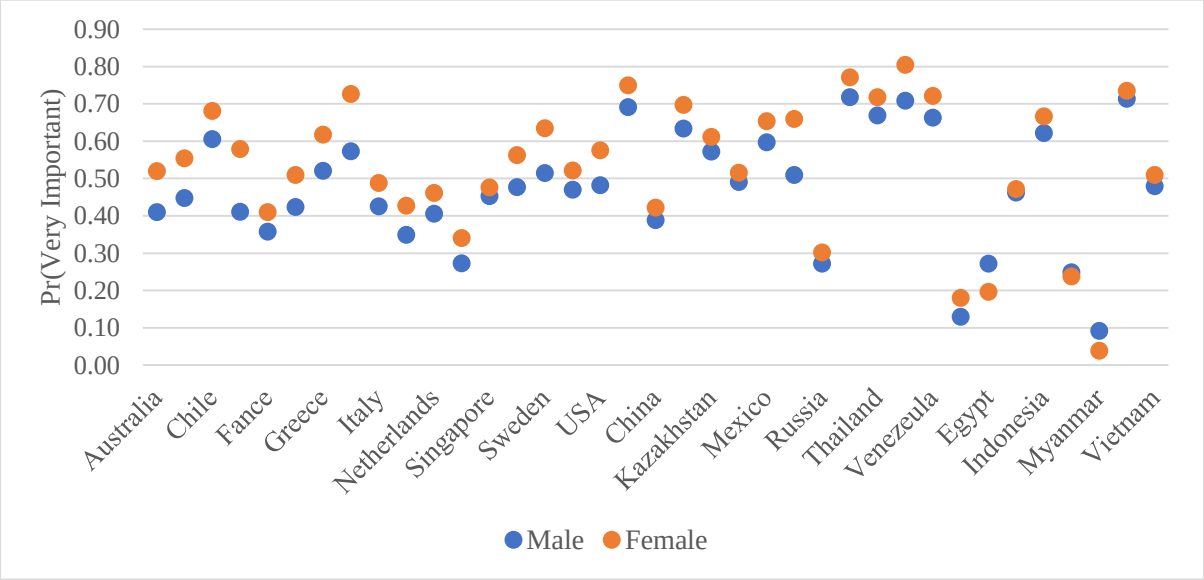

Figure 5-6 Adjusted predictions of very important

Fig.6 illustrates how people think about the importance of energy sustainability and its sustainability for the future. In most of the 37 countries, females have a higher probability of perceiving concerns about energy sustainability as very important than males do, including in high-income (e.g., Australia, Canada, Chile, Czech Republic, France, Germany, Greece, Hungry, Italy, Japan, the Netherlands, Poland, Spain, Sweden, the United Kingdom and the USA), upper-middle-income (e.g., Brazil, Colombia, Kazakhstan, Mexico, Romania, South Africa, Thailand, Turkey, Venezuela and Sri Lanka) and lower-middle-income countries (e.g., Indonesia), but not Egypt and Myanmar. In contrast, although some countries, Singapore, China, Malaysia, Russia, India, Mongolia, the Philippines, and Vietnam, show that females' probability of considering energy sustainability concerns to be very important is higher than that of males, but the marginal effect is comparatively small. However, we noted that high-income-countries, including Australia, Canada, Chile, Czech Republic, Germany, Greece, Hungary, Japan, Poland, Spain, Sweden, and the USA, show a considerable gap in the marginal effect of gender compared to that in upper- middle and lower-middle-income countries. Most upper-middle-income countries (e.g., Brazil, China, Colombia, Kazakhstan, Malaysia, Mexico, Russia, South Africa, Thailand, Turkey, Venezuela and Sri Lanka) show slight differences, except Romania. Moreover, lower-middle-income countries (e.g., India, Indonesia, Mongolia, the Philippines and Vietnam) show the opposite results: males have a higher probability of perceiving high importance than females. For the example of country differences, females' probability of deciding the energy sustainability concerns are very important is 9 percentage points higher than that

of males in the Czech Republic. in the differences are 7 percentage points for Australia, 5 for Colombia and 4 for Venezuela.

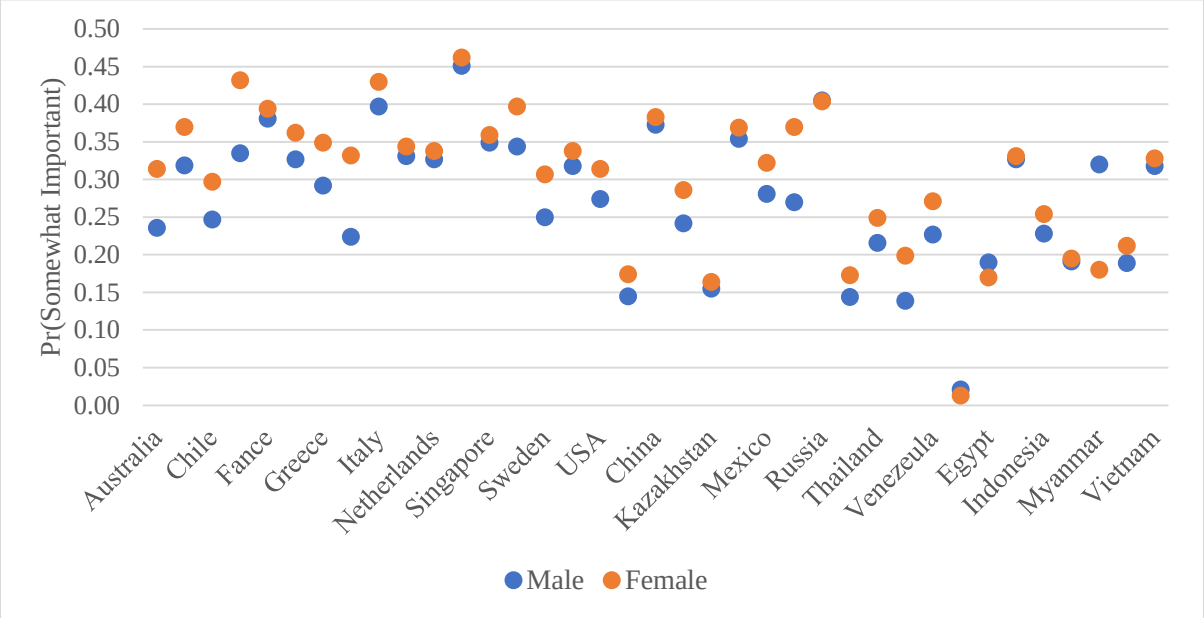

Figure 5-7 Adjusted predictions based on somewhat important

Similarly, the effect shown in **Figure 5-7** is similar to that in **Figure 5-6**. Twenty-three countries, including high-income (e.g., Australia, Canada, Chile, Czech Republic, Germany, Greece, Hungary, Italy, Spain, Sweden and the USA), upper-middle-income countries (e.g., Indonesia and Philippines), show that females have a higher probability of perceiving energy sustainability concerns as somewhat important than males do. Furthermore, some high-income countries (e.g., France, Japan, the Netherlands, Poland, Singapore and the United Kingdom) and upper-middle-income countries (e.g., China, Kazakhstan and Malaysia) show that females are more likely to regard their concern about energy sustainability as somewhat important than males are. In addition, Sri Lanka shows very low level of predicted probabilities for males and females compared to those in other countries. In contrast, Egypt and Myanmar, as lower-middle-income countries, show similar results for the very important category: females' probability of

perceiving energy sustainability concerns as somewhat important is higher than that of males. Moreover, Russia and India have no gender difference in marginal effects. Furthermore, the marginal effect of gender is different within countries than between countries, and high-income countries show more differences within countries than other countries.

In addition to the results for Eq. (3), the results for Eq. (4) show that in many countries, females' probability of regarding energy sustainability concerns as important is higher than that of males except in Egypt, Mongolia, and Myanmar (see **Appendix Figure 5-9**). Therefore, we concluded that this probability is higher for females than for males in both binary and ordered logistic analyses. The paired t-test confirmed that those gender differences are statistically significant (see **Appendix Table 5-8**), supporting the robustness of the results. This inference is in line with existing environmental research (e.g.,(Lee et al., 2013; Torgler et al., 2008; Xiao and McCright, 2015; Zelezny et al., 2000)). Hence, these results are consistent with Hypothesis 2.

However, considering the countries, we noted that all other countries show evidence of our main findings except for Egypt, Myanmar, and Mongolia, which show unique results. Egypt and Myanmar show opposite results: males have a higher probability of rating their knowledge and concerns about energy sustainability as higher than females in all four regression analyses. These opposite results are consistent with women showing less awareness and concerns about environmental issues than men in Egypt (Mostafa, 2007) and men have a positive attitude toward protected (forest) areas and both the problems and benefits related to those areas than women do in Myanmar

(Allendorf and Allendorf, 2013). Although Mongolia shows an equal effect between the genders for all four regression results, existing education research has found a greater effect for better-educated females than for better-educated males (Weidman and Lelei, 2003).

Table 5-3 presents some of the estimated results for the Eq. (3), which is the predicted probabilities of *Gender* influencing the importance of energy sustainability.

Table 5-3 Estimation results for Eq. (3) for gender

Countries	**Gender**	**Predicted probability of level of knowledge**		
		Very/high	**Moderate**	**Average**
Overall result	Male	0.147***	0.357***	0.313***
		(0.002)	(0.002)	(0.002)
	Female	0.118***	0.321***	0.333***
		(0.001)	(0.002)	(0.002)
Australia	Male	0.096***	0.313 ***	0.389***
		(0.008)	(0.013)	(0.011)
	Female	0.060***	0.230***	0.410***
		(0.005)	(0.011)	(0.011)
Chile	Male	0.178***	0.379***	0.295***
		(0.013)	(0.015)	(0.014)
	Female	0.134***	0.340***	0.330***
		(0.017)	(0.015)	(0.015)
Japan	Male	0.048***	0.339***	0.378***
		(0.002)	(0.006)	(0.005)
	Female	0.024***	0.218***	0.379***
		(0.001)	(0.005)	(0.005)
Singapore	Male	0.116***	0.357***	0.388***
		(0.016)	(0.023)	(0.021)

	Female	0.070***	0.274***	0.439***
		(0.011)	(0.021)	(0.022)
Brazil	Male	0.207***	0.399***	0.254***
		(0.011)	(0.011)	(0.009)
	Female	0.166***	0.374***	0.284***
		(0.009)	(0.011)	(0.284)
China	Male	0.144***	0.420***	0.313***
		(0.003)	(0.004)	(0.004)
	Female	0.139***	0.415***	0.318***
		(0.003)	(0.004)	(0.004)
Colombia	Male	0.159***	0.390***	0.305***
		(0.014)	(0.017)	(0.015)
	Female	0.093***	0.310***	0.360***
		(0.009)	(0.015)	(0.015)
Kazakhstan	Male	0.244***	0.208***	0.260***
		(0.018)	(0.013)	(0.014)
	Female	0.241***	0.207***	0.261***
		(0.016)	(0.013)	(0.014)
Malaysia	Male	0.131***	0.379***	0.353***
		(0.012)	(0.017)	(0.054)
	Female	0.088***	0.314***	0.399***
		(0.009)	(0.016)	(0.016)
Mexico	Male	0.140***	0.412***	0.296***
		(0.010)	(0.014)	(0.012)
	Female	0.097	0.353***	0.338***
		(0.008)	(0.013)	(0.012)
Russia	Male	0.082***	0.251***	0.378***
		(0.007)	(0.011)	(0.011)

	Female	0.048***	0.173***	0.378***
		(0.004)	(0.009)	(0.010)
Thailand	Male	0.265***	0.347***	0.283***
		(0.014)	(0.015)	(0.016)
	Female	0.188***	0.316***	0.342***
		(0.013)	(0.015)	(0.016)
South Africa	Male	0.186***	0.378***	0.331***
		(0.017)	(0.015)	(0.015)
	Female	0.160***	0.359***	0.357***
		(0.014)	(0.014)	(0.016)
Venezuela	Male	0.174***	0.374***	0.292***
		(0.016)	(0.018)	(0.017)
	Female	0.157***	0.361***	0.305***
		(0.015)	(0.018)	(0.017)
Egypt	Male	0.075***	0.151***	0.250***
		(0.009)	(0.023)	(0.014)
	Female	0.048***	0.109***	0.220***
		(0.008)	(0.010)	(0.013)
India	Male	0.269***	0.345***	0.238***
		(0.007)	(0.006)	(0.006)
	Female	0.257***	0.342***	0.245***
		(0.007)	(0.006)	(0.006)
Indonesia	Male	0.156***	0.358***	0.361***
		(0.008)	(0.011)	(0.011)
	Female	0.158***	0.360***	0.359***
		(0.010)	(0.011)	(0.012)
Mongolia	Male	0.040***	0.051***	0.265***
		(0.010)	(0.010)	(0.023)
	Female	0.046***	0.052***	0.268***

		(0.010)	(0.011)	(0.022)
Myanmar	Male	0.003***	0.092***	0.348
		(0.002)	(0.011)	(0.018)
	Female	0.001***	0.036***	0.198
		(0.001)	(0.005)	(0.014)
Philippine	Male	0.255***	0.355***	0.312***
		(0.014)	(0.012)	(0.013)
	Female	0.204***	0.336***	0.357***
		(0.012)	(0.012)	(0.014)
Vietnam	Male	0.158***	0.330***	0.308***
		(0.011)	(0.013)	(0.012)
	Female	0.125***	0.296***	0.329***
		(0.010)	(0.013)	(0.012)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

According to the overall results of 37 countries, females show a higher probability than males in both the very important and somewhat important categories of energy sustainability. In detail, in **Table 5-3** column 3 (very important), countries such as Chile, Greece, Hungary, Spain, Sweden, the United Kingdom, the USA, Brazil, Colombia, Kazakhstan, Malaysia, Mexico, South Africa, Thailand, Turkey, Venezuela, Indonesia, the Philippines, and Vietnam show probabilities higher than the overall probabilities for both genders. By contrast, probabilities are lower than average for some high-income-countries, namely, France, Italy, Singapore, Japan, the Netherlands, Poland; upper-middle-income countries, namely, China, Romania, Russia, Sri Lanka, Egypt, Mongolia,

and Myanmar. The probabilities for Australia, Canada, Czech Republic, and Germany are lower for males and higher for females than the overall probabilities.

