Predictive modelling of religiosity, prosociality and moralizing in 295,000 individuals from European and non-European populations

Pierre O. Jacquet^{1,2*}, Farid Pazhoohi^{3*}, Charles Findling¹, Hugo Mell^{1,3}, Coralie Chevallier¹, Nicolas Baumard²

¹ LNC², Département d'études cognitives, École normale supérieure, INSERM, PSL Research University, 75005 Paris, France.

² Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL Research University, 75005 Paris, France.

³ Department of Psychology, University of British Columbia, 2136 West Mall, Vancouver, British Columbia, Canada V6T 1Z4.

Corresponding Authors:

Pierre O. Jacquet

E-Mail address: pierre.ol.jacquet@gmail.com

ORCID : <https://orcid.org/0000-0002-6495-5581>

Nicolas Baumard

E-Mail address: nbaumard@gmail.com

ORCID: <https://orcid.org/0000-0002-1439-9150>

Département d'Etudes Cognitives, Ecole Normale Supérieure, PSL Research University, 29, rue d'Ulm, F-75005 Paris, France. Voice: +33144322640

Abstract

Why do moral religions exist? An influential explanation is that religious beliefs in supernatural punishment is cultural group adaptation enhancing prosocial attitudes and thereby large-scale cooperation. An alternative explanation is that religiosity is an individual strategy that results from high level of mistrust and the need for individuals to control others' behaviours through moralizing. Existing evidence is mixed but most works are limited by sample size and generalizability issues. The present study overcomes these limitations by applying k -fold cross-validation on multivariate modelling of data from more than 295,000 individuals in 108 countries of the World Values Surveys and the European Value Study. This methodology demonstrates that in European as well as in non-European samples, religious people invest less in collective actions and are more mistrustful of others. By contrast, we find a strong and positive association between higher level of mistrust, higher level of moralizing and higher level of religiosity.

Introduction

A range of explanations has been put forward to account for the existence of moralizing religions (1,2). One influential explanation is that they sustain large-scale cooperation (3). The belief in invisible, rule-enforcing agents would increase the believers' compliance with cooperative norms. These cooperative behaviours would in turn increase tolerance, social trust and cooperation between unfamiliar members of the group, and allow human populations to live in increasingly complex social groups (4-7). Ultimately, religious groups would be favoured over non-religious groups, leading to the diffusion of moralizing religions across the globe (3,8,9).

An alternative explanation is that higher social mistrust should lead individuals to higher religiosity through increased moralization of other people's behaviours (10-13). In this perspective, religiosity is a way for individuals to police others so that they adopt behaviours that are more favorable to their own fitness and their own strategy. Weeden and colleagues (12-13) for instance, have put forward the 'Reproductive Religiosity Model' in which the primary function of religiosity is to make others adopt behaviours that are more favorable to monogamous strategies. Monogamy and high parental investment require increased commitment from marriage partners. Religious beliefs and norms might help increase the effectiveness of moralizing sexual promiscuity, hence making monogamy a more stable strategy. Such policing behaviours should be higher when individuals perceive their environment as non-cooperative, that is, when they have low level of trust in others.

Despite a range of empirical works, the two explanations remain hard to disentangle (see for instance, the recent controversy around Whitehouse and colleagues (7)). One of the reasons is the lack of quantitative data which drastically limits the use of sophisticated statistical tools. Even in modern societies, previous papers have often used very limited samples.

In this paper, we use the European Value Study and the World Value Survey, two very large datasets containing information about the values, the beliefs, and the behaviours of more than 295 000 individuals from high income but also middle-income and low-income countries, including African, Asian, American, European and Oceanian countries. Another methodological innovation of our paper is that we study people's values and beliefs at the individual level. So far, large-scale studies on the origins of religiosity have limited their analyses to the aggregated level (14). One major problem with this approach is that it runs the risk of falling into the well-known ecological fallacy. The ecological fallacy occurs when inferences about the nature of individuals are deduced from inferences about the group to which those individuals belong. For instance, the well-known association between religiosity and low levels of GDP per capita at the aggregate level does not tell us whether the same association is valid at the individual level.

A frequently used alternative consists in mixing both aggregated and individual levels (13,15). But a second problem comes out once these two levels of description are put together: in the present case, an infinite number of aggregated factors might compete to explain the individual data. Which aggregated factor must be selected to explain the associations between social distrust, cooperation, policing needs, and religiosity? Should it be the countries' geographical vicinity? Their linguistic vicinity? Their population density? Their GDP per capita? Their education rate? Their political system? Any other forms of cultural norms? In any case, the final choice is necessarily arbitrary.

A final issue characterizing existing studies is the systematic lack of generalizability attempts. The capacity of statistical models to generalize their predictions to unknown, out-of-sample data is almost never tested. This weakness considerably limits the scope of their findings.

To overcome these problems, we apply stratified k -fold cross-validation to multivariate structural equation models. By repeatedly testing the models' predictive accuracy on individual data picked-up at random within the European and non-European countries composing the datasets, cross-

validation offers a powerful way to extract the behavioural patterns that generalize across individuals regardless of arbitrary country-level factors.

Our methodology consists in few steps. The full data set is first randomly partitioned into 10 folds of nearly equal size. Subsequently 10 iterations of training and validation are performed such that within each iteration a different fold of the data is held-out for validation (the test data: here representing 10% of the whole sample) while the remaining $k-1$ folds are used for training (the training data, here representing 90% of the whole sample). At each iteration, the covariance matrix fitted by the multivariate structural equation model on the training data is compared to the covariance matrix observed in the test data. The predictive accuracy of the training model is further checked by comparing the fitted parameters on a covariance matrix observed in a test dataset whose individual values have been randomly permuted. The aim is to verify that the model parameters fitted on the training data fail at predicting the test data when its internal structure is broken down by means of random permutations. Therefore, this procedure allows us to fully confirm that the latent structure hypothesized by our structural equation model is present or absent in the data. In the end of the 10 iterations, the whole sample is reshuffled and re-stratified before a new round of 10 iterations starts. The whole procedure is repeated 100 times (100 rounds of 10 iterations) in order to obtain reliable performance estimation.

Two series of SEM models fitted on individual data were run on each dataset (EVS and WVS). The first class of **models** test **Hypothesis 1** according to which religiosity leads individuals to higher levels of social trust and large-scale cooperation (**models 1**). The second class of **models** test **Hypothesis 2** according to which higher social mistrust leads individuals to higher religiosity through increased moralization of other people's behaviours. This second class involves models focusing on attitudes aiming to moralize sexual promiscuity to specifically expand on the predictions derived from the 'Reproductive religiosity hypothesis' (for a review, see (16)) (**models 2.1**), and models focusing on attitudes aiming to moralize free-riding (**models 2.2**).

Results

Structural equation models involve two major parts: a 'measurement' model and a 'structural' model. The measurement model consists in relating a number of directly observed variables – labelled 'indicators' – to a smaller set of hypothesized constructs – labelled 'latent' variables – presumed to cause the covariations among the indicators, hence reflecting a continuum that is not directly observable. The structural model consists in estimating a restricted set of a priori specified pathways between the latent variables identified by the measurement model. Therefore, SEM allows for the modelling of the covariations among all these factors by a theoretically driven model (17), a procedure particularly suited for the purpose of the present study. The models 1 test the robustness of the hypothetical latent variables *Religiosity* (including practices and beliefs), *Social mistrust*, and *Large-scale cooperation*, as well as their direct associations. The model 2.1 tests the robustness of the hypothetical latent variables *Social mistrust*, *Religiosity*, and *Moralizing sexual promiscuity*, as well as their direct and indirect associations. The model 2.2 involves the latent *Moralizing free-riding* in place of *Moralizing sexual promiscuity*.

In order to improve the reading of the text, all statistical indices and parameter estimates corroborating the description of the models are reported in the tables included in the main text and in the Supplementary Materials. The models' goodness of fit indices are reported in Table 1. The parameter estimates of their measurement and structural parts are reported in Table 2 for the EVS dataset, and in SM Table S4 for the WVS dataset. Finally, results of their cross-validation are reported in Table 3.

Goodness of fit indices. All the EVS and WVS models provide an excellent fit. This is supported by scaled *CFI* values > .95, scaled *RMSEA* values < .05, and scaled *SRMR* values < .08 (Table 1). These results indicate that the discrepancies between the sample and the model-implied covariance matrices are minimal (*RMSEA*), and that the models performed better than their *null* versions including only the variance of the indicators as parameters (*CFI*, *SRMR*).

Table 1. Goodness of fit indices.

	EVS Model 1	EVS Model 2.1	EVS Model 2.2
n respondents	90 539	90 539	90 539
n parameters	46	46	49
df	74	74	87
χ^2 .scaled	8966.958	18 409.525	9102.514
<i>CFI</i> .scaled	0.974	0.956	0.970
<i>RMSEA</i> .scaled [ci.lower - ci.upper]	0.036 [0.036 - 0.037]	0.052 [0.052 - 0.053]	0.034 [0.033 - 0.034]
<i>SRMR</i> .scaled	0.033	0.037	0.029
	WVS Model 1	WVS Model 2.1	WVS Model 2.2
n respondents	176 323	176 323	176 323
n parameters	30	33	33
df	25	33	33
χ^2 .scaled	8817.046	12 204.92	4097.663
<i>CFI</i> .scaled	0.963	0.956	0.981
<i>RMSEA</i> .scaled [ci.lower - ci.upper]	0.045 [0.044 - 0.045]	0.046 [0.045 - 0.046]	0.026 [0.026 - 0.027]
<i>SRMR</i> .scaled	0.028	0.030	0.022

Table 1. Goodness of fit indices. The fit indices reported in the table are averaged on the 1000 iterations that have been set for cross-validating each model. A *RMSEA* $\leq$ 0.05, a *CFI* $\geq$ 0.95 and a *SRMR* $\leq$ 0.08 indicate an excellent fit.

Measurement models. The measurement parts of these models show that all the indicators load positively and significantly on their respective hypothetical latent variable (EVS: Table 2, Figure 1.a, 1.b and 1.c; WVS: SM Table S4, SM Figure S1.a, S1.b, S1.c). First, respondents who score high on the latent *Religiosity* attend religious services more often, place a higher confidence in religious institutions, define themselves as religious persons, place a higher value in religion in general and in god in particular and finally, display a greater number of religious moral beliefs. Second, those who score high on the latent *Social mistrust* declare mistrusting other people more and declare rejecting a greater number of social categories as potential neighbours. Third, respondents scoring high on the latent *Large-scale cooperation* undertake more actions that benefit the large-scale community such as volunteering for collective activities and participating in collective political actions. Fourth, respondents who score high on the latent *Moralizing sexual promiscuity* express greater needs of moralizing homosexuality, prostitution, abortion, divorce, adultery and casual sex. Finally, respondents who score high on the latent *Moralizing free-riding* variable express greater needs of moralizing individuals who: claim government benefits while they are not eligible to, who avoid a fare on public transport, who cheat on taxes, who accepts a bribe, those who steal a car (joyriding), those who lie, or those who pay cash in order to avoid taxes.

Table 2. Measurement and structural parts estimated by the EVS model 1, 2.1, and 2.2

a. Model 1. Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent variables	Indicators	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Religiosity	≈ Religious service attendance	1.681	0.006	277.226	< .001	1.668	1.692	0.697
		≈ Confidence in religious institutions	0.705	0.003	255.538	< .001	0.699	0.711	0.715
		≈ Religious person	0.412	0.002	215.694	< .001	0.409	0.416	0.705
		≈ Important in life: religion	0.828	0.003	324.027	< .001	0.823	0.833	0.789
		≈ Important in life: god	2.841	0.007	391.227	< .001	2.827	2.855	0.868
		≈ Moral beliefs	1.240	0.004	283.374	< .001	1.231	1.248	0.680
	Social mistrust	≈ General mistrust	0.092	0.026	67.710	< .001	1.707	1.808	0.520
		≈ Interpersonal mistrust	1.757	0.001	63.888	< .001	0.089	0.095	0.385
	Large-scale cooperation	≈ Involvement in collective activities	0.196	0.005	41.208	< .001	0.187	0.206	0.169
		≈ Signing petitions	0.535	0.002	223.677	< .001	0.530	0.540	0.665
		≈ Joining boycotts	0.458	0.002	198.937	< .001	0.453	0.462	0.714
		≈ Attending lawful demonstrations	0.535	0.002	229.333	< .001	0.529	0.539	0.722
		≈ Joining unofficial strikes	0.307	0.002	139.224	< .001	0.302	0.311	0.566
		≈ Occupying building or factories	0.191	0.002	95.856	< .001	0.187	0.195	0.442
Structural model	Social mistrust	~ Religiosity	0.304	0.007	41.371	< .001	0.290	0.319	0.291
	Large-scale cooperation	~ Religiosity	-0.213	0.004	-47.658	< .001	-0.222	-0.204	-0.208
Covariance	Social mistrust	~~ Large-scale cooperation	-0.389	0.007	-53.700	< .001	-0.404	-0.375	-0.389

