Are socio-economic factors valid determinants of suicide?

Controlling for national cultures of suicide with fixed-effects estimation

REVISED VERSION

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National cultures of suicide, that is culturally shared attitudes that are either supportive or restrictive towards the act of committing suicide, have found renewed interest in the recent literature on variation in suicide rates. Fixed effects, our panel data estimation technique, controls more elegantly and comprehensively for national cultures of suicide than other approaches. We use a range of economic and social explanatory variables based on economic as well as Durkheimian sociological theory in fixed-effects and random-effects estimation of age-standardized suicide rates in a large panel of up to 68 countries over the period 1980 to 1999. We find that economic and social factors impact upon cross-country differences in suicide rates in accordance with theory. Importantly, we find that the fixed-effects estimation results do not differ systematically from the random-effects results. This suggests that the vast majority of the existing literature, which typically fails to control for national cultures of suicide and suggests socio-economic factors as important determinants of suicide, can still be expected to come to valid results.

In recent contributions to the voluminous literature on cross-national differences in suicide rates the concept of a 'national culture of suicide' has received new interest. One can define the concept as the extent to which deeply entrenched culturally shared attitudes exist within nation states that are either supportive or restrictive towards the act of committing suicide. Quite possibly, such attitudes are contingent on the contextual circumstances in which individuals take their lives. Such national cultures can be expected

to influence the decision on whether or not to take one's life by some individuals and therefore to have an influence on aggregate suicide rates as well. Whereas already Hendin (1964) addressed differences in the national cultures of suicide amongst Scandinavian countries in his case studies, attempts to control for this phenomenon in quantitative research are of a very recent nature. One of the reasons for this failure to control for national cultures of suicide in the vast majority of the existing literature is the lack of quantitative data measuring such attitudes.

The main objectives of this article are twofold. First, we will show that fixed-effects estimation can more elegantly control for the potential existence of a national culture of suicide than any of the other methods employed so far (see Fernquist and Cutright (1998), Cutright and Fernquist (2000, 2001)). Second, we will test whether controlling for national cultures of suicide changes the signs and statistical significance of the socio-economic determinants of suicide typically employed in quantitative studies. If this was the case, then failure to control for a national culture of suicide would lead to biased estimates and therefore misleading conclusions, which would put doubt on past studies failing to control for such cultural differences. We will show that this is not the case and that cross-national studies of suicide, which fail to control for national cultures of suicide, can still be expected to arrive at unbiased results.

A NATIONAL CULTURE OF SUICIDE?

The strongest evidence in favor of a fixed national culture of suicide that varies across countries stems from the fact that, as Krupinski (1980, p. 262) already observes, 'countries of a very similar social structure have marked differences in suicide rates'. For example, in 1998 Sweden had a total age-standardized suicide rate of 12.73 per 100,000 inhabitants, whereas the rate of Finland was almost double at 22.69. The Czech Republic had a rate of 14.63, whereas Hungary's rate was more than double at 29.89 (WHO-

Europe, 2002). Such stark differences cannot be explained with differences in social and economic characteristics alone.

Most existing studies simply ignore the issue and Fernquist and Cutright (1998) and Cutright and Fernquist (2000, 2001) can be credited for trying various approaches to control for a national culture of suicide. The obvious one is to try to find proxy variables for a culture of suicide, for example a control variable for social approval towards the justifiability of suicide. Cutright and Fernquist (2001) include such a variable, which stems from the World Values Survey (Inglehart et al., 2000). The problem with this approach is that these data are only available for a very restricted number of countries. Furthermore, it assumes that the culture of suicide can be sufficiently well measured by stated approval rates of the general justifiability to the act of committing suicide, where no allowance is made for the fact that such attitudes might depend on the contextual circumstances in which individuals take their lives. Another approach is taken by Cutright and Fernquist (2000) who use errors of prediction as a proxy for the culture of suicide. The idea is that positive errors of prediction suggest a culture that is more accepting of suicide than the predictions based on the control variables would suggest, whereas negative errors of prediction would suggest a culture that is more condemning of suicide. This represents a rather cumbersome way of controlling for a culture of suicide and faces the problem that the errors of prediction can be volatile, and actually are somewhat volatile for some countries in Cutright and Fernquist's (2000) study, whereas the culture of suicide by definition is very persistent. For our 20-year period of analysis one can even justifiably assume it to be constant as a first approximation. A third approach is to include regional dummy variables as also done by Cutright and Fernquist (2000). The problem with this is that countries need to be put together into regions and it is assumed that the culture of suicide is the same in all countries of the region. Rather than simply assuming this, one would prefer to test for it.

