Social Relationships and Suicide in Comparative Perspective:

A New Look at Durkheim's Old Inquiry

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Abstract

As social connectedness has become widely acknowledged as a significant factor in suicide, this study takes a step further to investigate contextual influences on the link between social integration and suicide. Using multilevel models and data from the WHO Mortality Database and the World Values Survey (1981-2007), the study examines the effects of marital and intergenerational relationships, religious participation, general trust, and confidence in major organizations on suicide rates across 7 regions of the world (East Asia, English-speaking countries, Latin America, and Northern, Western, Southern, and Eastern Europe). The findings demonstrate that these social relationships are differentially associated with suicide rates across regions: while they are protective against suicide in some regions, they may be ineffective or even harmful in other regions. For example, divorce and separation predict higher risk of suicide only in East Asia, and Southern, Western, and Eastern Europe. Parenthood (represented by the number of children) is only protective in Latin American, English-speaking countries, and Northern and Eastern Europe. Moreover, while religious participation shows very strong protective effects in Latin America, it is related to elevated suicide rates in East Asia and Southern and Western Europe. Overall, the findings reflect the cultural and institutional impact on the association between social integration and suicide. The study implies that interventions that accommodate local values, norms, and institutions are required for suicide prevention. Accordingly, more complex theories that incorporate dimensions of social context will advance the sociology of suicide.

Introduction

Suicide is one of the crucial indicators of health and well-being. According to the WHO, it is among the top twenty leading causes of death for all ages worldwide, and among the three leading causes of death for people aged 15-44 in some countries (World Health Organization 2012). Not only is suicide linked to individuals' psychological and biological health, but it is also a product of social and cultural conditions. Sociological research, which has been greatly influenced by Durkheim's theory on solidarity, emphasizes that disrupted social relationships are important risk factors for suicide (Durkheim 1897; Wray, Colen, and Pescosolido 2011). In particular, Durkheimian studies argue that maintaining social ties, such as being married, having children, and belonging to a religious community, provide social support and social control that prevent individuals from committing suicide.

Although social integration/cohesion has been recognized as an important determinant of suicide, few studies have examined whether it contributes to the wide variation of suicide risk across regions and countries. In particular, the WHO Map of Suicide Rates suggests that the level of suicide rates demonstrates a regional pattern; for example, East Asian and Eastern European countries tend to have higher suicide rates, and Latin American countries tend to show lower suicide rates (World Health Organization 2012). However, little is known about whether this regional suicide pattern is linked to differences in the level of social integration. It is likely that societies with more cohesive social relationships, such as higher rates of religious participation, have lower risks of suicide. Moreover, few studies have investigated the effects of social ties on suicide risk across societies. Due to differences in cultural and institutional practices, such as social acceptability of marital dissolution, expectation of elderly care provided by adult children, and state welfare regimes, societies may benefit from integrated relationships

unequally. For example, living with parents may be more strongly associated with lower suicide rates in places where elderly care is not institutionalized by the government or where co-residence with elder parents is culturally expected. Because the majority of previous research on suicide and social cohesion focuses on a single context or a set of contexts with relatively similar cultural or institutional backgrounds, particularly in Western Europe and North America, how social contexts shape the influences of social integration on suicide risk has been rarely discussed.

This paper examines the association between social relationships and suicide rates across 7 regions of the world, including East Asia, English-speaking countries, Latin America, and Northern, Western, Southern, and Eastern Europe. The study investigates how much the "protective" effects of social ties against suicide vary across regions and whether levels of social cohesion explain the regional differences in suicide rates. By examining marital relationship, intergenerational relationship, religious participation, general social trust, and confidence in major organizations, the study reassesses Durkheim's theory on social cohesion and suicide through a global lens. It argues that not all types of cohesive social relationships are related to lower risk of self-inflicted deaths in all contexts, and that institutional and cultural practices shape the link between social relationships and suicide.

Social Relationships and Suicide

Sociological research on suicide that follows Durkheim's tradition argues that cohesive social relationships reduce risk of suicide through two major mechanisms: social integration and social regulation (Wray, Colen, and Pescosolido 2011). Integration provides a sense of belonging and sources of emotional and instrumental support that enhance mental well-being; regulation provides guidance and monitoring that retrain deviant behavior (Berkman and Glass 2000; House,

Umberson, and Landis 1988; Van Tubergen, Grotenhuis, and Ultee 2005). According to Durkheim (1897), suicide rates are the lowest when social ties are moderately integrated and regulated.

In order to test and elaborate Durkheim's theory, many studies have examined the association between social relationships and suicide in contemporary societies. The majority of these studies focus on marital dissolution and religious affiliation. Overall, findings are mixed and demonstrate geographical or temporal variation in the effects of social ties. In particular, while some studies indicate that divorce and separation are positively related to suicide rates (Cutler, Glaeser, and Norberg 2001; Gunnell et al. 2003; Luoma and Pearson 2002; Messner et al. 2006; Phillips et al. 2002), others argue that the effects of marital dissolution are not significant (Kposowa, Breault, and Singh 1995; Norström 1995). Moreover, studies suggest that whether divorce encourages suicide ideation or attempt may depend on the prevalence of divorce in a region or period (Pampel 1998; Stack 1990). As divorce becomes more common and socially accepted, the gap of suicide rates between the divorced and the married narrows. In other words, the harmful effects of marital dissolution on suicide may be attenuated in contexts where divorced individuals are less stigmatized.

Similarly, the religion-suicide association is also contingent on local contexts. Although the protective effects of religious affiliation against suicide are richly documented (Duberstein et al. 2004; Neeleman and Lewis 1999; Stack and Kposowa 2011; Van Tubergen, Grotenhuis, and Ultee 2005), the strength and direction of the effects varies. For example, the availability of religiously similar individuals in local areas defines the protectiveness of a religion, whether it is Catholicism, Protestantism, or Judaism (Ellison, Burr, and McCall 1997; Pescosolido 1990; Pescosolido and Georgianna 1989; Wray, Colen, and Pescosolido 2011). Even Catholicism,

which is historically well-known for its strong protection against suicide, can be related to elevated suicide rates in the American South because the region lacks an integrated community for Catholics (Pescosolido 1990). Consistently, religious homogeneity is found to be associated with reduced suicide rates (Ellison, Burr, and McCall 1997). Overall, the key issue is not whether individuals formally identify themselves as a believer but whether they (can) actively involve in a religious community that provides them with strong social support and regulation.

In addition to marital dissolution and religious participation, a few studies have also shown that other types of relationships, such as familial integration, friendship, and general trust are negatively associated with suicide risk. Specifically, parenthood reduces suicide rates especially for women. Among married women, the number of children is related to lower suicide rates, independent of socioeconomic status (Hoyer and Lund 1993). Further, married women who commit suicide tend to do so later than their male counterparts (Cantor and Slater 1995). It is likely that women are protected against intentional self-inflicted deaths by their greater responsibilities for childcare and their closer ties to children. Moreover, friends provide another source of social support that may enhance mental health and lower suicide risk. Having more friends is associated with fewer depressive symptoms (Ueno 2005). Consistently, isolation from friends and a friendship network of lower density (i.e., one's friends are not friends with each other) are both linked to more suicide thoughts (Bearman and Moody 2004). Lastly, general trust or perception that most people can be trusted, an indicator of cohesion between individuals and society as a whole, is also associated with lower suicide rates (Helliwell 2006).