b. Model 2.1 Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent variables	Indicators	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Social mistrust	≈ General mistrust	0.095	0.001	68.002	< .001	0.092	0.098	0.381
		≈ Interpersonal mistrust	1.856	0.025	76.466	< .001	1.809	1.903	0.526
	Moralizing sexual promiscuity	≈ Homosexuality	1.917	0.013	152.402	< .001	1.893	1.942	0.672
		≈ Prostitution	1.212	0.010	118.904	< .001	1.193	1.233	0.589
		≈ Abortion	1.976	0.013	157.012	< .001	1.952	2.001	0.771
		≈ Divorce	1.824	0.012	154.021	< .001	1.801	1.847	0.723
		≈ Adultery	0.791	0.008	94.875	< .001	0.775	0.808	0.448
		≈ Having casual sex	1.311	0.011	123.066	< .001	1.290	1.332	0.584
	Religiosity	≈ Religious service attendance	1.435	0.006	236.518	< .001	1.423	1.447	0.703
		≈ Confidence in religious institutions	0.600	0.003	223.309	< .001	0.595	0.606	0.719
		≈ Religious person	0.344	0.002	195.211	< .001	0.340	0.347	0.694
		≈ Important in life: religion	0.707	0.003	269.159	< .001	0.702	0.713	0.796
		≈ Important in life: god	2.394	0.008	293.586	< .001	2.378	2.410	0.864
		≈ Moral beliefs	1.045	0.004	237.976	< .001	1.034	1.054	0.677
Structural model	(a) Moralizing sex. prom.	~ Social mistrust	0.635	0.011	55.252	< .001	0.612	0.657	0.534
	(b) Religiosity	~ Moralizing sexual promiscuity	0.528	0.007	77.832	< .001	0.515	0.541	0.529
	(c) Religiosity	~ Social mistrust	0.007	0.007	0.789	= .448	-0.010	0.025	0.006
	Indirect effect	:= a * b	0.335	0.006	54.488	< .001	0.323	0.347	0.284

c. Model 2.2 Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent	Indicator	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Social mistrust	≈ General mistrust	0.087	0.002	44.066	< .001	0.083	0.090	0.346
		≈ Interpersonal mistrust	2.045	0.043	47.105	< .001	1.960	2.131	0.579
	Moralizing free-riding	≈ Claiming government benefits	1.010	0.010	102.702	< .001	0.991	1.030	0.489
		≈ Avoiding a fare on public transport	1.392	0.010	139.174	< .001	1.373	1.413	0.599
		≈ Cheating on taxes	1.497	0.010	151.943	< .001	1.478	1.521	0.674
		≈ Someone accepting a bribe	0.963	0.010	102.256	< .001	0.945	0.982	0.586
		≈ Stealing a car	0.546	0.009	64.622	< .001	0.529	0.563	0.416
		≈ Lying	1.494	0.009	162.367	< .001	1.476	1.512	0.684
		≈ Paying cash in order to avoid taxes	1.588	0.010	162.102	< .001	1.569	1.607	0.625
	Religiosity	≈ Religious service attendance	1.585	0.007	239.409	< .001	1.572	1.598	0.700
		≈ Confidence in religious institutions	0.659	0.003	221.308	< .001	0.653	0.665	0.711
		≈ Religious person	0.387	0.002	198.979	< .001	0.383	0.390	0.703
		≈ Important in life: religion	0.783	0.003	272.909	< .001	0.777	0.789	0.794
		≈ Important in life: god	2.666	0.009	304.262	< .001	2.648	2.683	0.867
		≈ Moral beliefs	1.163	0.005	245.486	< .001	1.154	1.172	0.679
Structural model	(a) Moralizing free-riding	~ Social mistrust	0.030	0.006	4.720	< .001	0.017	0.042	0.030
	(b) Religiosity	~ Moralizing free-riding	0.290	0.005	45.544	< .001	0.202	0.220	0.199
	(c) Religiosity	~ Social mistrust	0.290	0.008	38.177	< .001	0.275	0.305	0.273
	Indirect effect	:= a * b	0.006	0.001	4.823	< .001	0.004	0.009	0.006

Table 2. Measurement and structural parts of a. EVS model 1, b. EVS model 2.1, c. EVS model 2.2. The unstandardized and standardized values of the indicators' loadings composing the latent variables (denoted ≈), the regression coefficients characterizing their associations (denoted ~), and the residual covariances (denoted ~~) are labelled *P*.unstd and *P*.std, respectively. We also report under the *z* label values of Wald tests (and their p values) as indicators of simple effect sizes.

Structural models. The Hypothesis 1 states that religiosity should lead individuals to higher levels of trust and cooperation. The structural parts estimated by the EVS (Table 1.a; Figure 1.a) and the WVS models 1 (SM Table S4.a; SM Figure S1.a) show the exact opposite. In the EVS model 1, respondents high on the latent *Religiosity* are also high on the latent *Social mistrust*, while they are low on the latent *Large-scale cooperation*. The same pattern emerges from the WVS model 1. In sum, the respondents who display the highest levels of religiosity are those who mistrust unfamiliar others the most, who reject the greater number of social categories as potential neighbours, and who undertake the smallest number of actions benefiting the large-scale community. Note that in both models, *Social mistrust* and *Large-scale cooperation* negatively covary: respondents displaying the highest levels of mistrust show the lowest level of large-scale cooperation.

We now turn to the structural parts of the EVS model 2.1 (Table 1.b; Figure 1.b) and the WVS model 2.1 (SM Table S4.b; SM Figure S1.b). In line with the Hypothesis 2, respondents high on the latent *Social mistrust* are also high on the latent *Moralizing sexual promiscuity*. On the other hand, those with higher scores on *Moralizing sexual promiscuity* also display higher levels of *Religiosity*. Importantly, the EVS model 2.1 reveals no direct effect of *Social mistrust* on *Religiosity*. Instead, the effect of *Social mistrust* is fully transmitted to *Religiosity* via the *Moralizing sexual promiscuity* latent variable. The mediation effect of the latent *Moralizing sexual promiscuity* is still present in the WVS model 2.1, though in a weaker extent.

The structural patterns estimated by the models 2.1 are not entirely reproduced by the EVS model 2.2 (Table 1.c; Figure 1.c) nor by the WVS model 2.2 (SM Table S4.b; SM Figure S1.b). While respondents showing higher scores on the latent *Moralizing free-riding* also show elevated levels of *Religiosity*, the consistency of the link between *Social mistrust* and *Moralizing free-riding* is almost null in the EVS model 2.2, and does not reach the standard significance threshold in the WVS model 2.2. Finally, in these models *Social mistrust* has a strong positive effect on *Religiosity* and as a result, the portion of this effect that is mediated by the *Moralizing free-riding* latent variable is weak in the EVS model 2.2, and turns to null in the WVS model 2.2.

Overall, results of the EVS and the WVS models 2.1 remarkably fit the Hypothesis 2. This hypothesis is only partially validated by the EVS and the WVS models 2.2.

Figure 1. Measurement and structural models. **a.** EVS model 1, **b.** EVS model 2.1, **c.** EVS model 2.2. Standardized parameter values estimated by the structural equation models applied on the training dataset (90% of the full sample) and averaged on the 1000 iterations set for cross-validation. Ellipses represent latent variables, rectangles represent their indicators. In the WVS model, social mistrust is modeled as a single composite variable, here represented by a rectangle. Paths between the latent variables and/or the single composite represent regressions. Paths between the indicators and the latent variables represent factor loadings. Note that all indicators and the single composite variable ‘Social mistrust’ are regressed against the covariate ‘age of the respondent’. Significant paths at the 5% level are represented with bold arrows. **d. Cross-validation.** Distributions of predictive accuracy ratios obtained from the stratified 10-folds cross-validation of the EVS model 1, 2.1 and 2.2 (10*100 rounds in total for each model).

Stratified 10-folds cross-validation. All the EVS and the WVS models show good predictive accuracy and therefore well generalize to unknown test data ($F \approx 0$; $\chi^2_{\text{model1}} < \chi^2_{\text{null.model1}}$; $RMSEA < 0.05$) (Table 3). This is further supported by the values of predictive accuracy ratio which show that the models fail at predicting test data whose internal structure is broken down by means of random permutations (EVS: Figure 1.d; WVS: SM Figure S1.d). Overall, cross-validation analyses corroborate the fact that the EVS and the WVS datasets have latent structures that are well captured by our models 1, 2.1 and 2.2. Importantly however, a modified Brown-Forsyth Levene-type test of equality of variance reveals that the distribution across cross-validation iterations ($n = 1000$) of the predictive accuracy ratio is less noisy for the EVS model 2.1 than for the EVS model 2.2 (Levene's test statistic = 276.22, $p < 2.2\text{e-}16$), indicating that the former is more stable than the latter. The same thing is observed for the WVS model 2.1, relative to the WVS model 2.2 (Levene's test statistic = 185.62, $p < 2.2\text{e-}16$).

Table 3. Stratified 10-folds cross-validation results. Performance estimates (mean $\pm$ sd)

	Real test data			Randomly permuted test data			Model comparison	
	F	χ^2	$RMSEA$	F	χ^2	$RMSEA$	<i>Predictive accuracy ratio</i>	
	mean ($\pm$ sd)	mean ($\pm$ sd)	mean ($\pm$ sd)	mean ($\pm$ sd)	mean ($\pm$ sd)	mean ($\pm$ sd)	mean ($\pm$ sd)	relative sd
EVS Model 1	0.103 (± 0.007)	1038.677 (± 66.548)	0.037 (± 0.001)	7.820 (± 0.057)	78 663.257 (± 577.933)	0.273 (± 0.001)	76.042 (± 4.870)	0.064
EVS Model 2.1	0.143 (± 0.007)	1438.145 (± 70.351)	0.044 (± 0.001)	11.054 (± 0.069)	111 190.460 (± 577.933)	0.324 (± 0.001)	77.498 (± 3.783)	0.048
EVS Model 2.2	0.092 (± 0.008)	927.762 (± 78.875)	0.031 (± 0.001)	7.633 (± 0.057)	76 780.612 (± 571.348)	0.252 (± 0.001)	83.449 (± 7.021)	0.088
WVS Model 1	0.041 (± 0.002)	796.215 (± 49.161)	0.040 (± 0.001)	2.410 (± 0.020)	47 204.293 (± 384.187)	0.232 (± 0.001)	59.511 (± 3.693)	0.062
WVS Model 2.1	0.043 (± 0.002)	837.374 (± 45.850)	0.036 (± 0.001)	3.332 (± 0.022)	65 284.53 (± 429.89)	0.246 (± 0.001)	78.196 (± 4.291)	0.055
WVS Model 2.2	0.022 (± 0.002)	427.923 (± 32.391)	0.026 (± 0.001)	2.120 (± 0.017)	41 533.45 (± 326.62)	0.196 (± 0.001)	97.604 (± 7.309)	0.075

Discussion

The aim of the present study was to test two hypotheses supposedly explaining the prevalence of religious beliefs and behaviours in the modern world. The first hypothesis posits that religiosity observed at the individual should be associated with *higher* levels of social trust and *higher* levels of large-scale cooperation (i.e. investments in collective activities and political actions). The second hypothesis posits that *higher* social mistrust should lead individuals to *higher* religiosity through *higher* moralization of other people's behaviours. Both hypotheses were tested by applying stratified k -fold cross-validation on structural equation models fitted on more than 295,000 participants in the European Value Study and the World Value Survey (18), and belonging to both Western and non-Western countries.

Strikingly, none of the predictions derived from the first hypothesis were verified by the 1st series of models. Both the EVS model 1 and the WVS model 1 reveal that higher levels of religiosity are associated with lower levels of large-scale cooperation: participants declaring being highly religious invest less in collective activities and participate less to political actions. In addition, highly religious participants also feel more threatened by their conspecifics, as revealed by the fact that they display higher levels of social mistrust, whether it is against the general population or against more specific social minorities. Overall, results extracted from the analyses of both the European and the non-European datasets show that religious people are not more prosocial, but rather less prosocial: they mistrust other people more, they invest less in collective activities and they participate less in

political actions. This suggests that religiosity is not associated with higher level of cooperation, but rather with a lack of cooperation, a lack of social trust, and a need to police others.

This idea is confirmed further by the EVS and the WVS models 2.1 and 2.2 showing that higher level of social mistrust leads to higher religiosity via increased needs to moralize behaviours deviating from sexual monogamy (homosexuality, prostitution, abortion, divorce, adultery, having casual sex) and, to a smaller extent, behaviours deviating from the cooperative moral (paying taxes, paying in public transport, telling the truth, etc.). This is notably explained by the fact that the most moralizing individuals – at least for the reproductive domain – are not the most prosocial ones, but rather the *least* prosocial.

All these patterns of associations are further supported by cross-validation analyses which highlight the capacity of the models to predict unknown individual data randomly drawn from both European, and non-European samples. More generally, they converge with a large set of works in the social sciences demonstrating that religiosity is more prevalent in the societies where social trust is lower, legal institutions weaker, welfare state lower and interpersonal violence higher, that is in societies where large-scale cooperation is *weaker* (19,20). Religious beliefs are much higher in Sub-Saharan Africa, in South America or in South Asia than in Western Europe, North America or East Asia (14). Within the US, religious beliefs are also much higher in states where violence, social mistrust and poverty are higher (14). All these observations run against the idea that religion is a factor that contributes to increase social complexity via the promotion of large-scale cooperation.