In column 4 (somewhat important), Canada, Czech Republic, France, Germany, Italy, Japan, the Netherlands, Poland, Singapore, Spain, the United Kingdom, China, Malaysia, Romania, and Russia show probabilities higher than the overall probabilities for both males and females. In contrast, Australia, Chile, Sweden, the USA, Brazil, Colombia, Kazakhstan, Mexico, South Africa, Thailand, Turkey, Venezuela, Sri Lanka, Egypt, Indonesia, Mongolia, Myanmar, and Philippines show probabilities lower than the overall probability for both genders. The rest of the countries, Greece, Hungary, and India, show mixed results between males and females.

In addition, according to binary logistic analysis (see **Appendix Table 5-7**), in countries such as Canada, Chile, Czech Republic, Germany, Greece, Hungary, Italy, Singapore, Spain, Sweden, the United Kingdom, the USA, Brazil, Colombia, Malaysia, Mexico, Thailand, Turkey, Venezuela, Sri Lanka, Indonesia, Philippines, and Vietnam, that the probabilities for both males and females are higher than the overall probabilities. In contrast, in France, Japan, the Netherlands, Poland, China, Kazakhstan, Romania, Russia, Egypt, Mongolia, and Myanmar probabilities are less than the overall probabilities for both genders, and Australia, South Africa, and India show mixed results. Commonly, we noted that Spain, the United Kingdom and Malaysia show higher effects than the overall probability, whereas the Netherlands, Mongolia, and Myanmar show probabilities lower than the overall probability in both models.

5.4.3 Other sociodemographic factors

Turning to the analysis of other independent variables, we report here only the results for Eq. (2) and Eq. (4). Both analyses show that the predicted probabilities for all other independent variables are significant in most countries. Although *Income Groups* did not yield specific results differing from the lower-income group (reference category) for either regression, *Labor Force* and *Education Level* show some interesting results (see **Appendix Table 5-9** and **Table 5-10**). *Labor Force* includes two categories: employed and unemployed. When we consider Eq. (2), in most countries, employed respondents has a higher' probability of rating themselves as knowledgeable about energy sustainability than unemployed respondents. Thus, employed respondents show more knowledge of energy sustainability than unemployed respondents except in a few countries, including Australia, Japan, Singapore, Brazil and Mexico. The reason for these opposite results may be that students were included in the unemployed category, which suggests that students are also more knowledgeable about energy sustainability in those few countries than in other countries. In contrast, unemployed respondents' probability of rating concerns about energy sustainability as important is higher than that of employed respondents. Likewise, compared to the other three categories of education, more than 65% of those with tertiary education show a higher level of knowledge and concern about energy sustainability in most countries, except Egypt, Mongolia and Myanmar. In those countries, the values are 53%, 50%, and 48%, respectively, for Eq. (2) and 54%, 55%, and 46%, for Eq. (4).

The *Age* factor suggests mixed results. Although there is no clear trend between age groups and knowledge of energy sustainability, all age groups show significant

probabilities above 50% in most countries. In Eq. (4), the probability of regarding energy sustainability concerns as important is higher age group 2 and 3 (31-40 and 41-50) than for age group 1 (18-30) (see **Appendix Table 5-11** and **Table 5-12**). This is in line with findings that older people consider energy-saving behavior more than younger individuals do (Barr et al., 2005) .

GE (gender with education levels) and *GC* (gender with children) are interaction variables, and those variables are also directly connected to *Gender* (the main independent variable). First, when we consider the results for Eq. (2) results, educated males' probability of considering themselves knowledgeable about energy sustainability is higher than that for educated females. Educated males in particular show a higher probability of being knowledgeable about energy in the tertiary education category than in the category lacking education (not attended) (reference category) in most countries. In addition, we identified that most of the categories of educated females were more likely to consider concerns about energy sustainability as important than the categories of educated males (see **Appendix Table 5-13** and **Table 5-14**). The variable *GC* is included only in Eq. (3) and Eq. (4), and according to the results for Eq. (4), the average number of children is five per person or respondent. An interesting result of this interaction variable is that if the respondent is a female with children, her probability of considering energy sustainability concerns important is higher than that of a male with children. On the other hand, the probability of females without children recognizing the importance of energy sustainability is higher than that of males without children (see **Appendix Table 5-15**), and these results confirmed that some previous studies on females concerned about the children, health and well-being of the family

(e.g.,(Adams et al., 2012; Beutel and Marini, 1995; Michel Laroche et al., 2001; Wehrmeyer and McNeil, 2000)).

5.5. Conclusion

This study provides novel evidence concerning sociodemographic factors and human behavior factors considering knowledge of energy sustainability and the importance of energy sustainability. This study also contributes to the existing literature on the of environment, energy, neuroscience, and psychology by investigating these linkages. This paper explores whether females' decisions tend to be based on holistic associations (intuition) and males' decisions tend to rely on cause-effect logic (rationality) in making decisions about energy sustainability.

The first and most important findings are that males are more knowledgeable about the sustainability of the energy supply than females are (*Hypothesis 1*) and that females show greater concern about the importance of the sustainability of the energy supply than males do (*Hypothesis 2*) for most countries. This is consistent with females showing more environmentally friendly behavior and concern than males (e.g., (Brounen et al., 2013; Ding et al., 2017; Halder et al., 2010; Lee et al., 2013; Xiao and McCright, 2014, 2012; Zelezny et al., 2000; Zyadin et al., 2014)) and males showing more knowledge of the environment than females (e.g.,(Eisler et al., 2003; Mostafa, 2007; Tikka et al., 2000)). Likewise, we found that females who have children, tend to rate the importance of energy sustainability as higher than do males with children. On the other hand, for females without children, the importance of energy sustainability to them is higher than that for males without children. The above facts apply for both

developing and developed countries. Many developed countries show greater gender differences than developing countries. Therefore, people's decision making/thinking is a more crucial factor than their country background. Likewise, males show more knowledge of energy sustainability than females, and according to the existing literature, male brains are organized to accommodate connections between perception and coordinated action (Ingalhalikar et al., 2014). Perception is a source of knowledge, and information stored in memory based on past experience (stored knowledge) can influence observation itself (Rock, 1985). Additionally, essential standards of theory and practice are problem solving, which compelling if the information base and use of that information (Carson, 2007) and rationality begin with logic reasoning (Moshman, 2004). Additionally, rational thinking is related to masculinity (Epstein et al., 1996);thus, males' decision-making tends to be based on cause-effect logic. In contrast, females show more concern about the importance of energy sustainability than males. This result is line with natural reasoning, which may have various ramifications for people, and intuitive, feeling-based thinking is related to femininity (Epstein et al., 1996). Furthermore, according to neuroscience studies, female brains are composited to accommodate connections between analytical and intuitive preparation modes (Ingalhalikar et al., 2014) and compared to men, women tend to be more kind, generous and universally concerned (Adams et al., n.d.; Beutel and Marini, 1995). Therefore, the findings suggest that greater concern is connected to the holistic association thinking style of females. Additionally, some empirical studies have acknowledged gender differences in analytical and intuitive decision-making processes. For instance, Heilman et al., (1989) found that successful managers are characterized as logical, analytical and

objective, and implication is that female managers are seen as less analytical and more intuitive than male managers. Furthermore, one of valuable contribution of women is bring intuition to management (Claes, 1999) and leadership (Hambleton and Murray, 1983). Additionally, nurses often use intuition to guide patient care decisions (Ruth-Sahd and Hendy, 2005) and preference for use of intuition in nursing increases with experience (Pretz and Folse, 2011).

These results suggest that when people make decisions, males tend to rely on cause-effect logic, whereas females consider holistic associations. While intuitive and rational decision making are fundamentally different concepts, together, they lead to better decision making (Epstein, 1994). Some previous studies suggested that decision makers would benefit from utilizing both intuition and rationality (e.g.,(Elbanna and Child, 2007; Hitt and Tyler, 1991; Langley et al., 1995)). However, in general, rational thinking and intuitive thinking cannot easily coexist (e.g.,(Hodgkinson et al., 2009; Hodgkinson and Clarke, 2007; Salas et al., 2010)). In this context, cognitive psychology researchers have suggested that an appropriate way to accommodate both intuition and rationality is at the team level, such as combining individuals with more rational versus more intuitive decision-making in teams (Hodgkinson and Healey, 2011; Volkema and Gorman, 1998). Furthermore, some cognitive psychology studies suggest that although rationality and intuition remain independent in the human brain, they are contemporary information processes that interact (Epstein, 1994; Evans, 2003), and thus, intuition and rationality could be combined at the individual level in decision making (Calabretta et al., 2017).

However, future research should thoroughly investigate the effect of other sociodemographic factors on knowledge and the importance of energy sustainability. Furthermore, future studies could examine how to properly link two types of thinking, holistic associations (intuition) and cause-effect logic (rationality) based on gender for making decisions energy security for a better future.

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Appendix 5

Table 5-4 Survey information

Country name	Sample size	Survey method	Survey period		Income group*
Australia	2,029	Internet	2016/02/10	2016/02/22	High
Canada	1,333	Internet	2016/09/01	2016/09/13	High
Chile	1,192	Internet	2015/07/24	2015/07/28	High
Czech Republic	1,400	Internet	2017/03/08	2017/03/16	High
France	2,138	Internet	2016/08/26	2016/09/07	High
Germany	3,165	Internet	2016/08/26	2016/09/07	High
Greece	1,382	Internet	2016/08/31	2016/09/12	High
Hungary	1,354	Internet	2017/03/08	2017/03/15	High
Italy	2,106	Internet	2016/08/29	2016/09/10	High
Japan	11,167	Internet	2015/07/14	2015/08/05	High
Netherlands	1,371	Internet	2016/08/29	2016/09/10	High
Poland	2,227	Internet	2017/03/08	2017/03/17	High
Singapore	587	Internet	2015/07/15	2015/07/21	High
Spain	2,116	Internet	2016/08/26	2016/09/07	High
Sweden	1,330	Internet	2016/08/31	2016/09/12	High
United Kingdom	2,993	Internet	2016/08/16	2016/08/28	High
USA	10,683	Internet	2016/08/16	2016/08/28	High
Brazil	2,298	Internet	2015/07/23	2015/07/26	Upper-Middle
China	20,744	Internet	2016/01/12	2016/02/29	Upper-Middle
Colombia	1,115	Internet	2015/07/24	2015/07/27	Upper-Middle
Kazakhstan	1,000	Interview	2015/08/25	2015/09/24	Upper-Middle
Malaysia	1,106	Internet	2015/07/23	2015/07/29	Upper-Middle
Mexico	1,678	Internet	2015/07/24	2015/07/27	Upper-Middle
Romania	1,386	Internet	2017/03/08	2017/03/18	Upper-Middle
Russia	2,221	Internet	2015/08/31	2015/09/14	Upper-Middle
Sri Lanka	500	Interview	2017/03/09	2017/03/30	Upper-Middle
South Africa	1,123	Internet	2015/07/15	2015/07/23	Upper-Middle