By and large, cohesive relationships seem to predict lower risk of suicide. However, the strength of this association also depends on the broader cultural and institutional setting. While a few studies have explored the variation in the "protective" effects of social ties across social

contexts (with respect to marital dissolution and religious affiliation in particular), more research in this direction is required to further understand how social connectedness or integration is linked to suicide risk in different contexts. This study examines social relationships and suicide rates across regions of the world, and three hypotheses are tested as follows.

Hypotheses

H1. In general, well-integrated social relationships are associated with lower risk of suicide.

H2. Although the global effects of social relationships are protective against suicide as described in H1, the effects vary significantly across regions of the world.

H3. The level of social integration (e.g., % being currently divorced or separated) partially explains the differences in suicide rates across regions.

Data and Methods

Data

The data come from three different sources. Age-sex-specific suicide rates (dependent variable) for people aged 15 and above are obtained from the WHO Mortality Database[1]. In most cases, a country has 14 observations of suicide rates for a year (2 sexes x 7 age groups[2]). The variables of social relationships come from the World Values Survey. Because the World Values Survey (WVS) collects individual-level data, I calculate the mean of each relationship variable for every age-sex group so that the information of social relationships can be linked to suicide rates at the same level of analysis. In addition, data of the country-level control variable, GDP per capita, are collected from the World DataBank.

[1] The only exception is that the age-sex-specific suicide rates in Taiwan come from the Department of Health, Executive Yuan, Taiwan.

[2] Age groups are defined as follows: 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, and 75 and above.

The study includes 42 countries from 7 regions of the world[3]: East Asia (Hong Kong, Japan, Singapore, South Korea, Taiwan), English-speaking countries (Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States), Latin America (Argentina, Brazil, Chile, Colombia, Mexico, Peru, Uruguay, and Venezuela), Northern Europe (Denmark, Finland, Norway, and Sweden), Western Europe (Austria, Belgium, France, Germany, and the Netherlands), Southern Europe (Bulgaria, Croatia, Greece, Italy, Macedonia, Portugal, and Spain), and Eastern Europe (Czech, Hungary, Moldova, Poland, Romania, Slovakia, Slovenia). Overall, the period of study spans from 1981 to 2006. However, because the countries participated in the World Values Survey at different points in time, as well as for an unequal number of times[4], the years and the number of observations vary across countries. On average, each country participated in 3 WVS surveys throughout the period (see Appendix). The final sample includes 1,687 observations of age-sex groups across countries and years.

Statistical Approach

I first use OLS linear regression to test whether social integration is negatively related to suicide rates in general (H1). The OLS regression models assume that the effects of social relationships on suicide are the same across regions of the world. This assumption that all social relationships are equally "protective" against suicide, however, may not be reasonable. Given that values, norms, and institutions vary widely across social contexts, the beneficial effects of social integration may be significantly different by region. To address this concern, I then use multilevel linear regression with random-slope specification to test the Hypotheses 2 and 3. The random-slope models allow coefficient estimates to vary across regions. Therefore, these models

[3] The major criterion for country selection is the availability of complete data of both suicide and social relationships.
[4] The World Values Survey conducted four waves of data collection during the period: 1981-1984, 1989-1993, 1994-1998, 1999-2004, and 2005-2007.

are able to test whether the direction and magnitude of the association between social relationships and suicide differ from region to region (H2). Further, I use the same models to test whether the level of social integration explains some of the regional differences in suicide rates (H3).

The random-slope models have two levels, with age-sex groups (the lower level) nested in seven world regions (the higher level). I use region instead of country as the higher level of analysis for several reasons. First, the between-region variance in suicide rates accounts for a significant proportion of the between-country variance in suicide rates. When the regional difference is not controlled for, the between-country variance is 0.3991; in contrast, when the regional difference is controlled for, the between-country variance is reduced to 0.1261 (a reduction by 68%). As Figure 1 shows, the trend of age-standardized suicide rates is not only stable throughout the past three decades in most countries (exceptions include Austria, Finland, Hungary, Slovenia, South Korea, and Taiwan), but also clustered by region. In particular, countries of the same region (in the same color) tend to sit closer to one another in the figure. Finally, region as an analytical level is much more statistically powerful than country simply because a region contains more age-sex-specific observations ($125 \leq n \leq 349$) than a country does ($14 \leq n \leq 84$). For the above reasons, region rather than country is used as the higher level of analysis in the multilevel linear regression.

Variables

Suicide rates are measured by the number of deaths resulted from intentional self-harm per 100,000 person-years (approximated by per 100,000 mid-year population). The rates are calculated by country, year, sex, and age group. According to the International Classification of

Diseases (ICD), deaths caused by intentional self-harm include, for example, self-inflicted and intentional poisoning, hanging, drowning, firearm discharge, jumping from a high place, and crashing of motor vehicle; these causes of death are coded as X60-X84 in the ICD 10th revision and as E950-E959 in the ICD 9th revision. Previous studies argue that official suicide statistics suffer from the misclassification and underreport of suicide deaths (Douglas 1967; Kapusta et al. 2011; Pescosolido and Mendelsohn 1986; Timmermans 2005; Whitt 2006). In particular, deaths of intentional self-harm may be the most likely to be misclassified as deaths of injury with undetermined intent, unintentional poisoning, and unintentional drowning (O'Carroll 1989; Rockett 2010; Rockett and Thomas 1999; Värnik et al. 2010). Because the extent of misreporting may depend on cultural and institutional factors, such as the stigma toward suicide, resources for forensic death investigations, and the adoption of a coronial or medico-legal system (Douglas 1967; Kapusta et al. 2011; Timmermans 2005; Whitt 2006; Värnik et al. 2010), the undercount of suicide deaths could significantly bias the interpretation of results, especially those from comparative research such as the current study. To address this concern, I conduct a sensitivity analysis that incorporates death rates of injury with undetermined intent, unintentional poisoning, and unintentional drowning.

Social relationships, from the strongest to the weakest social ties, are examined in this study. Frist, marital relationship represents the most inner layer of relational structure. I use *the percentage of people currently divorced or separated* (in a age-sex group) to measure the strength of this intimate relationship. Further, intergenerational relationships stand for the next layer of social connection. They are measured by two variables: *the number of children and the percentage of people living with parents*. Moreover, religious participation may provide additional social support and social regulation outside the circle of family. I use *the percentage*

of people attending religious services at least once a month to measure this type of social integration. Lastly, trust in people and confidence in major organizations indicate the relationship between individuals and the society as a whole. They represent the weakest type of social connection that shapes the outer layer of network structure. They are measured by two variables: *the percentage of people reporting that most people can be trusted* and *the number of organizations in which people have a great deal of confidence*, including churches, armed forces, the press, labor unions, the police, the parliament, civil services, the government, political parties, major companies, and the justice system.