Obviously, the validity of these results depends on the validity of the measures. While indicators used to model *Religiosity* and *Social mistrust* are canonical in the social sciences (14,19), those we used to model large-scale cooperation can be subject to discussion. One could argue that they could reflect something else. The reason why we used volunteering in collective activities and involvement in various political actions as indicators to model large-scale cooperation is because they represent behaviours having real and tangible costs for the individuals (time and energetic resources are spent without financial pay-offs). From this perspective, they are more relevant than declarative attitudes in the sense that they allow grasping part of an individual's motivation to pay the cost inherent to large-scale cooperation (21). Also, we cannot entirely rule out the possibility that the 'volunteering' indicator reflects a more general prosocial trait, for example, openness to novelty. More dramatically, engaging in political actions of the kinds reported in the models might reflect anything but prosociality. For instance, a white supremacist might be ready to pay the cost of spending time, money and energy to spread his/her cause and might therefore engaged in political actions such like signing petitions, attending demonstrations, etc. We have good hope that it is not the case however. Indeed, the social mistrust indicators (general, interpersonal) negatively correlate with the 'political actions' and the 'volunteering' indicators (SM Table S6). This leads to a strong correlation between the *Social mistrust* and the *Large-scale cooperation* latent variables in both the EVS model 1 (Table 1.a) and the WVS model 1 (SM Table S4.a). A reverse pattern would have been expected if those behaviours were indeed driven by anti-sociality. We are therefore reasonably confident that what is captured by our hypothetical latent constructs is a trait akin to the motivation to cooperate in large networks.

In conclusion, what the 1st series of models suggests is that religiosity is not driven by the need to cooperate nor by the trust participants place in others. How to make sense of these results? The results obtained in the 2nd series of model suggest an explanation, albeit counterintuitive at first hand: support for moralizing religions and supernatural punishment should be associated with a lower level of cooperation and a higher level of mistrust because it is precisely when an individual is low in cooperation and high in social mistrust that she feels the need to influence others. People might therefore engage in religion in the hope of fostering trust and cooperation via moralizing others.

We note that our paper does not explain the ultimate origins of the cultural variability of religious beliefs. Why are some countries more religious than others? This paper suggests that religiosity is partly determined by the need to moralize others and ultimately by the level of social trust (i.e., what people think of others' level of cooperation). We can thus hypothesize that religiosity and the need to moralize others will vary according to the level of cooperation in a group. When cooperation is low, individuals feel more of a need to moralize others; when cooperation is high, individuals feel less of a need to control others.

But what then explain the cultural variability of cooperation? An emerging body of work suggest that living standard, levels of resources, and environmental harshness partially determined levels of cooperation (21-24). One likely explanation is that when resources are low and unpredictable, individuals start their life with little capital (embodied capital, economic capital, human capital, etc.) and as such must meet basic needs as adults. Individuals with low capital should be impatient to collect resources such that to improve their productivity and/or survival. In that situation, avoiding waiting costs by favoring short-term rewards is a strategy that might prove advantageous. By contrast, for those who inherited a lot of capital, accumulating new benefits has a marginal value. In that situation being patient and waiting for future and potentially greater pay-offs is a more profitable strategy (25). Since cooperation is a strategy that pay-off on the long run, lower levels of resources are likely to be associated with lower levels of cooperation (21). Lower levels of cooperation would produce lower levels of social trust, creating a need to moralize others and to promote the belief in supernatural punishment.

This approach is particularly promising for the domain of reproduction. A large body of work has documented the association between harshness and a short-term reproductive decision-making strategy (lower level of sexual commitment, lower level of parental investment) (26,27). In harsher environment, individuals may thus feel more threatened by the sexual promiscuity of others and more willing to moralize them.

Such a theory would explain the strong association between lower economic development, higher levels of religiosity and higher level of intolerance often documented in the social sciences literature. Obviously, more work is needed, especially to test the association between religiosity, levels of resources and reproductive strategies at the individual level.

Methods

EVS and WVS Respondents. The EVS and the WVS are independent large-scale sociological surveys exploring people's values and beliefs across countries and times. The EVS and the WVS have relied on social scientists since 1981 to collect data from large representative samples of the populations from more than 100 countries in total.

Our two hypotheses are first tested on individuals who participated in the 3rd and the 4th waves of the European Value Survey (EVS - data collected between 1999 and 2004), hence taken as the datasets of reference. Unlike the EVS waves 1 and 2, the 3rd and 4th EVS waves allow a reasonably complete modelling of our theoretically specified latent constructs *Religiosity*, *Social mistrust*, *Large-scale cooperation*, *Moralizing sexual promiscuity*, and *Moralizing free-riding*. We also try to replicate the effects eventually found with the EVS models on an independent data set including individuals from non-European countries, i.e., the World Value Survey (WVS). Multivariate analyses were ran on the WVS waves 3 to 6. For a matter of data incompleteness, the WVS waves 1 and 2 were not included in the analyses.

The EVS dataset includes 164 997 respondents, 107 406 of them being part of the 3rd and 4th EVS waves. Among these 107 406, 100 599 respondents belonging to 46 countries remained after

removing those with too many missing values (+ 2SDs from the sample mean) and those who presented missing values in continuous variables that could not be faithfully imputed (i.e., age). The list of countries (and their respective sample size) included in the final EVS dataset is available in the Supplementary Material.

The WVS dataset includes 348 532 respondents, 236 378 of them remained after removing European countries, and 219 533 after removing respondents with too many missing values (+ 2SDs from the sample mean) and those who presented missing values in continuous variables that could not be faithfully imputed (i.e., age). Finally, for a matter of data completeness, we focused our analyses on the WVS waves 3 to 6, ending up with a final sample of 195 914 respondents belonging to 62 countries. The list of countries (and their respective sample size) included in the final WVS dataset is available in the Supplementary Material.

Missing data. Multiple imputation techniques were used to preserve sample size and avoid biased estimations of model parameters. Twenty complete EVS datasets and 20 complete WVS datasets were generated by fully conditional specifications for categorical, ordinal and continuous data (i.e. predictive mean matching, logistic regression imputation, proportional odds model). The reader can find in the SM Tables S1 and S2 the percentages of imputed values by items, for each dataset.

Multivariate analyses. The EVS and WVS datasets were independently subjected to multivariate analyses through structural equation modelling (SEM). Structural equation models involve two major parts: a ‘measurement’ model and a ‘structural’ model. The measurement model consists in relating a number of directly observed variables – labelled ‘indicators’ – to a smaller set of hypothesized constructs – labelled ‘latent’ variables – presumed to cause the covariations among the indicators, hence reflecting a continuum that is not directly observable. The measurement model allows theoretical specification of latent variables as *a priori* hypotheses to be tested against the observed covariations of the data. The *a priori* assignment of each indicator to the theoretically specified latent variables leads to the reduction of the number of parameters estimated by the model, which is then expected to enhance the efficiency of parameter estimation. The ‘structural’ model consists in estimating a restricted set of *a priori* specified pathways between the latent variables identified by the measurement model. Therefore, SEM allows for the modelling of the covariations among all these factors by a theoretically driven model (17), a procedure particularly adapted for the purpose of the present study. For each dataset, three structural equation models were designed: **model 1** tested the **Hypotheses 1**, while **model 2.1** and **model 2.2** tested the **Hypothesis 2**.

Specification of the measurement model. For the EVS and the WVS models, the measurement part aims to represent *Religiosity*, *Social mistrust*, *Large-scale cooperation*, *Moralizing sexual promiscuity* and *Moralizing free-riding* as latent variables from several indicators. While the EVS dataset contains enough items to allow the modelling of *Social mistrust* as a latent construct as well, in the WVS data the number of items which could reflect interpersonal mistrust is smaller and the item reflecting general mistrust only provides a binary response. To overcome this limitation, we chose to model *Social mistrust* from the WVS data as a single composite variable (more details below). The full list of EVS and WVS indicators as well as their original scores are reported in SM Tables S1 and S2, and in the Supplementary Methods section. In addition, descriptive statistics of the indicators involved in the EVS and WVS models 1, 2.1 and 2.2 are available in the SM Tables S3.

Specification of the structural model. The structural part of the EVS and the WVS models 1 allows testing our hypothesis 1 by estimating two regression parameters representing the following direct associations: i) *Religiosity* and *Large-scale cooperation*, ii) *Religiosity* and *Social mistrust*. A covariance term was added in order to estimate the correlations between *Large-scale cooperation* and *Social mistrust*. Let’s now focus on the EVS and the WVS models 2.1 and 2.2. Their structural part allows testing

our hypothesis 2 by estimating three regression parameters representing the following direct associations: i) *Social mistrust* and *Religiosity*, ii) *Social mistrust* and *Moralizing sexual promiscuity/free-riding Religiosity*, iii) *Moralizing sexual promiscuity/free-riding* and *Religiosity*. In addition, the models allow the estimation of the indirect effect of *Social mistrust* on *Religiosity* via *Moralizing sexual promiscuity/free-riding*.

Religiosity. EVS models 1, 2.1 and 2.2. The latent variable reflecting the individuals' level of *Religiosity* was modelled from 6 indicators (SM Table S1) covering various aspects like ritualistic practices, commitment to religious faith, confidence into religious institutions, or beliefs in religious moral. **WVS models 1, 2.1 and 2.2.** Since religious moral beliefs item are not available in the WVS data, *Religiosity* is modelled as a latent variable involving the first 5 *Religiosity* items (WVS code: F028, E069_01, F034, A006, F063) used in the EVS models (SM Table S2).

Social mistrust. EVS models 1, 2.1 and 2.2. *Social mistrust* was modelled as a latent variable aiming to capture the covariations of two indicators (SM Table S1). The 1st indicator is labelled General mistrust, and expresses the sum of scores (z-transformed and then rescaled between 0 and 1) on the 3 general trust items classically reported in the social sciences literature. The 2nd indicator takes the form of a single composite variable aiming to quantify the number of social categories (up to 15) that the respondents would not like to have as neighbours. We labelled it the Interpersonal mistrust indicator, by opposition to the General mistrust indicator. Scores on the Interpersonal mistrust indicator is expressed in terms of the sum of positive answers on the 15 available social categories. **WVS models 1, 2.1 and 2.2.** In the WVS models, *Social mistrust* was measured as a single composite variable instead of a latent construct. The reason is that in the WVS, the only available general trust item involves a binary response. Since it is often difficult to handle binary measures with structural equation models which also involve ordinal and continuous measures (17), we opted for summing the binary General mistrust (z-) scores and the Interpersonal mistrust (z-) scores described above (SM Table S2). Note that in the WVS database, 6 social categories (instead of 15 in the EVS database) could be exploited to compute the Interpersonal trust score (i.e., 'People of different race', 'Heavy drinkers', 'Immigrants', 'People who have AIDS', 'Drug addicts', 'Homosexuals'). The sum of the general trust and the Interpersonal trust z-scores was then rescaled between 0 and 1. Greater scores on this single composite variable therefore indicate greater levels of mistrust.

Large-scale cooperation. EVS model 1. *Large-scale cooperation* was modelled as a latent variable aiming to capture the covariations of 6 indicators (SM Table S1). The 1st *Large-scale cooperation* indicator is Volunteering in collective activities, a single composite variable aiming to quantify the number of social groups or organizations for which the respondents freely dedicate time and energy without receiving any financial compensation (up to 15). The other 5 indicators reflect the respondents' involvement in several types of political actions. Item scores were coded such that greater scores indicate greater involvement in each type of political actions. Importantly, the Volunteering in collective activities indicators and the 5 Involvement in political actions indicators offer the advantage of tapping actual behaviours involving tangible costs for the agent and concrete benefits for others (21). Although these two measures are limited in their own way (for instance, many cooperative interactions happen outside the activities described in these items), they are the most concrete instances of true investment in collective goods available in the EVS and the WVS. **WVS model 1.** In the WVS sample, only 3 political actions indicators are available. The items used in the EVS to reconstruct the respondents' volunteering in collective activities are unfortunately empty of data. Therefore, *Large-scale cooperation* was modelled as a latent construct involving the 3 political actions indicators (SM Table S2).

Moralizing sexual promiscuity. EVS model 2.1. A number of recent studies suggest that religiosity might be primarily associated with a willingness to moralize behaviours deviating from sexual monogamy, but less with free-riding (for a recent review, see (16)). In line with these works, we model moralizing attitudes separately for promiscuous sexual behaviours and free-riding. *Moralizing sexual promiscuity* was hence modelled as a latent variable aiming to capture the covariations of 6 indicators (SM Table S1) reflecting the tolerance of the respondents when confronted to several practices. The 6 indicators' scores were coded such that greater scores indicate greater intolerance towards promiscuous sex. **WVS model 2.1.** In the WVS data set, the approach used to model moralizing attitudes towards sexual promiscuity was almost identical to the one described above (SM Table S2). The only difference is that in the WVS model, the *Moralizing sexual promiscuity* latent variable could only be captured from 4 instead of 6 indicators.

Moralizing free-riding. EVS model 2.2. *Moralizing free-riding* was modelled as a latent variable aiming to capture the covariations of 7 indicators (SM Table S1) reflecting the tolerance of the respondents when confronted to several free-riding behaviours. The 7 indicators' scores were coded such that greater scores indicate greater intolerance towards free-riding. **WVS model 2.2.** In the WVS data set, the *Moralizing free-riding* latent variable only involves 3 instead of 7 indicators (SM Table S2).

