



# Impact of the Intra-household Education Gap on Wives' and Husbands' Well-Being: Evidence from Cross-Country Microdata

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## Abstract

Using original cross-sectional Internet survey data from 32 countries in six continents, we investigate the effect of intra-household education gap on the well-being of wives and husbands. According to the results, both wives and husbands with larger intra-household education gaps report a lower probability of life satisfaction. In particular, subjective well-being is worse for a wife or husband with longer years of schooling than their partner, compared to other groups (i.e., a couple with an equal level of education or wife or husband with a lower education level than her or his partner). The impact of intra-household education gap on well-being is greater for both wives and husbands in Asian and non-high-income countries, and only wives in Western and high-income countries. It is greater for the well-educated group than for the less-educated group for both wives and husbands. Individual income remains a satisfactory channel for both wives and husbands, while the impact of the family satisfaction channel is only confirmed for wives.

**Keywords** Intra-household education gap · Happiness · Life satisfaction · Cross-country

## 1 Introduction

Investigating the determinants of an individual's well-being is crucial to introducing policies to improve national well-being. From an economic perspective, well-being is considered an approximate measure, or reflection of utility, because it is measured as a cardinal not an ordinal number (Diener 2006; Diener et al. 2018; Frey and Stutzer 2002;

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Hamermesh 2004; Helliwell and Akin 2018; Oswald 1997). Education is an essential factor in human capital that greatly influences economic growth and development and individuals' labor market outcomes. Thus, an empirical study on the relationship between education and well-being is essential.

While several empirical studies have focused on the relationship between education level and individual subjective well-being, the research has not reached a consensus. Both, a positive relationship (Belfield and Harris 2002; Cuñado and Gracia 2012; Di Tella et al. 2001; Ferrer-i-Carbonell and Van Praag 2003; Florida et al. 2013; Hartog and Oosterbeek 1998; Hayo and Seifert 2003; Nikolaev 2018; Van Praag et al. 2003), and a negative relationship (Blanchflower and Oswald 1998; Clark 1999; Clark and Oswald 1996) between an individual's education level and subjective well-being have been reported. Blanchflower and Oswald (1998) show that job satisfaction is lower for highly educated workers (individuals who have completed college) than for the less educated. Other studies show that the relationship between education and subjective well-being is not significant (Inglehart and Klingemann 2000; Nikolaev 2015).

Regarding the intra-household education gap<sup>1</sup> and well-being, Theunis et al. (2018) and Schwartz and Han (2014) investigated and correlated the gap with marital dissolution. They found that highly educated wives have lower marriage satisfaction and are more likely to opt for divorce. Groot and Van Den Brink (2002), Ma and Piao (2019), and Ma (2020) reported that an intra-household education gap negatively affects the happiness of Dutch, Japanese, and Chinese wives.

The main contributions of this study are as follows. It provides evidence of the association between intra-household education gap and well-being. This is the first international comparative study on this issue, to the best of our knowledge. This study uses original cross-sectional Internet survey data from 32 countries. The results provide new evidence for an international comparison (i.e., Asian vs. Western and Eastern areas; high-income countries vs. non-high-income countries; well-educated individuals vs. less-educated individuals). We investigated the impact of the intra-household education gap on well-being for an improved understanding of this issue.

The remainder of this paper is structured as follows. First, we introduce approaches to explain how the intra-household education gap influences the well-being of wives and husbands and summarize the results of previous empirical studies on the relationship between education and well-being. Second, we describe the methods of analysis and introduce models and data. We then provide the calculated results and interpret the econometric results. Finally, we present the main conclusions and highlight policy implications.

## 2 Literature Review

### 2.1 Channel Impact of Intra-household Education Gap on Well-being

From an economic perspective, two effects (positive and negative) may explain the influence of intra-household education gap on individual well-being.

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<sup>1</sup> In this study, the indices of intra-household education gap are (1) actual educational difference and (2) absolute educational difference. For the detailed definitions of these two indices, please refer to Sect. 3.

First, based on Chiappori's (1992) collective model, intra-household differences between husband and wife significantly affect resource (i.e., income, time) allocation (Browning et al. 1994, 2013; Cherchye et al. 2012, 2015; Chiappori et al. 2002; Couprie 2007; Haddad 2015; Lise and Seitz 2011; Lise and Yamada 2014). From the bargaining utility perspective, the intra-household education gap between spouses presents one aspect. As higher intra-household bargaining power leads to higher individual utility, well-being may be better for highly educated individuals than for less-educated ones. For example, based on the absolute income hypothesis,<sup>2</sup> well-being is higher for high-income groups than for low-income groups (Duesenberry 1949; Leibenstein 1950). Thus, as individual income is higher for highly educated family members, well-being may be higher for them. Besides, based on the relative income hypothesis,<sup>3</sup> the probability of unhappiness is higher for those whose income is lower than that of the reference group. Therefore, within a household, a highly educated family member with a higher income may feel happier than the less-educated family members with lower income. These income effect hypotheses may demonstrate the positive influence of the intra-household education gap on individual well-being (positive effect of income).

Second, the intra-household education gap may be related to marital dissatisfaction, which can negatively affect individual well-being. The following four channels play a role: (1) based on gender role consciousness, as in "women are homemakers and men are breadwinners," even if a highly educated wife earns more income, she still has to undertake more housework than her husband (Álvarez and Miles 2003; Bertrand et al. 2015; Ma and Piao 2019; Piao 2020). Such work-family conflicts may worsen wives' well-being (negative effect of the gender role consciousness hypothesis). (2) Highly educated individuals may have more professional ability and skills (Bynner et al. 2003; Cronin and Glenn 1991; Gerstein and Friedman 2016; Kruss et al. 2015). When there is a gap in skill levels for a couple, the highly educated individual probably cannot expect help from the less-educated partner to overcome difficulties in life and work, decreasing their well-being. (3) Highly educated individuals may work longer hours than their less-educated partners. It has been found that longer working hours may also negatively affect well-being (Ma 2009). (4) Highly educated individuals may have higher expectations from marriage, life, and work; therefore, they may feel unhappy or dissatisfied more easily than their spouses (less-educated individuals). For example, Clark and Oswald (1996) indicate that the expectations of higher income and better job may reduce a highly educated person's job satisfaction. Therefore, work-family conflict may be severe for couples with significant intra-household education gaps, decreasing their well-being through family dissatisfaction (negative effect of marital dissatisfaction).