All the regression analyses in this study control for sex, age group, time trend, the version of the International Classification of Diseases (ICD), and GDP per capita.

Results

Descriptive Statistics

Both suicide rates and social relationships vary significantly across world regions (Table 1). Overall, Eastern Europe has the highest suicide rates, followed by East Asia, Western Europe, Northern Europe, Southern Europe, English-speaking countries, and finally Latin America. Regional difference is significant: the suicide rate in Eastern Europe is about 3 times higher than that in Latin America. Moreover, the level of social integration and cohesion, represented by marital dissolution, number of children, co-residence with parents, religious participation, trust, and confidence in organizations, also varies significantly from region to region. In particular, East Asians are the least likely to be currently divorced or separated (2.42%); in contrast, Northern Europeans are the most likely to be in this marital status (8.23%). On average, Latin Americans have a higher number of children (2.66 persons), especially when compared to

Northern Europeans (1.67 persons). In addition, co-residence with parents is quite common in East Asia (31.24%); however, the prevalence in Northern Europe (8.38%) is relatively low. Also, regular attendance at religious services is much more prevalent in Latin American (55.82%) than in Northern Europe (12.75%); on the contrary, the majority of Northern Europeans express trust in most people (61.98%), whereas only a minority of people in Latin America does so (17.73%). Finally, although people across all these regions generally show very low confidence in the organizations, the regional variation is still statistically significant: Latin Americans report 1.44 organizations in which they have great confidence; in contrast, East Asians only report 0.47 organizations.

Because social relationships are not consistently more or less integrated in one region than another, it is indeed difficult to tell whether cohesive relationships are negatively associated with suicide rates by glancing over the descriptive statistics. However, the statistics seem to demonstrate that social integration is established on different types of relationships across region, and that people in all these regions are integrated by at least one or two types of relationships. Specifically, East Asians and Southern Europeans do relatively well on marital and intergenerational relationships (particularly in terms of co-residence with parents); people from English-speaking countries have relative strengths in parenthood, religious communities, and trust; Latin Americans maintain the strongest connection through religious communities and parenthood; Northern Europeans show their advantage in general trust. Finally, while Western and Eastern Europeans do not have strengths in particular social ties, neither do they show obvious weaknesses.

[Table 1 about here]

OLS Linear Regression

The OLS regression models support the Hypothesis 1: well-integrated social relationships are generally associated with lower risk of suicide (Table 2). First, the baseline model demonstrates that East Asia, the reference region, has higher suicide rates than all the other regions except Eastern Europe when the control variables are held constant (Model 1). In particular, the suicide rate in Latin America is only 32% (i.e., exp(-1.13)) of the suicide rate in East Asia. The suicide rates in Southern Europe, English-speaking countries, Northern Europe, and Western Europe are 37%, 56%, 81%, and 84% of the rate in East Asia, respectively. Furthermore, maintaining well-integrated relationships predicts lower suicide rates. Specifically, an increase in divorce and separation rates by 1 percentage point is related to a 0.6% (i.e., 1-exp(0.004)) increase in suicide rates (Model 2). Also, having one more child is associated with an 24% (i.e., 1-exp(-0.203)) decrease in suicide rates (Model 3). Similarly, living with parents, attending religious services on a regular basis, trusting people, and having great confidence in major organizations are all significantly related to lower suicide rates (Models 4-7). This pattern persists when the social relationship variables are examined altogether in a single model, except that the effects of marital dissolution and confidence in organizations turn insignificant (Model 9).

In summary, the OLS models suggest that marital and intergenerational relationships, participation in religious communities, trust in people, and confidence in major organizations are all protective against suicide. However, these models assume that the protective effects of social integration are the same across regions of the world. In fact, this assumption may be unjustified if a region benefits from certain social relationships more than another. Therefore, in the following section, I use multilevel linear regression that relaxes the assumption to test the variant

effects of integrated relationships on suicide across regions.

[Table 2 about here]

Multilevel Linear Regression: Random-Slope Models

As the Hypothesis 2 predicts, the random-slope models indicate that all the social relationships examined in this study are differentially associated with suicide rates by region. In particular, the marginal effects of social relationship variables vary widely across regions: This is shown by that the standard deviations of the marginal effects are all significantly different from zero (Table 3). Figures 2(a)-(f) further demonstrate the marginal effects across region, ranked by their average magnitude. Specifically, marital dissolution is positively related to suicide rates in only four out of the seven regions: East Asia, Southern Europe, Western Europe, and Eastern Europe (Figure 2a). Surprisingly, it has negative effects on suicide in Northern Europe, Latin America, and English-speaking countries. Further, parenthood is also unequally protective against suicide across regions (Figure 2b). Although having more children is related to lower suicide rates in Latin America, English-speaking countries, Northern Europe, and Eastern Europe, this relationship is not significant in Western Europe, East Asia, and Southern Europe. In addition, co-residence with parents is more effective in lowering suicide rates in East Asia and Eastern, Western, and Southern Europe than in Northern Europe, Latin America, and English-speaking countries (Figure 2c).

Moreover, the effects of religious participation on suicide rates also vary widely across regions (Figure 2d). Frequent attendance at religious services shows a much stronger protective effect in Latin America than in any other regions. In contrast, involvement in religious activities does not seem protective in East Asia, Southern Europe, and Western Europe: It is actually

associated with a higher risk of suicide. Lastly, while trust in people is mostly related to lower suicide rates in most regions, the association is significant only in Western and Southern Europe and East Asia (Figure 2e). Also, confidence in organizations is protective against suicide in English-speaking countries, Northern Europe, Latin America, and Eastern Europe, but it demonstrates positive (i.e., harmful) effects in Southern Europe, East Asia, and Western Europe (Figure 2f).

[Table 3 about here]

[Figures 2(a)-(f) about here]

The random-slope models not only indicate that the association between social relationships and suicide differs by region, but also suggest that the level of social integration explains some of the regional variation in suicide rates (as described in Hypothesis 3). In particular, when the number of children is held constant at the sample mean, differences in suicide rates between East Asia and Latin America become significantly smaller (this can be seen by comparing Model 3 with Model 1 in Table 4). Because number of children is negatively related to suicide rates in Latin America but it has no significant effects in East Asia (see Figure 2b), and because Latin Americans have more children than the sample average (in contrast, the number of children that East Asians have is close to the average) (see Table 1), controlling for the number of children deteriorates suicide rates in Latin America relative to East Asia. Therefore, the suicide gap between these regions narrows, which suggests that number of children explains some of the regional differences in suicide rates. Further, the prevalence of living with parents also partially drives the regional variation in suicide rates. In fact, co-residence with parents suppresses the suicide disparity between East Asia and all the other regions, particularly Northern and Western Europe (this is shown by comparing Model 4 with

Model 1 in Table 4). Holding the co-residence rates constant across these regions at the sample mean widens their suicide disparities. This is because living with parents is much more common in East Asia than in Northern Europe and Western Europe (see Table 1). If co-residence were not as prevalent in East Asia as its current level and if it were not as uncommon in Northern and Western Europe as it is, suicide rates would be even higher in East Asia and lower in Northern and Western Europe.