Covariates. The respondents' age at the time of the interview was used as the adjustment variable in each of the EVS and WVS models. Two reasons explain this choice. First, including too many covariates in a model often limits the interpretability of the results (28). Second, it decreases the parsimony of the model by artificially inflating its predictive value with factors which are somehow minimally relevant with regard to the purpose of the study. Introducing the age of the respondents as the adjustment variable is nevertheless necessary as its effects on religiosity (15), prosocial behaviours (29) or moralizing attitudes (30) are well-documented. Each effect estimated by the models was therefore adjusted for the respondents' age.

Assessing models' fit. To overcome issues of sample size dependency of the χ^2 fit metrics, together with the non-normality of our datasets (see SM Tables S5 and S6 for descriptive statistics), we opted for a weighted-least squares estimator (WLSMV) and report the χ^2 , *CFI*, *RMSEA* and *SRMR* statistics corrected by a scaling factor which compensates for the average kurtosis of the data (31). A model's fit is generally considered excellent when the *RMSEA* is close to 0.05, the *CFI* close to 0.95 and *SRMR* close to 0.08.

Fit indices and parameter estimates. The fit indices and parameter estimates reported in the main text and in the SM are the average of the 1000 iterations that have been set for cross-validating a model. The scaled versions of the chi-squared, the *CFI*, the *RMSEA* (and the 95% confidence intervals) and of the *SRMR* statistics are labelled as follows: χ^2 .scaled, *CFI*.scaled, *RMSEA*.scaled [CI.lower; CI.upper], *SRMR*.scaled. The unstandardized values of the indicators' loadings composing the latent variables, the regression coefficients characterizing the associations between the latent/composite variables, and the residual covariance of variables are labelled *P.unstd*. The standardized versions of these parameters are labelled *P.std*. We also report under the χ label the value of the Wald test (and its *p* value) – the ratio between the parameter value and its standard error – as an indicator of the simple effect size and statistical significance. The observed and model-implied (fitted) correlation matrices averaged on the 1000 iterations of each model can be found at the end of the present Supplementary Material file in the SM Tables S6, S7 and S8.

Testing the predictive accuracy of the models using *k*-fold cross-validation. One of the main advantages of structural equation modelling is that it is a statistical technique specifically designed to account for complex, multivariate data. Yet, this advantage can become its greater limitation.

The inherent complexity of SEMs (high number of fitted parameters) often increases the risk of overfitting. Overcoming this risk and ensuring the capacity of a SEM to predict new, out-of-sample data is therefore necessary to ensure its validity (32). Yet, this task is more than rarely achieved in practice (32-24). The present study takes up this challenge by using a stratified k -fold cross-validation methods (35). Cross validation allows to assess the predictive performance of the models and to judge how they perform outside the sample to a new dataset. The motivation to use cross validation techniques is that when a model is fitted, it is fitted to a training dataset. Without cross validation one can only have information on how does the model perform to the in-sample data. Ideally, one would like to see how the model perform in terms of accuracy of its predictions when one have a new dataset. In brief, for a given model:

1. The full data set (either the EVS or the WVS datasets, depending on the model) is first randomly partitioned into 10 folds of nearly equal size.
2. Subsequently 10 iterations of training and validation are performed such that within each iteration a different fold of the data is held-out for validation (the *test data*: here representing 10% of the whole sample) while the remaining $k-1$ folds are used for fitting (the *training data*, here representing 90% of the whole sample).
3. At each iteration, the model-implied covariance matrix estimated from the training data is compared to the covariance matrix directly observed in the test data. The smaller the difference between the two matrices, the greater the predictive power of the training model. Matrix comparison is achieved by means of a weighted-least square discrepancy function F , defined as a weighted sum of squared residuals (36). To calculate F , we use the weight matrix exploited by the WLSMV estimator to fit the training dataset. A F value of 0 indicates that the model and parameter estimates perfectly reproduce the real data. Hence, the closer to zero the F value, the greater the predictive power of the model. For facilitating the interpretation, the F value is converted into a χ^2 metric, which is then used to calculate the absolute fit index $RMSEA$ (using the degree of freedom of the test model and the sample size of the test dataset) (37).
4. The predictive value of the training model is further checked by applying the same cross-validation procedure on a test dataset whose individual values have been randomly permuted *within* each indicator. The aim is to check that the fitted values obtained from modelling the training data failed at predicting the test data when its internal structure is broken down by means of randomization. This procedure ultimately tests whether the latent structure hypothesized by our structural equation model is present or absent in the training samples. A *predictive accuracy ratio* is calculated by dividing the F values obtained from the cross-validation procedure applied on the *randomly permuted* test data by the F values obtained from the cross-validation procedure applied on the *real* test data. A ratio equal to 1 indicates that the predictive accuracy of the model is null, because it fits the *real* and the *randomly permuted* test datasets equally well. The more the ratio deviates positively from 1, the greater the predictive accuracy of the model. The mean and standard deviation of this ratio therefore provide standardized performance estimations allowing a direct comparison of the models' predictive accuracy.
5. At the end of the 10 iterations, the whole sample is reshuffled and re-stratified before a new round of 10 iterations starts.
6. The whole procedure is repeated 100 times (100 rounds of 10 iterations) in order to obtain reliable performance estimation (the mean and standard deviations across iterations of the predictive accuracy ratio). Note that at each iteration within a round, the training and the test datasets always include different data points.

Analytic plan. The analyses therefore comprise: i) the EVS and the WVS Models each fitted on 1000 training sets; ii) stratified k -fold cross-validation analyses testing the capacity of the training models to predict the test data; iii) stratified k -fold cross-validation analyses ensuring that the training models are unable to predict randomly permuted test data. All statistical analyses were carried out in R (<https://www.r-project.org/>) with R Studio. Missing data of the EVS and the WVS datasets were imputed using the R package *mice* (38). The EVS and WVS models were fitted using the R package *lavaan* (39) and the function *runMI* of the R package *semTools* (40) was used to pool the parameter estimates, the standard errors and the fit indices obtained for the 20 imputed datasets. The WLSMV estimator was used for its robustness to deviations from normality.

Data availability

The EVS and WVS data used in the present study are respectively available at <http://www.worldvaluessurvey.org/WVSDocumentationWVL.jsp> and at <https://dbk.gesis.org/dbksearch/sdesc2.asp?no=4804&db=e&doi=10.4232/1.12253>. The EVS and the WVS data used in the present study, the R codes developed to extract and pre-process the data, to perform multiple imputations, to fit and cross-validate the models on the imputed data files, as well as files containing all the results, are available at <https://osf.io/27rpg/>.

References

1. Baumard, N., Boyer, P. Explaining moral religions Trends Cogn Sci. **17**, 272-280 (2013).
2. McKay, R., Whitehouse, H. Religion and morality. Psychol Bull. **141**, 447-473 (2015).
3. Norenzayan, A., Shariff, A.F., Gervais, W.M., Willard, A.K., McNamara, R.A., Slingerland, E., Henrich, J. The cultural evolution of prosocial religions. Behav Brain Sci. **39**, e1 (2016).
4. Henrich J, Heine SJ, Norenzayan A. The weirdest people in the world? Behav Brain Sci. **33**, 61-83 (2010).
5. Turchin P. Warfare and the evolution of social complexity: A multilevel selection approach. Structure and Dynamics **4**, 1-37 (2011).
6. Wilson DS. Darwin's Cathedral: Evolution, religion, and the nature of society. University of Chicago Press (2003).
7. Whitehouse H, François P, Savage PE. et al. Complex societies precede moralizing gods throughout world history. Nature **568**, 226–229 (2019).
8. Johnson DDP, Bering JM. Hand of God, Mind of Man: Punishment and Cognition in the Evolution of Cooperation. Evol Psychol. **4**, 219–233 (2006).
9. Purzycki BG, Apicella C, Atkinson QD, et al. Moralistic gods, supernatural punishment and the expansion of human sociality. Nature **530**, 327-330 (2016).
10. Baumard N, Chevallier C. The nature and dynamics of world religions: a life-history approach. Proc Roy Soc B Biol Sci., **282**, 20151593 (2015)
11. Pazhoohi F, Lang M, Xygalatas D, Grammer K. Religious veiling as a mate-guarding strategy: Effects of environmental pressures on cultural practices. Evol Psychol Sci. **3**, 118-124 (2017).
12. Weeden J, Cohen AB, Kenrick DT. Religious attendance as reproductive support. Evol Hum Behav. **29**, 327-334 (2008).

13. Weeden J, Kurzban R. What predicts religiosity? A multinational analysis of reproductive and cooperative morals. *Evol Hum Behav.* **34**, 440-445 (2013).
14. Norris P, Inglehart R. Sacred and secular: Religion and politics worldwide. Cambridge University Press (2011).
15. Ruck DJ, Bentley RA, Lawson DJ. Religious change preceded economic change in the 20th century. *Sci Adv.* **4**, eaar8680 (2018).
16. Moon JM, Krems JA, Cohen AB, Kenrick DT. Is nothing sacred? Religion, sex, and reproductive strategies. *Curr Dir Psychol Sci.* **28**, 361-365 (2019).
17. Kline RB. Principles and Practice of Structural Equation Modeling, Fourth Edition. Guilford Publications (2015).
18. Inglehart R, Haerpfer C, Moreno-Alvarez A, et al. (Eds.). World Values Survey: All rounds-Country pooled datafile version. Madrid, Spain: JD Systems Institute. Retrieved from www.worldvaluessurvey.org/WVSDocumentationWVL.jsp (2014).
19. Inglehart R. Trust, well-being and democracy. In M. Warren (Ed.), *Democracy and Trust* (pp. 88-120). Cambridge: Cambridge University Press (1999).
20. Guiso L, Sapienza P, Zingales L. Does culture affect economic outcomes? *J Econ Perspect.* **20**, 23-48. (2006).
21. Lettinga N*, Jacquet PO*, André JB, Baumard N, Chevallier C. Environmental harshness is associated with lower investment in collective actions *BioRxiv* **663518** (2019).
22. Korndörfer M, Egloff B, Schmukle SC. A large scale test of the effect of social class on prosocial behavior. *PloS ONE* **10**, e0133193 (2015).
23. McCullough ME, Pedersen EJ, Schroder JM, Tabak BA, Carver CS. Harsh childhood environmental characteristics predict exploitation and retaliation in humans. *Proc Roy Soc B Biol Sci.* **280**, 20122104 (2013).
24. Safra L, Tecu T, Lambert S, Sheskin M, Baumard N, Chevallier C. Neighborhood deprivation negatively impacts children's prosocial behavior. *Frontiers in Psychology*, **7**, 1760 (2016).
25. Mell H, Baumard N, André JB. Time is money. Waiting costs explain why selection favors steeper time discounting in deprived environments. *EcoEvoRxiv* DOI: 10.32942/osf.io/7d56s (2019)
26. Belsky J, Schlomer GL, Ellis BJ. Beyond cumulative risk: distinguishing harshness and unpredictability as determinants of parenting and early life history strategy. *Dev. Psychol.* **48**, 662-673. (2012).
27. Kusawa CW, Adair L, Bechayda SA, Borja JRB, Carba DB, Duazo PL, Eisenberg DTA, Georgiev AV, Gettler LT, Lee NR, Quinn EA, Rosenbaum S, Rutherford JN, Ryan CP, McDade TW. Evolutionary life history theory as an organizing framework for cohort studies: insights from the Cebu Longitudinal Health and Nutrition Survey. *Ann Hum Biol.* **47**, 94-105 (2020).
28. Pearl J. Causality: models, reasoning, and inference. Cambridge, U.K.: Cambridge University Press (2009).
29. Freund AM, Blanchard-Fields F. Age-related differences in altruism across adulthood: making personal financial gain versus contributing to the public good. *Dev Psychol.* **50**, 1125-1136 (2014).
30. Truett KR. Age Differences in Conservatism *Pers Ind Diff.* **14**, 405-411 (1993).

31. Satorra A, Bentler PM. A scaled difference chi-square test statistic for moment structure analysis *Psychometrika* **66**, 507-514 (2001).
32. MacCallum RC, Roznowski M, Necowitz LB. Model modifications in covariance structure analysis: The problem of capitalization on chance. *Psychol Bull.* **111**, 490–504 (1992).
33. Breckler SJ. Applications of covariance structure modeling in psychology: Cause for concern? *Psychol Bull.* **107**, 260-273 (1990).
34. Whittaker TA., Stapleton LM. The Performance of Cross-Validation Indices Used to Select Among Competing Covariance Structure Models Under Multivariate Nonnormality Conditions. *Multivariate Behav Res.* **41**, 295-335 (2006).
35. Arlot S, Celisse A. A survey of cross-validation procedures for model selection. *Statistics Surveys* **4**, 40-79 (2010).
36. Browne MW, Cudeck R. Alternative ways of assessing model fit. *Sociol Methods Res.* **21**, 230-258 (1992).
37. Chen FF, Sensitivity of goodness of fit indexes to lack of measurement invariance. *Struct Equ Modeling* **14**, 464-504 (2007).
38. van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate imputation by chained equations in R. *J Stat Softw.* **45**, 1-67 (2011).
39. Rosseel Y. lavaan: An R package for structural equation modeling. *J Stat Softw.* **48**, 1-36 (2012).
40. Jorgensen TD, Pornprasertmanit S, Schoemann AM, Rosseel Y. semTools: Useful tools for structural equation modeling. R package version 0.5-0. Retrieved from <https://CRAN.R-project.org/package=semTools> (2018).
41. Li KH, Meng XL, Raghunathan TE, Rubin DB. Significance levels from repeated p-values with multiply-imputed data. *Statistica Sinica* **1**, 65-92 (1991).