Fixed-effects estimation offers a much more elegant way of controlling for a fixed national culture of suicide. It allows each country to have its own fixed effect and therefore its own culture of suicide. Hence there is no need to group countries together into regions with a supposedly shared culture. Formally, the fixed-effects estimator is derived from estimating the following model:

$$y_{it} = \alpha + x'_{it}\beta + \gamma_t + a_i + u_{it}$$

Time is indicated by t, countries are indicated by i, y is the suicide rate per 100,000 people, α is a constant, x' contains the explanatory variables, β is the corresponding vector of coefficients to be estimated. The γ variables are T-1 period specific dummy variables. Their inclusion lets each time period have its own intercept to allow for aggregate time effects such as a secular change in suicide rates that affect all countries. The a_i represent individual country effects, which are captured by country dummy variables. If national cultures of suicide are as a first approximation time-invariant within the time span of our analysis, then their existence is captured by these dummy variables. Failure to include the fixed effects leads to biased estimated of β if x' is correlated with the a_i.[1]

The fixed-effects estimator has two main advantages for tackling the potential incidence and impact of a national culture of suicide. First, inclusion of fixed effects ensures that the coefficients of time-varying variables are free from bias even if they are correlated with the fixed effects. Second, in order to see whether the national fixed effects would actually bias our estimations if they were not controlled for, one can compare the results from the fixed-effects estimator with those from the so-called random-effects estimator.

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[1] Note that this is equivalent to an omitted variable bias.

The random-effects estimator uses both the cross-sectional (between) and time-series (within) variation of the data. However, it depends on the assumption that the country effects are not correlated with the explanatory variables so that the individual country effects a_i can be regarded as part of a composite error term $v_{it} = (a_i + u_{it})$. This random-effects assumption can be tested with a so-called Hausman test. This tests whether the coefficients estimated by a random-effects estimator systematically differ from the coefficients estimated by a fixed-effects estimator for those variables that can be estimated with the fixed-effects estimator. If this test rejects the hypothesis that the coefficients do not systematically differ from each other, then we know that the country-specific fixed effects bias the estimations of the time-varying determinants of variation in suicide rates in a systematic manner.

Whilst fixed-effects estimation represents an elegant way to control for national cultures of suicide given that these are time-invariant and therefore fixed in first approximation, it suffers from an important drawback. The drawback is that there can be other fixed effects, which have nothing to do with a culture of suicide. Since fixed-effects estimation wipes out all time-invariant variables these other fixed effects cannot be estimated either. It would therefore be wrong to attribute all the variation in suicide rates "explained" by the country dummy variables, usually quite a substantial part of overall variation explained, to differences in national cultures of suicide. The random-effects estimator allows estimation of time-invariant variables, which theory suggests as further determinants of suicide other than national cultures of suicide. We will therefore employ both fixed-effects and random-effects estimation.

THEORETICAL REFLECTIONS ON THE DETERMINANTS OF SUICIDE

To see which variables we need to include in our analysis, we briefly review the sociological and economic literature trying to explain differences in suicide rates with differ-

ences in social and economic variables. Most of the modern sociological theory of suicide is based on Durkheim's (1897/2002) path-breaking study on suicide, in which he argues that suicide is a phenomenon with a 'dominantly social' explanation (p. iv). For him the key to understanding variation in suicide rates lies in the extent to which individuals are integrated into a social group as well as regulated by its norms and conventions. Egoistic suicide occurs when individuals lose touch with social groups (family, religious communities, society at large). Anomic suicide occurs when the social group and their norms and conventions lose control over the individual, but egoistic and anomic suicide are 'usually merely two different aspects of one social state' (Durkheim, 1897/2002, p. 251).[2] He develops a number of testable hypotheses that he subjects to empirical analysis with the help of descriptive suicide statistics from mainly France and Germany.

Following Durkheimian analysis, we would expect, for example, that the (lack of) integration of individuals into the family and the consequent lack of social regulation represents an important determinant of suicide: Higher marriage and fertility rates should be negatively associated, higher divorce rates positively associated with suicide rates. Lower average household size signals a greater potential for feelings of loneliness and lack of integration and should be positively associated with suicide.

Similarly with religious communities: Those belonging to religious groups that are characterized by greater social cohesion should be less prone to commit suicide. In his days, Catholics and Jews as opposed to Protestants represented such groups. Stack

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[2] In principle, Durkheim (1897/2002) distinguishes these from yet another form of suicide, namely altruistic suicide, which results from a sacrifice of individuals for the sake of the social group. This form of suicide is more relevant for extremely integrated social groups and therefore of less relevance to modern societies.