Moreover, the frequency of religious participation is another contributor to the differences in suicide rates. When the percentage of people attending religious services at least once a month is held constant, the suicide gap between East Asia and Latin America narrows significantly (this is demonstrated by comparing Model 6 with Model 1 in Table 4). This change can be attributed to both the prevalence of religious participation and the direction of religious effects on suicide. In particular, the percentage of people attending religious services is lower than average in East Asia but higher than average in Latin America by roughly the same margin (Table 1). Additionally, religious participation has only a moderate positive effect on suicide in East Asia, whereas it has a much stronger negative effect in Latin America (Figure 2d). As a result, when the people of attending services is held constant at the sample mean, suicide rates rise in both regions, with a relatively moderate increase in East Asia but a more dramatic increase in Latin American. In turn, the suicide gap between these two regions narrows. Following a similar logic, the suicide gap between East Asia and Northern Europe becomes wider when the percentage of people participating in religious services is held constant (this is demonstrated by comparing Model 6 with Model 1 in Table 4). Specifically, the percentage of people frequently attending religious services in both East Asia and Northern Europe is lower than the average (Table 1). At the same time, religious participation has a positive relationship

with suicide in East Asia whereas a negative relationship with suicide in Northern Europe (Figure 2d). Therefore, as the percentage of people attending services is held constant at the sample mean, suicide rates rise in East Asia but fall in Northern Europe. In turn, the suicide gap between these regions grows. Finally, when the percentage of people reporting most people can be trusted is held constant, the difference in suicide rates between East Asia and Northern Europe is diminished (this can be seen by comparing Model 7 with Model 1 in Table 4). This suggests that the level of trust among people may also provide some explanation for the suicide gap between these regions.

[Table 4 about here]

Sensitivity Analysis

Since suicide deaths are likely to be undercounted non-randomly (e.g., the extent of undercounting varies across social contexts and time periods), official suicide statistics may just be artifacts lacking value of theorization and policy implications; in particular, findings based on official rates may mask the real protective and risk factors for suicide. To address this concern, I incorporate the death rates of three common equivocal categories with suicide rates; these categories of cause of death include injury with undetermined intent, unintentional poisoning, and unintentional drowning. I re-estimate the multilevel regression models using the "adjusted" suicide rates.

Table 5 compares suicide rates with three kinds of "adjusted" rates across regions. It shows that the death rates of injury with undetermined intent do not add much to suicide rates except in Latin America. Particularly, in most regions the death rates of injury with undetermined intent range from 2 to 5 deaths per 100,000; only in Latin American these rates are

exceptionally high, reaching more than 13 deaths per 100,000. It is therefore more likely that real suicide deaths are hidden in the death category of injury with undetermined intent in Latin America. Moreover, the death rates of unintentional poisoning and drowning are higher in Eastern and Northern Europe than other regions. Assuming that all these deaths are hidden suicide, the "adjusted" suicide rates would increase by 9 and 11 deaths per 100,000 in Eastern Europe and Northern Europe, respectively; in contrast, the "adjusted" rates only increase by 2-5 deaths per 100,000 in the other regions. Finally, when all the death rates of injury with undetermined intent, unintentional poisoning, and unintentional drowning are incorporated into suicide rates, the ranking of suicide rates shifts. The most notable change is that Latin America no longer has the lowest level of suicide rates; its "adjusted" rates are higher than those in English-speaking countries and Southern Europe. Additionally, Northern Europe and Western Europe switch their ranks after the adjustment.

[Table 5 about here]

There are several changes in the results of multilevel regression models. However, most changes are moderate and do not overturn the earlier findings. Specifically, the marginal effects of divorce and separation maintain the same regional ranking as before (see Figure 2a) even though the effects are slightly attenuated for English-speaking countries, Latin America, and Northern Europe (Figure 3a). Regarding the number of children, its marginal effects on suicide for Eastern Europe were significantly negative, but they have turned insignificantly positive (Figures 2b & 3b). In addition, the regional ranking for the marginal effects of co-residence with parents remains roughly the same although the effects in Latin America and English-speaking countries change from being insignificantly negative to insignificantly positive (Figures 2c & 3c). Similarly, the beneficial effects of religious participation are attenuated, particularly for Latin

America; however, the regional ranking is generally the same as before (Figures 2d & 3d). Further, the beneficial effects of trust become statistically significant for English-speaking countries and East Asia though the direction and magnitude of the effects for these regions remains similar as before (Figures 2e & 3e). Finally, the effects of confidence in organizations across regions do not change significantly except that the effects for Latin America turn significantly positive from significantly negative and that the effects for Eastern Europe become insignificant (Figures 2f & 3f).

In summary, when suicide rates are considered together with the death rates of injury with undetermined intent, unintentional poisoning, and unintentional drowning, there are only limited changes in the association between social integration and suicide. Indeed, the changes are mostly moderate attenuation of the beneficial effects of social relationships, and they often do not shift the regional ranking on the effects. Among all the regions, Latin America seems to have the most significant changes, particularly in the effects of divorce and separation, religious participation, and confidence in organizations. These shifts in Latin America may reflect its exceptionally high death rates of injury with undetermined intent as described earlier, which perhaps include some misclassified suicide cases. Nevertheless, the overall changes found in the sensitivity analysis do not alter the major conclusion that social relationships are differentially associated with suicide rates across regions of the world.

[Figures 3(a)-(f) about here]

Discussion

In progress…

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Table 1: Descriptive statistics of suicide rates and social relationships by region

	Range	Overall	East Asia	English-speaking	Latin America	Northern Europe	Western Europe	Southern Europe	Eastern Europe
Suicide rates (per 100,000)	0.4-176.9	19.1	25.6	14.3	9.6	21.5	23.4	15.4	27.7
% Being currently divorced or separated	0-100	5.4	2.4	6.7	6.8	8.2	5.8	3.0	4.7
Number of children	0-6.5	2.0	2.0	2.2	2.7	1.7	1.8	1.8	1.8
% Living with parents	0-100	20.0	31.2	14.9	23.5	8.4	14.2	25.3	20.9
% Attending religious services at least once a month	0-100	38.5	22.6	46.3	55.8	12.7	29.6	39.4	40.7
% Reporting most people can be trusted	0-100	31.0	33.8	43.3	17.7	62.0	33.7	25.4	21.4
Number of organizations in which people have a great deal of confidence	0-11	1.0	0.5	1.3	1.4	0.8	0.6	0.9	0.9
N (sample size)	---	1687	125	238	307	166	210	292	349

Note: The range refers to the minimum and maximum possible values at the level of age-sex-country group. All the variables are different across regions at the 1% significance level according to the non-parametric Kruskal Wallis test.