Continued					
Thailand	1,127	Internet	2015/07/18	2015/07/23	Upper-Middle
Turkey	2,120	Internet	2017/03/07	2017/03/20	Upper-Middle
Venezuela	827	Internet	2015/07/24	2015/08/05	Upper-Middle
Egypt	1,016	Interview	2015/09/14	2015/10/27	Lower-Middle
India	6,700	Interview Internet	2015/07/25	2015/08/11	Lower-Middle
Indonesia	2,412	Interview Internet	2015/07/18	2015/07/23	Lower-Middle
Mongolia	500	Interview	2015/08/19	2015/09/03	Lower-Middle
Myanmar	1,083	Interview	2015/07/06	2015/08/10	Lower-Middle
Philippines	1,686	Internet	2015/07/15	2015/07/22	Lower-Middle
Vietnam	1,741	Interview Internet	2015/07/18	2015/07/28	Lower-Middle

* World Bank New country classifications by income level: 2019-2020

Table 5-5 Two types of regression models

Dependent variable	Likert scales	Model	Bivariate		Model
KE (*Knowledge of Energy*)	Very knowledgeable =5 Moderately knowledgeable =4 Average =3 Not so knowledgeable =2 Do not have any knowledge =1	Ordered logistic model (1)	Very knowledgeable =5 Moderately knowledgeable =4 Average =3	=1	Binary logistic model (2)
			Not so knowledgeable =2 Do not have any knowledge =1	=0	
IE (*Importance of Energy*)	Very important =5 Somewhat important =4 Neither =3 Not very important =2 Not at all important =1	Ordered logistic model (3)	Very important =5 Somewhat important =4	=1	Binary logistic model (4)
			Neither =3 Not very important =2 Not at all important =1	=0	

Note: Model (2):1=Knowledgeable 0=Otherwise and Model (4): 1= Important 0=Otherwise

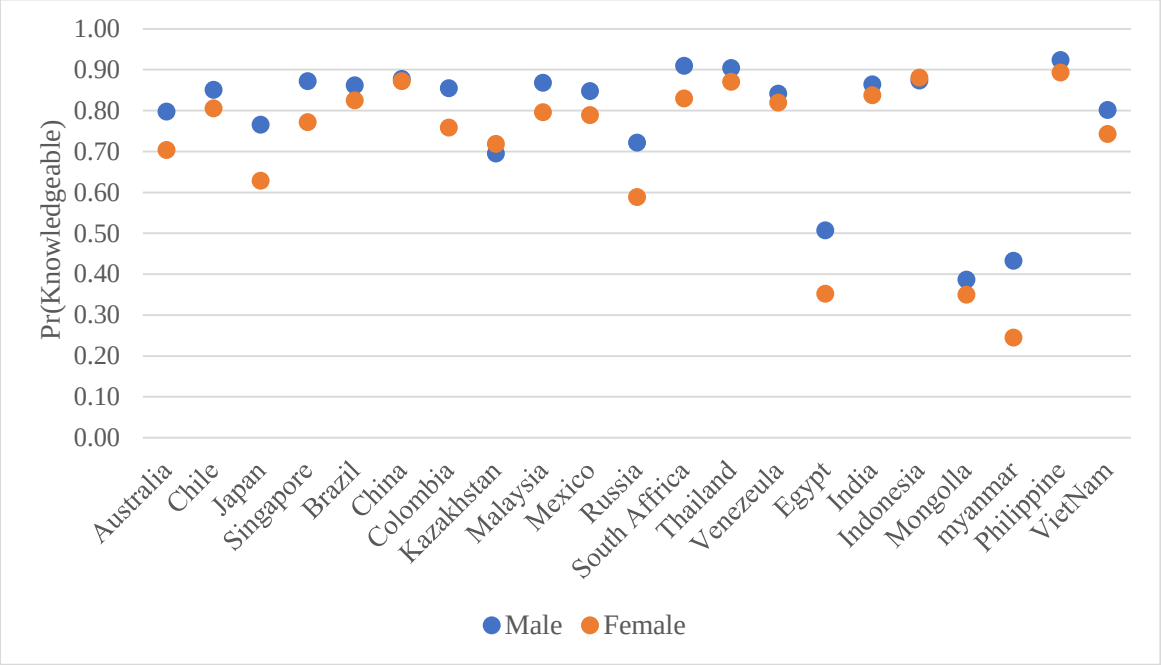

Figure 5-8 Adjusted predictions of knowledgeable

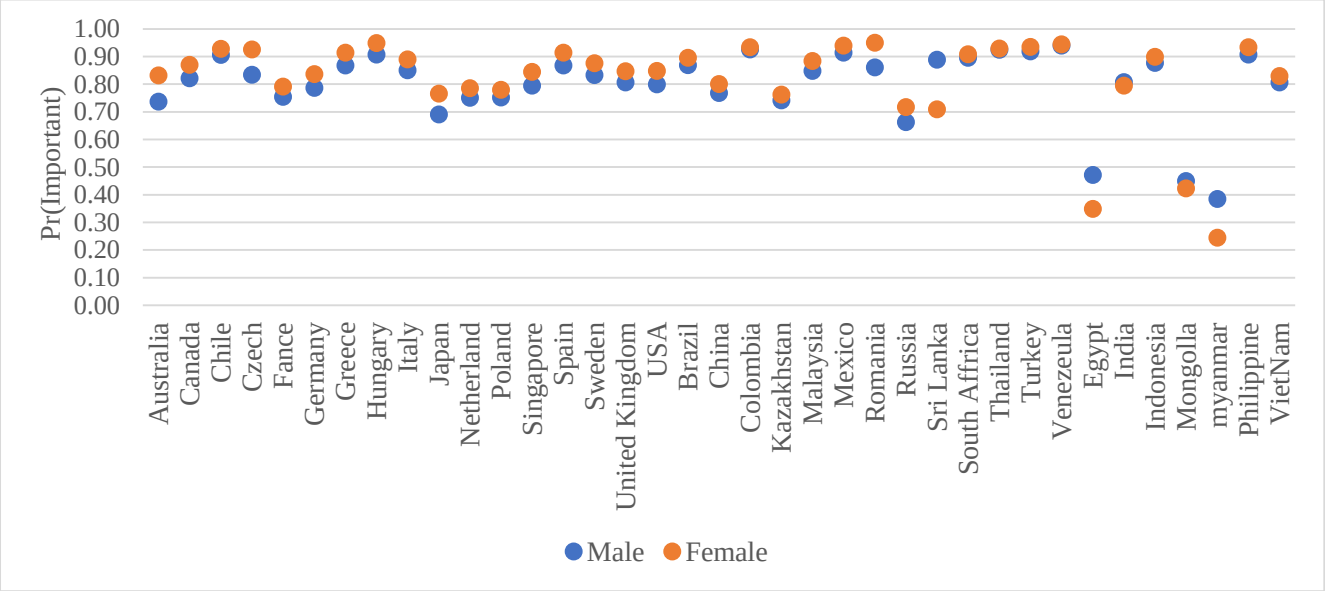

Figure 5-9 Adjusted predictions of important

Table 5-6 Estimation results of Eq. (2) for gender

Countries	Gender	Predicted probabilities
		Knowledgeable*
Overall result	Male	0.824*** (0.002)
	Female	0.767*** (0.002)
Australia	Male	0.798*** (0.013)
	Female	0.704*** (0.014)
Chile	Male	0.851*** (0.014)
	Female	0.806*** (0.017)
Japan	Male	0.766*** (0.006)
	Female	0.629*** (0.006)
Singapore	Male	0.872*** (0.019)
	Female	0.772*** (0.024)
Brazil	Male	0.862*** (0.101)
	Female	0.825*** (0.011)
China	Male	0.878*** (0.003)
	Female	0.872*** (0.003)
Colombia	Male	0.855*** (0.016)
	Female	0.759***

		(0.017)
Kazakhstan	Male	0.695*** (0.022)
	Female	0.719*** (0.019)
Malaysia	Male	0.868*** (0.014)
	Female	0.796*** (0.018)
Mexico	Male	0.848*** (0.013)
	Female	0.789*** (0.014)
Russia	Male	0.722*** (0.014)
	Female	0.589*** (0.014)
Thailand	Male	0.904*** (0.012)
	Female	0.871*** (0.014)
South Africa	Male	0.91*** (0.013)
	Female	0.83*** (0.015)
Venezuela	Male	0.842*** (0.018)
	Female	0.82*** (0.018)
Egypt	Male	0.507*** (0.022)
	Female	0.352*** (0.022)
India	Male	0.864*** (0.006)
	Female	0.838*** (0.007)

Indonesia	Male	0.874*** (0.009)
	Female	0.881*** (0.011)
Mongolia	Male	0.387*** (0.032)
	Female	0.35*** (0.029)
Myanmar	Male	0.433*** (0.023)
	Female	0.245*** (0.018)
Philippine	Male	0.924*** (0.009)
	Female	0.893*** (0.011)
Vietnam	Male	0.802*** (0.014)
	Female	0.743*** (0.016)

Note: * included very knowledgeable, somewhat knowledgeable and average knowledgeable. *** denote statistical significance at the 1% level. Standard errors in parentheses.

Table 5-7 Estimation results of Eq. (4) for gender

Countries	Gender	Predicted probabilities Important
Overall result	Male	0.787*** (0.002)
	Female	0.822*** (0.002)
Australia	Male	0.737*** (0.014)
	Female	0.832*** (0.012)
Canada	Male	0.821*** (0.015)
	Female	0.87*** (0.013)
Chile	Male	0.906*** (0.011)
	Female	0.928*** (0.012)
Czech Republic	Male	0.834*** (0.014)
	Female	0.925*** (0.009)
France	Male	0.754*** (0.014)
	Female	0.791*** (0.012)
Germany	Male	0.786*** (0.010)
	Female	0.836*** (0.009)
Greece	Male	0.868*** (0.013)
	Female	0.914***

		(0.010)
Hungary	Male	0.907*** (0.011)
	Female	0.949*** (0.008)
Italy	Male	0.850*** (0.011)
	Female	0.89*** (0.010)
Japan	Male	0.690*** (0.006)
	Female	0.766*** (0.006)
Netherlands	Male	0.751*** (0.017)
	Female	0.785*** (0.015)
Poland	Male	0.752*** (0.013)
	Female	0.78*** (0.012)
Singapore	Male	0.794*** (0.019)
	Female	0.844*** (0.024)
Spain	Male	0.868*** (0.011)
	Female	0.914*** (0.008)
Sweden	Male	0.833*** (0.014)
	Female	0.876*** (0.013)
United Kingdom	Male	0.806*** (0.010)

	Female	0.847*** (0.009)
USA	Male	0.799*** (0.006)
	Female	0.848*** (0.005)
Brazil	Male	0.869*** (0.010)
	Female	0.895*** (0.009)
China	Male	0.768*** (0.004)
	Female	0.8*** (0.004)
Colombia	Male	0.925*** (0.012)
	Female	0.934*** (0.010)
Kazakhstan	Male	0.741*** (0.021)
	Female	0.762*** (0.018)
Malaysia	Male	0.848*** (0.015)
	Female	0.884*** (0.014)
Mexico	Male	0.914*** (0.009)
	Female	0.939*** (0.008)
Romania	Male	0.750*** (0.013)
	Female	0.78*** (0.012)
Russia	Male	0.663*** (0.015)

	Female	0.717*** (0.013)
South Africa	Male	0.888*** (0.013)
	Female	0.709*** (0.012)
Thailand	Male	0.895*** (0.011)
	Female	0.908*** (0.011)
Turkey	Male	0.924*** (0.008)
	Female	0.929*** (0.007)
Venezuela	Male	0.918*** (0.012)
	Female	0.935*** (0.011)
Sri Lanka	Male	0.939*** (0.021)
	Female	0.944*** (0.027)
Egypt	Male	0.472*** (0.023)
	Female	0.349*** (0.023)
India	Male	0.807*** (0.007)
	Female	0.795*** (0.008)
Indonesia	Male	0.877*** (0.009)
	Female	0.899*** (0.011)
Mongolia	Male	0.450*** (0.033)

	Female	0.423*** (0.018)
Myanmar	Male	0.385*** (0.022)
	Female	0.245*** (0.018)
Philippines	Male	0.907*** (0.010)
	Female	0.934*** (0.009)
Vietnam	Male	0.806*** (0.014)
	Female	0.829*** (0.014)

Note: * included very important and somewhat important. *** denote statistical significance at the 1% level. Standard errors in parentheses.