As both positive and negative effects emerge, it is unclear how intra-household education gap affects the well-being of spouses. Thus, this issue should be investigated empirically. Gender role consciousness regarding family responsibility and workplace situations differ in various countries. Therefore, the influence of intra-household education gap may differ by country. Thus, an international comparative study based on cross-country data should be conducted to expand knowledge on this issue. Here, we

<sup>2</sup> Most previous studies support the absolute hypothesis in developed countries, including Japan (Easterlin 2001; Ferrer-i-Carbonell 2005; Ma and Piao 2019; Vendrik and Woltjer 2007), and developing countries (Ma 2016; Wang and VanderWeele 2011).

<sup>3</sup> The relative income hypothesis is supported for developed countries (Ferrer-i-Carbonell 2005; Ma and Piao 2019; Vendrik and Woltjer 2007) and developing countries (Brockmann et al. 2009; Ma 2016; Wang and VanderWeele 2011).

conduct an empirical study to provide new evidence. We also investigate the influence of two channels: the positive effect of the income hypothesis and the negative effect of marriage dissatisfaction.

## 2.2 Empirical Evidence of the Relationship Between Education and Well-being

While many empirical studies have been conducted on the relationship between levels of education and individual subjective well-being, the research has not reached a consensus. Specifically, a positive relationship between an individual's education level and their subjective well-being has been reported (Belfield and Harris 2002; Cuñado and Gracia 2012; Di Tella et al. 2001; Ferrer-i-Carbonell and Van Praag 2003; Florida et al. 2013; Hartog and Oosterbeek 1998; Hayo and Seifert 2003; Nikolaev 2018; Van Praag et al. 2003). For example, using individual-level data from Spain, Cuñado, and Gracia (2012) confirmed the positive impact of education on happiness, on increasing household income, and on the likelihood of being employed. Using Australian data, Nikolaev (2018) highlighted a definite link between education and subjective well-being in terms of experiencing more positive and less negative emotions. Similarly, people with a higher level of education are more likely to be satisfied with their income, labor status, and local community, among others. However, a negative relationship has also been identified (Clark 1999; Clark and Oswald 1996). For example, using data from Britain, Clark, and Oswald (1996) demonstrated a significant negative association between education and happiness after controlling for income. Other studies did not find a significant relationship between education and subjective well-being (Inglehart and Klingemann 2000; Nikolaev 2015).

Accordingly, regarding education and other satisfaction, Blanchflower and Oswald (1998) indicated that job satisfaction is lower for highly educated workers (i.e., individuals who have completed college) than for less-educated workers.

Regarding the association between intra-household education gap and an individual's well-being, a number of findings have been presented. First, based on the collective model (Chiappori 1992), it was found that educational differences between the couple significantly affect resource allocation (Browning et al. 1994, 2013; Cherchye et al. 2012, 2015; Chiappori et al. 2002; Couprie 2007; Haddad 2015; Lise and Seitz 2011; Lise and Yamada 2014). Lise and Yamada (2014) use the education gap as an index in an empirical study to test the intra-household bargaining power hypothesis. Theunis et al. (2018) and Schwartz and Han (2014) found that the intra-household education gap affects marital satisfaction. In particular, couples with a more significant difference in education (i.e., couples where the wife is highly educated) are more likely to opt for divorce. The adverse effects of the intra-household education gap on marital satisfaction provide evidence, from the above-mentioned channel, of its influence on well-being (life satisfaction, happiness) because marital and life satisfaction or happiness are correlated. Third, Groot and Van Den Brink (2002), Ma and Piao (2019) and Ma (2020) directly estimated the association between intra-household education gap and subjective well-being. They found a negative relationship between intra-household education gap and subjective well-being of wives: the higher the intra-household education gap, the lower the wives' happiness.

However, prior studies did not address the problem of endogeneity in the intra-household education gap and satisfaction outcomes when estimating its impact on well-being, and they did not conduct an international comparison. Therefore, this study fills these gaps in the literature.

### 3 Methodology

#### 3.1 Models

First, this study used an ordered probit regression model to investigate the relationship between the intra-household education gap and well-being. Due to the questionnaire items, the well-being variable is usually a scale variable ranging from the lowest to highest value, thus a majority of the previous studies use both an ordered probit regression model and an ordered logit regression model. This study uses the ordered probit regression model as the basic estimation model, as shown in Eq. (1). The ordered logit regression and other models (i.e., ordinary least squares (OLS), binary probit regression model) are used to perform robustness checks.

$$SWB_{iC}^* = \alpha + \theta K_{iC} + X_{iC}\beta + D_C\delta + \varepsilon_{iC}$$

$$SWB_{i=j} \text{ if } SWB_{j-1} < SWB_j^* < SWB_{j+1} \quad (1)$$

In Eq. (1), the dependent variable (*SWB*) is an ordered categorical variable (ordinal variable) of subjective well-being (i.e., happiness, life satisfaction), ranked from the lowest to the highest rank. Furthermore, *i* refers to individuals (wives or husbands) in a country *C*. *K* denotes the two indices of intra-household education gaps: actual educational difference (wife's years of education minus husband's years of education) or absolute educational difference (absolute years of educational difference between wives and husbands). Separate regressions are performed for different intra-household education gap measures. *X* denotes a set of exogenous demographic and socioeconomic variables, introduced in the section on variables. *D* is the country dummy used to capture country-level heterogeneity;  $\alpha$  is constant;  $\theta$ ,  $\beta$ , and  $\delta$  are the estimated coefficients; and  $\varepsilon$  is an error term.

When the coefficients of absolute educational difference are negative and statistically significant, wives or husbands with greater intra-household education gaps are more likely to feel dissatisfied or unhappy. Absolute educational differences only indicate a large intra-household education gap, not its direction (who in the household has obtained a higher level of education).

The actual difference in education level indicates the direction of the intra-household education gap. For example, a positive value for actual educational difference means that the wife has more years of schooling than her husband and vice versa. For a wife, when the coefficient of actual educational difference is negative and statistically significant, it indicates that she may feel dissatisfied or unhappy if she has more years of schooling than her husband. For a husband, when the coefficient of actual educational difference is positive and statistically significant, it indicates that his wife has more years of schooling, which may increase the likelihood of his subjective well-being.