Table 2: OLS linear regression of logged suicide rates on social relationships

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Region (Ref: East Asia)								
English-speaking countries	-0.581**	-0.599**	-0.517**	-0.667**	-0.443**	-0.537**	-0.490**	-0.421**
	(0.049)	(0.050)	(0.048)	(0.049)	(0.050)	(0.050)	(0.053)	(0.054)
Latin America	-1.132**	-1.158**	-0.982**	-1.190**	-0.892**	-1.199**	-1.034**	-0.952**
	(0.067)	(0.068)	(0.066)	(0.066)	(0.069)	(0.068)	(0.070)	(0.072)
Northern Europe	-0.172**	-0.196**	-0.242**	-0.333**	-0.239**	-0.036	-0.123*	-0.214**
	(0.060)	(0.062)	(0.058)	(0.062)	(0.059)	(0.069)	(0.061)	(0.069)
Western Europe	-0.208**	-0.217**	-0.258**	-0.307**	-0.166**	-0.223**	-0.198**	-0.330**
	(0.049)	(0.050)	(0.048)	(0.050)	(0.048)	(0.049)	(0.049)	(0.048)
Southern Europe	-1.000**	-0.998**	-1.050**	-1.030**	-0.847**	-1.043**	-0.960**	-1.018**
	(0.059)	(0.059)	(0.057)	(0.058)	(0.060)	(0.060)	(0.060)	(0.058)
Eastern Europe	-0.001	-0.014	-0.116+	-0.068	0.108+	-0.046	0.027	-0.140*
	(0.063)	(0.064)	(0.062)	(0.063)	(0.062)	(0.064)	(0.063)	(0.063)
% Divorced or separated		0.006+						-0.003
		(0.003)						(0.003)
Number of children			-0.273**					-0.236**
			(0.024)					(0.024)
% Living with parents				-0.009**				-0.008**
				(0.001)				(0.001)
% Attending religious services at least once a month					-0.007**			-0.005**
					(0.001)			(0.001)
% Reporting most people can be trusted						-0.005**		-0.008**
						(0.001)		(0.001)
Number of organizations in which people has a great deal of confidence							-0.130**	-0.014
							(0.031)	(0.031)
Constant	1.819**	1.864**	1.519**	2.376**	1.743**	1.854**	1.778**	2.045**
	(0.071)	(0.075)	(0.073)	(0.099)	(0.069)	(0.071)	(0.071)	(0.099)
R-squared	0.724	0.724	0.743	0.734	0.739	0.726	0.727	0.765

+p<0.1, *p<0.05, **p<0.01. Standard errors are in parentheses. All the models control for age, sex, time trend, ICD version, and GDP per capita.

Table 3: Standard deviations of the marginal effects of social relationships across regions (random-slope models)

Variable	S.D. Estimate	S.E.	p value
% Being currently divorced or separated	0.010	0.003	<0.001
Number of children	0.152	0.043	<0.001
% Living with parents	0.005	0.001	<0.001
% Attending religious services at least once a month	0.011	0.004	0.002
% Reporting most people can be trusted	0.006	0.002	0.004
Number of organizations in which people has a great deal of confidence	0.265	0.082	0.001

Table 4: Social relationships accounting for regional differences in logged suicide rates (random-slope models)

	Model 1	Model 2	Model 3	Model 4	Model 6	Model 7	Model 8
Region (Ref: East Asia)	Basic	Basic + Marital dissolution	Basic + Number of children	Basic + Coresidence with parents	Basic + Religious participation	Basic + Trust	Basic + Confidence
English-speaking countries	-0.581**	-0.624**	-0.504**	-0.633**	-0.583**	-0.569**	-0.629**
	(0.049)	(0.047)	(0.045)	(0.049)	(0.048)	(0.061)	(0.068)
Latin America	-1.132**	-1.176**	-0.878**	-1.231**	-0.650**	-1.113**	-1.186**
	(0.066)	(0.064)	(0.062)	(0.065)	(0.069)	(0.074)	(0.083)
Northern Europe	-0.172**	-0.249**	-0.257**	-0.325**	-0.552**	-0.169	-0.321**
	(0.060)	(0.058)	(0.057)	(0.067)	(0.123)	(0.114)	(0.077)
Western Europe	-0.208**	-0.280**	-0.206**	-0.341**	-0.202**	-0.201**	-0.162**
	(0.049)	(0.047)	(0.045)	(0.050)	(0.048)	(0.050)	(0.061)
Southern Europe	-1.000**	-1.033**	-0.990**	-1.039**	-1.055**	-1.064**	-1.087**
	(0.059)	(0.057)	(0.054)	(0.058)	(0.058)	(0.061)	(0.076)
Eastern Europe	-0.001	-0.058	-0.036	-0.079	-0.087	-0.037	-0.127
	(0.063)	(0.061)	(0.060)	(0.062)	(0.061)	(0.068)	(0.078)

*p<0.05, **p<0.01. Standard errors are in parentheses. All the models control for age, sex, time trend, the ICD version, and GDP per capita.

Table 5: Death rates of suicide, injury with undetermined intent, and unintentional poisoning and drowning by region (deaths per 100,000)

	Overall	East Asia	English-speaking	Latin America	Northern Europe	Western Europe	Southern Europe	Eastern Europe
Suicide rates	19.1	25.6	14.3	9.6	21.5	23.4	15.4	27.7
Suicide rates + death rates of injury with undetermined intent	24.4	30.0	16.3	22.9	24.6	26.2	17.9	33.3
Suicide rates + death rates of unintentional poisoning and drowning	24.9	31.5	18.1	13.6	30.4	25.8	19.5	38.5
Suicide rates + death rates of injury with undetermined intent, unintentional poisoning, and unintentional drowning	30.2	35.9	20.2	26.9	33.6	28.5	22.0	44.2
N (sample size)	1687	125	238	307	166	210	292	349