Table 5-8 Paired T-test results

Categories (ordered logit)	**Mean. Diff**	**95% Conf. Interval**		**t**	**P-value**
Very knowledgeable					
Male	0.03***	0.019	0.039	6.092	0.000
Female	(0.005)				
Moderately knowledgeable					
Male	0.05***	0.025	0.057	5.440	0.000
Female	(0.007)				
Average knowledgeable					
Male	-0.01	-0.033	0.007	-1.385	0.181
Female	(0.009)				
Very importance					
Female	0.06***	0.043	0.076	7.332	0.000
Male	(0.008)				
Somewhat importance					
Female	0.03***	0.015	0.042	4.205	0.000
Male	(0.007)				
Categories (binary logit)	**Mean. Diff**	**95% Conf. Interval**		**t**	**P-value**
Knowledgeable					
Male	0.06***	0.041	0.091	5.471	0.000
Female	(0.012)				
Importance					
Female	0.02**	0.000	0.037	2.069	0.045
Male	(0.009)				

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

Table 5-9 Estimation results of Eq. (2)

Country	Dependent variable: Knowledge of Energy Sustainability (Knowledgeable =1, other =0)										
	Labor Force		**Education**				**Income group**				
	Employed	**Unemployed**	**Not attended**	**Primary**	**Secondary**	**Tertiary**	**Lower**	**Lower Middle**	**Middle**	**Upper Middle**	**Upper**
Overall result	0.808*** (0.002)	0.766*** (0.002)	0.735*** (0.010)	0.717*** (0.013)	0.755*** (0.003)	0.836*** (0.002)	0.698*** (0.007)	0.759*** (0.003)	0.802*** (0.002)	0.866*** (0.003)	0.869*** (0.009)
Australia	0.0746*** (0.011)	0.761*** (0.018)	0.72*** (0.038)	0.749*** (0.065)	0.696*** (0.015)	0.808*** (0.013)	0.723*** (0.024)	0.719*** (0.020)	0.756*** (0.070)	0.805*** (0.023)	0.751*** (0.070)
Chile	0.835*** (0.014)	0.823*** (0.019)	0.857*** (0.039)	0.855*** (0.059)	0.796*** (0.016)	0.887*** (0.017)	0.942*** (0.032)	0.811*** (0.022)	0.832*** (0.015)	0.839*** (0.029)	0.783*** (0.077)
Japan	0.694*** (0.005)	0.713*** (0.007)	0.691 (0.036)	0.386* (0.219)	0.657*** (0.007)	0.738*** (0.006)	0.594*** (0.012)	0.654*** (0.008)	0.731*** (0.007)	0.807*** (0.009)	0.851*** (0.037)
Singapore	0.807*** (0.018)	0.888*** (0.030)	0.762*** (0.087)	-	0.774*** (0.027)	0.863*** (0.019)	0.729*** (0.074)	0.744*** (0.035)	0.862*** (0.019)	0.854*** (0.040)	0.727*** (0.228)
Brazil	0.839*** (0.009)	0.849*** (0.013)	0.827*** (0.033)	0.583*** (0.068)	0.817*** (0.011)	0.895*** (0.010)	0.755*** (0.032)	0.809*** (0.013)	0.873*** (0.010)	0.909*** (0.022)	0.963*** (0.036)
China	0.885*** (0.002)	0.812*** (0.008)	0.788*** (0.025)	0.872*** (0.017)	0.855*** (0.004)	0.895*** (0.003)	0.827*** (0.011)	0.862*** (0.005)	0.873*** (0.003)	0.908*** (0.005)	0.888*** (0.019)
Colombia	0.826*** (0.014)	0.762*** (0.022)	0.874*** (0.044)	0.693*** (0.095)	0.779*** (0.017)	0.836*** (0.019)	0.777*** (0.055)	0.754*** (0.025)	0.823*** (0.016)	0.820*** (0.029)	0.865*** (0.074)
Kazakhstan	0.726*** (0.018)	0.677*** (0.026)	0.650*** (0.140)	0.508*** (0.349)	0.695*** (0.019)	0.732*** (0.022)	0.656*** (0.098)	0.579*** (0.045)	0.713*** (0.018)	0.769*** (0.031)	0.873*** (0.083)
Malaysia	0.839*** (0.012)	0.824*** (0.026)	0.750*** (0.096)	0.672*** (0.133)	0.803*** (0.020)	0.859*** (0.013)	0.856*** (0.039)	0.791*** (0.024)	0.838*** (0.015)	0.921*** (0.012)	0.709*** (0.109)

Continued

Mexico	0.811***	0.826***	0.770***	0.938***	0.791***	0.841***	0.786***	0.784***	0.822***	0.859***	0.826
	(0.012)	(0.017)	(0.054)	(0.059)	(0.015)	(0.031)	(0.044)	(0.020)	(0.013)	(0.022)	(0.064)
Russia	0.651***	0.648***	0.671***	-	0.619***	0.668***	0.544***	0.610***	0.684***	0.747***	0.863***
	(0.012)	(0.020)	(0.067)		(0.017)	(0.013)	(0.038)	(0.017)	(0.014)	(0.044)	(0.127)
South Africa	0.872***	0.856***	0.851***	0.761***	0.853***	0.894***	0.888***	0.836***	0.873***	0.903***	0.862***
	(0.011)	(0.024)	(0.055)	(0.209)	(0.014)	(0.015)	(0.035)	(0.022)	(0.014)	(0.022)	(0.073)
Thailand	0.903***	0.827***	0.858***	0.813***	0.864***	0.902***	0.803***	0.835***	0.895***	0.967***	0.975***
	(0.009)	(0.026)	(0.055)	(0.078)	(0.019)	(0.011)	(0.055)	(0.023)	(0.012)	(0.016)	(0.024)
Venezuela	0.828***	0.841***	0.852***	0.855***	0.798***	0.862***	0.789***	0.825***	0.848***	0.824***	0.909***
	(0.016)	(0.025)	(0.068)	(0.077)	(0.021)	(0.018)	(0.042)	(0.023)	(0.019)	(0.039)	(0.085)
Egypt	0.435***	0.428***	0.526***	0.219***	0.326***	0.527***	0.175***	0.383***	0.411***	0.408***	0.646***
	(0.021)	(0.025)	(0.034)	(0.056)	(0.023)	(0.027)	(0.062)	(0.038)	(0.021)	(0.042)	(0.078)
India	0.865***	0.830***	0.706***	0.739***	0.803***	0.900***	0.779***	0.821***	0.833***	0.900***	0.949***
	(0.005)	(0.009)	(0.026)	(0.023)	(0.009)	(0.005)	(0.036)	(0.013)	(0.006)	(0.008)	(0.011)
Indonesia	0.879***	0.866***	0.766***	0.958	0.873***	0.882***	0.669***	0.813***	0.887***	0.926***	0.956***
	(0.008)	(0.019)	(0.069)	(0.408)	(0.011)	(0.009)	(0.063)	(0.019)	(0.009)	(0.012)	(0.025)
Mongolia	0.376***	0.356***	0.258	0.087***	0.294***	0.498***	0.299***	0.369***	0.368***	0.409***	0.956**
	(0.029)	(0.034)	(0.212)	(0.085)	(0.025)	(0.036)	(0.074)	(0.057)	(0.026)	(0.063)	(0.025)
Myanmar	0.839***	0.824***	-	0.223***	0.274***	0.481***	0.278***	0.302***	0.361***	0.288***	-
	(0.012)	(0.026)		(0.056)	(0.017)	(0.028)	(0.041)	(0.025)	(0.018)	(0.094)	
Philippines	0.910***	0.899***	0.846***	0.959***	0.908***	0.911***	0.924***	0.886***	0.908***	0.921***	0.963***
	(0.008)	(0.017)	(0.042)	(0.040)	(0.015)	(0.008)	(0.009)	(0.016)	(0.009)	(0.018)	(0.026)
Vietnam	0.743***	0.743***	0.735***	0.646***	0.744***	0.793***	0.480***	0.717***	0.769***	0.841***	0.735***
	(0.012)	(0.028)	(0.061)	(0.111)	(0.021)	(0.013)	(0.091)	(0.035)	(0.014)	(0.019)	(0.093)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses. Occupation (students included as unemployed).

Table 5-10 Estimation results of Eq. (4)

Country	Predicted probabilities										
	Labor Force		**Education**				**Income group**				
	Employed	**Unemployed**	**Not attended**	**Primary**	**Secondary**	**Tertiary**	**Lower**	**Lower Middle**	**Middle**	**Upper Middle**	**Upper**
Overall result	0.805 (0.001)	0.800 (0.002)	0.679 (0.008)	0.673 (0.010)	0.796 (0.002)	0.827 (0.002)	0.774 (0.004)	0.805 (0.002)	0.802 (0.002)	0.822 (0.003)	0.832 (0.007)
Australia	0.784*** (0.011)	0.789*** (0.018)	0.663*** (0.040)	0.699*** (0.070)	0.798*** (0.013)	0.794*** (0.013)	0.812*** (0.021)	0.769*** (0.019)	0.771*** (0.014)	0.811*** (0.217)	0.834*** (0.057)
Canada	0.840*** (0.113)	0.850*** (0.021)	0.708*** (0.061)	0.733*** (0.072)	0.858*** (0.014)	0.854*** (0.014)	0.847*** (0.028)	0.840*** (0.021)	0.835*** (0.015)	0.876*** (0.022)	0.874*** (0.054)
Chile	0.924*** (0.009)	0.900*** (0.015)	0.870*** (0.033)	0.891*** (0.051)	0.921*** (0.010)	0.919*** (0.015)	0.912*** (0.039)	0.910*** (0.016)	0.931*** (0.010)	0.885*** (0.023)	0.876*** (0.049)
Czech Republic	0.883*** (0.009)	0.875*** (0.020)	0.815*** (0.081)	0.854*** (0.038)	0.884*** (0.010)	0.886*** (0.017)	0.901*** (0.024)	0.873*** (0.016)	0.878*** (0.012)	0.926*** (0.027)	0.653*** (0.019)
France	0.779*** (0.010)	0.757*** (0.019)	0.588*** (0.046)	0.727*** (0.055)	0.781*** (0.013)	0.793*** (0.014)	0.735*** (0.031)	0.794*** (0.018)	0.769*** (0.013)	0.770*** (0.025)	0.811*** (0.044)
Germany	0.809*** (0.007)	0.820*** (0.015)	0.568*** (0.043)	0.703*** (0.042)	0.831*** (0.008)	0.817*** (0.013)	0.769*** (0.021)	0.815*** (0.013)	0.815*** (0.010)	0.835*** (0.019)	0.803*** (0.055)
Greece	0.879*** (0.011)	0.918*** (0.013)	0.720*** (0.068)	0.446*** (0.145)	0.887*** (0.013)	0.913*** (0.010)	0.885*** (0.027)	0.888*** (0.014)	0.899*** (0.011)	0.881*** (0.036)	0.839*** (0.118)
Hungary	0.932*** (0.008)	0.923*** (0.016)	0.859*** (0.058)	0.938*** (0.030)	0.937*** (0.008)	0.921*** (0.013)	0.906*** (0.021)	0.916*** (0.012)	0.947*** (0.009)	0.956*** (0.025)	_
Italy	0.869*** (0.009)	0.879*** (0.014)	0.609*** (0.056)	0.741*** (0.061)	0.882*** (0.009)	0.895*** (0.012)	0.848*** (0.027)	0.862*** (0.015)	0.879*** (0.009)	0.874*** (0.022)	0.905*** (0.055)