Second, to investigate the channels of impact of the intra-household education gap on well-being, we analyze the impact of actual educational differences on income satisfaction and family satisfaction using the logit regression model (Eq. 2); whereas, using the ordered probit regression model, we examine the influence of income satisfaction or family satisfaction on subjective well-being (Eq. 3).

The family and income satisfaction function is employed (*Y*), as shown in Eqs. (2) and (3):

$$Y_{iC} = \alpha + \gamma K_{iC} + X_{iC}\beta + D_C\delta + \varepsilon_{iC} \quad (2)$$

$$SWB_{iC} = \alpha + \rho Y_{iC} + X_{iC}\beta + D_C\delta + \varepsilon_{iC} \quad (3)$$

In Eqs. (2) and (3),  $Y$  denotes income satisfaction or family satisfaction ( $Y$ ),  $\gamma$  captures the effect of the intra-household education gap on satisfaction ( $Y$ ), and  $\rho$  expresses the influence of satisfaction (i.e., income satisfaction or family satisfaction) on well-being. When the coefficients of  $\gamma$  and  $\rho$  are statistically significant, it indicates that the effect of the intra-household education gap on well-being may be through the channel of income or family satisfaction (intra-household education gap income or family satisfaction-well-being channel).

### 3.2 Data

To investigate the impact of intra-household education gap on well-being, we conducted an Internet survey via a professional survey company in Japan (Nikkei Research Company) between 2015 and 2017. The target respondents are randomly selected according to the gender and age distributions in each country. Nikkei Research has provided many reliable web-based survey services in recent decades and has a comprehensive panel that ensures the sample matches the specified gender and age distributions. A questionnaire is distributed to the randomly sampled registered panel who met the stipulated conditions. Because of the low number of respondents in the category of women aged 60 years or more in developing countries, we select women in the next age group to attain the national gender age distribution and avoid sample selection bias. The translated questionnaire is subjected to multiple checks to ensure accuracy. It is known that Internet-based surveys tend to select well-educated respondents with a high household income because non-Internet users are excluded (Pew Research Center 2015).

This original survey, which measured subjective well-being and socioeconomic factors, comprised an Internet survey in 32 countries and face-to-face surveys with respondents from five areas. The sample included 100,956 respondents from six continents. The survey was conducted once in each country from 2015 to 2017.<sup>4</sup> In total, 61,687 survey respondents lived with a partner, and after excluding missing values for key variables, 53,365 observations are included in the analysis: 25,533 for wives and 28,032 for husbands. A more detailed description of the data for this survey is included in Chapman et al. (2019).

The list of countries by region is as follows: Asia (Japan, Thailand, Malaysia, Indonesia, Singapore, Vietnam, the Philippines, India, and China); Europe (Russia, Germany, the United Kingdom, France, Spain, Italy, Sweden, the Netherlands, Greece, Turkey, Hungary, Poland, Czech Republic, and Romania); North America (Mexico, Canada, and the United States); South America (Venezuela, Chile, Brazil, and Colombia); Australia (Australia), and Africa (South Africa). Detailed information on the duration of data collection and observations regarding individuals with partners in each country are in the Appendix. The reasons for selecting these countries and the six-continent areas are as follows: first, the countries in our survey are largely selected based on region-specific representative population size, from a global viewpoint of education issues. Second, we also consider in our

<sup>4</sup> For the detailed information of samples, country names, continents, and survey years, please refer Appendix Table 7.

selection the differences in economic development levels among countries, as these are easily identified by third-party survey companies. Third, cultures (i.e., gender role consciousness) differ by region; for example, the influence of Confucianism is greater in parts of Asia than in other areas (Hang 2011; Yum 1988). Therefore, we consider the geographic distance among countries to construct the six-continent areas. It can be assumed that countries near one another are more likely to be influenced by a similar societal culture. For example, the countries of East Asia (i.e., China, Japan) are highly influenced by Confucianism. Although the original international survey had problems in sampling and representation, leaving room for improvement in future research, the data is considered appropriate for an international comparative study on the correlation between an intra-household education gap and the well-being of spouses.

### 3.3 Variables

#### 3.3.1 Indices of Well-Being: Life Satisfaction and Happiness

Based on the questionnaire items of the survey and previous studies, the main dependent variables are constructed as ordinal variables, ranging from the lowest to highest rank: from one to five for happiness and from zero to 10 for life satisfaction, respectively. Referring to previous studies (Helliwell et al. 2012; Graham and Nikolova 2015; Stone and Mackie 2014; Bjørnskov 2010; Ma and Piao 2019) we designed the questionnaire items for life satisfaction based on OECD guidelines. Respondents are asked to imagine a ladder with steps numbered from 0 (bottom) to 10 (top): “The top of the ladder represents the best possible life for you, and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you feel you stand at this time?” For the scaled variable of happiness, respondents are asked: “Overall, how happy are you with your life?” The happiness ratings are: 5 = very happy, 4 = slightly happy, 3 = neither, 2 = slightly unhappy, and 1 = unhappy.

Income satisfaction (satisfied with household income = 1; other = 0) and family satisfaction (satisfied with family relationship = 1; other = 0) are employed to investigate the channels.

#### 3.4 Indices of the Intra-household Education Gap

The primary independent variable is the intra-household education gap, which includes actual educational difference and absolute educational difference. First, actual educational difference is calculated by the wife's years of education minus the husband's years of education.<sup>5</sup> It expresses the direction of the intra-household education gap. Specifically, a positive (negative) value for actual educational difference indicates longer (shorter) years of schooling for the wife than for her husband (Lise and Yamada 2014; Ma and Piao 2019; Schwartz and Han 2014; Theunis et al. 2018). Second, absolute educational difference is the absolute years of educational difference between wives and husbands, which is equal to or greater than zero. This indicates the size of the intra-household education gap and is

<sup>5</sup> Never attended school is scored as 0, dropped out of primary school as 3, completed primary school as 6, completed junior high school as 9, completed high school as 12, completed vocational school as 14, completed junior college as 15, completed university/college education as 16, completed graduate school (master's degree) as 18, and completed graduate school (doctorate degree) as 23.

utilized in Groot and Van Den Brink (2002). The absolute educational difference, which is the difference in educational attainment levels of wives to husbands, is examined to ensure the robustness of the results.<sup>6</sup>

### 3.5 Other Variables

The other independent variables are as follows: (1) age; (2) female dummy variable; (3) per capita household income (which is equivalent household income transformed based on the equivalent scale<sup>7</sup> and converted into US dollars following the exchange rate<sup>8</sup> in each survey year); (4) 10 work and occupational status dummy variables (individual unemployed, full-time employee, part-time employee, company owner, government employee, professional worker (e.g., physician, professor), self-employed, student, housewife/househusband, and others); (5) individual educational attainment dummy variables (junior high school or less, senior high school, vocational school, college, university, graduate school); (6) the number of children; (7) three housing status dummy variables (rent house, own house, and other); and (8) dummy variables for three continents to control for country-level heterogeneity.