(1981) suspects that such confessional differences within Christianity are likely to have shrunk into insignificance. Arguably, however, there remain substantial differences in the extent of social cohesion and integration between, for example, predominantly Christian and Muslim societies (Simpson and Conklin, 1989). Similarly based on the basic ideas of Durkheim, one could also argue that a greater degree of ethno-linguistic heterogeneity within a society is likely to lead to less societal integration and is therefore associated with higher suicide rates. More ethnically homogeneous societies tend to be more integrated societies.

Maybe somewhat surprisingly, Durkheim (1897/2002, pp. 25-29) was rather dismissive of alcohol consumption patterns as an explanation of suicide, whereas modern scholars have found evidence that heavy consumption of alcohol is strongly related to higher suicide rates, due to both its negative social effects on the individual and others and the higher risk of committing violent acts in a state of acute intoxication (Brainerd, 2001; Ramstedt, 2001). This could be because Durkheim (1897/2002, p. 25) saw alcoholism more as a 'psychopathic state', to which 'all the ills of our civilization' were attributed in his time, rather than as a symptom of a lack of integration of the affected individuals.

Even where Durkheim did not develop testable hypotheses himself (perhaps due to the time he was writing in), others have fruitfully used his basic theory to hypothesize that, for example, increased female labor force participation is associated with higher suicide rates. Males are challenged in their role as the bread winners and are less likely to be comforted in their sorrows due to the labor force participation of their female partners, which is particularly problematic for men as their female partners are often their main source of emotional comfort (Stack, 1998). Women, on the other hand, are exposed to the stress of the employed work life and often face a double burden of paid outside employment and unpaid housework.

In addition to these fundamental social determinants, modern theorists have put more attention on distinctly economic factors and particularly on the level of income and fluctuations in economic conditions (for an overview, see Lester and Yang, 1997). Of course, the potential impact of these did not escape Durkheim's attention. For example, he believed that sudden economic change, both in the form of economic crisis and sudden economic prosperity, upsets the social order and thus leads to an increase in anomic suicide (Durkheim, 1897/2002, pp. 201ff.). Others, such as Ginsberg (1966, cited in Lester and Yang, 1997), argue that economic growth unambiguously raises the suicide rate, whereas Henry and Short (1954) argue the exact opposite, for rather complex reasons (see Lester and Yang, 1997). Ginsberg's hypothesized relationship is supported by modern economic theory, which suggests that individuals take their life if and once their expected present-value lifetime utility becomes zero. As economic crises lower the life-time income of individuals and therefore their consumption level making living less attractive relative to committing suicide, economic crises should raise and economic growth should lower the social suicide rate (Hamermesh and Soss 1974).

With respect to the level of income, rather than its growth rate, Durkheim (1897/2002, p. 214) noted a 'remarkable immunity of poor countries' since 'poverty protects against suicide because it is a restraint in itself'. Modern sociological theorists have questioned Durkheim's proposition, arguing that poor people are also confronted with many more personal problems, known to raise the inclination to commit suicide. It stresses the social and psychological deprivations poor people are exposed to and the positive effect of unemployment on suicide (Stack, 2000). Lester (1996), based on Henry and Short (1954), argues in favor of Durkheim, however, suggesting that higher average income levels imply fewer obvious external factors to blame for life failures and misery, thus raising the suicide rate. Unnithan, Huff-Corzine, Corzine and Whitt (1994, p. 120) also state as a matter of fact that 'suicide increases (...) with economic

development'. Against this, modern economic theory predicts the opposite result to Durkheim's hypothesis since higher life-time incomes raise the relative costs of committing suicide (Hamermesh and Soss, 1974).

Another reason why higher income levels might be associated with lower suicide rates is the generally better quality of emergency medical services in high-income societies, which should lower the success rate of attempted suicides. Ideally, one would want to control for the quality of emergency medical services directly, but this is rendered impossible due to lack of data.

In comparison, Durkheim was rather dismissive of potential explanations of differences in suicide rates stemming from outside the social or economic sphere. He found 'conditions of the physical environment' such as the climate (Durkheim, 1897/2002, p. 263) both theoretically unconvincing as well as unsupported by descriptive empirical evidence (see his Book I on extra-social factors). However, climatic conditions might have an effect on the incidence of depression, which is known to be a strong correlate of suicide. Do climates with low amounts of sunshine render people more depressed and therefore prone to commit suicide? Does the average temperature have an impact on suicide rates? Robbins, DeWalt and Pelto (1972) find a positive association between suicide and cold climate, Thorson and Kasworm (1984) with lack of sunshine, whereas Lester (1988) finds no such relationship.