Acknowledgements

We thank Jean-Baptiste André and Hugo Mercier for insightful conversations. P.O.J. was supported by ANR-10-LABX-0087 IEC and ANR-10-IDEX-0001-02 PSL*. C.F. was supported by a graduate research fellowship from the Direction Générale de l'Armement (2015-60-0041).

Author contributions

P.O.J., F.P., C.F., H.M., C.C. and NB designed the study. P.O.J. coded the R scripts. P.O.J. and F.P. checked the data. P.O.J. and C.F. analyzed the data. P.O.J. prepared the figures. P.O.J., F.P. and NB interpreted the results. P.O.J., F.P. and N.B. wrote the first draft of the manuscript. P.O.J., F.P., C.F., H.M., C.C. and NB revised the manuscript up to the final version. All authors gave final approval for publication.

Competing interests

The authors declare no competing interests.

Predictive modelling of religiosity, prosociality and moralizing in 295,000 individuals from European and non-European populations

Pierre O. Jacquet^{1,2*}, Farid Pazhoohi^{3*}, Charles Findling¹, Hugo Mell^{1,3}, Coralie Chevallier¹, Nicolas Baumard²

¹ LNC², Département d'études cognitives, École normale supérieure, INSERM, PSL Research University, 75005 Paris, France.

² Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL Research University, 75005 Paris, France.

³ Department of Psychology, University of British Columbia, 2136 West Mall, Vancouver, British Columbia, Canada V6T 1Z4.

Supplementary materials

1. [List of countries included in the EVS dataset \(N = 100 599\)](#)
2. [List of countries included in the WVS dataset \(N = 195 914\)](#)
3. [Detailed description of EVS and WVS items used the models](#)
4. [Detailed description of the indicators and scaling](#)
5. [Descriptive statistics of indicators used in the models](#)
6. [Measurement and structural parts estimated by the WVS models 1, 2.1, and 2.2.](#)
7. [SM Figure S1. WVS data. Measurement, structural models, and cross-validation.](#)
8. [Observed and model-implied \(fitted\) correlation matrices](#)
9. [References](#)

1. List of countries included in the EVS dataset (N = 100 599)

1. Albania (n = 1498)
2. Armenia (n = 1468)
3. Austria (n = 2991)
4. Belarus (n = 2444)
5. Belgium (n = 3395)
6. Bosnia Herzegovina (n = 1476)
7. Bulgaria (n = 2409)
8. Croatia (n = 2317)
9. Cyprus (n = 993)
10. Czech Republic (n = 3597)
11. Denmark (n = 1965)
12. Estonia (n = 2458)
13. Finland (n = 2084)
14. France (n = 3080)
15. Georgia (n = 1453)
16. Germany (n = 3765)
17. Great Britain (n = 2501)
18. Greece (n = 2560)
19. Hungary (n = 1506)
20. Iceland (n = 1728)
21. Ireland (n = 1362)
22. Italy (n = 2110)
23. Kosovo (n = 1543)
24. Latvia (n = 2494)
25. Lithuania (n = 2449)
26. Luxembourg (n = 2785)
27. Macedonia (n = 1484)
28. Malta (n = 2486)
29. Moldova (n = 1532)
30. Montenegro (n = 1485)
31. Netherlands (n = 2539)
32. Northern Cyprus (n = 488)
33. Northern Ireland (n = 1213)
34. Norway (n = 1080)
35. Poland (n = 2532)
36. Portugal (n = 2503)
37. Romania (n = 2520)
38. Russian Federation (n = 3945)
39. Serbia (n = 1458)
40. Slovakia (n = 2702)
41. Slovenia (n = 2328)
42. Spain (n = 2618)
43. Sweden (n = 2142)
44. Switzerland (n = 1236)
45. Turkey (n = 3215)
46. Ukraine (n = 3662)

2. List of countries included in the WVS dataset (N = 195 914)

1. Algeria (n = 2459)
2. Argentina (n = 4379)
3. Australia (n = 4914)
4. Azerbaijan (n = 3002)
5. Bangladesh (n = 3020)
6. Brazil (n = 4125)
7. Burkina Faso (n = 1450)
8. Canada (n = 4073)
9. Chile (n = 4197)
10. China (n = 6516)
11. Colombia (n = 7529)
12. Dominican Rep. (n = 409)
13. Ecuador (n = 1202)
14. Egypt (n = 5131)
15. El Salvador (n = 1246)
16. Ethiopia (n = 1500)
17. Ghana (n = 3080)
18. Guatemala (n = 1000)
19. Haiti (n = 1939)
20. Hong Kong (n = 2217)
21. India (n = 9878)
22. Indonesia (n = 2996)
23. Iran (n = 5168)
24. Iraq (n = 1200)
25. Japan (n = 5360)
26. Jordan (n = 3621)
27. Kazakhstan (n = 1500)
28. Kuwait (n = 1204)
29. Kyrgyzstan (n = 2543)
30. Lebanon (n = 1200)
31. Libya (n = 2100)
32. Malaysia (n = 2500)
33. Mali (n = 1401)
34. Mexico (n = 6562)
35. Morocco (n = 3600)
36. New Zealand (n = 2906)
37. Nigeria (n = 5750)
38. Pakistan (n = 3200)
39. Palestine (n = 1000)
40. Peru (n = 5366)
41. Philippines (n = 3600)
42. Puerto Rico (n = 1859)
43. Qatar (n = 1052)
44. Rwanda (n = 3034)
45. Saudi Arabia (n = 1479)
46. Singapore (n = 3449)
47. South Africa (n = 12419)
48. South Korea (n = 4844)
49. Taiwan (n = 3207)
50. Tanzania (n = 1143)
51. Thailand (n = 2718)
52. Trinidad and Tobago (n = 1999)
53. Tunisia (n = 1188)
54. Uganda (n = 1002)
55. United States (n = 6129)
56. Uruguay (n = 2997)
57. Uzbekistan (n = 1500)
58. Venezuela (n = 2397)
59. Vietnam (n = 2480)
60. Yemen (n = 984)
61. Zambia (n = 1489)
62. Zimbabwe (n = 2502)

3. Detailed description of EVS and WVS items used the models

The columns of the SM Tables S1 and S2 below feature, for the EVS and the WVS datasets respectively: 1) the variables' names reported in the odel; 2) their status in the models; 3) the indicators' names used in the models, 4) their names as EVS/WVS items, 5) their corresponding EVS/WVS codes, 6) their original scores (R indicates that scores were reversed), and 7) the percentages of imputed data by items.

SM Table S1. EVS. % of imputed values by variable (full data set)

Variable name	Variable status	Indicator name in the models	Original EVS items	EVS code	Score range	% imp. data
Religiosity	Latent	Religious services attendance	Religious services attendance	F028	1 to 8 R	0.86
		Confidence religious institutions	Confidence religious institutions	E069_01	1 to 4 R	3.19
		Religious person	Religious person	F034	1 to 3 R	5.13
		Value Religion	Value Religion	A006	1 to 4 R	1.38
		Value God	Value God	F063	1 to 8	2.80
		Moral beliefs	Belief in life after death	F051	0 to 1	15.68
			Belief in hell	F053	0 to 1	13.63
			Belief in heaven	F054	0 to 1	13.57
			Belief in sin	F055	0 to 1	9.24
			Belief in reincarnation	F057	0 to 1	15.86
		General mistrust	Most people can be trusted / Can't be too careful	A165	0 to 1	3.71
			Most people try to be fair	A168A	1 to 10 R	40.23
			People mostly try to be helpful	A168_01	1 to 10 R	39.54
			People with a criminal record	A124_01	0 to 1	1.22
			People of a different race	A124_02	0 to 1	1.32
			Heavy drinkers	A124_03	0 to 1	0.72
			Emotionally unstable people	A124_04	0 to 1	1.29
			Muslims	A124_05	0 to 1	2.66
			Immigrants	A124_06	0 to 1	1.50
			People who have AIDS	A124_07	0 to 1	1.37
			Drug addicts	A124_08	0 to 1	0.72
			Homosexuals	A124_09	0 to 1	1.07
			Jews	A124_10	0 to 1	1.30
			Gypsies	A124_17	0 to 1	1.29
Social mistrust	Latent	Interpersonal mistrust	Christians	A124_24	0 to 1	46.67
			Left wing extremists	A124_26	0 to 1	2.61
			Right wing extremists	A124_27	0 to 1	2.60
			People with large families	A124_28	0 to 1	1.07
			Social welfare organisation	A081	0 to 1	1.92
			Religious organisation	A082	0 to 1	1.33
			Cultural activities	A083	0 to 1	1.73
			Trade unions	A084	0 to 1	1.41
			Political parties / groups	A085	0 to 1	1.96
			Local community action	A086	0 to 1	1.95
			3rd world-development/ human rights	A087	0 to 1	1.95
			Environment, ecology, animal rights	A088	0 to 1	1.88
			Professional association	A089	0 to 1	1.88
			Youth work	A090	0 to 1	1.93
		Volunteering in collective activities	Sports/ recreation	A091	0 to 1	1.55
			Womens groups	A092	0 to 1	2.04
			Peace movement	A093	0 to 1	2.07
			Voluntary health organisations	A094	0 to 1	1.96
			Other groups	A096	1 to 3	2.90
			Political actions: Signing petition	E025	1 to 3 R	5.19
			Political actions: Joining boycotts	E026	1 to 3 R	7.15
			Political actions: Attending lawful demonstrations	E027	1 to 3 R	5.16
			Political actions: Joining unofficial strikes	E028	1 to 3 R	7.21
			Political actions: Occupying building or factories	E029	1 to 3 R	6.84
Moralizing free-riding	Latent	Justifiable: Claiming government benefits	Justifiable: Claiming government benefits	F114	1 to 10 R	2.01
		Justifiable: Avoiding a fare on public transport	Justifiable: Avoiding a fare on public transport	F115	1 to 10 R	16.54
		Justifiable: Cheating on taxes	Justifiable: Cheating on taxes	F116	1 to 10 R	1.58
		Justifiable: Someone accepting a bribe	Justifiable: Someone accepting a bribe	F117	1 to 10 R	0.99
		Justifiable: Joyriding	Justifiable: Joyriding	F125	1 to 10 R	0.65
		Justifiable: Lying	Justifiable: Lying	F127	1 to 10 R	1.04
		Justifiable: Paying cash in order to avoid taxes	Justifiable: Paying cash in order to avoid taxes	F131	1 to 10 R	3.44
Moralizing sexual promiscuity	Latent	Justifiable: Homosexuality	Justifiable: Homosexuality	F118	1 to 10 R	4.90
		Justifiable: Prostitution	Justifiable: Prostitution	F119	1 to 10 R	16.99
		Justifiable: Abortion	Justifiable: Abortion	F120	1 to 10 R	3.19
		Justifiable: Divorce	Justifiable: Divorce	F121	1 to 10 R	2.31
		Justifiable: Adultery	Justifiable: Adultery	F128	1 to 10 R	3.17
		Justifiable: Having casual sex	Justifiable: Having casual sex	F132	1 to 10 R	3.07
Age	Covariate	Age in year of the respondent	Age in year of the respondent	X003	-	0

SM Table S2. WVS. % of imputed values by variable (full data set)

Variable name	Variable status	Indicator name	Original WVS item	WVS code	Score range	% imp. data
Religiosity	Latent	Religious services attendance	Religious services attendance	F028	1 to 8 R	5.12
		Confidence religious institutions	Confidence religious institutions	E069_01	1 to 4 R	6.26
		Religious person	Religious person	F034	1 to 3 R	5.85
		Value Religion	Value Religion	A006	1 to 4 R	2.95
		Value God	Value God	F063	1 to 8	3.86
		General mistrust	Most people can be trusted / Can't be too careful	A165	0 to 1	4.59
Social mistrust	Single composite	Interpersonal mistrust	People of a different race	A124_02	0 to 1	4.04
			Heavy drinkers	A124_03	0 to 1	4.58
			Immigrants	A124_06	0 to 1	6.52
			People who have AIDS	A124_07	0 to 1	3.89
			Drug addicts	A124_08	0 to 1	3.83
			Homosexuals	A124_09	0 to 1	6.53
Large-scale cooperation	Latent	Political actions: Signing petition	Political actions: Signing petition	E025	1 to 3 R	13.18
		Political actions: Joining boycotts	Political actions: Joining boycotts	E026	1 to 3 R	15.38
		Political actions: Attending lawful demonstrations	Political actions: Attending lawful demonstrations	E027	1 to 3 R	14.09
Moralizing free-riding	Latent	Justifiable: Claiming government benefits	Justifiable: Claiming government benefits	F114	1 to 10 R	4.75
		Justifiable: Avoiding a fare on public transport	Justifiable: Avoiding a fare on public transport	F115	1 to 10 R	4.33
		Justifiable: Cheating on taxes	Justifiable: Cheating on taxes	F116	1 to 10 R	3.82
		Justifiable: Someone accepting a bribe	Justifiable: Someone accepting a bribe	F117	1 to 10 R	2.16
Moralizing sexual promiscuity	Latent	Justifiable: Homosexuality	Justifiable: Homosexuality	F118	1 to 10 R	8.49
		Justifiable: Prostitution	Justifiable: Prostitution	F119	1 to 10 R	15.50
		Justifiable: Abortion	Justifiable: Abortion	F120	1 to 10 R	4.92
		Justifiable: Divorce	Justifiable: Divorce	F121	1 to 10 R	2.82
Age	Covariate	Age in year of the respondent	Age in year of the respondent	X003	-	0