Table 1 summarizes the statistical descriptions of the variables utilized in this study. Married men (husband group) and married women (wife group) were randomly selected to ensure that the sample size matches the gender distribution in the population. Note that the selected men and women are *not* couples, and the sample sizes of wives and husbands differed because of the difference in missing variable values between these two groups. The questionnaire items include the spouses' educational information for both women and men; thus, we can construct the intra-household education gap variables to employ in the empirical study.

## 4 Results

### 4.1 Impact of the Intra-household Education Gap on the Life Satisfaction of Wives and Husbands

Table 2 summarizes the results of the relationship between life satisfaction and intra-household education gap, for married women (wives) and married men (husbands) who reside with their partners, across 32 countries, using the ordered probit regression model (Eq. 1).<sup>9</sup> The dependent variable is life satisfaction, which is a scale variable from zero to 10. The main independent variables are actual educational difference (wife's years of education minus the husband's years of education) and absolute educational difference (absolute value of actual educational difference).

The results are summarized as follows: first, the coefficients of absolute educational differences are -0.009 and -0.008 (columns 1 and 2) for wives and husbands, respectively, and statistically significant at the 1% levels. This result suggests that both wives and husbands

<sup>6</sup> The results using the educational attainment gap are available upon request.

<sup>7</sup> The equivalent scale is the square root of the number of family members.

<sup>8</sup> The exchange rate is applied on January 7<sup>th</sup> 2021.

<sup>9</sup> For the robustness checks, the different model results are summarized in the Appendix, Table 8. These results are consistent with those in Table 2.



**Table 1** Descriptive statistics. *Source* Calculations based on the original survey

	Wife Mean or percent	Husband Mean or percent
<i>Dependent variables</i>		
Life satisfaction (0–10)	6.97 (1.72)	6.86 (1.77)
Happiness (1–5)	4.01 (0.86)	4.00 (0.85)
<i>Main Independent variable</i>		
Actual Educational Difference (Wife's years of education minus the husband's years of education)	0.14 (2.82)	– 0.69 (3.04)
Absolute Education Difference (Absolute value of actual education difference)	1.57 (2.35)	2.57 (2.57)
<i>Control variables</i>		
Intra-country household Income (1,000 US dollar)	20.64	21.74
<i>Educational attainment</i>		
Junior high school or lower	6%	6%
Senior high school	17%	15%
Vocational school	9%	9%
College	15%	11%
University	41%	45%
Graduate school	11%	14%
Age	45.8	43.7
<i>Occupational status</i>		
Unemployed	5%	7%
Full-time employee	46%	57%
Part-time employee	10%	5%
Company owner	2%	3%
Government employee	3%	4%
Professional workers	3%	5%
Self-employed	5%	9%
Student	1%	1%
Housewife/househusband	18%	1%
Other	6%	7%
Number of children	1.5	1.4
<i>Housing status</i>		
Renter	22%	20%
Owner	75%	78%
Other	3%	2%
Volunteer in environmental activities	25%	26%
Objective health dummy	81%	84%
<i>Mechanism</i>		
Family satisfaction	77%	79%
Income satisfaction	38%	39%
Observation	25,333	28,032

Means (standard deviations) are given for continuous variables and percentages for binary variables

**Table 2** Impact of intra-household education gap on the life satisfaction of wives and husbands. Data Sources: original survey

	(1) Wife.Coef.(SE)	(2) Husband.Coef.(SE)	(3) Wife.Coef.(SE)	(4) Husband.Coef.(SE)
Absolute educational difference	- 0.009*** (0.003)	- 0.008*** (0.003)	- 0.022*** (0.003)	0.014*** (0.002)
Actual educational difference				0.009*** (0.000)
Intra-country household income	0.009*** (0.000)	0.009*** (0.000)	0.008*** (0.000)	0.009*** (0.000)
<i>Educational attainment</i> (ref. Senior high school)				
Junior high school or lower	0.162*** (0.035)	0.241*** (0.033)	0.095*** (0.035)	0.183*** (0.034)
Vocational school	0.015 (0.029)	0.032 (0.027)	0.037 (0.029)	0.047* (0.027)
College	0.063*** (0.025)	- 0.008 (0.026)	0.092*** (0.025)	0.013 (0.026)
University	0.124*** (0.021)	0.120*** (0.020)	0.161*** (0.021)	0.143*** (0.020)
Graduate school	0.208*** (0.028)	0.231*** (0.025)	0.264*** (0.029)	0.270*** (0.026)
Age	0.003*** (0.001)	0.002*** (0.001)	0.003*** (0.001)	0.002*** (0.001)
<i>Occupational status</i> (ref. Unemployed)				
Full-time employee	0.228*** (0.035)	0.142*** (0.029)	0.229*** (0.035)	0.139*** (0.029)
Part-time employee	0.152*** (0.039)	0.069* (0.039)	0.150*** (0.039)	0.064 (0.039)

Table 2 (continued)