Figure 1: Trend of suicide rates by country, 1979-2010

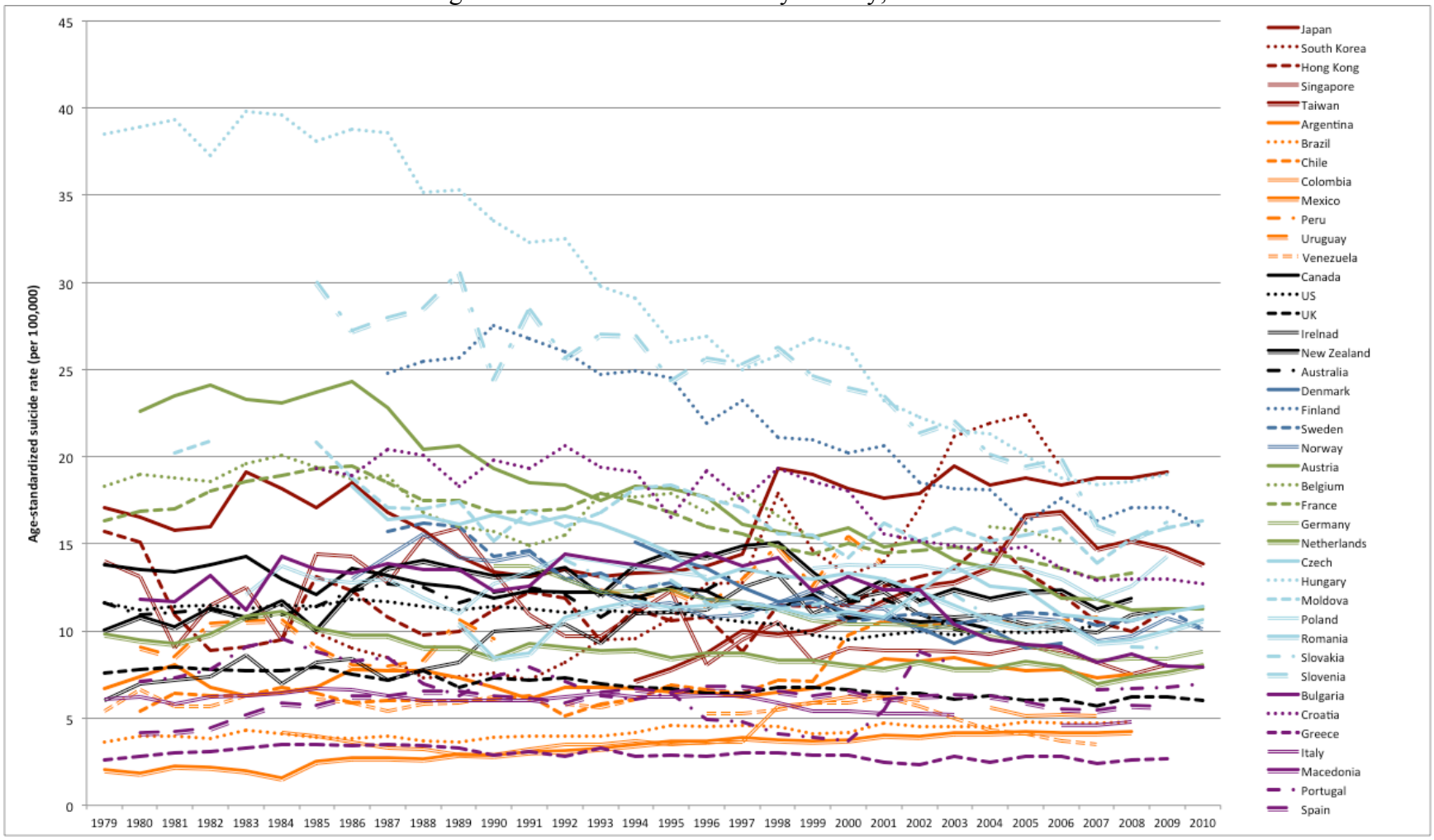


Figure 2(a)-(f): Marginal effects of social relationships on logged suicide rates

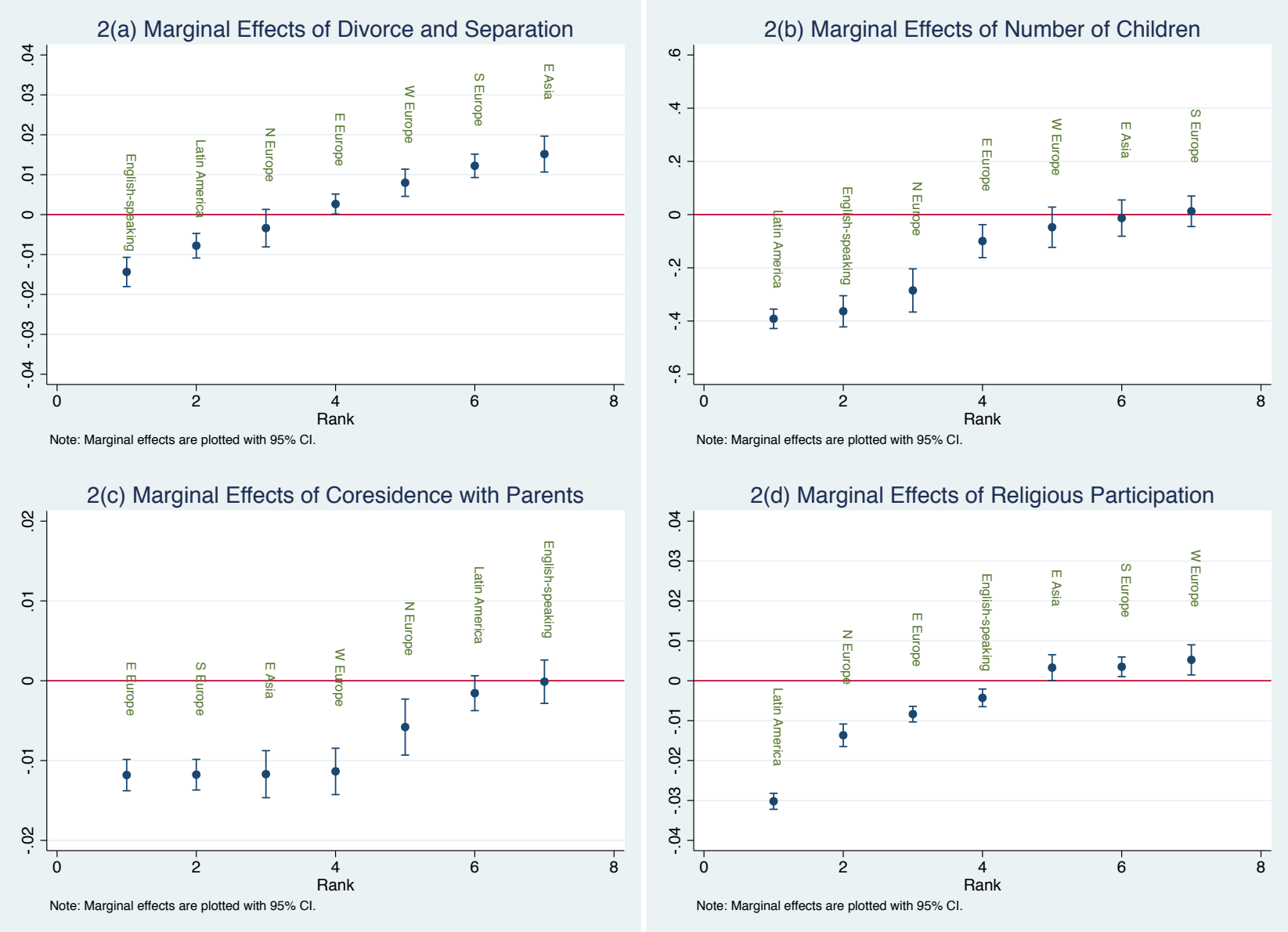
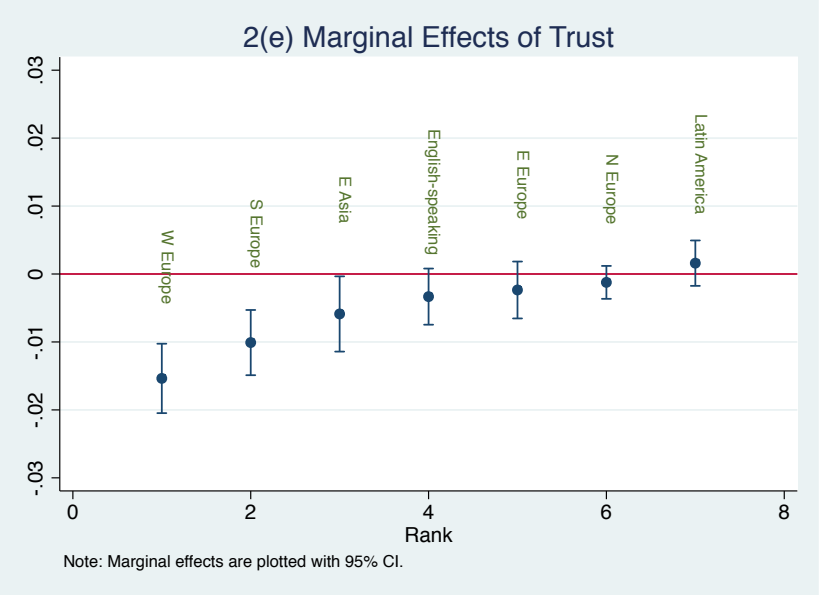
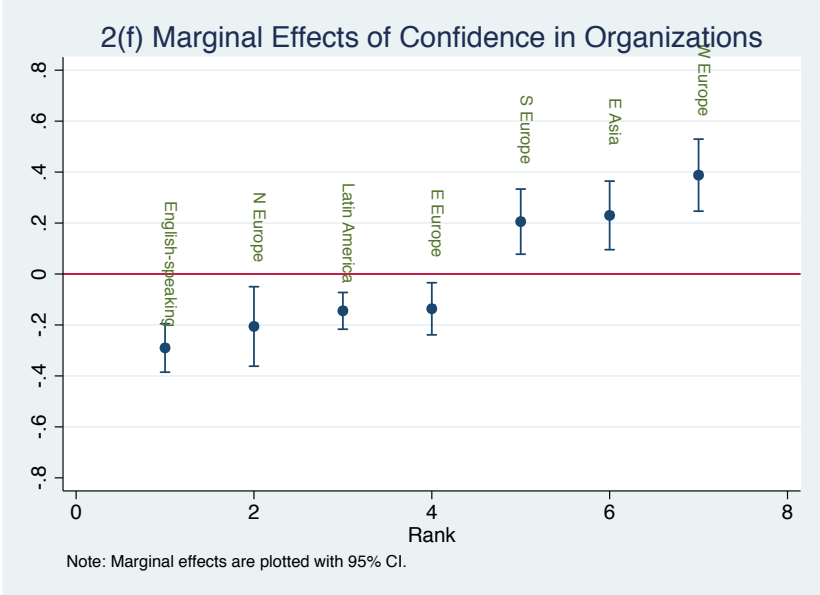