4. Detailed description of the indicators and scaling

Religiosity. EVS models 1, 2.1 and 2.2. The latent variable reflecting the individuals' level of *Religiosity* was modelled from 6 indicators (SM Table S1) covering various aspects like ritualistic practices, commitment to religious faith, confidence into religious institutions, or beliefs in religious moral. Indicators' scores were coded such that greater scores indicate greater levels of religiosity. The 1st *Religiosity* indicator is 'How often do you attend religious services?', with 8 possible answers from 'Never, practically never' to 'More than once a week'. The 2nd *Religiosity* indicator is 'How much confidence do you have in the Church?', with 4 possible answers from 'None at all' to 'A great deal'. The 3rd *Religiosity* indicator is 'Independently of whether you go to church or not, would you say you are a...', with 3 possible answers like 'Convinced atheist' or 'Religious person'. The 4th *Religiosity* indicator is 'How important is religion in your life?', with 4 possible answers from 'Not at all important' to 'Very important'. The 5th *Religiosity* indicator is 'How important is God in your life?', with 10 possible answers from 'Not at all important' to 'Very important'. Finally, the 6th *Religiosity* indicator is a single composite variable reflecting the religious moral beliefs of the respondents. It expresses the sum of scores obtained on 5 different items (1 if 'Yes', 0 if 'No'): 'Do you believe in life after death'; 'Do you believe in heaven'; 'Do you believe in hell'; 'Do you believe in sin'; 'Do you believe in reincarnation'. Greater scores therefore indicates stronger religious beliefs. **WVS models 1, 2 and 3.** Since items of religious moral beliefs are not available in the WVS data, *Religiosity* is modelled as a latent variable involving the first 5 *Religiosity* items used in the EVS models (SM Table S2).

Social mistrust. EVS models 1, 2.1 and 2.2. *Social mistrust* was modelled as a latent variable aiming to capture the covariations of two indicators (SM Table S1). The 1st indicator is labelled General mistrust, and expresses the sum of scores (z-transformed and then rescaled between 0 and 1) on the 3 general trust items classically reported in the social sciences literature. The 1st item is 'Most people can be trusted', with 2 possible answers: 'Most people can be trusted' and 'Cannot be too careful'. The 2nd item is 'Do you think most people try to take advantage of you if they got a chance, or would they try to be fair?', with 10 possible answers from 'Most people try to take advantage of me' to 'Most people try to be fair'. The 3rd item is 'Would you say that most of the time people try to be helpful or that they are mostly looking for themselves?', with 10 possible answers from 'People mostly look out for themselves' to 'People mostly try to be helpful'. Before being summed and z-transformed, item scores were recoded such that higher values reflect more mistrust. The 2nd indicator takes the form of a single composite variable aiming to quantify the number of social minorities (up to 15) that the respondents would not like to have as neighbours. We labelled it the Interpersonal mistrust indicator, by opposition to the General mistrust indicator. Fifteen social minorities are available in the EVS 3rd and 4th waves such like, among others, 'People with criminal records', 'People of different race', 'Heavy drinkers', or 'Immigrants'. Rejecting members of a social minority as potential neighbours is coded 1 (not expressing this wish is coded 0). Scores on the Interpersonal Mistrust indicator is expressed in terms of the sum of positive answers on the 15 available social categories. **WVS models 1, 2.1 and 2.2.** In the WVS models, *Social mistrust* was measured as a single composite variable instead of a latent construct. The reason is that in the WVS, the only available general trust item involves a binary response ('Most people can be trusted' vs 'Cannot be too careful'). Since it is often difficult to handle binary measures with structural equation models which also involve ordinal and continuous measures (1), we opted for summing the binary general trust (z-) scores and the Interpersonal trust (z-) scores described above (SM Table S2). Note that in the WVS database, 6 social minorities (instead of 15 in the EVS database) could be exploited to compute the Interpersonal trust score (i.e., 'People of different race', 'Heavy drinkers', 'Immigrants', 'People who have AIDS', 'Drug addicts', 'Homosexuals'). The sum of the general trust and the Interpersonal trust z-scores was then rescaled between 0 and 1. Greater scores on this single composite variable therefore indicate greater levels of mistrust.

Large-scale cooperation. EVS model 1. *Large-scale cooperation* was modelled as a latent variable aiming to capture the covariations of 6 indicators (SM Table S1). The 1st *Large-scale cooperation* indicator is Volunteering in collective activities, a single composite variable aiming to quantify the number of social groups or organizations for which the respondents freely dedicate time and energy without receiving any financial compensation (up to 15). Fifteen volunteering activities are reported in the EVS 3rd and 4th waves such like, among others, ‘Social welfare organization’, ‘Cultural activities’ or ‘Local community action’. Volunteering in one of those collective activities is coded 1, and not volunteering is coded 0. Scores on the Volunteering in collective activities indicator is expressed in terms of the sum of positive answers on the 15 available activities. The other 5 indicators reflect the respondents’ involvement in several types of political actions. Item scores were coded such that greater scores indicate greater involvement in each type of political actions. The interviewer asked to the respondent: ‘I’m going to read out some different forms of political action that people can take, and I’d like you to tell me, for each one, whether you have actually done any of these things, whether you would/might do it or would not/never, under any circumstances, do it/any of them’. Five actions were proposed: ‘Signing petitions’, ‘Joining boycotts’, ‘Attending lawful demonstrations’, ‘Joining unofficial strikes’, ‘Occupying building or factories’. For each action, the respondents could give one out of 3 possible answers: ‘Would never do’, ‘Might do’, ‘Have done’. Importantly, the Volunteering in collective activities indicators and the 5 Involvement in political actions indicators offer the advantage of tapping actual behaviours involving tangible costs for the agent and concrete benefits for others (2). Although these two measures are limited in their own way (for instance, many cooperative interactions happen outside the activities described in these items), they are the most concrete instances of true investment in collective goods available in the EVS and the WVS. **WVS model 1.** In the WVS model however, only 3 political actions indicators are available (‘Signing petition’, ‘Joining boycotts’, and ‘Attending lawful demonstrations’). The items used in the EVS to reconstruct the respondents’ volunteering in collective activities are unfortunately empty of data. Therefore, *Large-scale cooperation* was modelled as a latent construct involving the 3 political actions indicators (SM Table S2).

Moralizing sexual promiscuity. EVS model 2.1. A number of recent studies suggest that religiosity might be primarily associated with a willingness to police behaviours deviating from sexual moral, but less with cooperative moral (for a recent review, see (3)). In line with these works, we model policing attitudes separately for those targeting behaviours deviating for the cooperative moral and for those targeting behaviours deviating from the sexual moral. *Moralizing sexual promiscuity* was hence modelled as a latent variable aiming to capture the covariations of 6 indicators (SM Table S1) reflecting the tolerance of the respondents when confronted to several sexual behaviours. The interviewer asked to the respondents: ‘Please tell me for each of the following statements whether you think it can always be justified, never be justified, or something in between’. The 6 sexual behaviours to judge were: ‘Homosexuality’, ‘Prostitution’, ‘Abortion’, ‘Divorce’, ‘Adultery’, ‘Having casual sex’. Ten possible answers were available, from ‘Always justifiable’ to ‘Never justifiable’. The 6 indicators’ scores were coded such that greater scores indicate greater intolerance towards behaviours deviating from the sexual moral. **WVS model 2.1.** In the WVS data set, the approach used to model policing attitudes towards sexual behaviours was almost identical to the one described above (SM Table S2). The only difference is that in the WVS model, the *Moralizing sexual promiscuity* latent variable could only be captured from 4 instead of 6 indicators: ‘Homosexuality’, ‘Prostitution’, ‘Abortion’, ‘Divorce’.

Moralizing free-riding. EVS model 2.2. *Moralizing free-riding* was modelled as a latent variable aiming to capture the covariations of 7 indicators (SM Table S1) reflecting the tolerance of the respondents when confronted to several uncooperative behaviours. As for the uncooperative behaviours previously listed, the respondents were asked to say how much justifiable were behaviours deviating from the cooperative moral. The 7 uncooperative behaviours were: ‘Claiming

government benefits which you are not entitled to'; 'Avoiding a fare on public transport'; 'Cheating on taxes'; 'Someone accepting a bribe'; 'Joyriding' (stealing a car); 'Lying'; 'Paying cash in order to avoid taxes'. For each behaviour, the respondent could give 10 possible answers, from 'Always justifiable' to 'Never justifiable'. The 7 indicators' scores were coded such that greater scores indicate greater intolerance towards uncooperative behaviours. **WVS model 2.2.** In the WVS data set, the *Moralizing free-riding* latent variable only involves 3 instead of 7 indicators (SM Table S2). These indicators are: 'Avoiding a fare on public transport'; 'Cheating on taxes'; 'Someone accepting a bribe'.

5. Descriptive statistics of indicators used in the models

The SM Table S3 below shows the descriptive statistics of each indicator (after recoding and scaling) generated from the EVS and WVS items reported in the two tables above. Descriptive statistics are computed from the full EVS and WVS samples, that is, after multiple imputations but before their split into a training and a test datasets for cross-validation.

SM Table S3. Descriptive statistics. Full samples (EVS/WVS)

EVS	n total	mean	sd	median	min	max	range	skew	kurtosis	se
Religious services attendance	100 599	3.91	2.41	5.00	1.00	8.00	7.00	0.06	-1.47	0.01
Confidence religious institutions	100 599	2.62	0.98	3.00	1.00	4.00	3.00	-0.14	-0.99	0.00
Religious person	100 599	2.63	0.58	3.00	1.00	3.00	2.00	-1.34	0.81	0.00
Value Religion	100 599	2.62	1.05	3.00	1.00	4.00	3.00	-0.15	-1.17	0.00
Value God	100 599	6.29	3.25	7.00	1.00	10.00	9.00	-0.36	-1.27	0.01
Moral beliefs	100 599	2.32	1.76	2.15	0.00	5.00	5.00	0.01	-1.48	0.01
Interpersonal distrust	100 599	4.88	3.52	4.00	0.00	15.00	15.00	0.77	0.03	0.01
General distrust	100 599	0.59	0.25	0.62	0.00	1.00	1.00	-0.29	-0.74	0.01
Volunteering in collective activities	100 599	0.42	1.17	0.00	0.00	15.00	15.00	6.34	60.36	0.00
Political actions: Signing petition	100 599	2.07	0.81	2.00	1.00	3.00	2.00	-0.11	-1.47	0.00
Political actions: Joining boycotts	100 599	1.53	0.64	1.00	1.00	3.00	2.00	0.89	-0.25	0.00
Political actions: Attending lawful demonstrations	100 599	1.77	0.74	2.00	1.00	3.00	2.00	0.41	-1.10	0.00
Political actions: Joining unofficial strikes	100 599	1.31	0.54	1.00	1.00	3.00	2.00	1.67	1.95	0.00
Political actions: Occupying building or factories	100 599	1.18	0.43	1.00	1.00	3.00	2.00	2.47	5.75	0.00
How much justifiable: Claiming government benefits	100 599	8.75	2.05	10.00	1.00	10.00	9.00	-1.89	3.16	0.01
How much unjustifiable: Avoiding a fare on public transport	100 599	8.38	2.21	9.40	1.00	10.00	9.00	-1.52	1.68	0.01
How much unjustifiable: Cheating on taxes	100 599	8.59	2.21	10.00	1.00	10.00	9.00	-1.74	2.35	0.01
How much unjustifiable: Someone accepting a bribe	100 599	9.22	1.64	10.00	1.00	10.00	9.00	-2.62	7.14	0.01
How much unjustifiable: Joyriding	100 599	9.54	1.31	10.00	1.00	10.00	9.00	-3.73	15.56	0.00
How much unjustifiable: Lying	100 599	8.32	2.18	9.00	1.00	10.00	9.00	-1.34	1.15	0.01
How much unjustifiable: Paying cash in order to avoid taxes	100 599	7.96	2.51	9.00	1.00	10.00	9.00	-1.16	0.42	0.01
How much unjustifiable: Homosexuality	100 599	7.05	3.34	8.60	1.00	10.00	9.00	-0.70	-1.01	0.01
How much unjustifiable: Prostitution	100 599	8.36	2.31	9.95	1.00	10.00	9.00	-1.44	1.29	0.01
How much unjustifiable: Abortion	100 599	6.65	3.01	6.70	1.00	10.00	9.00	-0.42	-1.02	0.01
How much unjustifiable: Divorce	100 599	5.65	2.96	6.00	1.00	10.00	9.00	-0.02	-1.07	0.01
How much unjustifiable: Adultery	100 599	8.62	2.07	10.00	1.00	10.00	9.00	-1.61	2.04	0.01
How much unjustifiable: Having casual sex	100 599	7.95	2.63	9.00	1.00	10.00	9.00	-1.16	0.28	0.01
Age in year of the respondent	100 599	46.03	17.51	45.00	15.00	108.00	93.00	0.26	-0.88	0.06
WVS	n total	mean	sd	median	min	max	range	skew	kurtosis	se
Religious services attendance	195 914	5.05	2.57	6.00	1	8	7	-0.46	-1.32	0.01
Confidence religious institutions	195 914	3.02	0.98	3.00	1	4	3	-0.59	-0.79	0.00
Religious person	195 914	3.69	0.54	4.00	2	4	2	-1.59	1.63	0.00
Value Religion	195 914	3.29	0.97	4.00	1	4	3	-1.11	0.01	0.00
Value God	195 914	8.34	2.61	10.00	1	10	9	-1.55	1.30	0.01
Social distrust	195 914	0.57	0.23	0.59	0	1	1	-0.41	-0.28	0.00
Political actions: Signing petition	195 914	1.78	0.75	2.00	1	3	2	0.45	-1.13	0.00
Political actions: Joining boycotts	195 914	1.44	0.60	1.00	1	3	2	1.22	0.57	0.00
Political actions: Attending lawful demonstrations	195 914	1.59	0.67	1.40	1	3	2	0.82	-0.41	0.00
How much unjustifiable: Claiming government benefits	195 914	8.35	2.50	10.00	1	10	9	-1.59	1.56	0.01
How much unjustifiable: Avoiding a fare on public transport	195 914	8.50	2.38	10.00	1	10	9	-1.73	2.17	0.01
How much unjustifiable: Cheating on taxes	195 914	8.85	2.13	10.00	1	10	9	-2.17	4.17	0.00
How much unjustifiable: Someone accepting a bribe	195 914	9.12	1.91	10.00	1	10	9	-2.63	6.68	0.00
How much unjustifiable: Homosexuality	195 914	8.16	2.70	10.00	1	10	9	-1.38	0.77	0.01
How much unjustifiable: Prostitution	195 914	8.59	2.26	10.00	1	10	9	-1.74	2.30	0.01
How much unjustifiable: Abortion	195 914	8.23	2.51	10.00	1	10	9	-1.36	0.86	0.01
How much unjustifiable: Divorce	195 914	6.81	3.01	7.00	1	10	9	-0.51	-0.95	0.01
Age in year of the respondent	195 914	39.21	15.47	37.00	15	102	87	0.65	-0.31	0.03