	(1) Wife.Coeff.(SE)	(2) Husband.Coeff.(SE)	(3) Wife.Coeff.(SE)	(4) Husband.Coeff.(SE)
Company owner	0.349*** (0.056)	0.253*** (0.045)	0.341*** (0.056)	0.245*** (0.045)
Government employee	0.180*** (0.050)	0.147*** (0.039)	0.178*** (0.050)	0.144*** (0.039)
Professional	0.111** (0.047)	0.133*** (0.038)	0.107*** (0.047)	0.128*** (0.038)
Self-employed	0.108** (0.043)	0.063* (0.034)	0.106** (0.043)	0.058* (0.034)
Student	0.171** (0.070)	0.289*** (0.070)	0.158*** (0.070)	0.287*** (0.070)
Housewife/househusband	0.170*** (0.036)	0.042 (0.062)	0.163*** (0.036)	0.041 (0.062)
Other	0.125*** (0.043)	0.177*** (0.035)	0.124*** (0.043)	0.180*** (0.035)
Number of children	0.064*** (0.007)	0.062*** (0.007)	0.063*** (0.007)	0.062*** (0.007)
<i>Housing status (ref. Renter)</i>				
Owner	0.174*** (0.018)	0.164*** (0.017)	0.170*** (0.018)	0.163*** (0.017)
Other	-0.204*** (0.046)	-0.215*** (0.048)	-0.202*** (0.046)	-0.214*** (0.048)
Volunteer in environmental activities	0.115*** (0.015)	0.104*** (0.014)	0.112*** (0.015)	0.103*** (0.014)
Objective health	0.305*** (0.017)	0.238*** (0.017)	0.305*** (0.017)	0.237*** (0.017)

Table 2 (continued)

	(1) Wife.Coeff.(SE)	(2) Husband.Coeff.(SE)	(3) Wife.Coeff.(SE)	(4) Husband.Coeff.(SE)
Country dummy	Yes	Yes	Yes	Yes
Number of observations	25,333	28,032	25,333	28,032
Number of countries	32	32	32	32
Pseudo R2	0.03	0.04	0.03	0.04

The coefficients are the marginal effects at the mean values. White-robust standard errors are in parentheses

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$

**Table 3** Marginal effects of intra-household education gap on life satisfaction of wives and husbands (ordered probit model). Data Sources: original survey

	Absolute educational difference		Actual educational difference	
	(1) Wife	(2) Husband	(3) Wife	(4) Husband
Life satisfaction score	Coeff	Coeff	Coeff	Coeff
10= Best possible life	- 0.0007***	- 0.0007***	- 0.0018***	0.0012***
9	- 0.0013***	- 0.0010***	- 0.0031***	0.0018***
8	- 0.0012***	- 0.0011***	- 0.0031***	0.0020***
7	0.0003***	0.0001***	0.0007***	- 0.0001***
6	0.0008***	0.0007***	0.0020***	- 0.0013***
5	0.0009***	0.0007***	0.0021***	- 0.0012***
4	0.0006***	0.0005***	0.0014***	- 0.0010***
3	0.0004***	0.0004***	0.0010***	- 0.0008***
2	0.0002***	0.0002***	0.0005***	- 0.0004***
1	0.0001***	0.0001***	0.0002***	- 0.0002***
0= Worst possible life	0.0001***	0.0001***	0.0002***	- 0.0001***

The coefficients are the marginal effects at the mean values

\*\*\*  $p < 0.01$

with a larger absolute educational difference are likely to feel dissatisfied with their lives when other determinant factors are held constant.<sup>10</sup> The results for wives are consistent with Groot and Van Den Brink (2002), who found a significant negative effect of the intra-household education gap on wives' well-being. Compared with couples with an equal level of education, the spouse is likely to feel dissatisfied in a household with an intra-household education gap.

The coefficient of actual education for the wives is -0.022 (column 3) and statistically significant at the 1% level. This indicates that when the actual educational difference is larger, wives are less likely to feel satisfied. A positive value of actual educational difference means that wives tend to have more years of education when the husbands' years of education are subtracted. The results suggest that when a wife has more years of schooling than her husband, she is likely to feel dissatisfied with her life. These results are consistent with those of Ma and Piao (2019). In contrast, for husbands, the coefficient of actual educational difference is 0.014 (column 4) and statistically significant at the 1% level. This indicates that a husband's probability of being satisfied with life is higher when his wife has longer years of schooling than him. In sum, both wives and husbands with a partner with longer years of education, are likely to be satisfied with their lives. These conclusions are confirmed by the ordered logit regression model, OLS regression model in which the dependent variable is a scale variable ranging from 0 to 10 (life satisfaction) or from 1 to 5 (happiness), and the probit regression model in which a binary variable is utilized as the dependent variable (see Appendix, Table 8).

Moreover, based on the results in Table 2, we also calculated the marginal effects of the intra-education gap on the probabilities of being in the rank of life satisfaction from 0 (worst life) to 10 (best life) for wives and husbands. The results are summarized in Table 3. Columns

<sup>10</sup> The robustness results are obtained by additionally controlling for the partner occupation dummy variables.

1 and 2 display the results for absolute educational difference, and columns 3 and 4 presents for actual educational difference. Considering the effects of absolute educational difference, negative values are generated for both wives' and husbands' upper three high levels (from 8 to 10) of life satisfaction, statistically significant at 1%, while positive values are generated for the low- and medium-levels (from 0 to 7) of life satisfaction, statistically significant at 1%. It suggests that the increasing absolute educational difference is likely reducing the probabilities of being in higher life satisfaction levels for both wives and husbands. Regarding actual educational difference, the results differ by gender. For the wives group, the coefficients were negative values for the upper three high levels (from 8 to 10) of life satisfaction and positive values for the low- and medium-levels (from 0 to 7) of life satisfaction. It indicates that wives with better educated husbands are more likely to feel satisfied, when the years of schooling of a wife are longer (shorter) by one year compared with her husband, the wife's probability of evaluating the life satisfaction in the upper three high levels (from 8 to 10) may decrease (increase) by 0.18%, 0.31%, and 0.31% points, respectively. For the husband group, although the coefficients of actual educational difference are opposite to those of the wives, the tendency of the results are similar: husbands with better educated wives may feel much more satisfied when the wife's years of schooling are longer by one year compared with her husband. The husband's probability of evaluating the life satisfaction in the upper three high levels (from 8 to 10) may increase by 0.12%, 0.18%, and 0.20% points, respectively. These results suggest that for both wives and husbands, individuals with a better educated partner are likely to be more satisfied with their lives.

Second, according to the results in columns 1–4, (1) for intra-country household income, wives and husbands in the high-income group are more likely to be satisfied with life than those in the low-income group. This is consistent with the findings of previous studies (Ferrer-i-Carbonell 2005; Ma 2016; Vendrik and Woltjer 2007; Wang and VanderWeele 2011). (2) Individuals with a junior high school or lower and university or higher education have a higher probability of being satisfied with life. Cuñado and Gracia (2012) demonstrate a non-significant correlation between education and happiness when income, occupation, and other factors are constant. (3) Wives and husbands are more likely to be satisfied with their lives when they are employed. (4) The number of children is positively associated with life satisfaction. (5) Volunteering activities increase life satisfaction. (6) Good health conditions improve individuals' life satisfaction. (7) Homeowners have higher satisfaction than renters, which is consistent with the results of prior research (Hu and Ye 2019).