Continued

Japan	0.717*** (0.005)	0.749*** (0.007)	0.543*** (0.040)	0.261 (0.214)	0.698*** (0.007)	0.753*** (0.005)	0.675*** (0.012)	0.723*** (0.007)	0.073*** (0.007)	0.778*** (0.009)	0.725*** (0.043)
Netherlands	0.772*** (0.013)	0.759*** (0.023)	0.475*** (0.065)	0.679*** (0.064)	0.761*** (0.015)	0.829*** (0.018)	0.758*** (0.029)	0.783*** (0.024)	0.757*** (0.017)	0.787*** (0.028)	0.789*** (0.066)
Poland	0.769*** (0.010)	0.761*** (0.020)	0.687*** (0.033)	0.780*** (0.062)	0.766*** (0.013)	0.784*** (0.013)	0.738*** (0.026)	0.764*** (0.016)	0.771*** (0.013)	0.790*** (0.027)	0.833*** (0.065)
Singapore	0.811*** (0.018)	0.859*** (0.035)	0.657*** (0.098)	0.237 (0.223)	0.794*** (0.027)	0.855*** (0.019)	0.733*** (0.071)	0.797*** (0.032)	0.831*** (0.021)	0.861*** (0.039)	0.844*** (0.159)
Spain	0.892*** (0.008)	0.894*** (0.014)	0.735*** (0.078)	0.818*** (0.039)	0.896*** (0.009)	0.902*** (0.010)	0.886*** (0.027)	0.889*** (0.014)	0.894*** (0.009)	0.887*** (0.018)	0.955*** (0.031)
Sweden	0.849*** (0.011)	0.872*** (0.021)	0.751*** (0.038)	0.790*** (0.055)	0.850*** (0.013)	0.898*** (0.015)	0.829*** (0.034)	0.885*** (0.018)	0.850*** (0.014)	0.850*** (0.024)	0.804*** (0.069)
United Kingdom	0.827*** (0.008)	0.828*** (0.015)	0.612*** (0.042)	0.644*** (0.063)	0.823*** (0.011)	0.856*** (0.009)	0.849*** (0.016)	0.832*** (0.013)	0.808*** (0.011)	0.836*** (0.019)	0.853*** (0.036)
USA	0.824*** (0.004)	0.826*** (0.007)	0.707*** (0.017)	0.734*** (0.033)	0.826*** (0.005)	0.845*** (0.005)	0.803*** (0.011)	0.822*** (0.008)	0.816*** (0.006)	0.842*** (0.008)	0.892*** (0.013)
Brazil	0.879*** (0.008)	0.889*** (0.012)	0.770*** (0.037)	0.729*** (0.061)	0.876*** (0.009)	0.915*** (0.009)	0.868*** (0.024)	0.890*** (0.011)	0.880*** (0.010)	0.864*** (0.026)	0.942*** (0.039)
China	0.775*** (0.003)	0.831*** (0.007)	0.605*** (0.031)	0.682*** (0.026)	0.786*** (0.004)	0.788*** (0.004)	0.751*** (0.013)	0.784*** (0.006)	0.782*** (0.004)	0.791*** (0.007)	0.823*** (0.021)
Colombia	0.935*** (0.009)	0.921*** (0.014)	0.922*** (0.038)	0.766*** (0.088)	0.925*** (0.011)	0.947*** (0.011)	0.947*** (0.029)	0.913*** (0.016)	0.947*** (0.009)	0.903*** (0.023)	0.914*** (0.060)
Kazakhstan	0.769*** (0.017)	0.722*** (0.025)	0.641*** (0.145)	0.484 (0.351)	0.741*** (0.018)	0.774*** (0.021)	0.781*** (0.087)	0.705*** (0.042)	0.749*** (0.017)	0.795*** (0.029)	0.751*** (0.106)

Continued

Malaysia	0.849***	0.913***	0.814***	0.770***	0.836***	0.885***	0.819***	0.884***	0.872***	0.847***	0.706***
	(0.013)	(0.018)	(0.074)	(0.116)	(0.019)	(0.012)	(0.041)	(0.018)	(0.014)	(0.030)	(0.109)
Mexico	0.927***	0.930***	0.914***	0.665***	0.916***	0.946***	0.935***	0.930***	0.921***	0.956***	0.864***
	(0.008)	(0.012)	(0.035)	(0.112)	(0.010)	(0.008)	(0.026)	(0.013)	(0.009)	(0.013)	(0.054)
Romania	0.769***	0.761***	0.906***	0.786***	0.912***	0.906***	0.879***	0.895***	0.918***	0.897***	0.854***
	(0.010)	(0.020)	(0.039)	(0.096)	(0.012)	(0.011)	(0.037)	(0.016)	(0.009)	(0.025)	(0.069)
Russia	0.686***	0.710***	0.614***	0.710***	0.698***	0.692***	0.653***	0.676***	0.699***	0.805***	0.778***
	(0.011)	(0.019)	(0.068)	(0.178)	(0.016)	(0.013)	(0.037)	(0.016)	(0.014)	(0.039)	(0.141)
South Africa	0.911***	0.872***	0.849***	-	0.902***	0.910***	0.951***	0.904***	0.891***	0.910***	0.926***
	(0.009)	(0.024)	(0.052)		(0.012)	(0.013)	(0.022)	(0.017)	(0.014)	(0.021)	(0.051)
Thailand	0.921***	0.942***	0.684***	0.830***	0.921***	0.943***	0.862***	0.945***	0.932***	0.922***	0.839***
	(0.009)	(0.015)	(0.074)	(0.088)	(0.017)	(0.008)	(0.047)	(0.014)	(0.009)	(0.024)	(0.053)
Turkey	0.916***	0.946***	0.802***	0.722***	0.932***	0.937***	0.921***	0.911***	0.933***	0.934***	0.955***
	(0.008)	(0.008)	(0.056)	(0.071)	(0.009)	(0.007)	(0.027)	(0.012)	(0.007)	(0.014)	(0.033)
Venezuela	0.945***	0.937***	0.945***	0.908***	0.921***	0.967***	0.890***	0.962***	0.948***	0.932***	0.909***
	(0.010)	(0.014)	(0.038)	(0.061)	(0.014)	(0.009)	(0.029)	(0.012)	(0.026)	(0.026)	(0.084)
Sri Lanka	0.799***	0.786***	0.933***	0.594***	0.812***	-	0.673***	0.729***	0.809***	0.000***	0.548***
	(0.028)	(0.022)	(0.024)	(0.051)	(0.023)		(0.082)	(0.057)	(0.018)	(0.065)	(0.131)
Egypt	0.441***	0.373***	0.476***	0.201***	0.298***	0.536***	0.188***	0.424***	0.382***	0.414***	0.567***
	(0.021)	(0.025)	(0.035)	(0.055)	(0.023)	(0.027)	(0.065)	(0.038)	(0.021)	(0.042)	(0.038)
India	0.811***	0.782***	0.622***	0.623***	0.733***	0.865***	0.822***	0.795***	0.774***	0.851***	0.862***
	(0.006)	(0.009)	(0.028)	(0.026)	(0.011)	(0.006)	(0.033)	(0.013)	(0.007)	(0.009)	(0.017)
Indonesia	0.884***	0.895***	0.677***	0.617***	0.877***	0.905***	0.789***	0.869***	0.889***	0.904***	0.927***
	(0.007)	(0.016)	(0.077)	(0.105)	(0.011)	(0.009)	(0.051)	(0.016)	(0.009)	(0.014)	(0.029)

Continued

Mongolia	0.440*** (0.029)	0.436*** (0.035)	0.376 (0.208)	0.116 (0.109)	0.376*** (0.028)	0.548*** (0.036)	0.388*** (0.080)	0.458*** (0.059)	0.428*** (0.027)	0.521*** (0.064)	0.226*** (0.194)
Myanmar	0.849*** (0.013)	0.913*** (0.018)	-	0.188*** (0.054)	0.252*** (0.016)	0.459*** (0.029)	0.258*** (0.041)	0.319*** (0.026)	0.315*** (0.018)	0.330*** (0.099)	-
Philippines	0.916*** (0.008)	0.931*** (0.013)	0.825*** (0.039)	0.830*** (0.065)	0.890*** (0.016)	0.941*** (0.941)	0.967*** (0.023)	0.917*** (0.014)	0.923*** (0.009)	0.918*** (0.019)	0.871*** (0.039)
Vietnam	0.817*** (0.011)	0.817*** (0.024)	0.692*** (0.064)	0.752*** (0.099)	0.821*** (0.018)	0.824*** (0.012)	0.765*** (0.074)	0.828*** (0.029)	0.816*** (0.013)	0.829*** (0.019)	0.658*** (0.100)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses. Occupation (students included as unemployed).

Table 5-11 Estimation results of Eq. (2)

Country	**Predicted probabilities**						
	Age Groups						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Overall result	0.769*** (0.100)	0.779*** (0.005)	0.804*** (0.004)	0.820*** (0.007)	0.812*** (0.012)	0.908*** (0.011)	0.921*** (0.026)
Australia	0.738*** (0.020)	0.719*** (0.024)	0.708*** (0.024)	0.753*** (0.023)	0.791*** (0.022)	0.854*** (0.031)	0.867*** (0.878)
Chile	0.802*** (0.018)	0.815*** (0.025)	0.878*** (0.021)	0.854*** (0.028)	0.885*** (0.044)	-	-
Japan	0.612*** (0.016)	0.620*** (0.009)	0.656*** (0.009)	0.718*** (0.009)	0.794*** (0.009)	0.885*** (0.012)	0.946*** (0.030)
Singapore	0.876*** (0.028)	0.834*** (0.032)	0.779*** (0.036)	0.818*** (0.032)	0.758*** (0.075)	0.750*** (0.216)	-
Brazil	0.830*** (0.013)	0.844*** (0.015)	0.828*** (0.017)	0.867*** (0.018)	0.909*** (0.029)	-	-
China	0.899*** (0.004)	0.897*** (0.005)	0.875*** (0.005)	0.854*** (0.005)	0.721*** (0.017)	0.906*** (0.052)	0.818*** (0.116)
Colombia	0.792*** (0.020)	0.792*** (0.026)	0.825*** (0.025)	0.798*** (0.029)	0.864*** (0.052)	0.800*** (0.179)	-
Kazakhstan	0.673*** (0.024)	0.749*** (0.032)	0.717*** (0.033)	0.737*** (0.041)	0.723*** (0.049)	0.717*** (0.062)	-
Malaysia	0.851*** (0.015)	0.852*** (0.019)	0.799*** (0.032)	0.779*** (0.050)	0.562*** (0.124)	-	-
Mexico	0.777*** (0.018)	0.813*** (0.019)	0.829*** (0.022)	0.845*** (0.022)	0.888*** (0.032)	-	-
Russia	0.604*** (0.019)	0.585*** (0.024)	0.686*** (0.023)	0.693*** (0.018)	0.758*** (0.037)	0.625*** (0.171)	0.500 (0.353)
South Africa	0.888*** (0.015)	0.863*** (0.022)	0.854*** (0.025)	0.847*** (0.027)	0.886*** (0.036)	0.667*** (0.192)	-
Thailand	0.858*** (0.019)	0.903*** (0.017)	0.921*** (0.016)	0.866*** (0.026)	0.850*** (0.079)	-	-
Venezuela	0.750*** (0.027)	0.853*** (0.025)	0.905*** (0.022)	0.867*** (0.026)	0.750*** (0.082)	-	-
Egypt	0.450*** (0.024)	0.412*** (0.033)	0.437*** (0.038)	0.449*** (0.039)	0.273*** (0.067)	-	-

			Continued				
India	0.851***	0.876***	0.61***	0.813***	0.759***	0.882***	0.500
	(0.007)	(0.008)	(0.011)	(0.016)	(0.026)	(0.055)	(0.353)
Indonesia	0.831***	0.851***	0.846***	0.842***	0.893***	-	-
	(0.012)	(0.013)	(0.017)	(0.027)	(0.058)		
Mongolia	0.344***	0.345***	0.391***	0.469***	0.351***	0.538***	-
	(0.035)	(0.044)	(0.051)	(0.071)	(0.078)	(0.138)	
Myanmar	0.376***	0.343***	0.296***	0.285***	0.294***	-	-
	(0.024)	(0.031)	(0.032)	(0.037)	(0.045)		
Philippines	0.919***	0.887***	0.941***	0.873***	0.924***	0.857***	-
	(0.011)	(0.016)	(0.014)	(0.021)	(0.036)	(0.132)	
Vietnam	0.702***	0.767***	0.752***	0.621***	0.75***	-	-
	(0.015)	(0.021)	(0.027)	(0.052)	(0.125)		

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses. Age Groups (1=age18-30, 2=age 31–40, 3=age 41–50, 4=age 51–60, 5=age 61–70, 6=age 71-80, 7=age 81-90, 8=age 91-100).