In addition, there are other factors that theory would predict determine differences in suicide rates. Unfortunately, for many of these no data for a cross-national sample are available. This applies to, for example, the availability of firearms and other means of committing suicide (Killias, 1993), the existence of suicide prevention centers, access to mental health services and the like (Lester, 2000).

RESEARCH DESIGN

The independent variables

To control for the variables suggested as important social and economic determinants of variation in suicide rates by our review in the last section, we include the marriage, divorce and crude birth rate per 1000 inhabitants as well as the average number of persons living in a household to test for the impact of family integration on suicide rates. Marriage, divorce and household size data are taken from Euromonitor (2002) and complemented by UN (2001). Data on birth rates and on female labor force participation measured as a percentage of females aged 15 to 64 are taken from World Bank (2001). We also include pure alcohol consumption in liters per capita. This variable is taken from WHO-Europe (2002) and WHO (1999). As a proxy for ethnic and racial heterogeneity we take an index from Vanhanen (1999) who codifies data on ethnic heterogeneity based on racial, linguistic, national, tribal or established religious divisions. This index refers to the 1990s, is time-invariant and therefore dropped from the fixed-effects estimation. To our knowledge, no previous study has included a control variable for ethnolinguistic heterogeneity.

To test for the influence of religion we include three further variables, all of which are time-invariant and therefore dropped from the fixed-effects estimations. The first two are the percentage of Muslim and Catholic people taken from La Porta, Lopez-de-Silanes, Shleifer and Vishne (2000) and Parker (1997). This represents only a rather crude measure of the effect of religious community on suicide rates. We therefore include as a further variable for religious impact the percentage of religious to all books published in a country, with data taken from UN (2000). This variable has been used in previous studies, e.g., Stack (1983), Fernquist and Cutright (1998), Cutright and Fernquist (2001). Poor over-time availability of this variable prompted us to take the average

over the period 1980 to 2000 and restricted availability across countries means it is included only in separate model specifications.

To test for the impact of economic factors on suicide rates, we include GDP per capita in thousand US$ of purchasing power parity, with data generally taken from World Bank (2001). Missing income data were taken from estimations undertaken for WHO (2000). The income data were converted into constant US$(1997) with the help of the United States GDP deflator. It is important to use income data in purchasing power parity and not the conventional income data since the latter often substantially underestimate the power of incomes to purchase goods and services in low-income countries. Because of the diverging views on the effect of income on suicide between economic and sociological theories as well as among the latter we included a squared income term to pre-test for a non-linear relationship of income on suicide rates. Where both income terms pre-tested significantly, both were included in the final estimation results. If the two income terms pre-tested insignificantly, then the squared term was excluded from the final estimations. The economic growth variable is simply the percentage change in GDP per capita.

To test for the impact of climatic factors on suicide rates, we include two variables, which for obvious reasons are time-invariant and therefore dropped in fixed-effects estimation. One is the average annual temperature of a country, with data taken from Mitchell (2001). The other is the minimum of monthly average sunshine hours per day in the capital city of a country, with data taken from Harding (1998). The minimum tested better than the sum of monthly average sunshine hours and is also more relevant. This is because the long, dark winters should be responsible for higher suicide rates and the sum of sunshine hours does not reflect this very well, as many countries with long, dark winters have summer months with very long days such that the sum of sunshine hours does not reflect well the fact of dark, long winters.

The dependent variables

Age-specific numbers of suicide and population data for both men and women were taken from WHO (2002) and WHO-Europe (2002) and converted into age-standardized rates per 10000 inhabitants using the fictitious European standard population of the World Health Organization's (WHO) Regional Office for Europe as the standard. The choice of the standard population is essentially arbitrary (Barclay 1958). The European standard population has been taken as it is the reference point for the published age-standardized suicide rates in the 'Health for All' database of WHO-Europe (2002).

Using age-standardized suicide rates has the great advantage that national and, if less relevant, over time differences in the age structure are controlled for. This is important as the age structure varies tremendously across countries (and less so over time) and it is well known that elder people, for example, have a higher proneness to commit suicide than younger ones. Usage of age-standardized suicide rates also implies that one does not need to include control variables such as the population share of the elderly in the regressions. In spite of these advantages, it has only recently become common to use such data in studies of the determinants of suicide (for example, Fernquist and Cutright (1998); Cutright and Fernquist (2001)). The WHO has now decided to publish only age-standardized mortality rates, a practice already adopted before by its Regional Office for Europe.