#### 4.2 The Impact of the Intra-household Education Gap on the Well-being of Wives and Husbands by Continents and Inter-country Income Levels

Table 4 summarizes the results of the impact of actual educational differences<sup>11</sup> on the well-being of wives and husbands by using different subsamples. An ordered probit regression model is used. The dependent variable is life satisfaction in columns 1 and 3, and happiness in columns 2 and 4. The subsamples are distinguished by continent area (East Asia, Southeast Asia, and South Asia; North America and Europe; South America and Australia), income (high-income countries and non-high-income countries), and educational attainment level (high education: university or higher; low education: college or lower).

<sup>11</sup> As a robustness check, the education evaluation of educational attainment levels between 1 (never attend school) to 10 (doctor) are also used, and the conclusions are confirmed once more.

**Table 4** Impact of actual educational difference on the well-being of wives and husbands by different groups. Data Sources: original survey

Actual education difference	Wife		Husband	
	(1) Life satisfaction	(2) Happiness	(3) Life satisfaction	(4) Happiness
	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
Full sample	-0.022*** (0.003)	-0.010*** (0.003)	0.014*** (0.002)	0.011*** (0.003)
<i>By continent</i>				
Subsample 1: East Asia	-0.039*** (0.006)	-0.014** (0.006)	0.045*** (0.005)	0.027*** (0.006)
Subsample 2: Southeast Asia and South Asia	-0.026*** (0.007)	-0.008 (0.007)	0.011* (0.006)	0.006 (0.006)
Subsample 3: North America and Europe	-0.020*** (0.004)	-0.013*** (0.004)	0.003 (0.003)	0.007* (0.004)
Subsample 4: South America and Australia	0.007 (0.007)	0.006 (0.008)	0.014* (0.008)	0.006 (0.008)
<i>By inter-country income level</i>				
Subsample 5: non-high-income countries	-0.023*** (0.004)	-0.005 (0.004)	0.022*** (0.004)	0.015*** (0.004)
Subsample 6: high-income countries	-0.020*** (0.004)	-0.014*** (0.004)	0.004 (0.003)	0.006 (0.004)
<i>By education level</i>				
Subsample 7: high education	-0.030*** (0.004)	-0.012*** (0.004)	0.016*** (0.004)	0.011*** (0.004)
Subsample 8: low education	-0.015*** (0.004)	-0.009** (0.004)	0.011*** (0.003)	0.010*** (0.004)

The coefficients are the marginal effects at the mean. White-robust standard errors are in parentheses

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ . Covariates and country dummies are controlled

The main results are as follows: First, in general, the coefficients of the actual educational difference are -0.022 (life satisfaction) and -0.010 (happiness) for wives, and 0.014 (life satisfaction) and 0.011 (happiness) for husbands. These results are all statistically significant at the 1% level. This suggests that there is a difference in the impact of the actual educational difference on well-being by gender: the actual educational difference between a couple negatively affects wives' well-being, while it positively affects husbands' well-being. This can be explained by gender role consciousness or gender role segregation based on family economics theory (Becker 1985; Gronau 1977) and societal cultures (i.e., Confucianism).

Second, the results indicate that the impact of the actual educational difference on well-being differs by continent area for both wives and husbands. For example, for happiness (columns 2 and 4), although the effects are statistically significant for both wives and husbands in Asian areas (East Asia, Southeast Asia, and South Asia), North America, and Europe, the magnitude of the coefficients are higher for Asian areas than Western areas (North America and Europe). This suggests that for individuals (wives and husbands) in Asian areas, the probability of being satisfied with life is more likely influenced by the

intra-household education gap than those in other areas of the world. This may be attributed to the cultural differences between Asian and Western societies. In Asian areas, based on the culture of Confucianism, a husband's position in both society and the household should be higher than his wife. Therefore, the effect of the intra-household education gap on well-being is greater for both wives and husbands in Asian areas than in other areas. Regarding the influence of culture on well-being, it can be assumed that gender role consciousness may affect the housework allocation of couples which may affect wives' and husbands' well-being. Baxter and Tai (2016) use the data collected from 29 countries to investigate the housework allocation between wives and husbands. They found that wives tend to do more housework than their husbands in each country, suggesting that gender role consciousness (or family responsibility segregation) maintains in a majority of countries. However, the housework allocation setup differs by country; for example, the share of housework is 10% for Japanese husbands, while 33% for Danish husbands (Baxter and Tai 2016). These differences can explain why the effect sizes of the actual intra-educational difference on well-being are larger for Asian areas than other areas in the world.

Third, the results of non-high-income countries and high-income countries differ by gender. Specifically, for husbands, actual educational differences positively affect well-being in non-high-income countries (0.022 and 0.015 in columns 3 and 4 of subsample 5), while it is not statistically significant for high-income countries. On the contrary, for wives, the negative effect of actual educational difference on well-being is significant for both high- and non-high-income countries (columns 1 and 2 of subsamples 5). This suggests that changes in the negative effect of the intra-household actual educational difference on wives' well-being is small with economic growth. This indicates that changes in gender role consciousness or family responsibility segregation in society or family is small with economic growth.

Finally, for the low- and high-education groups, the effects of actual educational difference on life satisfaction (columns 1 and 3 of subsamples 7 and 8) and happiness (columns 2 and 4 of subsamples 7 and 8) are statistically significant for both the less-educated and the well-educated group for wives and husbands; however, the effect size is greater for well-educated wives. It suggests that although in both the low- and high-education group both wives and husbands are influenced by the intra-household education gap, the influence is greater for well-educated wives. This may be the case because well-educated wives are more likely to face work-family conflict if their working hours become longer.