Table 5-12 Estimation results of Eq. (4)

Country	Predicted probabilities							
	Age Groups							
	1	2	3	4	5	6	7	8
Overall result	0.792*** (0.023)	0.789*** (0.004)	0.806*** (0.003)	0.807*** (0.005)	0.839*** (0.008)	0.867*** (0.011)	0.837*** (0.028)	0.616*** (0.100)
Australia	0.716*** (0.023)	0.731*** (0.024)	0.789*** (0.022)	0.831*** (0.020)	0.823*** (0.021)	0.893*** (0.027)	0.888*** (0.076)	0.770*** (0.202)
Canada	0.834*** (0.023)	0.822*** (0.026)	0.854*** (0.023)	0.838*** (0.023)	0.879*** (0.021)	0.856*** (0.039)	0.783*** (0.205)	-
Chile	0.871*** (0.018)	0.929*** (0.018)	0.963*** (0.013)	0.973*** (0.014)	0.958*** (0.029)	-	-	-
Czech Republic	0.857*** (0.024)	0.856*** (0.021)	0.884*** (0.021)	0.888*** (0.022)	0.903*** (0.018)	0.968*** (0.022)	-	-
France	0.728*** (0.023)	0.777*** (0.023)	0.786*** (0.021)	0.791*** (0.021)	0.787*** (0.018)	0.785*** (0.046)	0.826*** (0.165)	-
Germany	0.777*** (0.018)	0.783*** (0.019)	0.808*** (0.017)	0.823*** (0.015)	0.839*** (0.013)	0.862*** (0.027)	0.717*** (0.169)	-
Greece	0.831*** (0.027)	0.852*** (0.022)	0.900*** (0.015)	0.952*** (0.012)	0.933*** (0.029)	-	-	-
Hungary	0.867*** (0.024)	0.908*** (0.018)	0.968*** (0.011)	0.937*** (0.016)	0.960*** (0.012)	-	-	-
Italy	0.802*** (0.024)	0.867*** (0.018)	0.884*** (0.016)	0.900*** (0.015)	0.892*** (0.014)	0.881*** (0.037)	-	-
Japan	0.651*** (0.016)	0.642*** (0.010)	0.707*** (0.009)	0.765*** (0.009)	0.796*** (0.009)	0.861*** (0.013)	0.774*** (0.057)	-
Netherlands	0.665*** (0.032)	0.703*** (0.032)	0.773*** (0.027)	0.820*** (0.025)	0.832*** (0.023)	0.813*** (0.039)	0.835*** (0.150)	-
Poland	0.679*** (0.023)	0.746*** (0.021)	0.766*** (0.022)	0.796*** (0.021)	0.866*** (0.017)	0.781*** (0.052)	0.651*** (0.166)	-
Singapore	0.823*** (0.033)	0.799*** (0.034)	0.838*** (0.032)	0.820*** (0.032)	0.795*** (0.069)	0.760*** (0.212)	-	-
Spain	0.843*** (0.021)	0.871*** (0.017)	0.898*** (0.014)	0.925*** (0.012)	0.923*** (0.014)	0.855*** (0.046)	-	-
Sweden	0.757*** (0.028)	0.799*** (0.027)	0.869*** (0.022)	0.889*** (0.022)	0.919*** (0.017)	0.959*** (0.018)	0.803*** (0.123)	-
United Kingdom	0.794*** (0.017)	0.779*** (0.018)	0.816*** (0.017)	0.835*** (0.015)	0.879*** (0.014)	0.905*** (0.022)	-	0.296 (0.254)

				Continued				
USA	0.805*** (0.008)	0.827*** (0.009)	0.812*** (0.009)	0.829*** (0.008)	0.841*** (0.008)	0.870*** (0.014)	0.896*** (0.035)	0.744*** (0.028)
Brazil	0.876*** (0.012)	0.871*** (0.014)	0.872*** (0.015)	0.898*** (0.016)	0.954*** (0.020)	-	-	-
China	0.833*** (0.006)	0.769*** (0.007)	0.772*** (0.006)	0.748*** (0.006)	0.781*** (0.016)	0.876*** (0.053)	-	0.679*** (0.137)
Colombia	0.912*** (0.015)	0.952*** (0.014)	0.929*** (0.019)	0.929*** (0.021)	0.947*** (0.037)	-	-	-
Kazakhstan	0.711*** (0.026)	0.762*** (0.031)	0.767*** (0.031)	0.821*** (0.035)	0.809*** (0.043)	0.732*** (0.060)	-	-
Malaysia	0.864*** (0.016)	0.835*** (0.021)	0.888*** (0.026)	0.987*** (0.016)	0.849*** (0.099)	-	-	-
Mexico	0.909*** (0.014)	0.937*** (0.012)	0.916*** (0.017)	0.941*** (0.016)	0.971*** (0.017)	-	-	-
Romania	0.879*** (0.021)	0.896*** (0.019)	0.918*** (0.016)	0.954*** (0.018)	0.901*** (0.018)	0.869*** (0.064)	-	-
Russia	0.650*** (0.021)	0.660*** (0.023)	0.719*** (0.023)	0.715*** (0.018)	0.795*** (0.036)	0.877*** (0.115)	0.493 (0.351)	-
South Africa	0.880*** (0.016)	0.891*** (0.020)	0.934*** (0.018)	0.912*** (0.022)	0.962*** (0.021)	0.858*** (0.133)	-	-
Thailand	0.896*** (0.017)	0.933*** (0.015)	0.949*** (0.013)	0.947*** (0.179)	0.841*** (0.086)	-	-	-
Turkey	0.876*** (0.017)	0.945*** (0.009)	0.948*** (0.010)	0.960*** (0.012)	0.963*** (0.022)	-	-	-
Venezuela	0.899*** (0.021)	0.949*** (0.017)	0.975*** (0.012)	0.959*** (0.017)	0.951*** (0.049)	-	-	-
Sri Lanka	0.833*** (0.042)	0.861*** (0.032)	0.788*** (0.040)	0.762*** (0.043)	0.717*** (0.056)	0.928*** (0.066)	-	-
Egypt	0.448*** (0.029)	0.375*** (0.032)	0.425*** (0.042)	0.394*** (0.044)	0.309*** (0.073)	-	-	-
India	0.777*** (0.009)	0.815*** (0.009)	0.831*** (0.012)	0.804*** (0.016)	0.806*** (0.024)	0.927*** (0.041)	0.546 (0.349)	0.682*** (0.264)
Indonesia	0.833*** (0.013)	0.886*** (0.012)	0.888*** (0.016)	0.882*** (0.025)	0.898*** (0.056)	-	-	-
Mongolia	0.483*** (0.043)	0.352*** (0.045)	0.521*** (0.054)	0.377*** (0.075)	0.509*** (0.093)	0.323** (0.139)	-	-
Myanmar	0.360*** (0.024)	0.279*** (0.029)	0.313*** (0.032)	0.245*** (0.035)	0.295*** (0.045)	-	-	-

				Continued				
Philippines	0.899***	0.921***	0.950***	0.938***	0.891***	0.806***	-	-
	(0.013)	(0.014)	(0.014)	(0.017)	(0.051)	(0.171)		
Vietnam	0.774***	0.806***	0.799***	0.732***	0.858***	-	-	-
	(0.015)	(0.020)	(0.026)	(0.049)	(0.095)			

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses. Age Groups (1=age18-30, 2=age 31–40, 3=age 41–50, 4=age 51–60, 5=age 61–70, 6=age 71-80, 7=age 81-90, 8=age 91-100).

Table 5-13 Estimation results of Eq. (2)

Country	Predicted probabilities				
		Gender*Education			
	Gender	Not attended	Primary	Secondary	Tertiary
Overall result	Male	0.761*** (0.013)	0.75*** (0.018)	0.774*** (0.004)	0.869*** (0.002)
	Female	0.689*** (0.017)	0.649*** (0.020)	0.702*** (0.004)	0.821*** (0.003)
Australia	Male	0.718*** (0.053)	0.75*** (0.097)	0.773*** (0.020)	0.839*** (0.017)
	Female	0.717*** (0.058)	0.727*** (0.094)	0.623*** (0.022)	0.783*** (0.019)
Chile	Male	0.836*** (0.049)	0.952*** (0.046)	0.794*** (0.021)	0.922*** (0.019)
	Female	0.885*** (0.063)	0.765*** (0.103)	0.796*** (0.021)	0.846*** (0.028)
Japan	Male	0.681*** (0.048)	0.500** (0.250)	0.720*** (0.010)	0.814*** (0.006)
	Female	0.627*** (0.068)	-	0.566*** (0.009)	0.653*** (0.010)
Singapore	Male	0.727*** (0.134)	-	0.812*** (0.039)	0.914*** (0.021)
	Female	0.769*** (0.117)	-	0.731*** (0.038)	0.813*** (0.032)
Brazil	Male	0.846*** (0.045)	0.581*** (0.089)	0.835*** (0.016)	0.919*** (0.013)
	Female	0.797*** (0.050)	0.609*** (0.102)	0.784*** (0.017)	0.886*** (0.014)
China	Male	0.777*** (0.031)	0.833*** (0.030)	0.846*** (0.005)	0.592*** (0.004)
	Female	0.808*** (0.045)	0.825*** (0.029)	0.833*** (0.006)	0.906*** (0.004)
Colombia	Male	0.824*** (0.092)	0.800*** (0.103)	0.831*** (0.023)	0.904*** (0.023)
	Female	0.867*** (0.062)	0.375*** (0.171)	0.698*** (0.026)	0.821*** (0.025)

Continued					
Kazakhstan	Male	0.8*** (0.179)	-	0.683*** (0.028)	0.724*** (0.034)
	Female	0.5** (0.204)	0.5** (0.354)	0.676*** (0.027)	0.769*** (0.027)
Malaysia	Male	0.765*** (0.103)	0.700*** (0.014)	0.824*** (0.027)	0.894*** (0.016)
	Female	0.857*** (0.132)	0.667** (0.272)	0.759*** (0.032)	0.828*** (0.021)
Mexico	Male	0.793*** (0.075)	-	0.811*** (0.023)	0.880*** (0.022)
	Female	0.733*** (0.081)	0.857*** (0.132)	0.761*** (0.021)	0.811*** (0.019)
Russia	Male	0.735*** (0.076)	-	0.675*** (0.023)	0.745*** (0.018)
	Female	0.647*** (0.116)	-	0.557*** (0.025)	-
South Africa	Male	0.913*** (0.058)	-	0.895*** (0.019)	0.933*** (0.016)
	Female	0.809*** (0.085)	0.667** (0.021)	0.809*** (0.021)	0.863*** (0.023)
Thailand	Male	0.955*** (0.044)	0.818*** (0.116)	0.877*** (0.026)	0.917*** (0.014)
	Female	0.722*** (0.106)	0.769*** (0.117)	0.776*** (0.037)	0.907*** (0.015)
Venezuela	Male	0.813 (0.098)	0.909 (0.087)	0.795 (0.030)	0.882 (0.022)
	Female	0.909*** (0.087)	0.778*** (0.138)	0.781*** (0.029)	0.856*** (0.024)
Egypt	Male	0.636*** (0.048)	0.154** (0.071)	0.407*** (0.032)	0.600*** (0.037)
	Female	0.357*** (0.045)	0.25*** (0.082)	0.218*** (0.032)	0.509*** (0.038)
India	Male	0.75*** (0.035)	0.796*** (0.032)	0.789*** (0.012)	0.916*** (0.006)
	Female	0.689 (0.036)	0.607 (0.035)	0.771 (0.015)	0.895 (0.007)
Indonesia	Male	0.8*** (0.089)	-	0.773*** (0.017)	0.895*** (0.011)
	Female	0.688*** (0.116)	0.75*** (0.217)	0.785*** (0.020)	0.889*** (0.013)

Continued					
Mongolia	Male	-	0.200*** (0.179)	0.285*** (0.038)	0.566*** (0.054)
	Female	0.25*** (0.217)	-	0.311*** (0.038)	0.418*** (0.047)
Myanmar	Male	-	0.259*** (0.084)	0.377*** (0.026)	0.647*** (0.041)
	Female	-	0.2* (0.08)	0.169*** (0.019)	0.383*** (0.036)
Philippines	Male	0.862*** (0.045)	0.958*** (0.041)	0.902*** (0.021)	0.938*** (0.010)
	Female	0.871*** (0.060)	-	0.915*** (0.019)	0.884*** (0.013)
Vietnam	Male	0.703*** (0.075)	0.461*** (0.138)	0.673*** (0.026)	0.812*** (0.017)
	Female	0.75*** (0.108)	0.428*** (0.132)	0.535*** (0.029)	0.780*** (0.018)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

Table 5-14 Estimation results of Eq. (4)

Country	Predicted probabilities				
		Gender*Education			
		Not attended	**Primary**	**Secondary**	**Tertiary**
Overall result	Male	0.658*** (0.011)	0.672*** (0.014)	0.779*** (0.003)	0.809*** (0.002)
	Female	0.686*** (0.002)	0.672*** (0.014)	0.809*** (0.002)	0.848*** (0.002)
Australia	Male	0.592*** (0.058)	0.599*** (0.109)	0.768*** (0.020)	0.736*** (0.020)
	Female	0.717*** (0.581)	0.772*** (0.089)	0.836*** (0.017)	0.846*** (0.017)
Canada	Male	0.676*** (0.080)	0.789*** (0.094)	0.849*** (0.021)	0.807*** (0.023)
	Female	0.684*** (0.107)	0.667*** (0.111)	0.868*** (0.019)	0.899*** (0.017)
Chile	Male	0.782*** (0.056)	0.857*** (0.076)	0.906*** (0.016)	0.913*** (0.019)
	Female	0.885*** (0.063)	0.941*** (0.057)	0.936*** (0.013)	0.947*** (0.017)
Czech Republic	Male	0.900*** (0.095)	0.794*** (0.069)	0.818*** (0.018)	0.879*** (0.025)
	Female	0.75*** (0.125)	0.865*** (0.047)	0.946*** (0.009)	0.885*** (0.026)
France	Male	0.508*** (0.065)	0.769*** (0.067)	0.748*** (0.019)	0.796*** (0.020)
	Female	0.643*** (0.064)	0.679*** (0.088)	0.814*** (0.016)	0.786*** (0.019)
Germany	Male	0.554*** (0.062)	0.717*** (0.062)	0.812*** (0.013)	0.771*** (0.019)
	Female	0.554*** (0.062)	0.696*** (0.055)	0.849*** (0.011)	0.877*** (0.018)
Greece	Male	0.625*** (0.121)	0.286* (0.171)	0.864*** (0.020)	0.892*** (0.017)
	Female	0.778*** (0.080)	0.6*** (0.219)	0.910*** (0.017)	0.933*** (0.013)