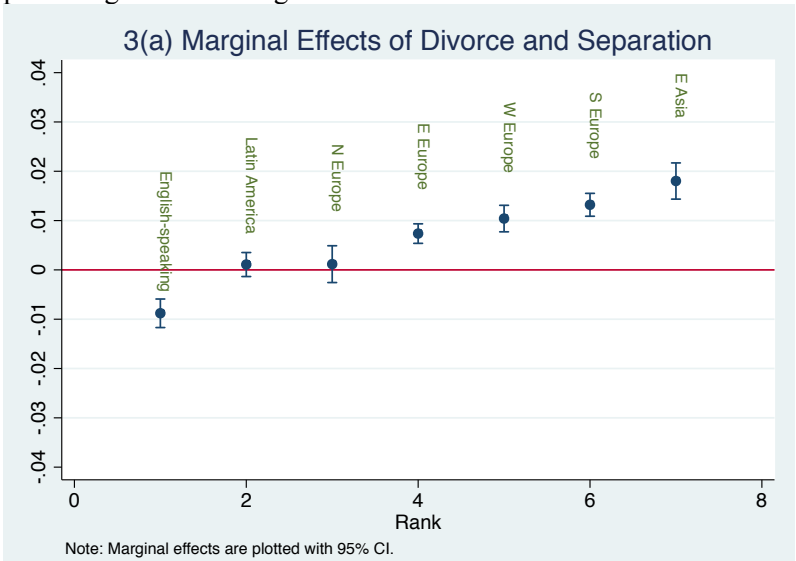
Figure 2(a)-(f) continued: Marginal effects of social relationships on logged suicide rates

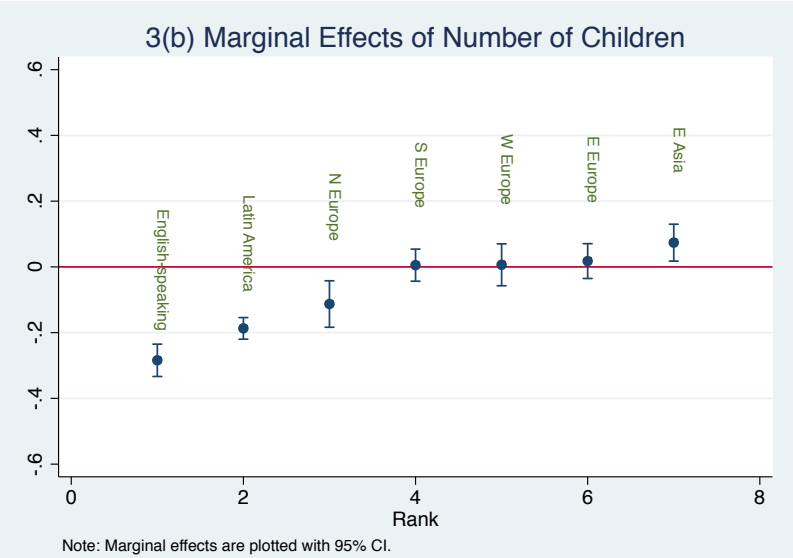


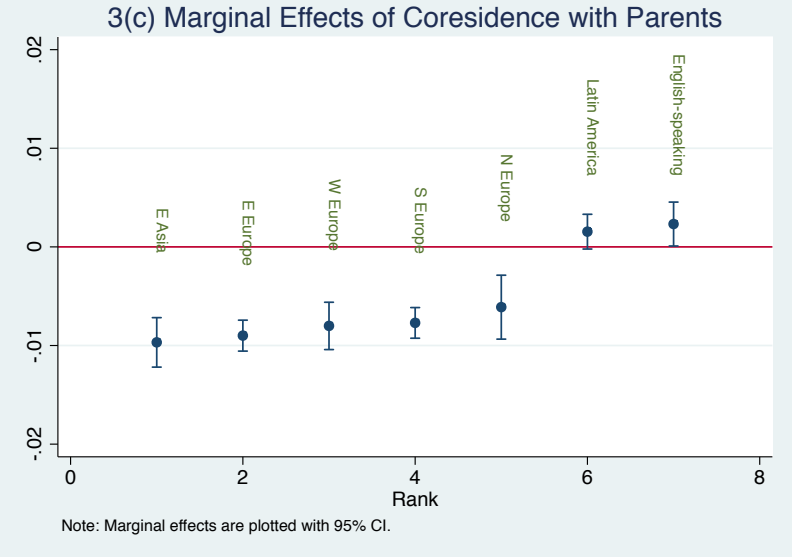


Note: The marginal effects are obtained from the multilevel linear regression models (random-slope models) that control for age, sex, time trend, the ICD version, and GDP per capita.