### 4.3 Potential Channels of Impact of the Intra-household Education Gap on the Well-being of Wives and Husbands

Table 5 summarizes the potential channels of impact of actual educational differences on life satisfaction. It is assumed that an actual intra-household educational gap may influence well-being via the channels of income or family satisfaction, as follows. First, for income satisfaction, based on the absolute income hypothesis (Duesenberry 1949; Leibenstein 1950), an individual with high income may feel happy more often compared to one with low income, when other factors are constant (Easterlin 2001; Ferrer-i-Carbonell 2005; Vendrik and Woltjer 2007). Thus, it can be expected that life satisfaction may be higher for an individual with higher income satisfaction. Based on human capital theory (Mincer 1973), years of education can be considered part of human capital; thus, the income of well-educated individuals is higher than that of people with a lower level of education. As such, the influence of actual educational differences on life satisfaction may occur through income satisfaction (income



**Table 5** Channels of impact of actual educational difference on the well-being of wives and husbands. Data Sources: original survey

	Income satisfaction		Family satisfaction		Life satisfaction		Life satisfaction	
	Wife (1).Coef.(SE)	Husband (2).Coef.(SE)	Wife (3).Coef.(SE)	Husband (4).Coef.(SE)	Wife (5).Coef.(SE)	Husband (6).Coef.(SE)	Wife (7).Coef.(SE)	Husband (8).Coef.(SE)
Actual educational difference	- 0.008*** (0.001)	0.005*** (0.001)	- 0.004*** (0.001)	0.001 (0.001)				
Family satisfaction					0.771*** (0.029)	0.722*** (0.029)	1.151*** (0.033)	1.105*** (0.032)
Income satisfaction					1.556*** (0.027)	1.573*** (0.026)	1.585*** (0.030)	1.583*** (0.030)
Number of observations	25,333	28,032	25,333	28,032	25,333	28,032	25,333	28,032
Number of countries	32	32	32	32	32	32	32	32
Pseudo R2	0.14	0.17	0.10	0.09	0.08	0.08	0.12	0.12

The coefficients are the marginal effects at the mean. White-robust standard errors are in parentheses

\*\*\*  $p < 0.01$ . Covariates and country dummies are controlled

satisfaction channel). Second, for the family satisfaction channel, it is highlighted that the educational difference between a wife and husband negatively affects family satisfaction (e.g., marital satisfaction) (Schwartz and Han 2014; Theunis et al. 2018). When family satisfaction affects life satisfaction, the intra-household educational gap affects life satisfaction via its influence on family satisfaction (family satisfaction channel).

Using the logit model, we analyzed the impact of actual educational differences on income satisfaction (columns from 1 to 2) and family satisfaction (columns from 3 to 4) for wife and husband groups separately. Using the ordered probit regression model, we investigate the influence of income satisfaction or family satisfaction on well-being (columns 5–8).

The main findings are as follows: First, regarding the association between actual educational difference and income satisfaction, the coefficients of actual educational difference showed negative values for wives and positive values for husbands, statistically significant at the 1% level (columns 1 and 2). For wives, the increasing value of actual educational difference is negatively associated with income satisfaction, indicating that having a husband with a lower level of education decreases her satisfaction with income. The results may be owed to the influence of gender role consciousness or gender role segregation in the family and labor market (Becker 1985; Gronau 1977). In contrast, for husbands, actual educational difference is positively associated with the likelihood of income satisfaction. The results can be explained as follows: a well-educated wife may obtain more earnings from the labor market, which may increase the overall household income. Based on the absolute income hypothesis, a husband with a well-educated wife (wife with high income) is likely to feel more satisfaction with income.

Second, for the association between actual educational difference and family satisfaction, actual educational difference is found to negatively affect wives' family satisfaction at the 1% level. Meanwhile, it is not statistically significant for husbands (columns 3 and 4). This indicates that when a wife marries a husband with a lower level of education, she is less likely to feel family satisfaction. Still, the intra-household education gap does *not* significantly influence the husband's family satisfaction.

Third, for the association between income satisfaction, family satisfaction, and well-being (life satisfaction or happiness), the coefficients of income and family satisfaction are all positive and statistically significant at 1% for both wives and husbands (columns 5–8). The results indicate that both income and family satisfaction are significantly associated with wives' and husbands' well-being.

For the two channels, it is clear that the intra-household education difference may influence both the wives' and husbands' income satisfaction, which can positively affect life satisfaction and happiness significantly. This suggests that for both wives and husbands, the influence of intra-household educational differences on well-being (life satisfaction or happiness) may be through the income satisfaction channel (intra-household educational difference-income satisfaction-well-being). The results of family satisfaction.

## 5 Conclusion

How does intra-household education gap affect the subjective well-being of wives and husbands among different areas or countries in the world? Using original cross-sectional Internet survey data from 32 countries on six continents, we investigated the impact of intra-household education gap between wives and husbands on their well-being, comparing the differences in association between the intra-household education gap and subjective well-being by different areas, countries, and educational attainment groups. The main findings are as follows:

First, both a wife and husband with a more substantial absolute intra-household educational difference report lower probabilities of life satisfaction (columns 1 and 2 in Table 2). In particular, subjective well-being is worse for a wife or husband with more years of education than their spouse, compared with the subjective well-being of other groups (a couple with an equal level of education or a wife or husband with fewer years of education than her or his spouse).

Second, the association between actual educational difference (the difference in the wife's years of education minus her husband's) and well-being differ by gender. Specifically, when the wife's education level is higher than her husband's, the wife is less likely to feel satisfied, while her husband is likely to feel more satisfied (columns 3 and 4 in Table 2). This suggests that the problem of work-family conflict may be severe for well-educated, married women.

Third, for the results of actual educational differences by different groups (Table 4), the impact of actual educational differences on well-being is much greater for both wives and husbands in Asian and non-high-income countries, and only for wives in Western and high-income countries. The impact on life satisfaction is greater for the well-educated group than for the less-educated group for both wives and husbands.

Fourth, for the two channels of impact of the intra-household education gap on well-being (Table 5), suggests that the income satisfaction channel may remain central (intra-household education difference-income satisfaction-well-being) for both wives and husbands. For wives, the impact of an intra-household education gap on well-being may be through the family satisfaction channel (intra-household education gap-family satisfaction-well-being channel), but the same is not confirmed for husbands.