The sample

We analyze variation in national age-standardized suicide rates over the period 1980 to 1999. 1980 is chosen as the cut-off date since many of our variables have poor availability before that date. Contrary to Fernquist and Cutright (1998) who restrict their analysis to developed countries, the size of the sample of our analysis is dictated en-

tirely by the availability of data. No country or time period is excluded *per se*. Appendix 1 lists the countries in the sample. Note that for some of them data are not available for all time periods. Clearly, developing countries other than the Latin American and Central Asian ones are under-represented. Nevertheless, there is substantial variation in all the social and economic factors analyzed in our study. Descriptive information of the variables can be found in appendix 2, a correlation matrix in appendix 3. Only few of the bivariate correlations are very high. In addition, variance inflation factors were computed to check for multicollinearity. For all regressions, the factors for all individual variables as well as the mean factor is below 5 (indeed, in many cases well below 3). There is therefore no reason to be concerned about multicollinearity (Kennedy, 1992).

RESULTS

Column I of Table 1 presents results from the fixed-effects estimation for male suicide rates with both robust and non-robust standard errors. The non-robust standard errors are the normal standard errors, whereas the robust ones are robust towards arbitrary heteroscedasticity and serial correlation. Column II reports results from the random-effects estimation. Note that there is no easy way to compute the random-effects model with robust standard errors so that the reported results for the random-effects model and therefore the Hausman test refer to non-robust standard errors.

What are statistically significant determinants of male suicide rates? Starting with economic factors, income has a non-linear effect on suicide rates. Higher income levels first lower the suicide rate, but at a decreasing rate, and then raise the suicide rate after a certain income level has been reached. The estimated turning point can be computed as $(-a/2b)$, where a is the coefficient of the income term and b the coefficient of the squared income term. The turning point, after which higher income levels are associated

with higher suicide rates is estimated to be at around US$30,700. This seems to suggest that economic development is associated with higher suicide rates as predicted by Durkheimian sociological theory only at very high levels of income, whereas the negative effect predicted by economic theory holds for the vast majority of countries at lower levels of income. Unemployment also matters with rising unemployment being associated with higher suicide rates. Higher birth and marriage rates lower the suicide rate, whereas a higher divorce rate, a higher female labor force participation rate and higher alcohol consumption raise it, all in line with expectation.

Contrary to our expectations, some variables test insignificantly, for example, the economic growth rate. Note that the same result prevails if the absolute value of economic change is entered instead.[3] What this implies is that the rate of economic change is simply insignificant and none of the hypotheses stated above concerning the impact of economic change on suicide rates is confirmed by the estimation results. Similarly insignificant is the average number of people living in a household.

Results are very similar to the fixed-effects estimation in terms of sign of coefficient and significance for the random-effects estimation reported in column II. Not surprisingly, then, the Hausman test fails to reject the hypothesis that the difference in the estimated coefficients of the two models is simply down to chance. This suggests no significant correlation of the fixed effects with the explanatory variables.

< Insert Table 1 about here >

Analogous results are reported for female suicide rates in columns I and II of Table 2. We find that some of the social and economic factors determine both male and female

[3] Detailed results are not shown due to space constraints, but are available from the author upon request.

suicide rates in similar ways. In particular, the impact of female labor force participation rate, the birth and divorce rates on female suicide are similar to the ones on male suicide. There is evidence for the expected effect of alcohol expenditures and income levels on suicide rates, which assume marginal significance only if standard errors are not robust, however. There are also some remarkable differences, however. Most importantly, the marriage rate, which was a highly significant determinant of male suicide rates is highly insignificant for female suicide. The same applies to the unemployment rate.[4]

The random-effects estimations are in line with the fixed-effects estimations. The only difference is that the alcohol consumption becomes marginally insignificant. The Hausman test fails to reject the hypothesis that the differences between the two models is not systematic and a comparison of the coefficients of both models also shows that they differ little from each other in substance as well.

< Insert Table 2 about here >

These results lead us to the important conclusion that the existence of fixed effects does not imply that our estimates from a random-effects estimation are heavily biased. Note that this does *not* mean that the fixed effects are not of importance. Indeed, looking at the R-squared values in columns I of Table 1 and 2 shows that the majority of the variation in suicide rates "explained" by our fixed-effects model needs to be attributed to the fixed effects. It just means that the fixed effects are not systematically correlated with our explanatory variables.

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[4] Note that since the squared term tested significantly the reported results refer to the model with this term dropped from the model.