Figure 3(a)-(f): Marginal effects of social relationships on logged death rates of suicide, injury with undetermined intent, and unintentional poisoning and drowning







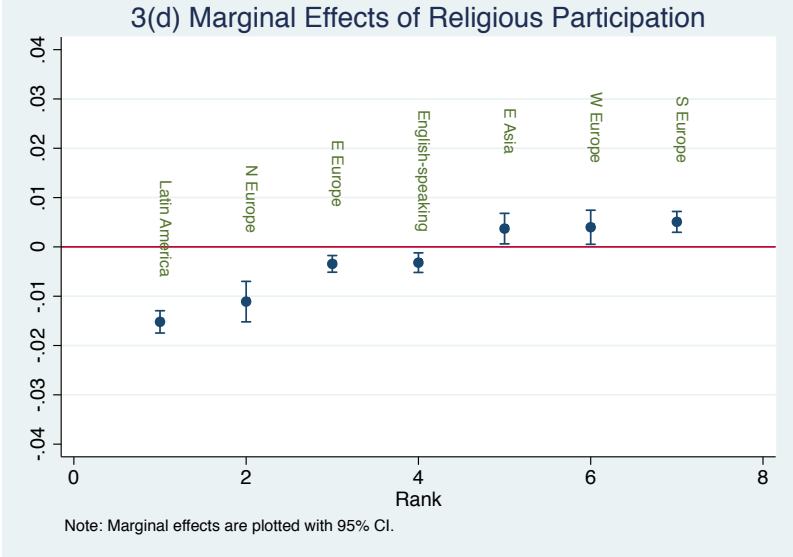
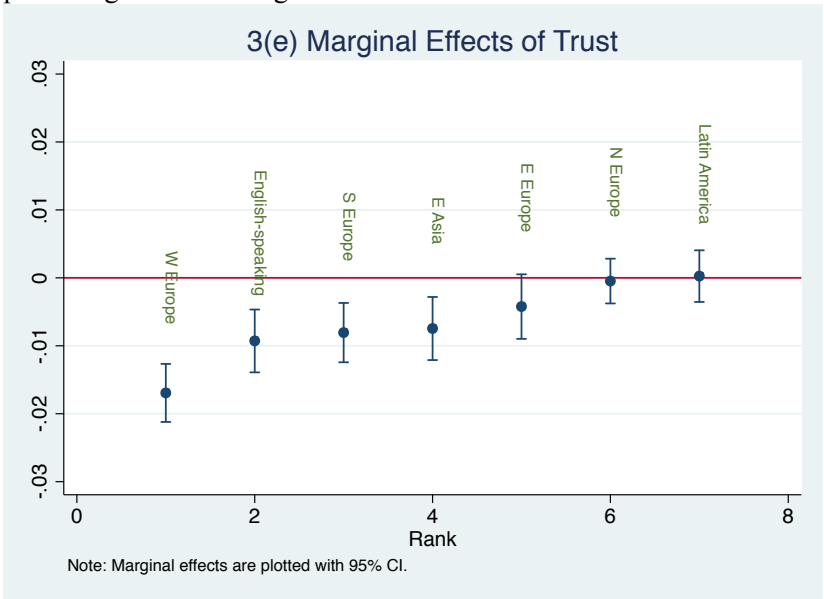
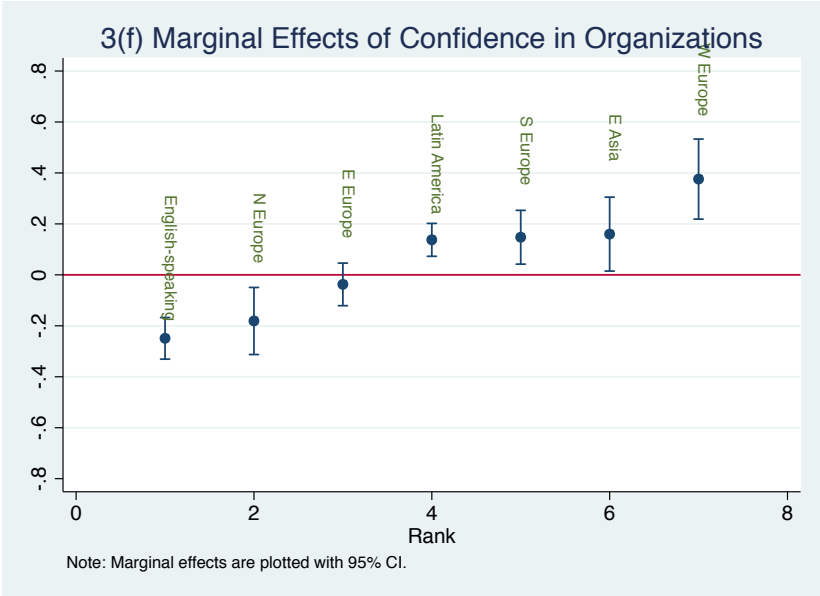


Figure 3(a)-(f) continued: Marginal effects of social relationships on logged death rates of injury with undetermined intent, and unintentional poisoning and drowning





Note: The marginal effects are obtained from the multilevel linear regression models (random-slope models) that control for age, sex, time trend, the ICD version, and GDP per capita.

Appendix: Number of WVS surveys participated by sample countries

Country	Wave of the World Values Survey					Total number of surveys participated by each country
	1981-1984	1989-1993	1994-1998	1999-2004	2005-2007	
Argentina	0	1	1	1	1	4
Australia	0	0	1	0	1	2
Austria	0	1	0	1	0	2
Belgium	1	1	0	1	0	3
Brazil	0	1	1	0	1	3
Bulgaria	0	1	1	1	1	4
Canada	1	1	0	1	0	3
Chile	0	1	1	1	1	4
Colombia	0	0	2	0	0	2
Croatia	0	0	1	1	0	2
Czech	0	2	1	1	0	4
Denmark	0	0	0	1	0	1
Finland	0	1	1	1	1	4
France	1	1	0	1	0	3
Germany	0	1	1	1	1	4
Greece	0	0	0	1	0	1
Hong Kong	0	0	0	0	1	1
Hungary	0	1	1	1	0	3
Ireland	1	1	0	1	0	3
Italy	1	1	0	1	1	4
Japan	0	1	1	1	1	4
South Korea	0	0	0	0	1	1
Macedonia	0	0	1	1	0	2
Mexico	0	1	1	1	1	4
Moldova	0	0	1	1	1	3
Netherlands	1	1	0	1	0	3
New Zealand	0	0	1	0	1	2
Norway	0	1	1	0	1	3
Peru	0	0	1	1	0	2
Poland	0	2	1	1	1	5
Portugal	0	1	0	1	0	2
Romania	0	0	1	1	1	3
Singapore	0	0	0	1	0	1
Slovakia	0	1	1	1	0	3
Slovenia	0	1	1	1	1	4
Spain	1	1	1	2	1	6
Sweden	0	1	1	1	1	4
Taiwan	0	0	1	0	1	2
UK	1	1	0	1	0	3
Uruguay	0	0	1	0	1	2
US	1	1	1	1	0	4
Venezuela	0	0	1	1	0	2
Total number of surveys in each wave	9	28	29	34	22	122