6. Measurement and structural parts estimated by the WVS models 1, 2.1, and 2.2.

SM Table S4. Measurement and structural parts estimated by the WVS model 1, 2.1, and 2.2

a. Model 1. Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent variables	Indicators	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Religiosity	=~ Religious service attendance	1.560	0.006	279.464	< .001	1.549	1.572	0.598
		=~ Confidence in religious institutions	0.615	0.002	262.726	< .001	0.611	0.620	0.616
		=~ Religious person	0.359	0.002	216.644	< .001	0.356	0.363	0.655
		=~ Important in life: religion	0.799	0.002	344.746	< .001	0.795	0.804	0.821
	Large-scale cooperation	=~ Important in life: god	1.916	0.008	238.783	< .001	1.901	1.932	0.722
		=~ Signing petitions	0.592	0.002	278.955	< .001	0.587	0.596	0.754
		=~ Joining boycotts	0.449	0.002	237.666	< .001	0.446	0.453	0.710
Structural model	Social mistrust	~ Religiosity	0.040	0.001	58.109	< .001	0.038	0.041	0.166
	Large-scale cooperation	~ Religiosity	-0.168	0.003	-49.025	< .001	-0.175	-0.161	-0.166
Covariance	Social mistrust	~~ Large-scale cooperation	-0.037	0.001	-52.402	< .001	-0.038	-0.035	-0.157

b. Model 2.1. Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent variables	Indicators	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Moralizing sexual promiscuity	=~ Homosexuality	2.015	0.008	251.599	< .001	2.000	2.030	0.747
		=~ Prostitution	1.610	0.008	213.888	< .001	1.595	1.624	0.702
		=~ Abortion	1.981	0.007	267.018	< .001	1.966	1.995	0.795
		=~ Divorce	1.978	0.007	275.890	< .001	1.964	1.992	0.666
	Religiosity	=~ Religious service attendance	1.467	0.006	266.439	< .001	1.456	1.478	0.616
		=~ Confidence in religious institutions	0.571	0.002	250.782	< .001	0.566	0.575	0.625
		=~ Religious person	0.314	0.002	199.691	< .001	0.311	0.317	0.626
		=~ Important in life: religion	0.728	0.002	308.568	< .001	0.723	0.732	0.819
		=~ Important in life: god	1.739	0.008	232.016	< .001	1.723	1.753	0.718
Structural model	(a) Moralizing sex. prom.	~ Social mistrust	0.932	0.012	76.739	< .001	0.908	0.956	0.217
	(b) Religiosity	~ Moralizing sexual promiscuity	0.407	0.004	104.548	< .001	0.400	0.415	0.381
	(c) Religiosity	~ Social mistrust	0.388	0.013	30.277	< .001	0.363	0.413	0.085
	Indirect effect	:= a * b	0.380	0.006	60.219	< .001	0.367	0.392	0.083

c. Model 2.2. Parameter estimates and statistics (averaged on the 1000 iterations set for cross-validation)

Model part	Latent variables	Indicators	<i>P</i> .unstd	se	z	p-val	ci.lower	ci.upper	<i>P</i> .std
Measurement model	Moralizing free-riding	=~ Claiming government benefits	1.517	0.008	188.326	< .001	1.501	1.533	0.596
		=~ Avoiding a fare on public transport	1.674	0.008	215.426	< .001	1.659	1.690	0.693
		=~ Cheating on taxes	1.604	0.008	198.593	< .001	1.588	1.620	0.742
		=~ Someone accepting a bribe	1.305	0.008	156.730	< .001	1.289	1.321	0.677
	Religiosity	=~ Religious service attendance	1.560	0.005	293.301	< .001	1.550	1.570	0.607
		=~ Confidence in religious institutions	0.603	0.002	264.921	< .001	0.599	0.608	0.613
		=~ Religious person	0.357	0.002	224.368	< .001	0.354	0.361	0.661
		=~ Important in life: religion	0.780	0.002	344.555	< .001	0.776	0.784	0.813
		=~ Important in life: god	1.878	0.008	244.284	< .001	1.863	1.893	0.719
Structural model	(a) Moralizing free-riding	~ Social mistrust	-0.017	0.012	-1.509	=0.149	-0.039	0.005	-0.004
	(b) Religiosity	~ Moralizing free-riding	0.045	0.003	15.638	< .001	0.039	0.050	0.044
	(c) Religiosity	~ Social mistrust	0.710	0.012	58.384	< .001	0.686	0.734	0.167
	Indirect effect	:= a * b	-0.001	0.001	-1.522	=0.146	-0.002	0.000	-0.000

SM Table S4. Measurement and structural parts of a. WVS model 1, b. WVS model 2.1, c. WVS model 2.2. The unstandardized and standardized values of the indicators' loadings composing the latent variables (denoted =~), the regression coefficients characterizing their associations (denoted ~), and the residual covariances (denoted ~~) are labelled *P*.unstd and *P*.std, respectively. We also report under the $\hat{\chi}$ label values of Wald tests (and their p values) as indicators of simple effect sizes.

7. SM Figure S1. WVS data. Measurement, structural models, and cross-validation.

SM Figure S1. Measurement and structural models. **a.** WVS model 1, **b.** WVS model 2.1, **c.** WVS model 2.2. Standardized parameter values estimated by the structural equation models applied on the training dataset (90% of the full sample) and averaged on the 1000 iterations set for cross-validation. Ellipses represent latent variables, rectangles represent their indicators. In the WVS model, social mistrust is modeled as a single composite variable, here represented by a rectangle. Paths between the indicators and the latent variables represent factor loadings. Note that all indicators and the single composite variable 'Social mistrust' are regressed against the covariate 'age of the respondent'. Significant paths at the 5% level are represented with bold arrows. **d. Cross-validation.** Distributions of predictive accuracy ratios obtained from the stratified 10-folds cross-validation of the WVS model 1, 2.1 and 2.2 (10*100 rounds in total for each model).

8. Observed and model-implied (fitted) correlation matrices

SM Table S6. Model 1. Observed and model-implied correlation matrices. Training data (EVS/WVS)

EVS. Observed		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.54	1.00													
Religious person	3	0.50	0.51	1.00												
Value Religion	4	0.59	0.59	0.56	1.00											
Value God	5	0.59	0.61	0.66	0.70	1.00										
Moral beliefs	6	0.48	0.48	0.47	0.52	0.61	1.00									
Interpersonal mistrust	7	0.10	0.13	0.10	0.14	0.15	0.12	1.00								
General mistrust	8	0.05	0.02	0.06	0.09	0.10	0.08	0.20	1.00							
Volunteering in collective activities	9	0.06	0.00	0.01	0.02	0.00	-0.01	-0.05	-0.11	1.00						
Political actions: Signing petition	10	-0.09	-0.17	-0.12	-0.15	-0.18	-0.10	-0.21	-0.17	0.15	1.00					
Political actions: Joining boycotts	11	-0.10	-0.12	-0.12	-0.12	-0.14	-0.08	-0.13	-0.12	0.12	0.50	1.00				
Political actions: Attending lawful demonstrations	12	-0.08	-0.13	-0.12	-0.12	-0.14	-0.09	-0.15	-0.12	0.13	0.51	0.52	1.00			
Political actions: Joining unofficial strikes	13	-0.10	-0.13	-0.12	-0.12	-0.14	-0.08	-0.10	-0.07	0.07	0.32	0.45	0.44	1.00		
Political actions: Occupying building or factories	14	-0.07	-0.11	-0.11	-0.08	-0.10	-0.05	-0.08	-0.02	0.06	0.24	0.36	0.34	0.52	1.00	
Age in year of the respondent	15	0.10	0.13	0.10	0.14	0.11	0.00	0.05	-0.02	-0.02	-0.09	-0.14	-0.12	-0.14	-0.13	1.00
EVS. Model-implied		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.51	1.00													
Religious person	3	0.50	0.52	1.00												
Value Religion	4	0.56	0.58	0.57	1.00											
Value God	5	0.62	0.64	0.62	0.70	1.00										
Moral beliefs	6	0.47	0.49	0.48	0.54	0.59	1.00									
Interpersonal mistrust	7	0.11	0.11	0.11	0.13	0.14	0.10	1.00								
General mistrust	8	0.08	0.08	0.08	0.08	0.09	0.08	0.20	1.00							
Volunteering in collective activities	9	-0.02	-0.02	-0.02	-0.03	-0.03	-0.02	-0.04	-0.03	1.00						
Political actions: Signing petition	10	-0.11	-0.11	-0.11	-0.12	-0.13	-0.09	-0.15	-0.11	0.11	1.00					
Political actions: Joining boycotts	11	-0.12	-0.13	-0.12	-0.14	-0.14	-0.10	-0.16	-0.11	0.12	0.49	1.00				
Political actions: Attending lawful demonstrations	12	-0.12	-0.12	-0.12	-0.14	-0.14	-0.10	-0.16	-0.11	0.12	0.49	0.53	1.00			
Political actions: Joining unofficial strikes	13	-0.10	-0.11	-0.10	-0.11	-0.12	-0.08	-0.13	-0.09	0.09	0.39	0.42	0.43	1.00		
Political actions: Occupying building or factories	14	-0.08	-0.09	-0.08	-0.09	-0.10	-0.06	-0.10	-0.07	0.07	0.31	0.33	0.34	0.27	1.00	
Age in year of the respondent	15	0.10	0.14	0.11	0.14	0.12	0.00	0.04	-0.03	0.01	-0.09	-0.14	-0.12	-0.15	-0.14	1.00
WVS. Observed		1	2	3	4	5	6	7	8	9	10					
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.40	1.00													
Religious person	3	0.42	0.38	1.00												
Value Religion	4	0.48	0.52	0.51	1.00											
Value God	5	0.40	0.41	0.54	0.60	1.00										
Political actions: Signing petition	6	-0.07	-0.14	-0.08	-0.17	-0.15	1.00									
Political actions: Joining boycotts	7	-0.03	-0.08	-0.06	-0.09	-0.11	0.50	1.00								
Political actions: Attending lawful demonstrations	8	0.00	-0.05	-0.02	-0.06	-0.04	0.46	0.51	1.00							
Social mistrust	9	0.09	0.08	0.08	0.17	0.14	-0.19	-0.09	-0.08	1.00						
Age in year of the respondent	10	-0.01	-0.04	-0.01	-0.05	-0.07	0.07	-0.01	-0.04	-0.04	1.00					
WVS. Model-implied		1	2	3	4	5	6	7	8	9	10					
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.37	1.00													
Religious person	3	0.39	0.40	1.00												
Value Religion	4	0.49	0.51	0.54	1.00											
Value God	5	0.43	0.45	0.47	0.60	1.00										
Political actions: Signing petition	6	-0.08	-0.08	-0.08	-0.11	-0.10	1.00									
Political actions: Joining boycotts	7	-0.07	-0.07	-0.08	-0.10	-0.08	0.53	1.00								
Political actions: Attending lawful demonstrations	8	-0.06	-0.06	-0.07	-0.08	-0.07	0.47	0.45	1.00							
Social mistrust	9	0.10	0.10	0.11	0.14	0.12	-0.14	-0.13	-0.11	1.00						
Age in year of the respondent	10	-0.02	-0.04	-0.01	-0.06	-0.07	0.08	-0.01	-0.05	-0.05	1.00					