It is tempting, but wrong to simply attribute all the variation in suicide rates "explained" by the fixed effects to national cultures of suicide. This is because of the existence of other time-invariant variables, which are absorbed in the fixed effects similar to national cultures of suicide. In our review of the theoretical literature on the determinants of suicide we have listed ethno-linguistic heterogeneity as well as religious and climatic factors and we will now test these empirically. Column III of Table 1 shows that ethno-linguistic heterogeneity is associated with higher male suicide rates. Of the climatic variables, the average temperature prevailing in a country tests insignificantly, but a higher minimum of daily sunshine hours is associated with lower suicide rates. As concerns the religious variables, neither the percentage of Muslim nor that of Catholic people is significant. The same is true for the percentage of religious books production added in column IV. The sign and statistical significance of the time-varying variables is mainly unaffected by the inclusion of these further control variables. The unemployment rate and female labor force participation become insignificant in the more restricted sample size of column IV.

Results for female suicide rates are similar in that ethnic heterogeneity is associated with higher suicide rates, whereas the religious variables are insignificant (see columns III and IV of table 2). A higher minimum number of sunshine hours is associated with lower suicide, but higher average temperatures with higher suicide. The sign and statistical significance of the time-varying variables are only affected in the more restricted sample of column IV. There the income level becomes insignificant, whereas the marriage rate and average household size are negatively associated with female suicide rates according to expectation.

DISCUSSION AND CONCLUDING OBSERVATIONS

As concerns male suicide rates, our results broadly confirm a Durkheimian theory of the determinants of suicide. Lack of social integration of individuals as measured by divorce, absence of children, higher female labor force participation and higher ethno-linguistic heterogeneity raises the suicide rate, whereas a higher marriage rate lowers it. This is in accordance with many previous studies (as listed in Stack (2000, pp. 22-24) and Lester and Yang (1997, pp. 162-166)). The average household size does not matter in the full sample size and only becomes significant in the rather restricted sample. This might suggest that it is perhaps not the number of individuals living together, but the relations amongst the individuals that matter. Higher alcohol consumption is associated with higher suicide rates as expected. With respect to economic factors, unemployment is positively associated with male suicide as both economic and sociological theory would predict, whereas income is negatively associated with suicide up to a high threshold of income. The economic growth rate is irrelevant.

As concerns female suicide rates, females seem to be somewhat less sensitive towards economic factors than males. Neither unemployment nor the economic growth rate are statistically significant in fixed-effects estimation and income exerts a negative effect that is statistically significant only with non-robust standard errors. Absence of children, divorce, female labor force participation and ethno-linguistic heterogeneity have a similar impact upon female as male suicide rates, but the marital status is significant only in one model estimation with a more restricted sample size. There is less clear evidence that higher alcohol consumption is positively associated with female suicide rates than was the case with male suicide rates.

For both sexes, we find no influence of religious variables. Admittedly, our measures of religious integration are rather crude, but the clear failure of our variables to test significantly is rather striking. We thus find some tentative evidence corroborating

Stack's (2000, p. 25) suspicion that 'in an increasingly secular society, religious correlates of suicide may not be as strong as secular correlates'.

We also find evidence that the lack of sunshine is associated with higher suicide rates in line with expectation. This variable becomes marginally insignificant in the more restricted sample, however. Average temperatures do not matter for male suicide rates, but somewhat surprisingly higher average temperatures are associated with higher female suicide rates. This is contrary to Robbins, De Walt and Pelto's (1972) finding who only looked at bivariate correlation coefficients, however, which puts severe doubt on the validity of their finding. Also, non-reported results show that the effect is only significant if minimum sunshine hours are simultaneously controlled for. More research seems warranted into the effect of climatic variables on national suicide rates, a topic largely neglected so far.

More important than these results, which are broadly in line with many previous studies, are two other things, however. First, this article has put forward a methodology, which elegantly controls for potentially existing national cultures supporting or restricting suicide. Second, it has also shown that a failure to control for such cultures by and large does not lead to biased estimation results. This follows from a comparison of the fixed-effects with the random-effects estimation results. It is an important result as very few studies of the voluminous literature on suicide have attempted to control for a national culture of suicide. Their findings would be put into doubt if the socio-economic time-varying variables they typically use were correlated with fixed effects.

It would be wrong to attribute the variation in suicide "explained" by the fixed effects in the estimation entirely to a national culture of suicide. We have shown that ethno-linguistic heterogeneity and climatic factors are time-invariant and statistically significant, yet not directly related to a national culture of suicide. Many others could not be tested due to lack of available data. Only more qualitative research and case-

studies will be able to explore in more detail the impact of national cultures of suicide. In the meantime, our results have demonstrated that we can have faith in the existing literature that fails to control for national cultures of suicide. Our estimations confirm that socio-economic characteristics are valid determinants of variation in suicide rates.