Regarding policy implications; first, it is clear that the educational attainment equality of a couple may improve the well-being for both wives and husbands. In majority of developing countries (low- and medium-income countries), the education enrollment rates for primary, secondary, and tertiary schools are lower for girls than for boys (Dong et al. 2020). Even in developed countries, there also remains a gender gap in educational attainment (Riphahn and Schwientek 2015). To improve the nation's well-being, educational equality policies should be promoted in each country in the world. Second, the results indicate that the negative effect of intra-household educational difference is greater for well-educated wives, suggesting that the problem of work-family

conflict is severe for well-educated women. This may be the case because the working hours of well-educated wives may be longer and their housework hours are also longer than their husbands (Baxter and Tai 2016), referred to as “the double burden” for women. In this sense, to improve working wives’ well-being, work-life balance policies or family friendly work policies should be considered (Spagnoli et al. 2020). Third, the effects of intra-household educational differences on well-being differ by countries or areas. Although it can be explained by cultural disparities among countries, and changes in culture were shown to be small with economic growth, gender equality labor and family friendly policies are expected to influence changes in individuals’ consciousness, which may affect changes in societal culture from a long-term perspective.

We acknowledge the following limitations of this study. First, potential bias may have been caused by the survey method. We have used data from an Internet-based survey, and the samples may comprise a higher proportion of well-educated people, which may not be representative of the population. We conducted the estimation of different groups (high-education and low-education groups); however, sample selection bias may persist, which should be addressed in future surveys. Second, regarding the problem of endogeneity, the family background factors including parents’ social-economic status (i.e., parents’ education attainment, occupations, and incomes) in childhood may significantly affect the cognitive, non-cognitive, and psychological characteristics of adults (e.g., self-confidence, self-esteem), which may also affect subjective well-being; therefore, parents’ education is not considered as an appropriate instrument variable. Owing to the international cross-sectional survey data that is employed in this study, the panel data analysis methods (e.g., fixed-effects model, GMM) could not be adopted to address the problems of heterogeneity and endogeneity. An empirical study using the instrument variables method and panel data analysis methods should be employed in the future based on appropriate survey data.

## Appendix

See Tables 6, 7 and 8.

**Table 6** Definitions of indices of subjective well-being and intra-household education gap

	Variables	Content
Subjective	(1) Life satisfaction	Life satisfaction Question in the survey: "Please imagine a ladder with steps numbered 0–10 at the top. The top of the ladder represents the best possible life for you, and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time? (10= Best possible life, ... 0 = worst possible life)"
Well-Being	(2) Happiness	Question in the survey: "Overall how happy are you with your life? (5 = very happy, 4 = slightly happy, 3 = neither, 2 = slightly unhappy and 1 = very unhappy)"
Intrahousehold education gap	(2) Actual Education difference	The difference in years of education between wives and husbands (the wife's years of education minus the husband's years of education)
	(1) Absolute education difference	Absolute years of education difference between wives and husbands

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**Table 7** Country list

Country name	Obs. survey (couple)	Obs. this study	High-income country	Continent	Start time	End time
Japan	7574	6108	Yes	Asia	2015/7/14	2015/8/5
Thailand	688	631	No	Asia	2015/7/18	2015/7/23
Malaysia	628	548	No	Asia	2015/7/23	2015/7/29
Indonesia	1385	1313	No	Asia	2015/7/18	2015/7/23
Singapore	335	273	Yes	Asia	2015/7/15	2015/7/21
Vietnam	943	883	No	Asia	2015/7/18	2015/7/28
<i>The Philippines</i>	973	835	No	Asia	2015/7/15	2015/7/22
Mexico	967	839	No	North America	2015/7/24	2015/7/27
Venezuela	427	380	No	South America	2015/7/24	2015/8/5
Chile	604	517	Yes	South America	2015/7/24	2015/7/28
Brazil	1394	1116	No	South America	2015/7/23	2015/7/26
Colombia	587	523	No	South America	2015/7/24	2015/7/27
South Africa	690	557	No	Africa	2015/7/15	2015/7/23
India	3514	3097	No	Asia	2015/7/25	2015/8/11
Russia	1521	1389	No	Europe	2015/8/31	2015/9/14
China	15,777	15,259	No	Asia	2016/1/12	2016/2/29
Australia	1219	874	Yes	Australia	2016/2/10	2016/2/22
<i>The United States</i>	6376	5346	Yes	North America	2016/8/16	2016/8/28
Germany	1901	1355	Yes	Europe	2016/8/26	2016/9/7
The United Kingdom	1831	1431	Yes	Europe	2016/8/16	2016/8/28
France	1480	1035	Yes	Europe	2016/8/26	2016/9/7
Spain	1457	1215	Yes	Europe	2016/8/26	2016/9/7
Italy	1416	1133	Yes	Europe	2016/8/29	2016/9/10
Sweden	795	510	Yes	Europe	2016/8/31	2016/9/12
Canada	766	597	Yes	North America	2016/9/1	2016/9/13
<i>The Netherlands</i>	814	542	Yes	Europe	2016/8/29	2016/9/10
Greece	917	780	Yes	Europe	2016/8/31	2016/9/12
Turkey	1368	1046	No	Europe	2017/3/7	2017/3/20
Hungary	880	719	Yes	Europe	2017/3/8	2017/3/15
Poland	1482	1034	Yes	Europe	2017/3/8	2017/3/17
Czech Republic	924	763	Yes	Europe	2017/3/8	2017/3/16
Romania	971	717	No	Europe	2017/3/8	2017/3/18
Total	61,687	53,365				

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**Table 8** Results of robustness checks. Data Sources: original survey

Life satisfaction	(1) Absolute education differences		(2) Actural education differences	
	Wife	Husband	Wife	Husband
	Coeff.(S.E.)	Coeff.(S.E.)	Coeff.(S.E.)	Coeff.(S.E.)
OLS	- 0.015*** (0.005)	- 0.016*** (0.004)	- 0.034*** (0.004)	0.024*** (0.004)
Ordered Logit	- 0.019*** (0.006)	- 0.015*** (0.005)	- 0.040*** (0.005)	0.026*** (0.004)
Probit	- 0.025*** (0.006)	- 0.012** (0.005)	- 0.036*** (0.005)	0.026*** (0.005)
Logit	- 0.015*** (0.004)	- 0.007** (0.003)	- 0.022*** (0.003)	0.016*** (0.003)

White-robust standard errors are in parentheses. \*\*\* $p < 0.01$ . The life satisfaction applied in probit model and logit model is dummy variable life satisfaction (upper three highest level of 11 = 1, other = 0)

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**Data Availability** The data is available upon reasonable requirement.

**Declarations**

**Conflict of interest** The authors declares that they have no conflict of interest.

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