SM Table S7. Model 2.1. Observed and model-implied correlation matrices. Training data (EVS/WVS)

EVS. Observed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Interpersonal mistrust	1	1.00														
General mistrust	2	0.20	1.00													
How much unjustifiable: Homosexuality	3	0.31	0.25	1.00												
How much unjustifiable: Prostitution	4	0.16	0.12	0.45	1.00											
How much unjustifiable: Abortion	5	0.17	0.14	0.51	0.39	1.00										
How much unjustifiable: Divorce	6	0.19	0.13	0.53	0.39	0.67	1.00									
How much unjustifiable: Adultery	7	0.06	0.04	0.25	0.40	0.32	0.33	1.00								
How much unjustifiable: Having casual sex	8	0.15	0.10	0.41	0.49	0.41	0.43	0.50	1.00							
Religious services attendance	9	0.10	0.05	0.24	0.23	0.34	0.29	0.17	0.24	1.00						
Confidence religious institutions	10	0.13	0.02	0.29	0.26	0.33	0.30	0.19	0.25	0.54	1.00					
Religious person	11	0.10	0.06	0.24	0.23	0.28	0.24	0.19	0.25	0.50	0.51	1.00				
Value Religion	12	0.14	0.09	0.30	0.28	0.37	0.32	0.22	0.29	0.59	0.59	0.56	1.00			
Value God	13	0.15	0.10	0.32	0.29	0.39	0.33	0.22	0.30	0.59	0.61	0.66	0.70	1.00		
Moral beliefs	14	0.12	0.08	0.21	0.19	0.31	0.25	0.15	0.19	0.48	0.48	0.47	0.52	0.61	1.00	
Age in year of the respondent	15	0.05	-0.02	0.16	0.12	0.13	0.14	0.12	0.24	0.10	0.13	0.10	0.14	0.11	0.00	1.00
EVS. Model-implied	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Interpersonal mistrust	1	1.00														
General mistrust	2	0.20	1.00													
How much unjustifiable: Homosexuality	3	0.20	0.13	1.00												
How much unjustifiable: Prostitution	4	0.17	0.12	0.42	1.00											
How much unjustifiable: Abortion	5	0.22	0.15	0.54	0.47	1.00										
How much unjustifiable: Divorce	6	0.21	0.15	0.51	0.45	0.58	1.00									
How much unjustifiable: Adultery	7	0.13	0.09	0.32	0.28	0.36	0.34	1.00								
How much unjustifiable: Having casual sex	8	0.18	0.11	0.43	0.38	0.48	0.46	0.30	1.00							
Religious services attendance	9	0.11	0.08	0.27	0.24	0.30	0.29	0.18	0.24	1.00						
Confidence religious institutions	10	0.12	0.08	0.28	0.24	0.31	0.30	0.19	0.26	0.52	1.00					
Religious person	11	0.11	0.07	0.26	0.23	0.30	0.28	0.18	0.24	0.50	0.51	1.00				
Value Religion	12	0.13	0.08	0.31	0.27	0.34	0.33	0.21	0.29	0.58	0.59	0.57	1.00			
Value God	13	0.14	0.09	0.33	0.29	0.37	0.35	0.22	0.30	0.62	0.64	0.61	0.70	1.00		
Moral beliefs	14	0.10	0.07	0.24	0.21	0.28	0.26	0.16	0.21	0.48	0.49	0.47	0.54	0.58	1.00	
Age in year of the respondent	15	0.04	-0.02	0.15	0.14	0.12	0.13	0.14	0.25	0.10	0.14	0.10	0.15	0.11	0.00	1.00
WVS. Observed	1	2	3	4	5	6	7	8	9	10	11					
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.40	1.00													
Religious person	3	0.42	0.38	1.00												
Value Religion	4	0.48	0.52	0.51	1.00											
Value God	5	0.40	0.41	0.54	0.60	1.00										
How much unjustifiable: Homosexuality	6	0.18	0.19	0.15	0.25	0.22	1.00									
How much unjustifiable: Prostitution	7	0.15	0.16	0.11	0.20	0.19	0.63	1.00								
How much unjustifiable: Abortion	8	0.22	0.23	0.19	0.30	0.28	0.51	0.57	1.00							
How much unjustifiable: Divorce	9	0.20	0.20	0.14	0.23	0.16	0.49	0.46	0.54	1.00						
Social mistrust	10	0.09	0.08	0.08	0.17	0.14	0.22	0.14	0.14	0.14	1.00					
Age in year of the respondent	11	-0.01	-0.04	-0.01	-0.05	-0.07	0.00	0.01	-0.01	-0.01	-0.04	1.00				
WVS. Model-implied	1	2	3	4	5	6	7	8	9	10	11					
Religious services attendance	1	1.00														
Confidence religious institutions	2	0.39	1.00													
Religious person	3	0.39	0.39	1.00												
Value Religion	4	0.50	0.51	0.51	1.00											
Value God	5	0.44	0.45	0.45	0.59	1.00										
How much unjustifiable: Homosexuality	6	0.18	0.19	0.19	0.24	0.21	1.00									
How much unjustifiable: Prostitution	7	0.17	0.17	0.18	0.23	0.20	0.52	1.00								
How much unjustifiable: Abortion	8	0.20	0.20	0.20	0.26	0.23	0.59	0.56	1.00							
How much unjustifiable: Divorce	9	0.16	0.17	0.17	0.22	0.19	0.50	0.47	0.53	1.00						
Social mistrust	10	0.10	0.11	0.11	0.14	0.12	0.16	0.15	0.17	0.14	1.00					
Age in year of the respondent	11	-0.01	-0.04	-0.01	-0.05	-0.07	0.00	0.01	-0.02	-0.01	-0.04	1.00				

SM Table S8. Model 2.2. Observed and model-implied correlation matrices. Training data (EVS/WVS)

EVS. Observed	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Interpersonal mistrust	1	1.00															
General mistrust	2	0.20	1.00														
How much justifiable: Claiming government benefits	3	0.02	-0.03	1.00													
How much unjustifiable: Avoiding a fare on public transport	4	0.02	0.00	0.32	1.00												
How much unjustifiable: Cheating on taxes	5	0.00	-0.01	0.45	0.41	1.00											
How much unjustifiable: Someone accepting a bribe	6	-0.01	-0.04	0.34	0.39	0.41	1.00										
How much unjustifiable: Joyriding	7	0.00	-0.01	0.31	0.31	0.30	0.41	1.00									
How much unjustifiable: Lying	8	0.04	0.00	0.33	0.44	0.46	0.45	0.32	1.00								
How much unjustifiable: Paying cash in order to avoid taxes	9	0.08	0.05	0.28	0.41	0.49	0.36	0.22	0.43	1.00							
Religious services attendance	10	0.10	0.05	0.05	0.11	0.09	0.07	0.02	0.15	0.13	1.00						
Confidence religious institutions	11	0.13	0.02	0.07	0.12	0.10	0.07	0.04	0.15	0.16	0.54	1.00					
Religious person	12	0.10	0.06	0.07	0.12	0.09	0.08	0.05	0.15	0.13	0.50	0.51	1.00				
Value Religion	13	0.14	0.09	0.08	0.16	0.14	0.11	0.06	0.20	0.19	0.59	0.59	0.56	1.00			
Value God	14	0.15	0.10	0.08	0.14	0.12	0.10	0.06	0.19	0.19	0.59	0.61	0.66	0.70	1.00		
Moral beliefs	15	0.12	0.08	0.03	0.06	0.05	0.05	0.01	0.10	0.11	0.48	0.48	0.47	0.52	0.61	1.00	
Age in year of the respondent	16	0.05	-0.02	0.13	0.21	0.15	0.13	0.11	0.18	0.15	0.10	0.13	0.10	0.14	0.11	0.00	1.00
EVS. Model-implied	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Interpersonal mistrust	1	1.00															
General mistrust	2	0.20	1.00														
How much justifiable: Claiming government benefits	3	0.01	0.00	1.00													
How much unjustifiable: Avoiding a fare on public transport	4	0.02	0.00	0.32	1.00												
How much unjustifiable: Cheating on taxes	5	0.02	0.00	0.35	0.43	1.00											
How much unjustifiable: Someone accepting a bribe	6	0.02	0.00	0.30	0.38	0.41	1.00										
How much unjustifiable: Joyriding	7	0.01	0.00	0.22	0.27	0.29	0.26	1.00									
How much unjustifiable: Lying	8	0.02	0.00	0.36	0.45	0.49	0.42	0.30	1.00								
How much unjustifiable: Paying cash in order to avoid taxes	9	0.02	0.00	0.33	0.41	0.44	0.39	0.28	0.46	1.00							
Religious services attendance	10	0.12	0.06	0.08	0.11	0.11	0.10	0.07	0.12	0.11	1.00						
Confidence religious institutions	11	0.12	0.07	0.09	0.12	0.12	0.10	0.07	0.13	0.11	0.51	1.00					
Religious person	12	0.12	0.07	0.08	0.11	0.11	0.10	0.07	0.12	0.11	0.50	0.51	1.00				
Value Religion	13	0.14	0.07	0.10	0.13	0.13	0.12	0.08	0.14	0.13	0.57	0.59	0.58	1.00			
Value God	14	0.15	0.08	0.10	0.13	0.14	0.12	0.09	0.15	0.13	0.62	0.63	0.62	0.71	1.00		
Moral beliefs	15	0.11	0.07	0.07	0.08	0.09	0.08	0.06	0.09	0.09	0.47	0.48	0.48	0.54	0.59	1.00	
Age in year of the respondent	16	0.05	-0.03	0.12	0.21	0.15	0.13	0.10	0.19	0.16	0.10	0.13	0.10	0.16	0.12	-0.01	1.00
WVS. Observed	1	2	3	4	5	6	7	8	9	10	11						
Religious services attendance	1	1.00															
Confidence religious institutions	2	0.40	1.00														
Religious person	3	0.42	0.38	1.00													
Value Religion	4	0.48	0.52	0.51	1.00												
Value God	5	0.40	0.41	0.54	0.60	1.00											
How much justifiable: Claiming government benefits	6	0.03	0.03	0.04	0.03	0.04	1.00										
How much unjustifiable: Avoiding a fare on public transport	7	0.01	0.03	0.01	0.01	0.01	0.47	1.00									
How much unjustifiable: Cheating on taxes	8	0.02	0.04	0.00	0.02	0.03	0.41	0.51	1.00								
How much unjustifiable: Someone accepting a bribe	9	-0.02	0.01	-0.01	0.00	0.03	0.39	0.44	0.60	1.00							
Social mistrust	10	0.09	0.08	0.08	0.17	0.14	-0.01	0.00	0.00	-0.01	1.00						
Age in year of the respondent	11	-0.01	-0.04	-0.01	-0.05	-0.07	0.07	0.09	0.08	0.08	-0.04	1.00					
WVS. Model-implied	1	2	3	4	5	6	7	8	9	10	11						
Religious services attendance	1	1.00															
Confidence religious institutions	2	0.37	1.00														
Religious person	3	0.40	0.41	1.00													
Value Religion	4	0.49	0.50	0.54	1.00												
Value God	5	0.44	0.44	0.48	0.59	1.00											
How much justifiable: Claiming government benefits	6	0.01	0.01	0.02	0.02	0.01	1.00										
How much unjustifiable: Avoiding a fare on public transport	7	0.02	0.02	0.02	0.02	0.02	0.42	1.00									
How much unjustifiable: Cheating on taxes	8	0.02	0.02	0.02	0.02	0.02	0.45	0.52	1.00								
How much unjustifiable: Someone accepting a bribe	9	0.02	0.02	0.02	0.02	0.02	0.41	0.48	0.51	1.00							
Social mistrust	10	0.10	0.10	0.11	0.14	0.12	0.00	-0.01	-0.01	-0.01	1.00						
Age in year of the respondent	11	-0.01	-0.03	-0.01	-0.06	-0.07	0.06	0.09	0.08	0.08	-0.04	1.00					

9. References

1. Kline, R.B. Principles and Practice of Structural Equation Modeling, Fourth Edition. Guilford Publications (2015).
2. Lettinga, N.*, Jacquet P.O.*, André, J.B., Baumard, N., Chevallier, C. Environmental harshness is associated with lower investment in collective actions BioRxiv **663518** (2019).
3. Moon, J.M., Krems, J.A., Cohen, A.B., Kenrick, D.T. Is nothing sacred? Religion, sex, and reproductive strategies. *Curr Dir Psychol Sci.* **28**, 361-365 (2019).