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Table 1. Fixed- and random-effects estimation of male suicide rates.

	I	II	III	IV
gdp p.c.	-1.68	-1.78	-1.64	-1.74
	(5.85)**	(6.92)**	(6.29)**	(5.93)**
	[5.35]**			
$(\text{gdp p.c.})^2$	0.027	0.030	0.027	0.031
	(3.80)**	(4.32)**	(3.89)**	(4.14)**
	[3.52]**			
economic growth	-0.008	-0.005	-.005	0.005
	(0.30)	(0.17)	(0.20)	(0.17)
	[0.21]			
unemployment rate	0.15	0.12	0.13	0.05
	(2.54)*	(2.08)*	(2.27)*	(0.70)
	[1.95]*			
female labor force participation	0.32	0.32	0.28*	0.19
	(2.22)*	(2.84)*	(2.32)	(1.26)
	[2.32]*			
birth rate	-0.53	-0.56	-0.54	-0.51
	(4.07)**	(5.06)**	(4.65)**	(3.59)**
	[4.15]*			
divorce rate	3.72	4.28	3.95	4.16
	(5.93)**	(7.21)**	(6.64)**	(6.47)**
	[4.48]**			
marriage rate	-0.95	-0.92	-.96	-1.35
	(3.85)**	(3.91)**	(4.06)**	(4.19)**
	[3.61]**			
household size	0.08	-0.61	0.06	-1.82
	(0.09)	(0.74)	(0.07)	(1.64)
	[0.10]			
alcohol consumption	1.28	1.10	1.18	1.16
	(7.32)**	(6.68)**	(7.20)**	(6.46)**
	[5.11]**			
ethnic heterogeneity			0.18	0.21
			(3.67)**	(2.81)**
% Muslim			0.01	0.03
			(0.15)	(0.35)
% Catholic			0.05	0.07
			(0.85)	(1.00)
average temperature			0.14	0.30
			(0.47)	(0.75)
minimum sunshine hours			-2.90	-2.72
			(2.45)*	(1.75)
share religious book production				-0.03
				(0.06)
adjusted R^2 (country dummies incl.)	0.9296			
R^2 (within)	0.3063			
R^2 (overall)		0.4484	.5755	0.5558
Hausman test chi^2		38.28	11.56	7.41
Hausman test p-value		0.1162	0.9984	1.0000
# countries	68	68	68	55
# observations	916	916	916	788

Dependent variable is age-standardised suicide rate (suicides per 100,000 inhabitants). Absolute t statistics refer to non-robust standard errors in round brackets and robust standard errors in squared brackets. Coefficients of period and country specific dummies not shown. * at 5%; ** at 1%.

Table 2. Fixed- and random-effects estimation of female suicide rates.

	I	II	III	IV
gdp p.c.	-0.08	-0.09	-0.07	-0.01
	(2.04)*	(2.74)**	(1.99)*	(0.37)
	[1.84]			
economic growth	-0.02	-0.01	-0.01	-0.01
	(1.86)	(1.31)	(1.58)	(1.38)
	[1.88]			
unemployment rate	0.02	0.01	0.01	-.01
	(1.19)	(0.47)	(0.63)	(0.49)
	[0.85]			
female labor force participation	0.20	0.12	0.13	0.13
	(4.13)**	(3.25)**	(3.49)**	(2.76)**
	[3.52]**			
birth rate	-0.26	-0.22	-0.24	-0.23
	(6.10)**	(6.15)**	(6.58)**	(5.27)**
	[5.88]**			
divorce rate	0.92	0.85	0.80	0.94
	(4.59)**	(4.52)**	(4.25)**	(4.76)**
	[4.27]**			
marriage rate	-0.06	-0.07	-0.08	-0.29
	(0.82)	(0.88)	(1.02)	(2.95)**
	[0.62]			
household size	-0.31	-0.32	-0.36	-0.78
	(0.99)	(1.19)	(1.25)	(2.32)*
	[1.02]			
alcohol consumption	0.12	0.09	0.10	0.10
	(2.20)*	(1.75)	(2.02)*	(1.78)
	[1.90]			
ethnic heterogeneity			0.05	0.05
			(3.36)**	(2.50)*
% Muslim			0.02	0.04
			(1.17)	(1.45)
% Catholic			0.01	0.01
			(0.35)	(0.44)
average temperature			0.22	0.29
			(2.44)*	(2.43)*
minimum sunshine hours			-0.95	-0.78
			(2.77)**	(1.74)
share religious book production				0.01
				(0.03)
adjusted R^2 (country dummies incl.)	0.9125			
R^2 (within)	0.3011			
R^2 (overall)		0.3255	0.4404	0.4081
Hausman test chi^2		29.42	27.57	31.22
Hausman test p-value		0.3915	0.4873	0.3076
# countries	68	68	68	55
# observations	907	907	907	788