		Continued			
Hungary	Male	0.769*** (0.117)	0.941*** (0.057)	0.915*** (0.014)	0.897*** (0.020)
	Female	0.882*** (0.078)	0.903*** (0.053)	0.950*** (0.011)	0.960*** (0.012)
Italy	Male	0.562*** (0.072)	0.708*** (0.093)	0.876*** (0.013)	0.845*** (0.021)
	Female	0.93*** (0.094)	0.8*** (0.073	0.890*** (0.012)	0.938*** (0.013)
Japan	Male	0.415*** (0.051)	0.25 (0.217)	0.679*** (0.011)	0.729*** (0.007)
	Female	0.608*** (0.068)	-	0.732*** (0.008)	0.776*** (0.009)
Netherlands	Male	0.4*** (0.098)	0.600*** (0.098)	0.757*** (0.022)	0.806*** (0.025)
	Female	0.531*** (0.088)	0.750*** (0.082)	0.781*** (0.019)	0.829*** (0.027)
Poland	Male	0.693*** (0.046)	0.769*** (0.083)	0.751*** (0.020)	0.766*** (0.020)
	Female	0.641*** (0.050)	0.765*** (0.103)	0.776*** (0.018)	0.808*** (0.017)
Singapore	Male	0.545*** (0.150)	-	0.762*** (0.042)	0.834*** (0.028)
	Female	0.692*** (0.128)	0.5 (0.353)	0.828*** (0.032)	0.873*** (0.027)
Spain	Male	0.667*** (0.122)	0.882*** (0.045)	0.919*** (0.014)	0.867*** (0.017)
	Female	0.688*** (0.116)	0.773*** (0.057)	0.919*** (0.011)	0.934*** (0.012)
Sweden	Male	0.677*** (0.059)	0.735*** (0.076)	0.831*** (0.019)	0.876*** (0.023)
	Female	0.833*** (0.048)	0.800*** (0.103)	0.869*** (0.017)	0.921*** (0.018)
United Kingdom	Male	0.618*** (0.056)	0.567*** (0.090)	0.827*** (0.015)	0.813*** (0.015)
	Female	0.569*** (0.014)	0.68*** (0.093)	0.835*** (0.014)	0.887*** (0.011)

Continued					
USA	Male	0.682*** (0.025)	0.737*** (0.044)	0.803*** (0.008)	0.820*** (0.008)
	Female	0.729*** (0.024)	0.735*** (0.048)	0.843*** (0.007)	0.874*** (0.007)
Brazil	Male	0.738*** (0.054)	0.677*** (0.084)	0.858*** (0.015)	0.916*** (0.009)
	Female	0.797*** (0.050)	0.783*** (0.086)	0.891*** (0.013)	0.919*** (0.012)
China	Male	0.592*** (0.036)	0.579*** (0.040)	0.761*** (0.006)	0.779*** (0.005)
	Female	0.705*** (0.052)	0.759*** (0.033)	0.805*** (0.006)	0.803*** (0.005)
Colombia	Male	0.941*** (0.057)	0.733*** (0.114)	0.923*** (0.017)	0.934*** (0.016)
	Female	0.900*** (0.055)	0.749*** (0.153)	0.922*** (0.015)	0.966*** (0.012)
Kazakhstan	Male	0.6*** (0.219)	-	0.741*** (0.027)	0.759*** (0.032)
	Female	0.667*** (0.192)	0.5 (0.353)	0.723*** (0.026)	0.805*** (0.025)
Malaysia	Male	0.765*** (0.103)	0.700*** (0.145)	0.839*** (0.026)	0.861*** (0.018)
	Female	0.714*** (0.171)	-	0.849*** (0.027)	0.906*** (0.016)
Mexico	Male	0.931*** (0.047)	0.636*** (0.145)	0.901*** (0.017)	0.932*** (0.012)
	Female	0.867*** (0.062)	0.714*** (0.171)	0.925*** (0.013)	0.963*** (0.009)
Romania	Male	0.92*** (0.054)	0.667*** (0.157)	0.863*** (0.023)	0.855*** (0.018)
	Female	0.885*** (0.063)	0.800*** (0.179)	0.941*** (0.015)	0.963*** (0.009)
Russia	Male	0.647*** (0.082)	0.667*** (0.192)	0.672*** (0.023)	0.649*** (0.012)
	Female	0.529*** (0.121)	-	0.714*** (0.023)	0.728*** (0.016)
South Africa	Male	0.913*** (0.059)	-	0.877*** (0.020)	0.916*** (0.018)
	Female	0.762*** (0.093)	-	0.921*** (0.015)	0.907*** (0.019)

		Continued			
Thailand	Male	0.636*** (0.102)	0.909*** (0.087)	0.929*** (0.021)	0.937*** (0.012)
	Female	0.667*** (0.111)	0.846*** (0.100)	0.92*** (0.024)	0.948*** (0.011)
Turkey	Male	0.632*** (0.111)	0.667*** (0.111)	0.925*** (0.013)	0.931*** (0.011)
	Female	0.882*** (0.055)	0.769*** (0.083)	0.937*** (0.012)	0.945*** (0.009)
Venezuela	Male	0.938*** (0.061)	-	0.892*** (0.023)	0.980*** (0.087)
	Female	0.909*** (0.087)	0.778*** (0.138)	0.932*** (0.018)	0.961*** (0.013)
Sri Lanka	Male	-	0.703*** (0.075)	0.914*** (0.024)	-
	Female	0.889*** (0.039)	0.358*** (0.066)	0.727*** (0.039)	-
Egypt	Male	0.596*** (0.049)	0.154** (0.071)	0.355*** (0.031)	0.617*** (0.037)
	Female	0.304*** (0.043)	0.214*** (0.078)	0.218*** (0.032)	0.514*** (0.038)
India	Male	0.638*** (0.039)	0.673*** (0.037)	0.732*** (0.013)	0.864*** (0.007)
	Female	0.609*** (0.038)	0.541*** (0.036)	0.682*** (0.017)	0.880*** (0.008)
Indonesia	Male	0.7*** (0.102)	0.632*** (0.111)	0.809*** (0.001)	0.903*** (0.011)
	Female	0.563*** (0.124)	0.5** (0.250)	0.829*** (0.019)	0.918*** (0.012)
Mongolia	Male	0.500 (0.353)	0.200 (0.179)	0.361*** (0.040)	0.614*** (0.053)
	Female	0.250 (0.216)	-	0.392*** (0.040)	0.500*** (0.048)
Myanmar	Male	-	0.185* (0.075)	0.317*** (0.025)	0.604*** (0.041)
	Female	-	0.2* (0.08)	0.188*** (0.020)	0.361*** (0.036)
Philippines	Male	0.724*** (0.059)	0.833*** (0.076)	0.871*** (0.024)	0.933*** (0.011)
	Female	0.903*** (0.053)	0.667*** (0.192)	0.915*** (0.019)	0.950*** (0.009)

			Continued		
Vietnam	Male	-	0.333 (0.272)	0.543*** (0.055)	0.778*** (0.139)
	Female	-	0.50** (0.204)	0.467*** (0.052)	0.833*** (0.152)

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

Table 5-15 Estimation results of Eq. (4)

Country		Predicted probabilities								
	Gender	Children								
		0	1	2	3	4	5	6	7	10
Overall result	Male	0.766*** (0.003)	0.796*** (0.003)	0.808*** (0.003)	0.808*** (0.006)	0.799*** (0.011)	0.769*** (0.021)	0.755*** (0.034)	0.711*** (0.052)	0.641*** (0.066)
	Female	0.817*** (0.003)	0.825*** (0.003)	0.832*** (0.003)	0.815*** (0.006)	0.773*** (0.011)	0.754*** (0.021)	0.761*** (0.034)	0.683*** (0.060)	0.625*** (0.085)
Australia	Male	0.772*** (0.019)	0.663*** (0.041)	0.717*** (0.032)	0.696*** (0.045)	0.731*** (0.071)	0.637*** (0.122)	-	-	-
	Female	0.846*** (0.018)	0.811*** (0.028)	0.843*** (0.024)	0.766*** (0.041)	0.825*** (0.049)	0.925*** (0.071)	-	-	-
Canada	Male	0.816*** (0.023)	0.816*** (0.034)	0.826*** (0.032)	0.826*** (0.032)	0.831*** (0.078)	0.834*** (0.151)	-	-	-
	Female	0.858*** (0.022)	0.899*** (0.026)	0.876*** (0.025)	0.857*** (0.042)	0.912*** (0.059)	0.795*** (0.129)	-	0.778*** (0.208)	-
Chile	Male	0.897*** (0.016)	0.945*** (0.024)	0.909*** (0.030)	0.918*** (0.045)	0.815*** (0.094)	-	-	-	-
	Female	0.922*** (0.018)	0.949*** (0.020)	0.921*** (0.028)	0.926*** (0.036)	0.942*** (0.055)	-	-	-	-
Czech Republic	Male	0.818*** (0.025)	0.843*** (0.034)	0.842*** (0.027)	0.934*** (0.063)	-	-	-	0.562 (0.343)	-
	Female	0.913*** (0.021)	0.924*** (0.021)	0.941*** (0.015)	0.909*** (0.033)	0.870*** (0.069)	-	-	-	-
France	Male	0.730*** (0.024)	0.748*** (0.029)	0.779*** (0.026)	0.789*** (0.039)	0.819*** (0.067)	0.538*** (0.150)	0.881*** (0.112)	0.674*** (0.190)	-
	Female	0.786*** (0.024)	0.828*** (0.023)	0.785*** (0.023)	0.788*** (0.033)	0.697*** (0.069)	0.700*** (0.125)	-	-	-
Germany	Male	0.785*** (0.016)	0.784*** (0.023)	0.803*** (0.023)	0.770*** (0.040)	0.838*** (0.060)	0.641*** (0.167)	0.808*** (0.173)	0.619** (0.288)	0.240 (0.204)
	Female	0.839*** (0.015)	0.872*** (0.017)	0.872*** (0.017)	0.860*** (0.029)	0.872*** (0.048)	0.752*** (0.107)	-	0.556 (0.347)	-
Greece	Male	0.859*** (0.021)	0.880*** (0.029)	0.858*** (0.029)	0.874*** (0.058)	0.844*** (0.136)	0.711*** (0.234)	-	-	-
	Female	0.899*** (0.017)	0.914*** (0.021)	0.955*** (0.015)	0.912*** (0.048)	0.876*** (0.113)	-	-	-	-
Hungary	Male	0.914*** (0.017)	0.889*** (0.028)	0.912*** (0.026)	0.903*** (0.046)	0.742*** (0.119)	-	-	-	-
	Female	0.942*** (0.016)	0.927*** (0.019)	0.969*** (0.091)	0.968*** (0.022)	0.888*** (0.102)	0.710*** (0.233)	-	-	-