Dependent variable is age-standardised suicide rate (suicides per 100,000 inhabitants). Absolute t statistics refer to non-robust standard errors in round brackets and robust standard errors in squared brackets. Coefficients of period and country specific dummies not shown. # significant at 10%; * at 5%; ** at 1%.

Appendix 1: Countries included in study.

Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Barbados, Belarus, Belgium, Belize, Brazil, Bulgaria, Canada, Chile, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Estonia, Finland, France, Georgia, Germany, Greece, Guatemala, Hungary, Iceland, Israel, Italy, Jamaica, Japan, Kazakhstan, Kuwait, Kyrgyz Republic, Latvia, Lithuania, Luxembourg, Macedonia (FYR), Mauritius, Mexico, Moldova, Netherlands, New Zealand, Norway, Panama, Poland, Portugal, Romania, Russian Federation, Singapore, Slovak Republic, Slovenia, South Korea, Spain, Sri Lanka, Suriname, Sweden, Switzerland, Trinidad and Tobago, Turkmenistan, Ukraine, United Kingdom, United States, Uruguay, Uzbekistan, Venezuela.

Appendix 2: Descriptive statistics of variables.

	Obs.	Mean	Std. Dev.	Min.	Max.
male suicide rate	916	24.6	17.4	0.1	87.7
female suicide rate	907	7.3	4.7	0.2	26.5
gdp p.c.	916	13.2	7.2	1.8	33.6
economic growth	916	0.8	7.6	-35.3	65.9
birth rate	916	16.2	6.6	7.6	37.2
female labor force participation	916	37.6	9.8	11.1	52.7
divorce rate	916	1.9	1.1	0.2	5.5
marriage rate	916	6.7	1.9	3	14.8
household size	916	3.4	1.0	2.0	9.1
unemployment rate	916	6.2	5.4	0	27.7
alcohol consumption	916	7.6	3.4	0	17.8
ethnic heterogeneity	916	28.8	27.6	0	177
% Muslim	916	7.12	20.5	0	95.1
% Catholic	916	20.8	29.9	0	97.8
average temperature	916	11.6	8.1	-5.4	27.1
minimum sunshine hours	916	2.8	2.1	0	8
religious book production	801	4.1	2.8	0.9	34.0

Appendix 3: Correlation matrix (n = 916).

	gdp p.c.	economic growth	birth rate	fem. labor force part.	divorce rate	marriage rate	unemploy-ment rate	alcohol con-sumption	household size	ethnic het-erogeneity	% Muslim	% Catholic	average temperature
economic growth	0.1815												
birth rate	-0.4231	-0.1065											
fem. labor force part.	0.2154	-0.0153	-0.6248										
divorce rate	0.2918	-0.0751	-0.3874	0.6249									
marriage rate	-0.1728	-0.0102	0.2198	0.0081	0.2346								
unemployment rate	0.0777	0.0641	-0.1246	-0.1384	-0.2236	-0.2273							
alcohol con-sumption	0.3155	0.1363	-0.4116	0.1207	0.0797	-0.0842	0.1928						
household size	-0.5195	-0.0805	0.7749	-0.6147	-0.4805	0.1791	-0.0964	-0.3856					
ethnic hetero-geneity	-0.3220	-0.1013	0.3524	-0.2102	0.0197	0.2443	-0.0152	-0.3921	0.3374				
% Muslim	-0.2571	-0.1295	0.4250	-0.1556	-0.1191	0.2087	-0.2485	-0.3246	0.5662	0.3289			
% Catholic	0.4632	0.0407	-0.2186	0.4480	0.3926	-0.1868	-0.0078	0.0166	-0.4565	-0.1648	-0.2247		
average tem-perature	-0.3219	0.024	0.5897	-0.6706	-0.5593	0.0760	0.1961	-0.1833	0.6767	0.2262	0.1454	-0.3952	
minimum sunshine hours	-0.2387	0.0189	0.5850	-0.6370	-0.5443	0.1127	0.2373	-0.0914	0.7103	0.2310	0.2298	-0.3798	0.8050