Continued

Italy	Male	0.841*** (0.018)	0.839*** (0.024)	0.871*** (0.024)	0.871*** (0.042)	0.871*** (0.084)	0.810*** (0.171)	0.539 (0.353)	-	0.747*** (0.229)
	Female	0.884*** (0.016)	0.913*** (0.018)	0.889*** (0.018)	0.889*** (0.035)	0.954*** (0.044)	0.793*** (0.182)	-	-	-
Japan	Male	0.675*** (0.009)	0.709*** (0.015)	0.711*** (0.011)	0.729*** (0.018)	0.708*** (0.052)	0.459*** (0.163)	-	-	-
	Female	0.755*** (0.009)	0.761*** (0.014)	0.768*** (0.011)	0.768*** (0.019)	0.705*** (0.062)	-	0.512** (0.249)	-	-
Netherlands	Male	0.744*** (0.027)	0.719*** (0.046)	0.791*** (0.030)	0.719*** (0.056)	0.700*** (0.095)	-	-	-	-
	Female	0.811*** (0.024)	0.726*** (0.043)	0.752*** (0.030)	0.843*** (0.047)	0.796*** (0.079)	0.815*** (0.117)	-	-	-
Poland	Male	0.769*** (0.022)	0.738*** (0.029)	0.749*** (0.026)	0.756*** (0.046)	0.665*** (0.107)	-	0.661** (0.272)	-	0.562* (0.339)
	Female	0.778*** (0.022)	0.789*** (0.022)	0.803*** (0.023)	0.712*** (0.042)	0.743*** (0.095)	0.735*** (0.128)	0.309 (0.258)	-	-
Singapore	Male	0.785*** (0.033)	0.842*** (0.052)	0.787*** (0.053)	0.749*** (0.099)	-	-	-	-	-
	Female	0.806*** (0.033)	0.867*** (0.047)	0.847*** (0.044)	0.963*** (0.036)	0.851*** (0.137)	-	-	-	-
Spain	Male	0.878*** (0.018)	0.894*** (0.020)	0.858*** (0.019)	0.845*** (0.043)	0.864*** (0.072)	0.903*** (0.092)	0.652*** (0.210)	-	-
	Female	0.914*** (0.015)	0.908*** (0.018)	0.922*** (0.014)	0.936*** (0.027)	0.869*** (0.061)	0.635*** (0.199)	-	-	-
Sweden	Male	0.816*** (0.024)	0.801*** (0.041)	0.859*** (0.027)	0.849*** (0.039)	0.801*** (0.076)	-	0.224 (0.199)	-	-
	Female	0.893*** (0.019)	0.853*** (0.037)	0.865*** (0.027)	0.886*** (0.037)	0.952*** (0.047)	0.889*** (0.073)	-	-	-
United Kingdom	Male	0.799*** (0.015)	0.779*** (0.027)	0.832*** (0.021)	0.807*** (0.036)	0.773*** (0.066)	0.779*** (0.110)	0.521** (0.247)	-	-
	Female	0.868*** (0.014)	0.845*** (0.021)	0.849*** (0.816)	0.816*** (0.033)	0.788*** (0.052)	0.778*** (0.066)	0.579*** (0.220)	-	-
USA	Male	0.781*** (0.009)	0.816*** (0.013)	0.841*** (0.010)	0.811*** (0.017)	0.775*** (0.027)	0.716*** (0.045)	0.780*** (0.064)	0.688*** (0.097)	0.725*** (0.099)
	Female	0.846*** (0.008)	0.846*** (0.011)	0.855*** (0.009)	0.844*** (0.034)	0.885*** (0.044)	0.881*** (0.064)	0.885*** (0.044)	0.881*** (0.064)	0.558*** (0.149)
Brazil	Male	0.858*** (0.017)	0.873*** (0.021)	0.878*** (0.022)	0.852*** (0.037)	0.892*** (0.051)	-	0.441* (0.251)	-	-
	Female	0.909*** (0.013)	0.896*** (0.017)	0.900*** (0.019)	0.866*** (0.034)	0.846*** (0.063)	0.592*** (0.156)	-	-	-

Continued

China	Male	0.729*** (0.009)	0.789*** (0.005)	0.737*** (0.012)	0.628*** (0.041)	-	-	-	-	-
	Female	0.794*** (0.009)	0.817*** (0.005)	0.761*** (0.012)	0.685*** (0.049)	-	-	-	-	-
Colombia	Male	0.903*** (0.021)	0.949*** (0.020)	0.916*** (0.027)	-	0.947*** (0.051)	0.899*** (0.096)	-	-	-
	Female	0.932*** (0.018)	0.924*** (0.020)	0.954*** (0.018)	0.963*** (0.026)	0.838*** (0.086)	-	-	-	-
Kazakhstan	Male	0.775*** (0.033)	0.706*** (0.050)	0.749*** (0.041)	0.847*** (0.057)	0.640*** (0.126)	0.239 (0.154)	-	-	-
	Female	0.792*** (0.034)	0.775*** (0.034)	0.774*** (0.033)	0.695*** (0.061)	0.528*** (0.101)	0.559*** (0.003)	-	-	-
Malaysia	Male	0.817*** (0.023)	0.858*** (0.038)	0.940*** (0.026)	0.893*** (0.043)	0.790*** (0.084)	0.815*** (0.166)	0.854*** (0.134)	-	-
	Female	0.903*** (0.017)	0.852*** (0.041)	0.881*** (0.039)	0.847*** (0.058)	0.884*** (0.077)	0.828*** (0.110)	-	-	-
Mexico	Male	0.953*** (0.046)	0.914*** (0.016)	0.909*** (0.025)	0.906*** (0.023)	0.931*** (0.028)	0.868*** (0.122)	0.689*** (0.254)	-	-
	Female	0.933*** (0.015)	0.929*** (0.018)	0.947*** (0.016)	0.947*** (0.021)	0.927*** (0.049)	-	-	-	-
Romania	Male	0.847*** (0.026)	0.869*** (0.024)	0.864*** (0.029)	0.885*** (0.049)	0.658*** (0.159)	-	-	-	-
	Female	0.945*** (0.016)	0.946*** (0.014)	0.978*** (0.011)	0.932*** (0.046)	0.930*** (0.067)	0.749*** (0.216)	-	-	-
Russia	Male	0.655*** (0.028)	0.648*** (0.026)	0.683*** (0.029)	0.669*** (0.598)	0.643*** (0.125)	0.767*** (0.199)	-	0.550 (0.347)	-
	Female	0.686*** (0.028)	0.728*** (0.019)	0.716*** (0.024)	0.793*** (0.058)	0.900*** (0.094)	0.716*** (0.166)	-	-	-
South Africa	Male	0.904*** (0.019)	0.921*** (0.029)	0.840*** (0.032)	0.929*** (0.031)	0.944*** (0.055)	-	-	-	-
	Female	0.899*** (0.021)	0.929*** (0.024)	0.878*** (0.025)	0.954*** (0.022)	0.948*** (0.051)	-	-	-	-
Thailand	Male	0.911*** (0.017)	0.958*** (0.018)	0.931*** (0.024)	0.905*** (0.052)	0.871*** (0.085)	-	-	-	-
	Female	0.920*** (0.016)	0.956*** (0.019)	0.918*** (0.028)	0.918*** (0.055)	-	-	-	-	-
Turkey	Male	0.929*** (0.012)	0.897*** (0.022)	0.925*** (0.021)	0.879*** (0.046)	0.866*** (0.086)	0.763*** (0.717)	0.717*** (0.246)	0.649*** (0.305)	-
	Female	0.954*** (0.009)	0.911*** (0.019)	0.932*** (0.018)	0.930*** (0.038)	0.800*** (0.123)	-	-	-	-

Continued

Venezuela	Male	0.931*** (0.018)	0.958*** (0.029)	0.938*** (0.031)	0.970*** (0.029)	0.887*** (0.075)	-	-	-	-
	Female	0.935*** (0.018)	0.929*** (0.027)	0.974*** (0.018)	0.929*** (0.048)	-	-	-	-	-
Sri Lanka	Male	0.942*** (0.029)	0.900*** (0.047)	0.898*** (0.036)	0.844*** (0.059)	-	0.648** (0.319)	-	-	-
	Female	0.904*** (0.047)	0.812*** (0.053)	0.722*** (0.053)	0.526*** (0.074)	0.543*** (0.113)	-	-	-	-
Egypt	Male	0.404 (0.035)	0.647*** (0.107)	0.476*** (0.058)	0.566*** (0.059)	0.568*** (0.067)	0.551*** (0.097)	0.583*** (0.166)	-	-
	Female	0.371 (0.036)	0.435*** (0.077)	0.452*** (0.057)	0.203*** (0.048)	0.275*** (0.058)	0.183 (0.117)	-	-	-
India	Male	0.809*** (0.011)	0.828*** (0.013)	0.813*** (0.013)	0.726*** (0.032)	0.733*** (0.059)	0.824*** (0.112)	0.588*** (0.220)	0.651** (0.277)	-
	Female	0.828*** (0.013)	0.819*** (0.014)	0.785*** (0.015)	0.700*** (0.034)	0.526*** (0.063)	0.501*** (0.083)	0.491** (0.158)	-	-
Indonesia	Male	0.836*** (0.016)	0.873*** (0.019)	0.872*** (0.019)	0.861*** (0.032)	0.859*** (0.053)	0.864*** (0.089)	-	0.299 (0.256)	-
	Female	0.888*** (0.015)	0.893*** (0.021)	0.869*** (0.023)	0.847*** (0.041)	0.833*** (0.076)	0.648*** (0.137)	0.734*** (0.224)	-	-
Mongolia	Male	0.501*** (0.068)	0.401*** (0.077)	0.409*** (0.069)	0.446*** (0.083)	0.576*** (0.103)	0.341** (0.163)	-	0.431 (0.343)	-
	Female	0.388*** (0.076)	0.428*** (0.071)	0.454*** (0.057)	0.478*** (0.071)	0.460*** (0.115)	0.404** (0.181)	-	0.275 (0.243)	-
Myanmar	Male	0.381*** (0.035)	0.403*** (0.039)	0.372*** (0.040)	0.483*** (0.121)	0.352** (0.729)	-	-	-	-
	Female	0.258*** (0.030)	0.271*** (0.036)	0.196*** (0.029)	0.329*** (0.101)	0.401* (0.218)	-	-	-	-
Philippines	Male	0.786*** (0.021)	0.796*** (0.031)	0.771*** (0.029)	0.725*** (0.061)	0.779*** (0.099)	0.779*** (0.139)	0.466 (0.352)	-	-
	Female	0.769*** (0.023)	0.809*** (0.027)	0.835*** (0.027)	0.702*** (0.081)	0.583*** (0.121)	0.745*** (0.220)	0.656*** (0.195)	-	-
Vietnam	Male	0.897*** (0.016)	0.893*** (0.025)	0.897*** (0.020)	0.925*** (0.028)	-	0.925*** (0.026)	-	-	-
	Female	0.942*** (0.013)	0.936*** (0.019)	0.912*** (0.024)	0.942*** (0.918)	0.918*** (0.045)	0.881*** (0.108)	-	-	-

Note: ***,** and * denote statistical significance at the 1%,5% and 10% levels, respectively. Standard errors in parentheses.

Chapter 6: Conclusion

This thesis aims to contribute to the literature by investigating whether social capital and sociodemographic factors are associated with the improvement or deterioration of both environmental problems and quality of life that affect wellbeing by using global survey data. For this purpose, this thesis conducted four case studies using a survey across 37 nations, including developed and developing countries across all continents. The main findings from this thesis are summarized as follows:

In Chapter 2, this study found that compared to high-income countries, most low-income countries with high levels of community attachment and social trust are associated with higher concern about the global warming problem, possibly because many developing countries are more vulnerable to climate change. Furthermore, the results of separate impacts reveal that social capital is correlated with less CO_2 emissions, while income is correlated with more CO_2 emissions. The combined effect of social capital and income is associated with an increased negative correlation of social capital and a decreased positive correlation of income with CO_2 emissions. Moreover, when of social capital is included with income, the turning point of household income is approximately 4,934 USD at the country level and 3,285 USD at the region level. Overall, these results suggest that negative correlation of social capital with emissions points out a new dimension for climate policy. Social trust and engagement can be used as a potential platform for sharing information and promoting public policies to reduce CO_2 emissions at the community-level. Furthermore, power groups of environmental organizations can be involved in sharing information and promoting processes across nations and regions.

In Chapter 3, this study shows that social capital-related factors, which are family bond and security, are associated with fewer COVID-19 deaths, while community attachment and social trust are associated with more COVID-19 deaths. These results might suggest that social capital can influence contemporary environmental problems, such as the COVID-19 pandemic. Moreover, older people have a higher COVID-19 mortality risk even if they have a better family relationship or security because of their poor health condition. Overall, people's behavior should be changed in terms of pandemic or health threat conditions.

In Chapter 4, the study found that less-developed or low-income countries have higher life satisfaction and good health than developed and high-income countries with high social capital. Moreover, low-income countries show a decreasing trend on perceived economic inequality when social capital increases, while developed countries present an increasing trend. Therefore, the results suggest that high-income countries can learn from low-income countries about the important factors that improve the level of social capital. Low-income countries have higher life satisfaction, and good health than high-income countries with increased individual-level social capital. At the community level, social contact between income groups seems to have a strong link with reducing economic inequality between the rich and the poor, suggesting that organizing community participation opportunities may be beneficial. Additionally, higher educational attainment of the country is associated with a smaller economic gap, suggesting that educational institutes not only develop human capital but also improve social capital by passing on social rules and norms.

In Chapter 5, the study shows that men report having more knowledge about energy sustainability than women, while women are more concerned about the importance of energy sustainability than men in most countries. These results are consistent with the evidence that men are stronger in cause-effect logic, and women are strong in holistic association. Moreover, many developed countries show greater gender differences than developing countries. Thus, the results suggest that people's thinking patterns are a more important factor than their country background. Therefore, integrating both styles of thinking would be beneficial for the decision-making process concerning energy sustainability and energy conservation practices.